

System Calibration Guide

Agilent 4072A Advanced Parametric Tester

Agilent 4073A Ultra Advanced Parametric Tester

Edition 4



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Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition is published. No information is incorporated into a reprinting unless it appears as a prior update; the edition does not change when an update is incorporated.

The software revision code printed before the date indicates the version level of the software product at the time the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between product updates and manual updates.

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Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual may impair the protections provided by the equipment. In addition, it violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies, Inc. assumes no liability for customer's failure to comply with these requirements.

NOTE Agilent 4072A/4073A complies with INSTALLATION CATEGORY II for main input and INSTALLATION CATEGORY I for measurement input terminals, and POLLUTION DEGREE 2 defined in IEC 1010-1.

The 4072A/4073A is INDOOR USE product.

The 4072A/4073A is CLASS 1 LASER product based on IEC 825-1 optical wave:

AEL power is less than 0.2 mW.

Wavelength is 650 nm of continuous wave.

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 Agilent Technologies Sales and Service Office for services and repair to ensure that safety features are maintained.










DANGEROUS PROCEDURE WARNINGS

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

WARNING Dangerous voltages, capable of causing death, are 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 and potential for electrical shock. Do not touch terminals that have this symbol when instrument is on.
	Protective conductor terminal. It is intended for connection to an external protective conductor for protection against electric shock in case of a fault or the terminal of a protective earth electrode.
	Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.
	Alternating current.
	Direct current.
	Electrical shock.
	ON (Supply).
	OFF (Supply).
CAT1	Means INSTALLATION CATEGORY I. Measurement terminals on the testheads comply with INSTALLATION CATEGORY I.
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.
NOTE	The note sign denotes important information. It calls attention to a procedure, practice, condition or the like, which is essential to highlight.

Electrical Work Types

The definitions of electrical work types are as follows.

Work Type 3	Energized circuits are exposed and inadvertent contact with uninsulated energized parts is possible. Potential exposure does not exceed 30 Vrms, 42.4 Vpeak, 60 Vdc, and 240 VA.
Work Type 4	Energized circuits are exposed and inadvertent contact with uninsulated energized parts is possible. Potential exposure can exceed 30 Vrms, 42.4 Vpeak, 60 Vdc, 240 VA, or hazardous RF current.

In This Guide

This guide contains the Agilent 4072A/4073A performance verification information, which you use to calibrate and to confirm the measurement performance of the 4072A/4073A parametric testers for periodical maintenance or after servicing.

For information about servicing the 4072A/4073A, refer to the *Service Guide*.

Audience

This manual is intended for Agilent customer engineers or service personal who maintain and calibrate the 4072A/4073A.

Contents

Chapter 1 , “System-Level Calibration Service Overview” describes overview of the 4072A/4073A system-level calibration service.

Chapter 2 , “Operating Procedure” describes the procedures of the 4072A/4073A performance verification, voltage and resistance reference calibration (V/R calibration), and PG level calibration.

Chapter 3 , “Operating Theory” explains the theory of tests for the 4072A/4073A performance verification and V/R and PG level calibrations.

Appendix A , “Specifications” lists the specifications of the 4072A and 4073A.

Appendix B , “CMU Calibration” describes the procedures of the CMU calibrations.

Appendix C , “PG Skew Calibration” describes the procedures and theory of operation of the PG skew calibration.

Appendix D , “Error Messages” describes the error messages that may be returned when an error occurs during the 4072A/4073A operation.

Other Manuals

You can refer to the following manuals when you service the 4072A:

Agilent 4070 User’s Guide (Agilent part number E3102-90000)

Agilent 4070 Programming Guide for BASIC Users (Agilent part number E3102-90010)

Agilent 4070 Programming Reference for BASIC Users (Agilent part number E3102-90110)

Agilent 4070 Programming Guide for C Users (Agilent part number E3102-90020)

Agilent 4070 Programming Reference for C Users (Agilent part number E3102-90120)

Agilent 4070 Maintenance Guide (Agilent part number E3102-90200)

Agilent 4072A/4073A Service Guide (Agilent part number E3102-90500)

Agilent 4072A/4073A Installation Guide (Agilent part number E3102-90520)

Agilent 4072A/4073A Pre-Installation Guide (Agilent publication number 5968-4911E)

Agilent E3190A Operation Guide (Agilent part number E3190-90000)

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1 System-Level Calibration Service Overview

This chapter describes the features of the Agilent 4072A/4073A system-level calibration service, performance verification, the relation between system-level calibration and performance verification, operating conditions, and required test equipment.

This chapter consists of the following sections:

- “System-Level Calibration Service for the Agilent 4072A/4073A”
- “Performance Verification for the Agilent 4072A/4073A”
- “Operating Conditions”
- “Required Equipment”

NOTE System-level calibration must be performed by Agilent customer engineers or service personnel trained for maintaining and calibrating the 4072A/4073A.

System-Level Calibration Service for the Agilent 4072A/4073A

Agilent customer engineers or service personnel perform the following functions in the system-level calibration service.

- Evaluate the tester performance.
- Calibrate the voltage and resistance references. If the 4072A/4073A is equipped with pulse sources, PG level calibration is executed.
- Print out the test data.
- Issue the calibration certificate.

The customer can trust the 4072A/4073A tester to perform the system-level calibration service.

NOTE Agilent Technologies recommends that the system-level calibration service is performed at least *once a year*.

Definition of System-Level Calibration

The system-level calibration service includes all procedures for traceability to national standards. It also guarantees that the 4072A/4073A tester satisfies commercial specifications.

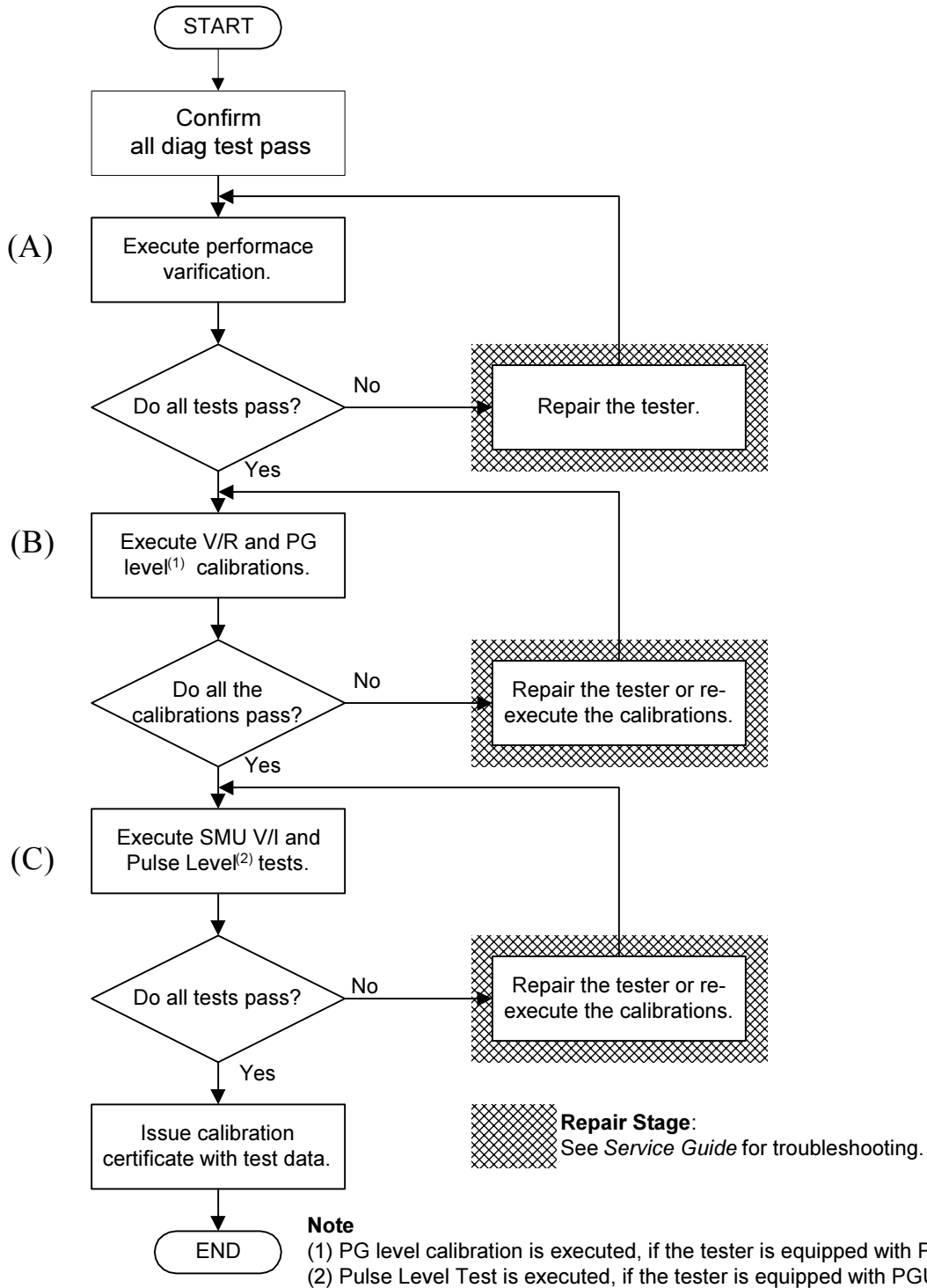
NOTE Agilent E3102A/E3103A option SP1 (Agilent E4411B) is not included in the system-level calibration. If you execute performance verification for the E4411B, send it to the Agilent service center.

System-Level Calibration Flow

You must perform the system-level calibration service using the following procedures.

1. Confirm the all diagnostic test pass.
2. Execute the performance verification program (PV4070).
3. Print out the performance verification data.
4. If PV4070 fails, contact the tester administrator to report the defect. If the tester administrator decides that the tester needs to be repaired, repair the tester and retry PV4070 until all tests pass. To repair the tester, see the *Service Guide* for troubleshooting information.
5. Calibrate the voltage and resistance references on the high-resolution ADC board (V/R calibration).
6. If the 4072A/4073A is equipped with pulse sources, execute the PG level calibration.
7. Execute the SMU Voltage Force and Measurement Test and the SMU Current Force and Measurement Test to verify the V/R calibration.
8. If the SMU tests fail, repair the tester or re-execute the V/R calibration and retry the SMU tests until all tests pass.
9. If the 4072A/4073A is equipped with pulse sources, execute the Pulse Level Test.
10. If the Pulse Level Test fails, repair the tester or re-execute the PG level calibration and retry the Pulse Level Test until it passes.
11. Print out the SMU tests data.
12. If the 4072A/4073A is equipped with pulse sources, print out the test results of the Pulse Level Test.
13. Issue the calibration certificate with the test data.

Figure 1-1 System-Level Calibration Flow



In the system calibration flow, you execute the PV4070 at least three times as the designations (A), (B), and (C) in figure 1-1. Table 1-1 shows the necessary test items of the PV4070 for each stage. "Yes" in the table shows that the test item is necessary for that stage. Chapter 2 provides information on how to execute the tests.

Table 1-1 Calibration Stage and Test Items of PV4070

Test Items	Stage (A)	Stage (B)	Stage(C)
Measurement pin location test	Yes		
Residual resistance test	Yes		
Isolation and offset current test	Yes		
GNDU output voltage test	Yes		
SMU voltage force and measurement test	Yes		Yes
SMU current force and measurement test	Yes		Yes
SMU output resistance test	Yes		
CMU capacitance and conductance (C-G) test	Yes		
CMU DC bias output voltage test	Yes		
DVM differential voltage measurement test	Yes		
Pulse switch test	Yes		
Pulse level test	Yes		Yes
Pulse parameter test	Yes		
Calibration for voltage references		Yes	
Calibration for resistance references		Yes	
PG level calibration		Yes	

Estimated Time

The system-level calibration service takes about 5 hours, including:

- 1 hour for preparation, including instrument warm-up.
- 45 minutes to 2 hours for executing the performance verification.
- 0.5 hours for the V/R and PG level calibrations.
- 0.5 hours for verifying the V/R and PG level calibrations.
- 0.5 hours for developing the calibration certificate.

Performance Verification for the Agilent 4072A/4073A

The performance verification evaluates the tester performance, and compares it against commercial specifications. It is the most important step in the system-level calibration service.

The performance verification is required when you perform the system-level calibration service or when you repair a part of the tester that is related to the tester performance. For example, if you repair the SMU, you must then perform the SMU voltage and current test.

Performance Verification Program

The PV4070 program has a graphical user interface (GUI), and can perform the performance verification semi-automatically. After the performance verification, the test data is stored in a text file that is formatted by the quick formatter (VIEW4070). You can easily print out the test data by using the quick formatter. PV4070 is included in the 4070 system software.

PV4070 executes several tests as shown in chapters 2 and 3, checks if the test (measured) data is within the test limits, and finally returns a PASS or FAIL result.

When all the tests pass, PV4070 returns the PASS result, which means that the 4072A/4073A satisfies commercial specifications. When any tests fail, PV4070 returns the FAIL result, which means that the 4072A/4073A does not satisfy commercial specifications completely.

Voltage and Resistance References Calibration

The V/R calibration confirms and calibrates the voltage and resistance references on the high-resolution ADC board. After the confirmation and calibration, the calibrated values and the calibration date are stored in EEPROM on the high-resolution ADC board.

The V/R calibration program is included and can execute in PV4070.

PG Skew and Level Calibration

The PG skew calibration gets the skew compensation data to synchronize the pulse timing from all the PGUs. The compensation data is kept in the `/etc/opt/hp4070/skewdata` file. The PG skew calibration program is included and can execute in the PV4070.

The PG level calibration gets the level compensation data for the output voltage over ± 16 V from the PGUs. The compensation data is kept in the `/etc/opt/hp4070/pgcaldata` file. The PG level calibration program is included and can execute in the CAL4070. The CAL4070 can be executed in the PV4070 main page, too.

Quick Formatter

You can print out and reformat the performance verification data easily by using the quick formatter (VIEW4070). To execute the quick formatter, see "Reporting Test Results" in chapter 2 for details. VIEW4070 is included in the 4070 system software.

Operating Conditions

Before the performance verification, you must perform or confirm the following items:

- Perform the system-level calibration service in an ambient temperature of $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and humidity between 5% and 70% (for 4072A) or 5% and 60% (for 4073A), to keep measurement uncertainties.
- Temperature changes after the SMU self-calibration must be less than 3°C .
- Allow the 4072A/4073A to warm up and stabilize for at least 40 minutes, to ensure proper tester performance.
- The diagnostics (DIAG4070) must be executed in manual mode, by using the PV Open Fixture. All tests of DIAG4070 must pass. To execute DIAG4070, see the *Maintenance Guide* and *Service Guide* for details.
- At least 12 pin boards must be installed in the testhead. The pin board locations are slots 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, and 48.
- Allow the Agilent 54750A/54751A or the Agilent 86100A/86112A to warm up and stabilize at least one hour.
- Allow the Agilent 3458A to warm up and stabilize at least one hour, then perform ACAL.

NOTE The 3458A normally requires a warm up time of at least four hours. For this test, however, only one hour is required because the test limits of the 4072A/4073A performance verification include the error that would occur by using the shorter warm up time.

Required Equipment

To perform the system-level calibration service, prepare the test equipment as shown in table 1-2.

Table 1-2 Required Test Equipment for Performance Verification

Agilent Product Number / Option Number	Description	Quantity
16353A	Standard resistor set	1
16380A	Standard air capacitor set	1
16380C	Capacitance standard set	1
3458A	Digital multimeter	1
option 002	High stability and accuracy	1
54750A ^a	Oscilloscope mainframe	1
option 001 ^a	20 dB attenuator	1
54751A ^a	20 GHz vertical plug-in	1
86100A ^b	Infinium DCA oscilloscope mainframe	1
86112A ^b	Dual 20 GHz electrical channel plug-in	1
8493C	Coaxial fixed attenuator, dc to 26.5 GHz	1
option 020	20 dB attenuator	1
E3190A	PV tool set	1
option 001	Add pulse fixture	1

- a. The 54750A/54751A is discontinued on May 1, 2001. The 86100A/86112A/8493C is the replacement of the 54750A/54751A.
- b. The 86100A/86112A is supported on software revision B.03.01 and later.

Required Equipment

The E3190A PV Tool Set consists of the parts shown in table 1-3. See the *Agilent E3190A Operation Guide* for details.

Table 1-3 Contents of the Agilent E3190A

Agilent Product Number / Part Number	Description	Quantity
04142-61641	Triaxial cable	3
04155-65041	Calibration adapter	1
04155-65042	Shorting box for 04155-65041 calibration adapter	1
11058A	Banana-to-banana cable	2
1250-0595	Triaxial-to-BNC adapter	2
1250-0781	BNC-T adapter	3
1250-0929	BNC shorting cap	2
1250-2405	BNC-T (m-m-f) adapter	1
42037A	1 kohm standard resistor	1
8120-1840	BNC cable (120 cm)	2
E3190-60041	PV fixture adapter	1
E3190-60042	PV open fixture	1
E3190-60043	PV short fixture	1
E3190-60044	PV connection fixture	1
E3190-60045	Short adapter for extended path	1
E3190-60046	Shorting Box for C-STD Connection	1
E3190-60141	Carrying case	1
E3190-61641	Cable for C-STD connection	2
E3190-61603	BNC-to-banana cable	2

Table 1-4 Contents of the Agilent E3190A Option 001

Part Number	Description	Quantity
1250-1700	BNC-to-SMA adapter	1
1250-2405	BNC-T (m-m-f) adapter	1
E3190-60021	PV pulse fixture	1
E3190-60142	Carrying case	1
E3190-61611	BNC-to-SMA cable	1
E3190-61612	Trigger cable	1

NOTE The 54750A/54751A, the 86100A/86112A, the 3458A, the 16353A, the 16380A, and the 16380C must be calibrated at calibration facilities by instruments traceable to national standards. The 42037A, which is included in the E3190A, must also be calibrated. These equipment must be calibrated at least once a year.

2 Operating Procedure

This chapter provides preparation, test procedures, and result examples for using the performance verification program (PV4070). It also includes procedures for the voltage and resistance references calibration (V/R calibration), CMU error compensation, and PG skew calibration.

This chapter consists of the following sections:

- “Preparation”
- “Performance Verification”
- “Voltage and Resistance References Calibration (V/R Calibration)”
- “Measurement for PG Level Error Compensation Data”
- “Reporting Test Results”

Preparation

This section provides preparation for the performance verification and V/R calibration. Prepare the Agilent 4072A/4073A and other equipment according to the instructions in this section.

Conditions

Before the performance verification and V/R calibration are performed, you must confirm the conditions. See “Operating Conditions” in chapter 1 for details.

Changing the GPIB Address for the Agilent 3458A

If the DMM address for the PV is the same as the DVM address in the tester, change the DMM address for the PV by using the following procedure.

1. To confirm the current GPIB address, press: "blue key" and **Local**^{Address}.
2. To select the ADDRESS, press: "blue key", **Auto Cal**^C, $\uparrow \times 6$.
3. To enter the new address, press: **Enter**.
4. To reconfirm the GPIB address, press: "blue key" and **Local**^{Address}.

Performing the ACAL ALL for the Agilent 3458A

Perform ACAL ALL for the 3458A by using the following procedure.

1. To select ACAL ALL, press: **Auto Cal**, \uparrow .
2. To enter the secure code, if required, press: **, 3, 4, 5, 8** (factory default setting).
3. Press **Enter**.

The ACAL ALL for the 3458A takes about 15 minutes.

Confirming and Changing the GPIB Address Setting for the Agilent 54750A

If you do not know the GPIB address setting of the 54750A, and if you need to change the GPIB address setting, use the following procedure.

1. Press **Utility** key in the SYSTEM key group on the front panel of the 54750A. Then the utility menu is displayed on the screen.
2. Select the GPIB Setup . . . softkey. Then the current setting of the GPIB address is shown in the screen.
3. If you need to change the GPIB address setting, enter the numbers of the address and press **Enter** key. Then the GPIB address setting is changed.
4. To finish confirming or changing, select **Exit** softkey.

Preparation

Confirming and Changing the GPIB Address Setting for the Agilent 86100A

If you do not know the GPIB address setting of the 86100A, and if you need to change the GPIB address setting, use the following procedure.

1. Choose the **Utilities: Remote Interface...** menu in the menu bar of the 86100A. Then the Remote Interface window is displayed on the screen and shows the GPIB address.
2. If you need to change the GPIB address setting, scroll the GPIB address by using the allow keys in the Remote Interface window.
3. Click **Close**. Then the GPIB address is stored in the 86100A, and the Remote Interface window closes.

Starting PV4070

Execute PV4070 by using the following procedure. If an error message is displayed during PV4070 execution, proceed to the troubleshooting section in the *Service Guide*.

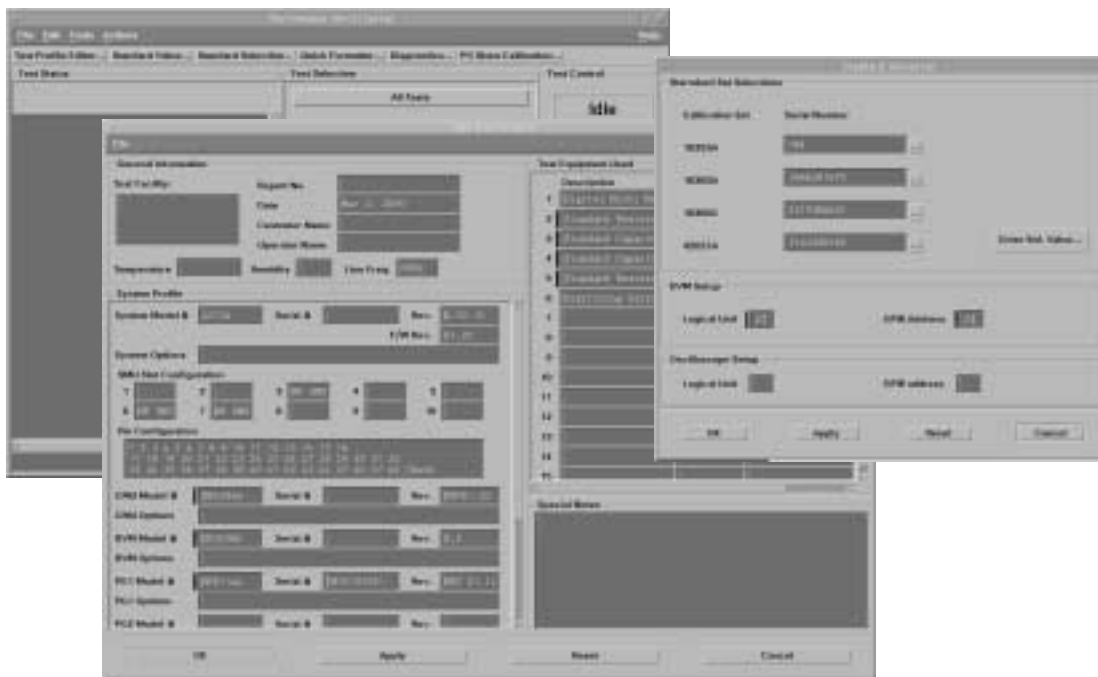
1. Turn the controller on and boot the HP-UX system.
2. Log in as any user.

NOTE All users can execute PV4070, if permission is not changed.

3. Execute PV4070.

 \$ pv4070 **Return.**

Figure 2-1 Performance Verification Window



Setting Up Test Equipment Configuration

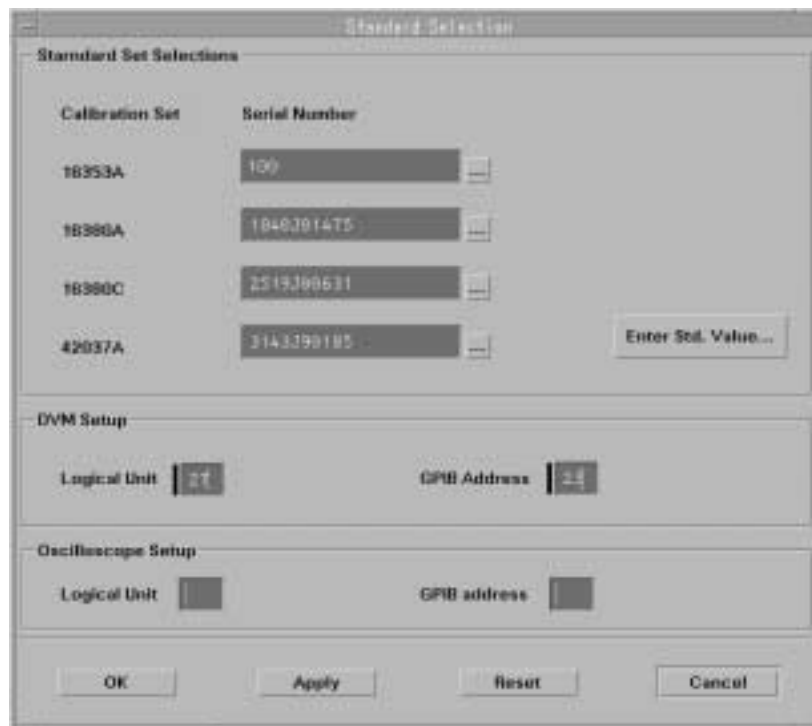
Selecting the Standards Used for the Performance Verification

Before performance verification, you must confirm or change the following items that are required for the tests.

- Agilent 16353A standard resistor set calibration values
- Agilent 16380A standard air capacitor set calibration values
- Agilent 16380C capacitance standard set calibration values
- Agilent 42037A 1 k Ω standard resistor calibration values
- Agilent 3458A DMM information (GPIB address)
- Agilent 54750A or Agilent 86100A oscilloscope information (GPIB address)

In the Standard Selection window, you can specify your standards by selecting their serial numbers, and also specify the GPIB addresses of the DMM and oscilloscope for PV.

Figure 2-2 Standard Selection Window

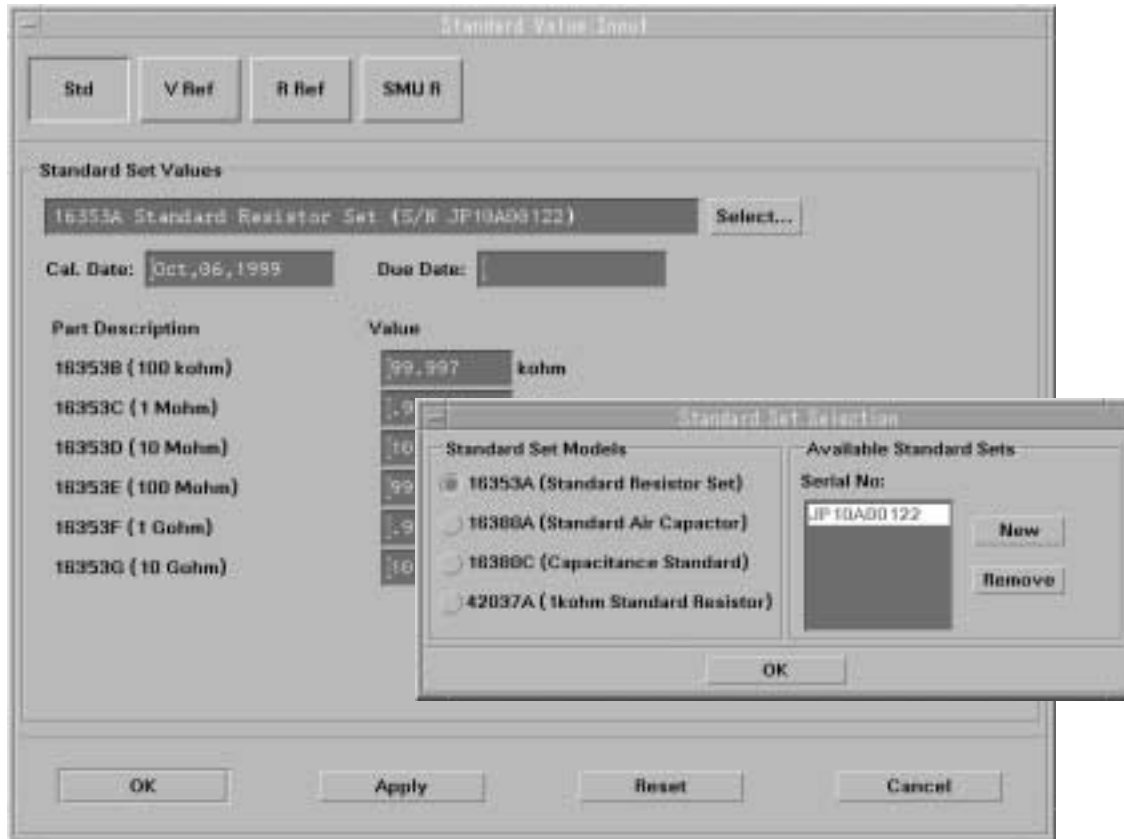


1. Click..., and select the serial number of your standards. Select all standards by using this procedure.
If you do not find the serial number of your standards, click **Enter Std. Value...** to create a new entry of your standards. See “Entering or Changing the Standard Values” on page 18.
2. Click **Enter Std. Value...** to confirm or change the current standard value setting. See “Entering or Changing the Standard Values” on page 18.
3. Enter the logical unit and GPIB address of the DMM (the 3458A) for PV.
4. Enter the logical unit and GPIB address of the 54750A or 86100A oscilloscope for PV, and click **OK**.

Preparation**Entering or Changing the Standard Values**

You can enter or change the current standard values in the Standard Value Input windows (figure 2-3):

Figure 2-3 Standard Value Input Window



You can also see the Standard Value Input window by clicking **Standard Value...** in the Performance Verification window.

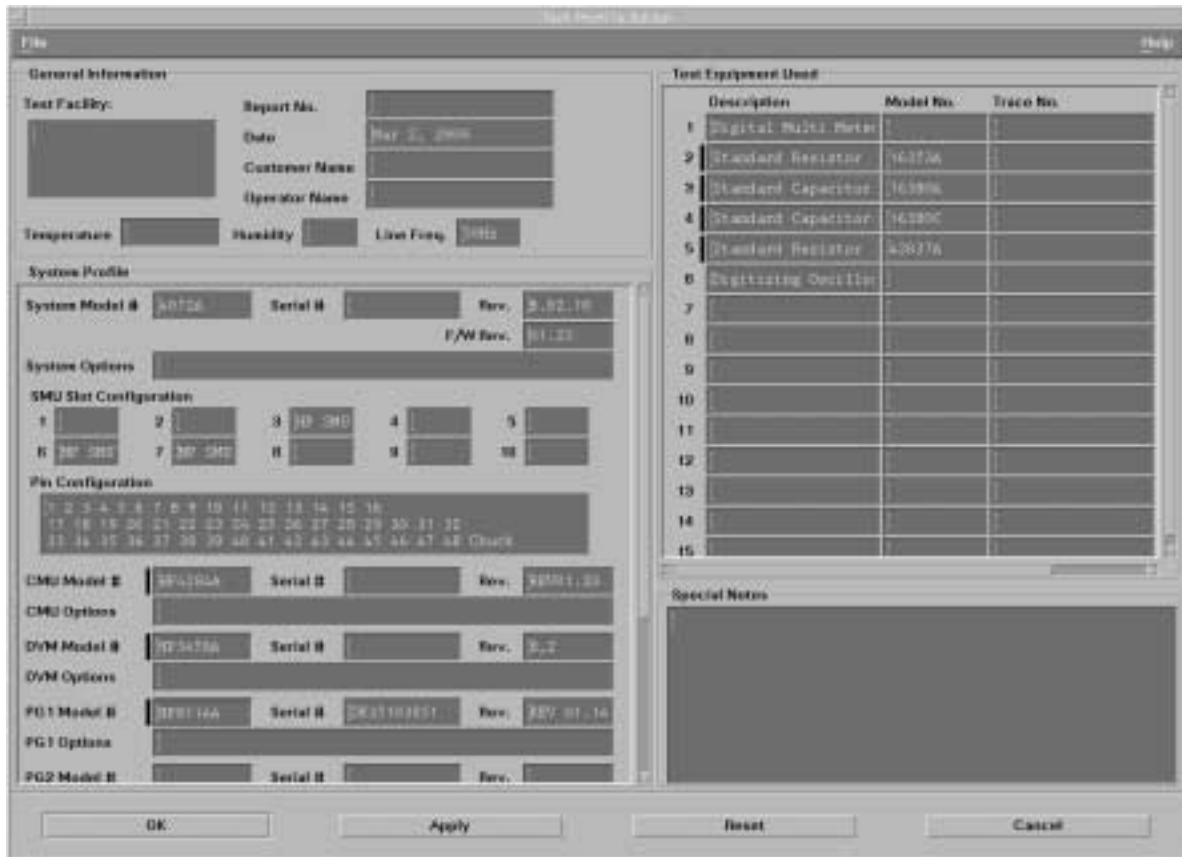
Use the following procedure to confirm and change the standard values.

1. Make sure that only the **Std** button is in the pressed position. The Standard Set Values area is shown in the Standard Values Input window.
2. Open the Standard Set Selection window by clicking **Select...** in the Standard Value Input window.
3. Select the model number for the standard set that you want to confirm or change. Then the registered serial numbers for the specified standards are shown in the Available Standard Sets area.
4. Select the serial number for your standard. If your standard's serial number is not shown in the Standard Set Selection window, click **New** to enter a new serial number for your standard.
5. After the selection or entry, click **OK**.
6. Confirm the standard values. If the values are not correct, change the values and click **Apply**.
7. Repeat step 2 to 6 to confirm all the standard values.
8. After entering all the standards values, click **OK**.

Setting Up Test Profile Data

Before performance verification, you must confirm or change the test profile data by using the test profile editor. This data is put in the header of the performance verification report. To confirm or to change the test profile data, click **Test Profile Editor...** in the performance verification window. You can see the detailed information of each item in the window by clicking the **Help: by Description...** menu.

Figure 2-4 Test Profile Editor Window



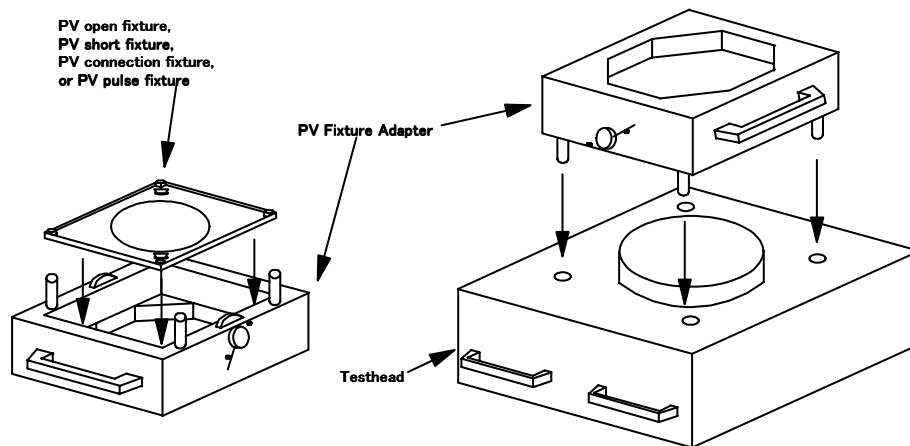
Preparation

Mounting Test Equipment on the Testhead

To mount the PV fixture adapter (E3190-60041), PV open fixture (E3190-60042), PV short fixture (E3190-60043), PV connection fixture (E3190-60044), and PV pulse fixture (E3190-60021) onto the testhead, use the following procedure.

1. Turn the test fixture and the PV fixture adapter upside down.
2. Position the test fixture in the PV fixture adapter and turn the black fasteners on the test fixture to lock the test fixture into the PV fixture adapter.
3. Turn the PV fixture adapter over again (topside up).
4. Position the PV fixture adapter on the testhead.
5. Push the front lever of the PV fixture adapter down to secure it on the testhead.

Figure 2-5 Mounting Test Equipment on the Testhead

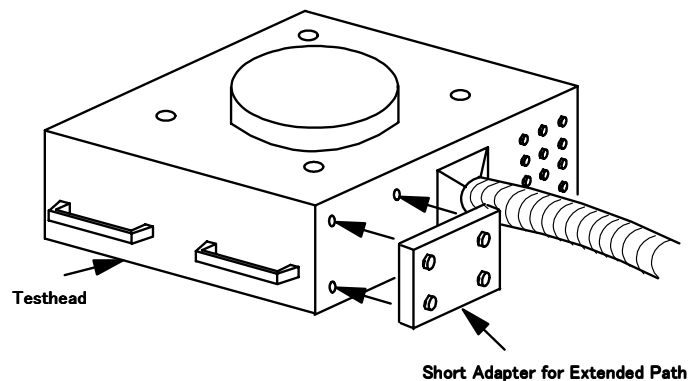


Installing Short Adapter for Extended Path

To install the short adapter for extended path (E3190-60045) onto the testhead, use the following procedure.

1. Position the short adapter for extended path on the side panel of the testhead.
2. Fasten the screws on the short adapter for extended path.

Figure 2-6 Installing Short Adapter for Extended Path

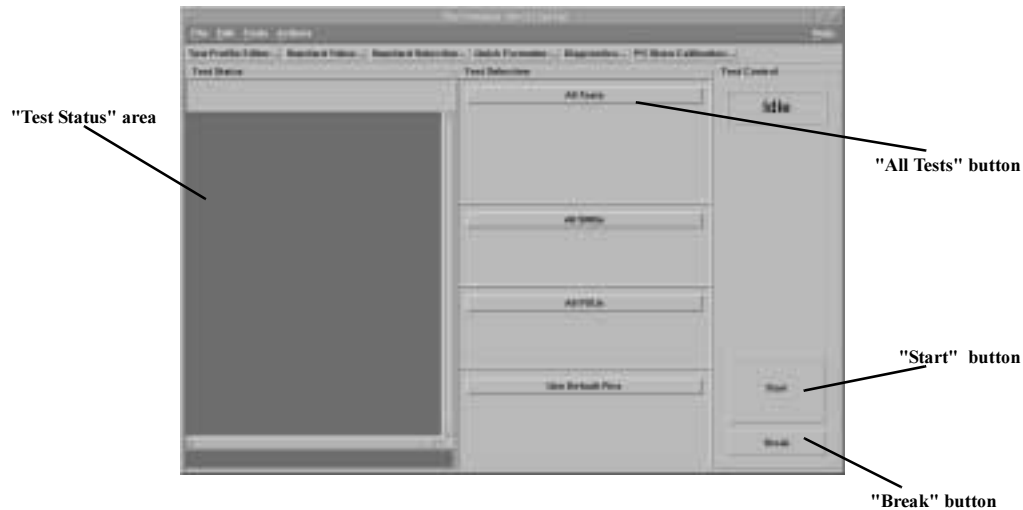


Performance Verification

This section provides procedures and required equipment for each performance verification test. Perform performance verification tests according to the instructions described in this section.

After setting up the preconditions for the performance verification execution, the main window of the Performance Verification appears as shown in figure 2-7

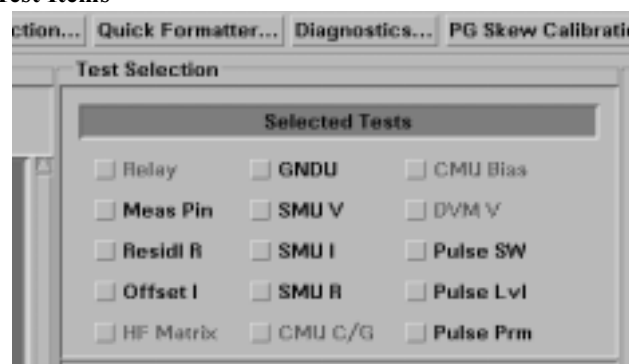
Figure 2-7 Performance Verification Main Window



When you execute the PV for system calibration service, use the test selection conditions above. All tests, all SMUs, all PGUs, and all the default pins are tested.

When you execute the PV for the performance confirmation after repair, you can select necessary tests by clicking the **All Tests** button. The button changes **Selected Tests** as shown in figure 2-8, and checked test items are actually executed.

Figure 2-8 Selecting Test Items



To start the tests, click the **Start** button. To abort the tests, click the **Break** button.

During the tests, the test status is shown in the **Test Status** area. The same status information is logged in the `/var/opt/hp4070/diag/log` file.

Test items in the PV4070

There are 14 test items in the PV4070 for the 4072A/4073A, as follows:

Meas Pin	“Measurement Pin Location Test”
Residl R	“Residual Resistance Test”
Offset I	“Isolation and Offset Current Test”
HF Matrix	“HF Matrix Relay Test”
GNDU	“GNDU Output Voltage Test”
SMU V	“SMU Voltage Force and Measurement Test”
SMU I	“SMU Current Force and Measurement Test”
SMU R	“SMU Output Resistance Test”
CMU C/G	“CMU Capacitance and Conductance (C-G) Test”
CMU Bias	“CMU dc Bias Output Voltage Test”
DVM V	“DVM Differential Voltage Measurement Test”
Pulse SW	“Pulse Switch Test”
Pulse Lvl	“Pulse Level Test”
Pulse Prm	“Pulse Parameter Test”

NOTE There is a dark test item **Relay** that you cannot check, because the Relay Test in the PV4070 is necessary only for the 4071A.

When the 4072A/4073A is not equipped with particular measurement resources such as CMU and DVM, the related test items are shown as dark items. For example, when no pulse generator is installed in the 4072A/4073A, the **Pulse SW**, **Pulse Lvl**, and **Pulse Prm** items are dark items.

Measurement Pin Location Test

The measurement pin location test confirms that the measurement pin socket is installed in the proper position. This test also confirms the guard pin contact and the broken wire (guard) between the PC board and pin socket of the pin board.

The measurement pin location test takes about 30 seconds.

Required Equipment

PV fixture adapter (E3190-60041)

PV short fixture (E3190-60043)

Test Procedure

1. Install the PV short fixture on the testhead.
2. Click **Continue**.

Residual Resistance Test

The residual resistance test confirms the residual resistance between the AUX ports and the pin boards. This test also confirms the sense and force pin contacts and the broken wires (sense and force) between the PC board and pin socket of the pin board.

The total time required to complete the residual resistance test depends on the number of pin boards installed in the testhead. For a fully configured tester, the residual resistance test takes about 15 minutes.

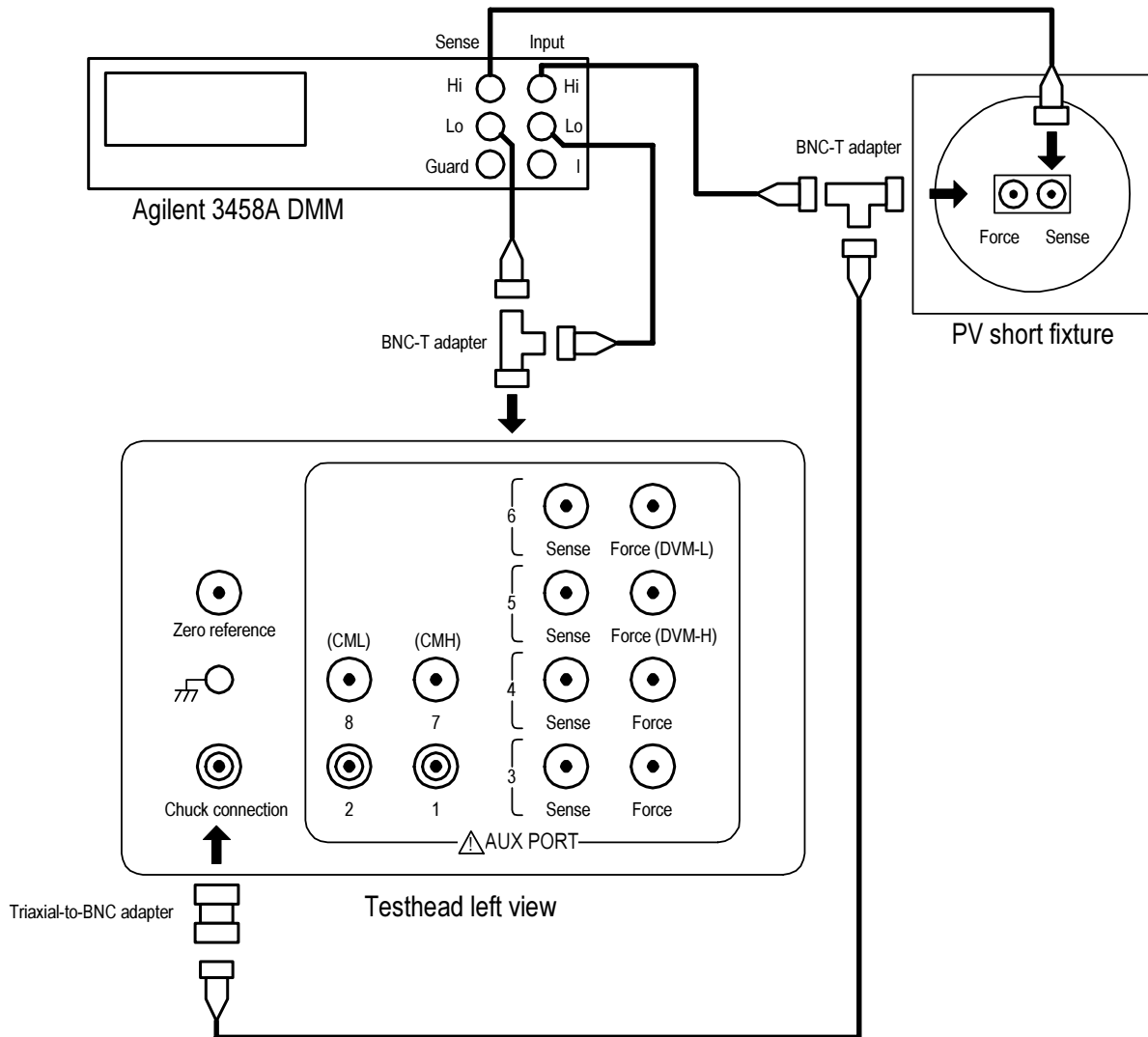
Required Equipment

- Agilent 3458A digital multimeter
- PV fixture adapter (E3190-60041)
- PV short fixture (E3190-60043)
- BNC-T adapter (1250-0781); 2 each
- BNC cable (8120-1840)
- BNC-to-banana cable (E3190-61603); 2 each
- Triaxial-to-BNC adapter (1250-0595); 2 each

Test Procedure

1. Install the PV short fixture on the testhead.
2. Connect the PV short fixture FORCE to the DMM-Input-Hi by using the BNC-T adapter and the BNC-to-banana cable.
3. Connect the PV short fixture FORCE to the chuck connection port by using the BNC cable and the Triaxial-to-BNC adapter.
4. Connect the PV short fixture SENSE to the DMM-Sense-Hi by using the BNC-banana-plug cable.
5. Connect the DMM-Input-Lo to the DMM-Sense-Lo by using the BNC-banana-plug cable and the BNC-T adapter.
6. Click **Continue**.
7. Connect the DMM-Input-Lo and the DMM-Sense-Lo to the AUX ports by using the BNC-banana-plug cable and the BNC-T adapter. If you connect the BNC-T adapter to the AUX1 port or the AUX2 port, also use the Triaxial-to-BNC adapter.
8. Click **Continue**.
9. Repeat step 7. through 8. according to the displayed instruction on the pop-up window.

Figure 2-9 Connection of Residual Resistance Test



Isolation and Offset Current Test

The Isolation and offset current test confirms the isolation and offset current between one of the SMU ports and the pin boards.

The Isolation and offset current test takes about 20 minutes.

Required Equipment

PV fixture adapter (E3190-60041)

PV open fixture (E3190-60042)

NOTE Before performing this test, check if an adapter or cable, such as the Triaxial-to-BNC adapter, is connected to the chuck connection port. If it is, disconnect it before proceeding with this procedure.

Test Procedure

1. Install the PV open fixture on the testhead.
2. Click **Continue**.

HF Matrix Relay Test

The HF matrix relay test confirms the operations of the relays in the HF matrix. This test checks the relays that are not checked in the DIAG4070. This test also performs cleaning of the relay contacts.

The HF matrix relay test takes about 30 seconds.

Required Equipment

- PV fixture adapter (E3190-60041)
- PV open fixture (E3190-60042)
- Short adapter for extended path (E3190-60045)

Test Procedure

1. Install the PV open fixture on the testhead.
2. Install the short adapter for extended path on the testhead.
3. Click **Continue**.

NOTE After the HF matrix relay test, remove the short adapter for extended path.

GNDU Output Voltage Test

The GNDU output voltage test confirms the output voltage of the GNDU.

The GNDU output voltage test takes about 20 seconds.

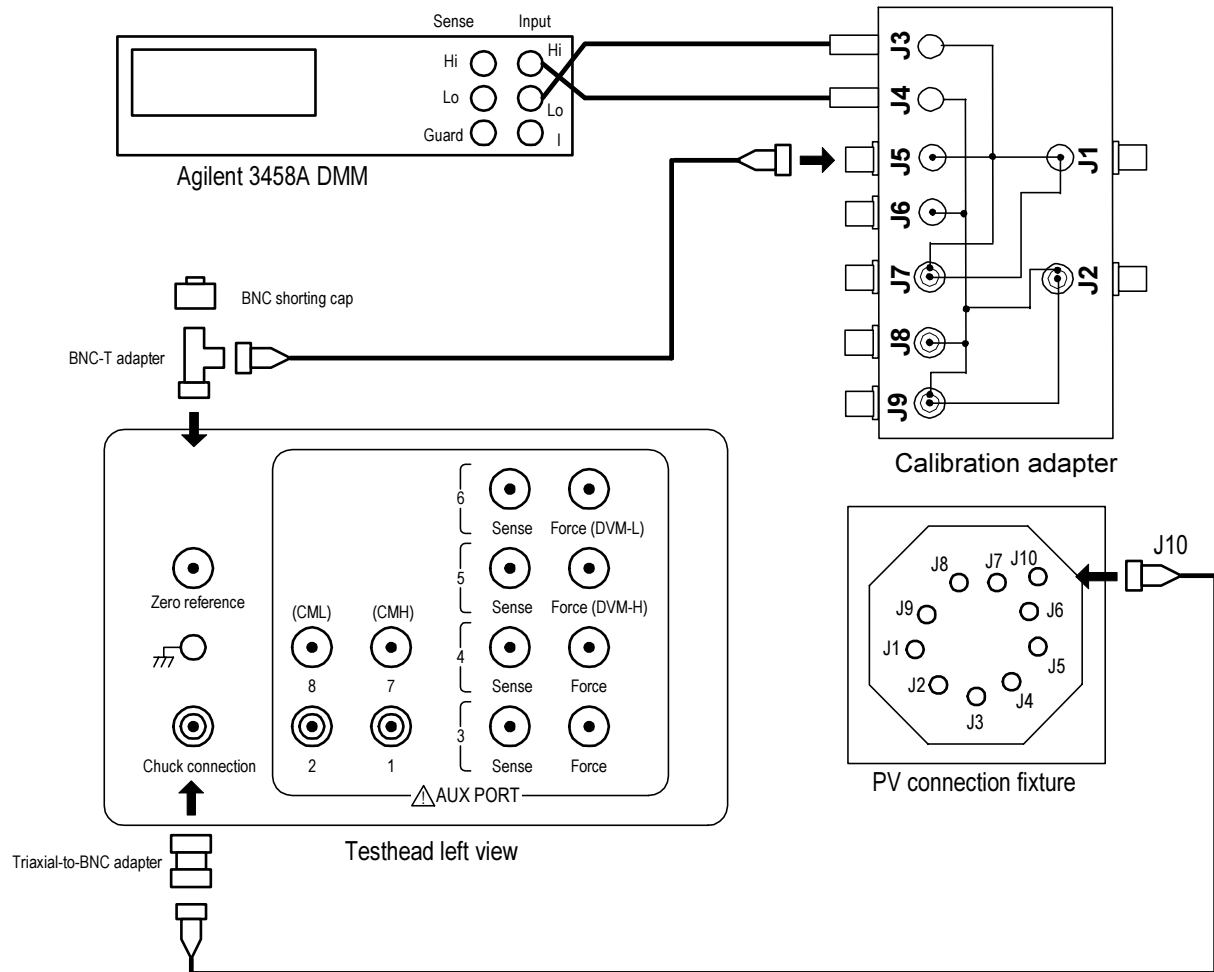
Required Equipment

- Agilent 3458A digital multimeter
- Agilent 11058A banana-to-banana cable; 2 each
- PV fixture adapter (E3190-60041)
- PV connection fixture (E3190-60044)
- BNC-T adapter (1250-0781)
- BNC shorting cap (1250-0929)
- BNC cable (8120-1840)
- Triaxial cable (04142-61641); 2 each
- Calibration adapter (04155-65041)

Test Procedure

1. Install the PV connection fixture on the testhead.
2. Connect the zero reference port to the calibration adapter J5 by using the BNC-T adapter, the BNC cable, and the BNC shorting cap.
3. Connect the calibration adapter J8 to the PV connection fixture by using the triaxial cable.
4. Connect the DMM-Hi to the calibration adapter J4 by using the banana-to-banana cable.
5. Connect the DMM-Lo to the calibration adapter J3 by using the banana-to-banana cable.
6. Connect the chuck connection port to the PV connection fixture J10 by using the triaxial cable.
7. Click **Continue**.

Figure 2-10 Connection of GNDU Output Voltage Test



SMU Voltage Force and Measurement Test

The SMU voltage force and measurement test confirms the output voltage and voltage measurement capability of SMUs.

The SMU voltage force and measurement test takes about 1 to 3 minutes.

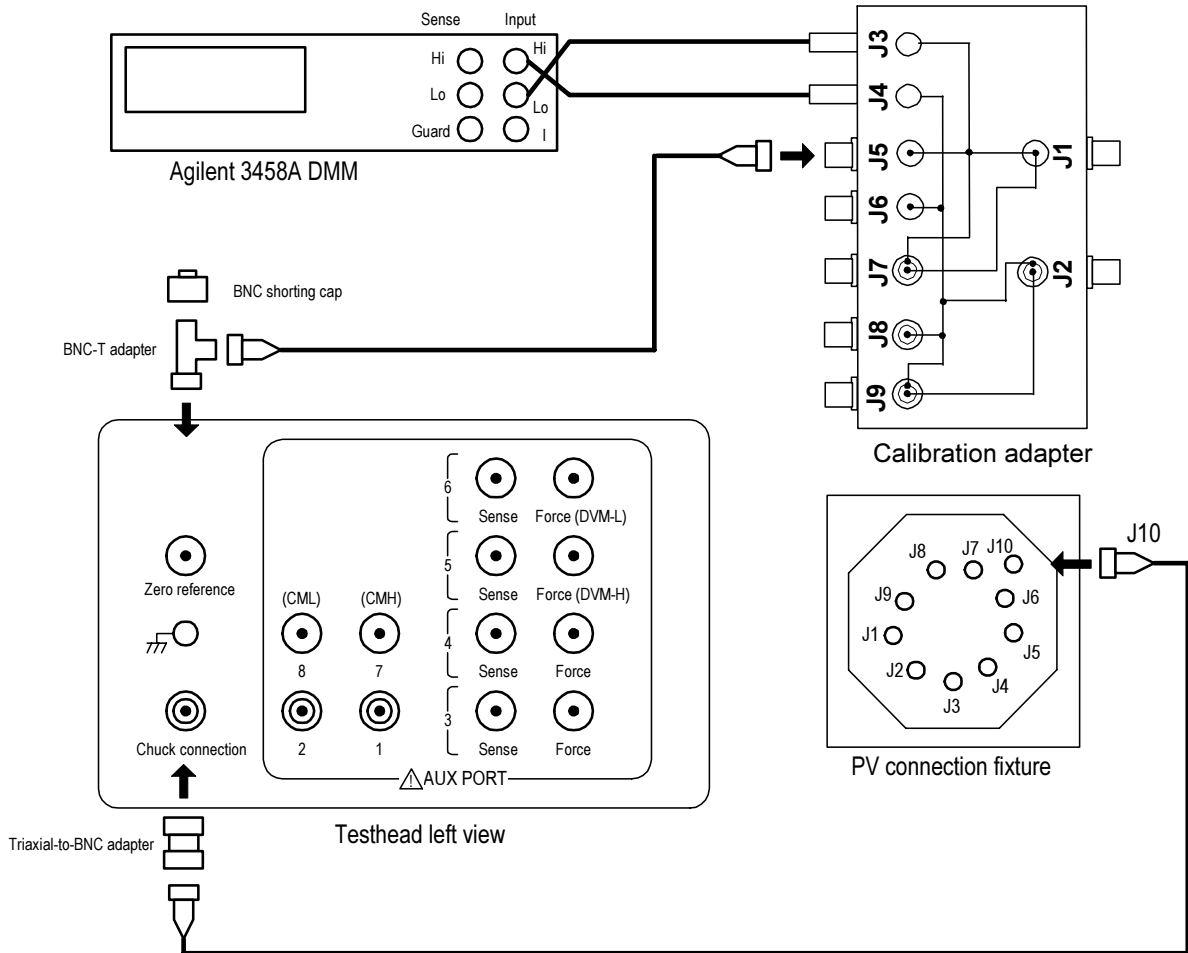
Required Equipment

- Agilent 3458A digital multimeter
- Agilent 11058A banana-to-banana cable; 2 each
- PV fixture adapter (E3190-60041)
- PV connection fixture (E3190-60044)
- BNC-T adapter (1250-0781)
- BNC shorting cap (1250-0929)
- BNC cable (8120-1840)
- Triaxial cable (04142-61641); 2 each
- Calibration adapter (04155-65041)

Test Procedure

1. Install the PV connection fixture on the testhead.
2. Connect the zero reference port to the calibration adapter J5 by using the BNC-T adapter, the BNC shorting cap, and the BNC cable.
3. Connect the calibration adapter J8 to the PV connection fixture using the triaxial cable.
4. Connect the DMM-Hi to the calibration adapter J4 by using the banana-to-banana cable.
5. Connect the DMM-Lo to the calibration adapter J3 by using the banana-to-banana cable.
6. Connect the chuck connection port to the PV connection fixture J10 by using the triaxial cable.
7. Click **Continue**.

Figure 2-11 Connection of SMU Voltage Force and Measurement Test



SMU Current Force and Measurement Test

The SMU current force and measurement test confirms the output current and current measurement capability of SMUs.

The total time required to complete the SMU current force and measurement test depends on the number of SMUs installed in the testhead. For a fully configured tester, the SMU current force and measurement test takes about 4 to 15 minutes.

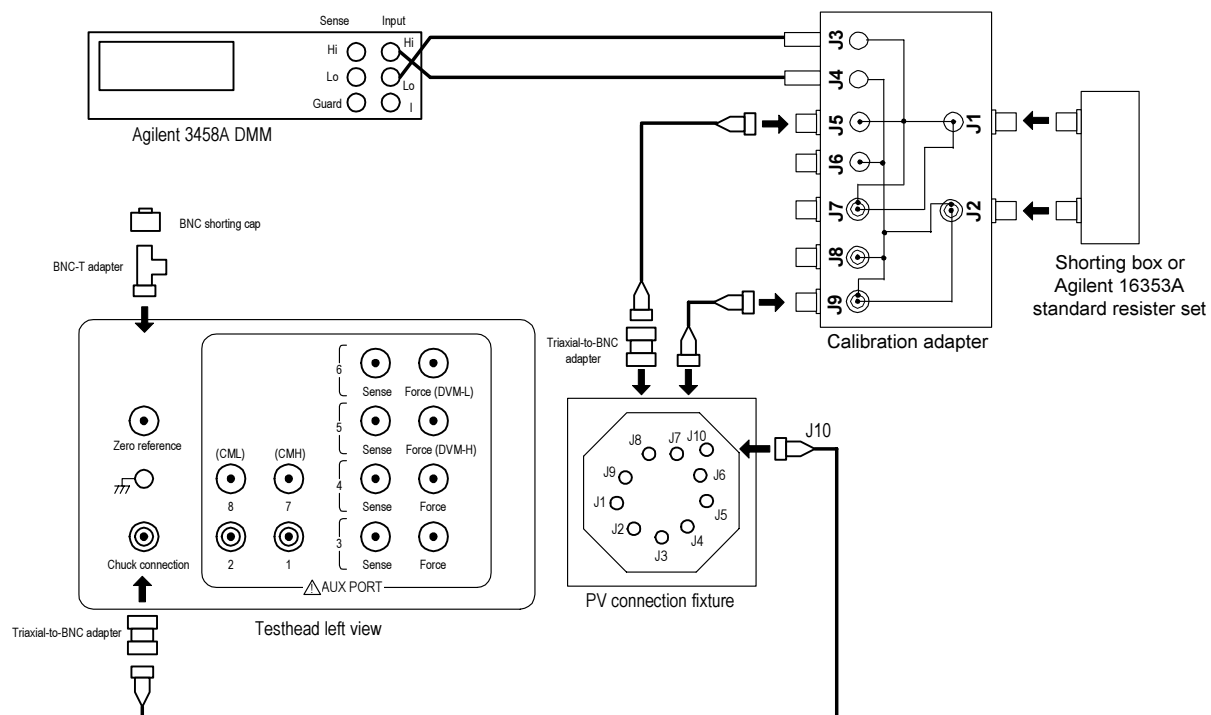
Required Equipment

- Agilent 3458A digital multimeter
- Agilent 11058A banana-to-banana cable; 2 each
- Agilent 16353A standard resistor set
- PV fixture adapter (E3190-60041)
- PV connection fixture (E3190-60044)
- BNC-T adapter (1250-0781)
- BNC shorting cap (1250-0929)
- BNC cable (8120-1840)
- Triaxial-to-BNC adapter (1250-0595)
- Triaxial cable (04142-61641); 2 each
- Calibration adapter (04155-65041)
- Shorting box for calibration adapter (04155-60042)

Test Procedure

1. Connect the cables as shown in figure 2-12.
 - a. Install the PV connection fixture on the testhead.
 - b. Connect the BNC-T adapter and BNC shorting cap on the zero reference port.
 - c. Connect the calibration adapter J9 to the PV connection fixture by using the triaxial cable.
 - d. Connect the calibration adapter J5 to the PV connection fixture by using the BNC cable and the triaxial-to-BNC adapter.
 - e. Connect DMM-Hi to the calibration adapter J4 by using the banana-to-banana cable.
 - f. Connect DMM-Lo to the calibration adapter J3 by using the banana-to-banana cable.
 - g. Connect the chuck connection port to the PV connection fixture J10 by using the triaxial cable.
 - h. Connect the shorting box (04155-65042) to the calibration adapter J1 and J2.
2. Click **Continue**.

Figure 2-12 Connection of SMU Current Force and Measurement Test ($\leq 10 \mu\text{A}$)



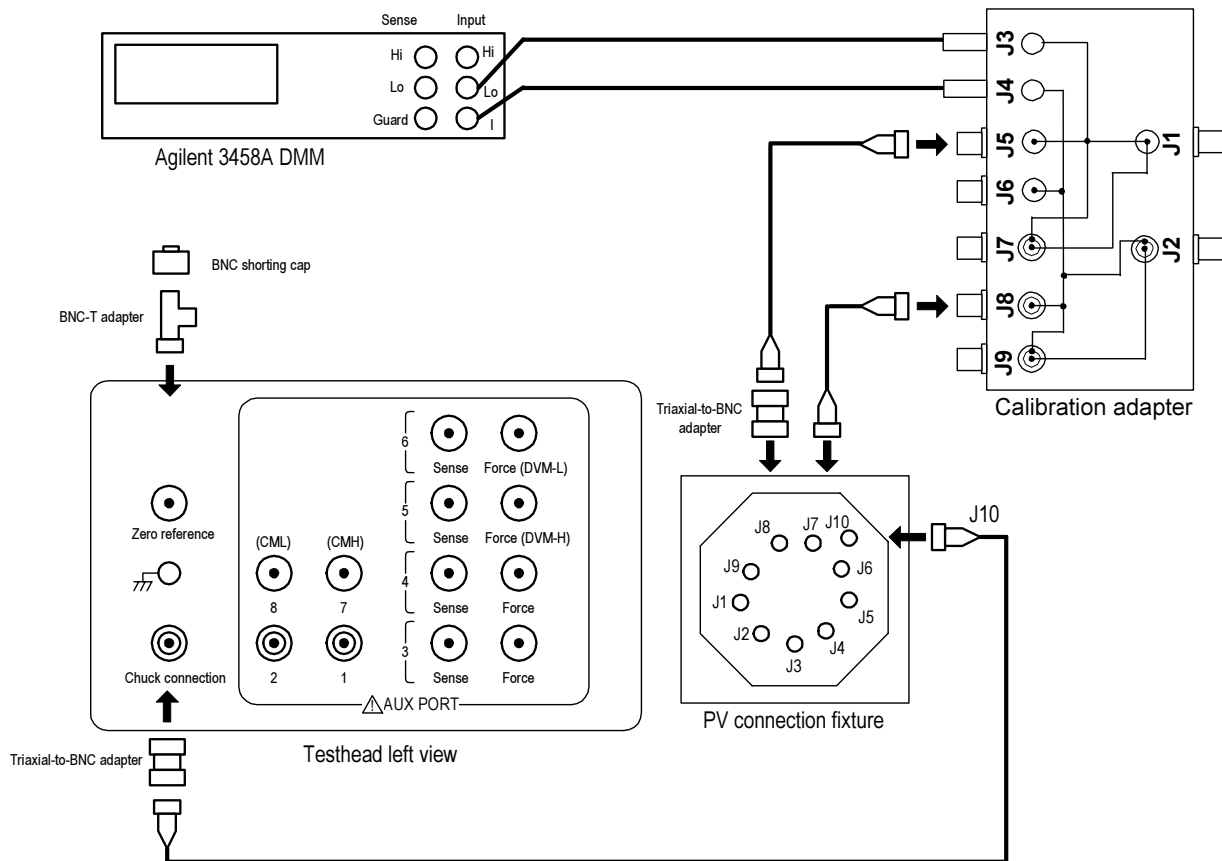
3. Remove the shorting box (04155-65042) from the calibration adapter, and connect the standard resistor to the calibration adapter J1 and J2, according to the displayed instruction on the pop-up window.
4. Click **Continue**.

The SMU current force and measurement test ($\leq 10 \mu\text{A}$) is performed.

5. Connect the cables as shown in figure 2-13.
 - a. Remove the triaxial cable from the calibration adapter J9 and connect it to J8.
 - b. Remove the banana-to-banana cable from DMM-Hi and connect it to DMM-I.
 - c. Remove the standard resistor from the calibration adapter.
6. Click **Continue**.

The SMU current force and measurement test ($\geq 100 \mu\text{A}$) is performed.

Figure 2-13 Connection of SMU Current Force and Measurement Test ($\geq 100 \mu\text{A}$)



7. Connect the cables as shown in figure 2-12.
 - a. Remove the triaxial cable from the calibration adapter J8 and connect it to J9.
 - b. Remove the banana-to-banana cable from DMM-I and connect it to DMM-H.
 - c. Connect the shorting box (04155-65042) to the calibration adapter J1 and J2.
8. Click **Continue**.
9. Repeat step 3. through 8., according to the displayed instruction on the pop-up window.

SMU Output Resistance Test

The SMU output resistance test confirms the output resistance between the SMU and the pin tip.

The SMU output resistance test takes about 30 to 60 seconds.

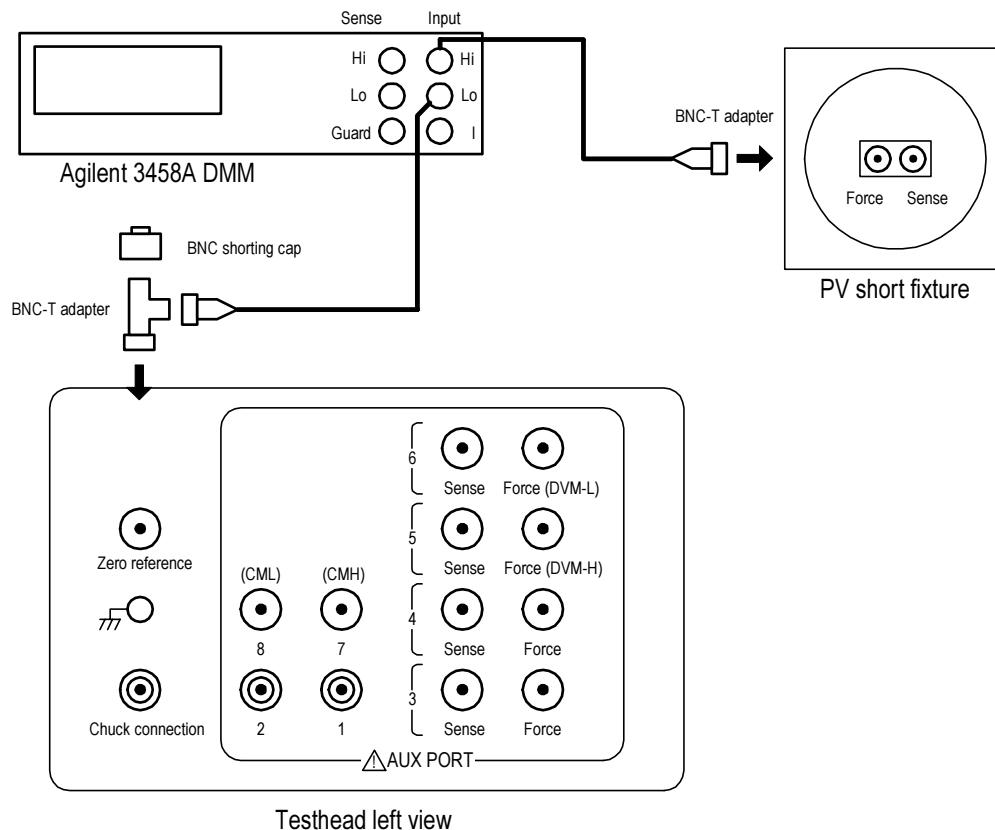
Required Equipment

- Agilent 3458A digital multimeter
- PV fixture adapter (E3190-60041)
- BNC-T adapter (1250-0781)
- BNC shorting cap (1250-0929)
- PV short fixture (E3190-60043)
- BNC-to-banana cable (E3190-61603)

Test Procedure

1. Install the PV short fixture on the testhead.
2. Connect DMM-Hi to the PV short fixture SENSE by using the BNC-banana-plug cable.
3. Connect DMM-Lo to the zero reference port by using the BNC-banana-plug cable, the BNC-T adapter, and the BNC shorting cap.
4. Click **Continue**.

Figure 2-14 Connection of SMU Output Resistance Test



CMU Capacitance and Conductance (C-G) Test

The CMU C-G test confirms the capacitance and conductance measurement capability of the CMU.

The CMU C-G test takes about 10 minutes.

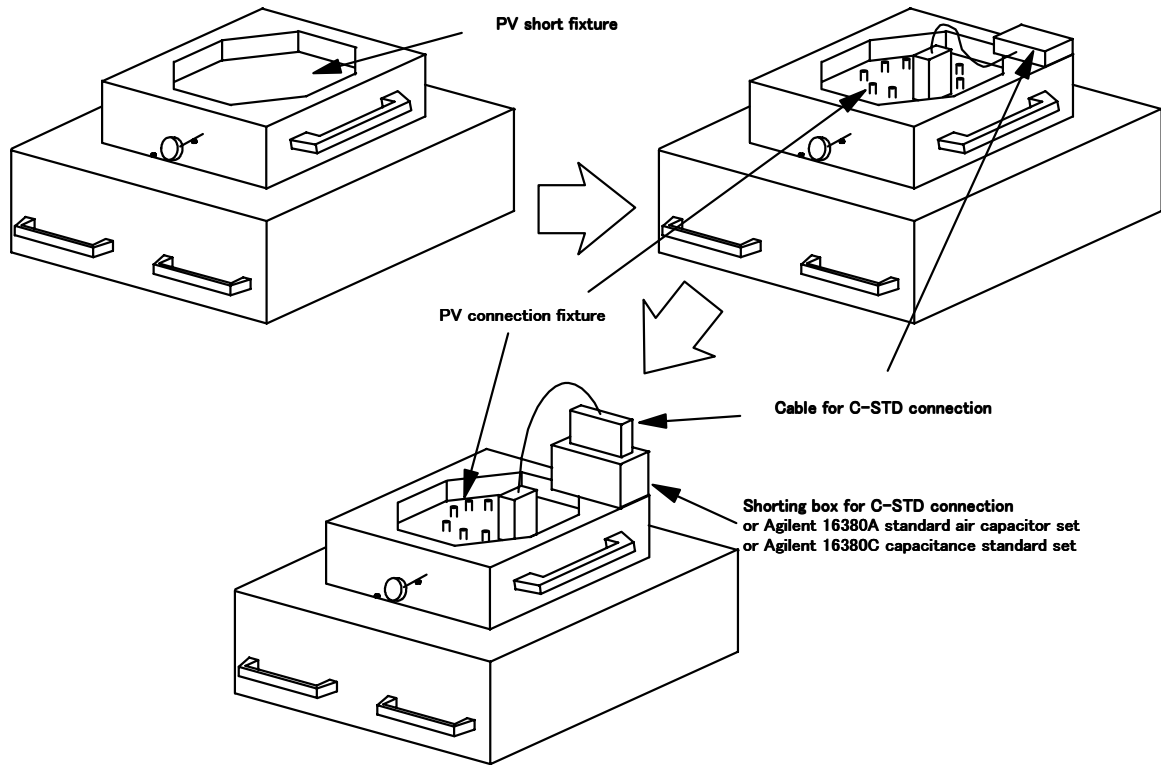
Required Equipment

- Agilent 16380A standard air capacitor set
- Agilent 16380C capacitance standard set
- Agilent 42037A 1 k Ω standard resistor
- PV fixture adapter (E3190-60041)
- PV short fixture (E3190-60043)
- PV connection fixture (E3190-60044)
- Shorting box for C-STD connection (E3190-60046)
- Cable for C-STD connection (E3190-61641)

Test Procedure

1. Install the PV short fixture on the testhead.
2. Click **Continue**.
The System L-R error measurement is performed.
3. Install the PV connection fixture on the testhead.
4. Connect the cable for C-STD connection to the PV connection fixture, according to the displayed instruction in the pop-up window.
5. Click **Continue**.
The capacitance and conductance pre-measurement is performed.
6. Connect the shorting box (E3190-60046) to the cable for C-STD connection.
7. Click **Continue**.
The inductance and resistance pre-measurement is performed.
8. Remove the shorting box (E3190-60046) from the cable for C-STD connection.
9. Connect the standard capacitor or the standard resistor to the cable for C-STD connection, according to the displayed instruction in the pop-up window.
10. Click **Continue**.
The CMU C-G test is performed.
11. Remove the standard from the cable for C-STD connection.
12. Click **Continue**.
13. Repeat step 4. through 12., according to the displayed instruction in the pop-up window.

Figure 2-15 Connection of CMU Capacitance and Conductance Test



CMU dc Bias Output Voltage Test

The CMU dc bias output voltage test confirms the output dc bias of the CMU. This test also executes the CMU self-test.

The CMU dc bias output voltage test takes about 30 seconds.

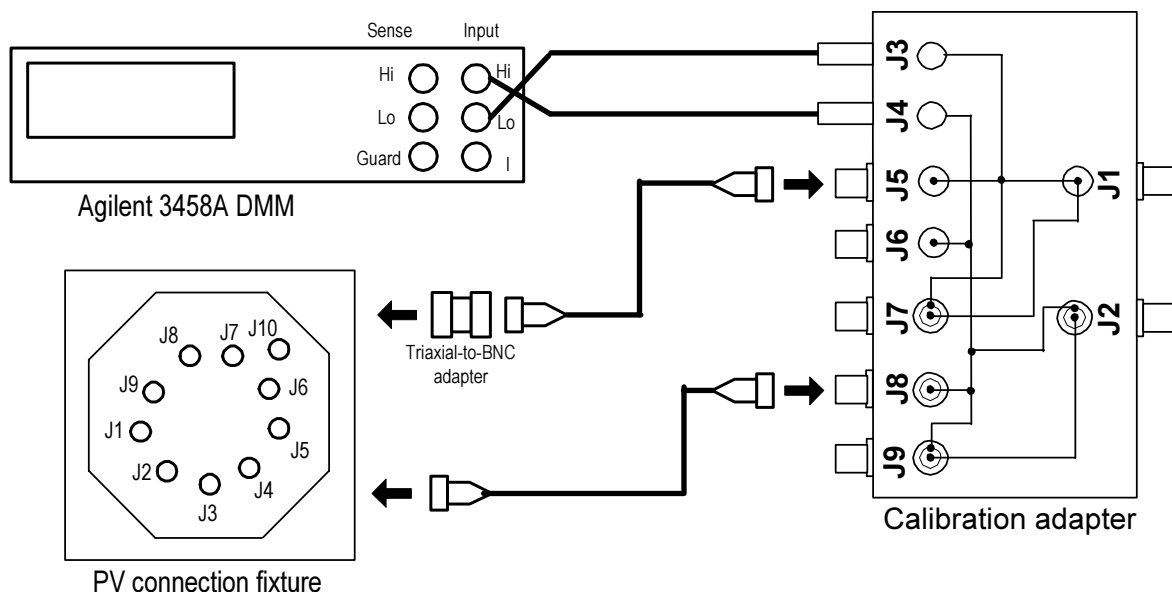
Required Equipment

- Agilent 3458A digital multimeter
- Agilent 11058A banana-to-banana cable; 2 each
- PV fixture adapter (E3190-60041)
- PV connection fixture (E3190-60044)
- BNC cable (8120-1840)
- Triaxial-to-BNC adapter (1250-0595)
- Triaxial cable (04142-61641)
- Calibration adapter (04155-65041)

Test Procedure

1. Install the PV connection fixture on the testhead.
2. Connect DMM-Hi to the calibration adapter J4 by using the banana-to-banana cable.
3. Connect DMM-Lo to the calibration adapter J3 by using the banana-to-banana cable.
4. Connect calibration adapter J8 to the PV connection fixture by using the triaxial cable.
5. Connect calibration adapter J5 to the PV connection fixture by using the BNC cable and triaxial-to-BNC adapter.
6. Click **Start**.

Figure 2-16 Connection of CMU DC Bias Output Voltage Test



DVM Differential Voltage Measurement Test

The DVM differential voltage measurement test confirms the differential voltage measurement capability of the DVM. This test also executes the DVM self-test.

The DVM differential voltage measurement test takes about 30 seconds.

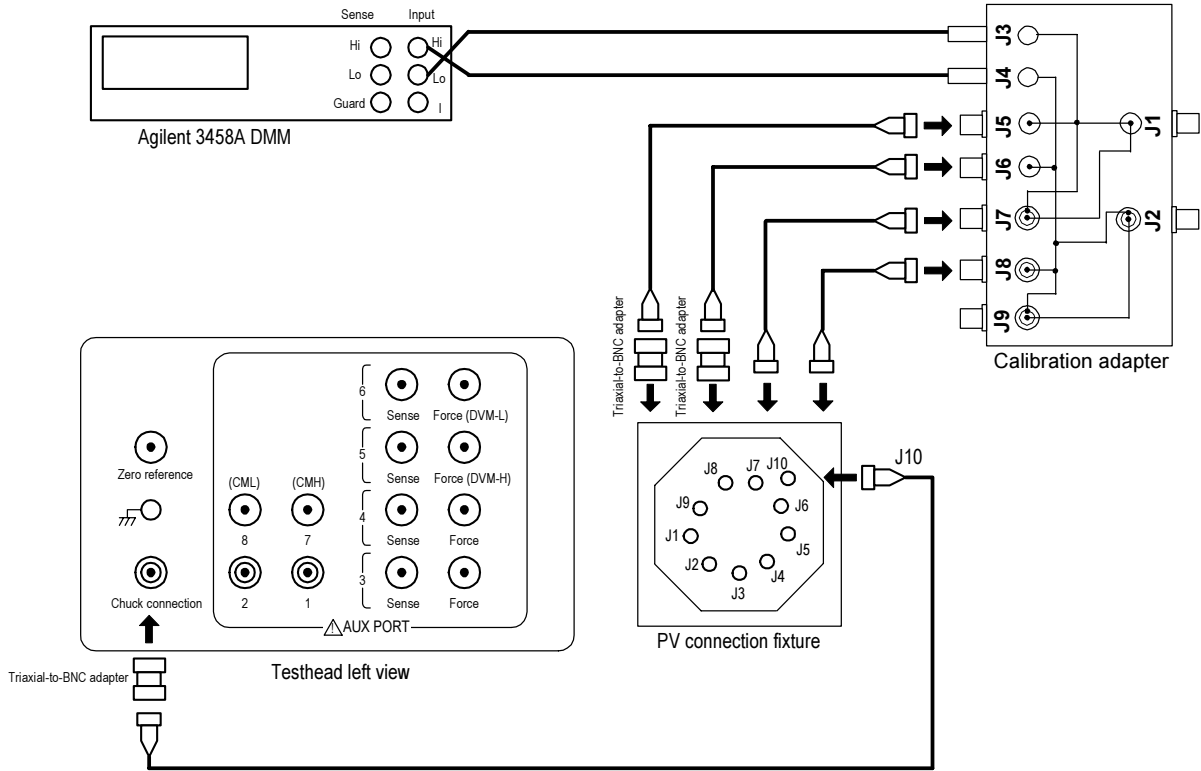
Required Equipment

- Agilent 3458A digital multimeter
- Agilent 11058A banana-to-banana cable; 2 each
- PV fixture adapter (E3190-60041)
- PV connector fixture (E3190-60044)
- BNC cable (8120-1840); 2 each
- Triaxial-to-BNC adapter (1250-0595); 2 each
- Triaxial cable (04142-61641); 3 each
- Calibration adapter (04155-65041)

Test Procedure

1. Install the PV connection fixture on the testhead.
2. Connect DMM-Hi to the calibration adapter J4 by using the banana-to-banana cable.
3. Connect DMM-Lo to the calibration adapter J3 by using the banana-to-banana cable.
4. Connect calibration adapter J5 to the PV connection fixture by using the triaxial-to-BNC adapter and BNC cable.
5. Connect calibration adapter J6 to the PV connection fixture by using the triaxial-to-BNC adapter and BNC cable.
6. Connect calibration adapter J7 to the PV connection fixture by using the triaxial cable.
7. Connect calibration adapter J8 to the PV connection fixture by using the triaxial cable.
8. Connect the chuck connection port to the PV connection fixture J10 by using the triaxial cable.
9. Click **Continue**.

Figure 2-17 Connection of DVM Differential Voltage Measurement Test



Pulse Switch Test

The pulse switch test confirms the operations of the relays in the pulse switches.

The pulse switch test takes about 3.5 minutes.

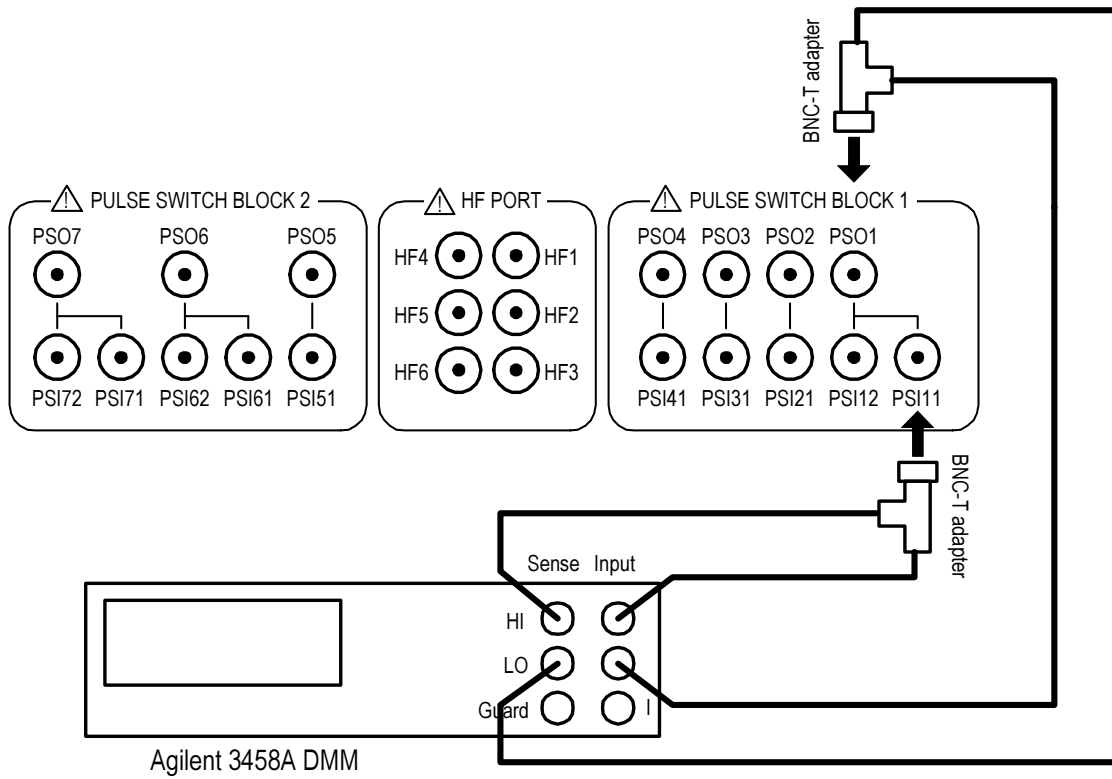
Required Equipment

- Agilent 3458A digital multimeter
- PV fixture adapter (E3190-60041)
- PV open fixture (E3190-60042)
- BNC-to-banana cable (E3190-61603), 2 each
- BNC-T (m-m-f) adapter (1250-2405), 2 each

Test Procedure

1. Install the PV open fixture on the testhead.
2. Connect the dual banana terminal of one BNC-to-banana cable to the DMM-Input terminals.
3. Connect the dual banana terminal of the other BNC-to-banana cable to the DMM-Sense terminals.
4. Connect both the BNC terminals tagged with "H" with the BNC-T (m-m-f) adapter.
5. Connect both the BNC terminals tagged with "L" with the BNC-T (m-m-f) adapter.
6. Connect the BNC-T adapter (tagged with "H") to the PSI11 terminal on the testhead.
7. Click **Continue**.
8. Connect the BNC-T adapter (tagged with "L") to the PSO1 terminal on the testhead.
9. Click **Continue**. Then the operation of one of the relays of the pulse switch is checked.
10. Repeat steps 6. through 9. according to the displayed instruction in the pop-up window.

Figure 2-18 Connection of Pulse Switch Test



Pulse Level Test

The pulse level test confirms the output voltage capability of the pulse sources.

The pulse level test takes about 0 to 6.5 minutes.

Required Equipment

Agilent 3458A digital multimeter

PV fixture adapter (E3190-60041)

PV short fixture (E3190-60043)

BNC-to-banana cable (E3190-61603)

BNC-T adapter (1250-0781)

BNC shorting cap (1250-0929)

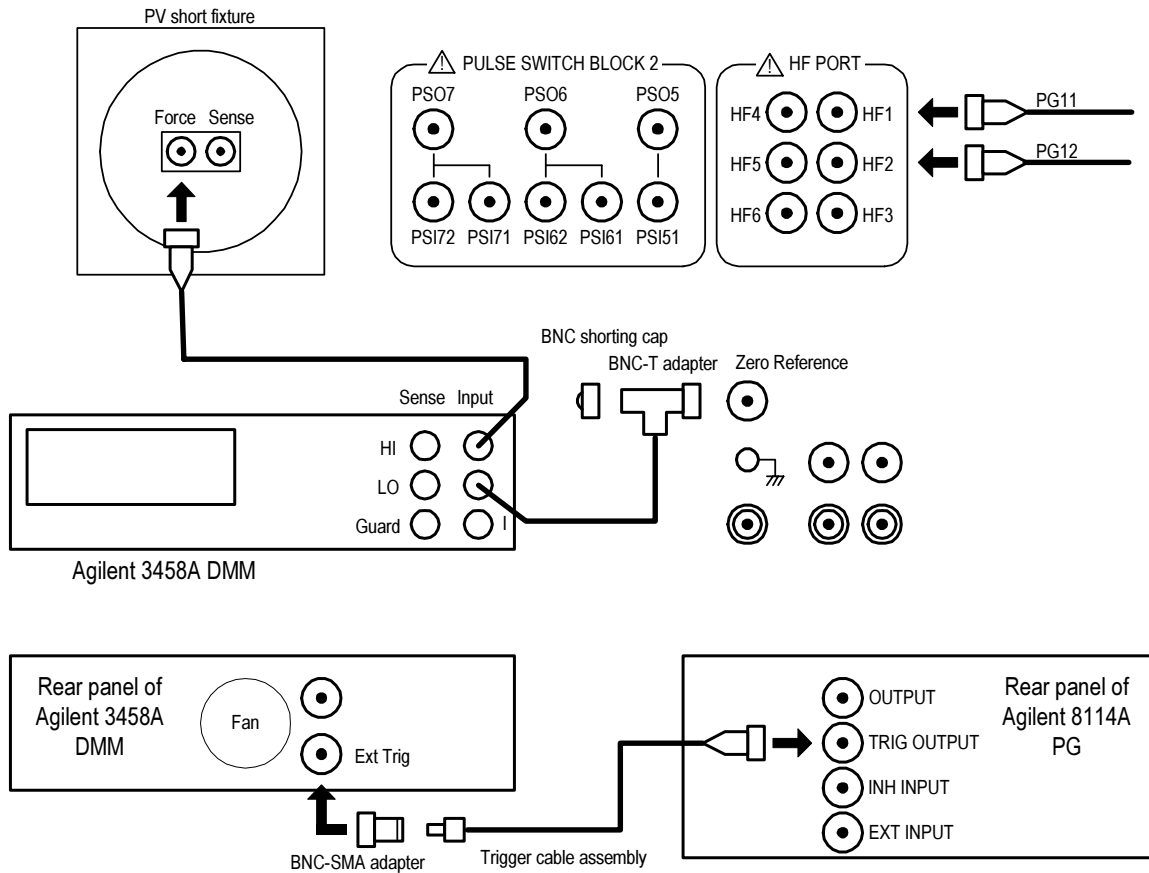
Trigger cable assembly (E3190-61612)

BNC-to-SMA adapter (1250-1700)

Test Procedure

1. Install the PV short fixture on the testhead.
2. Connect the dual banana terminal of one BNC-to-banana cable to the DMM-Input terminals.
3. Connect the BNC terminal tagged with "H" to the FORCE terminal on the PV short fixture.
4. Connect the BNC-T adapter with the BNC shorting cap to the zero reference terminal on the testhead.
5. Connect the BNC terminal tagged with "L" to the BNC-T adapter.
6. If the Agilent 8114A is installed for the pulse source, make the following connections additionally:
 - a. Click **Continue**.
 - b. Connect the BNC-to-SMA adapter to the SMA terminal of the trigger cable assembly.
 - c. Connect one BNC terminal of the trigger cable assembly to the TRIG OUTPUT TTL terminal on the rear panel of the 8114A.
 - d. Connect the BNC terminal of the BNC-to-SMA adapter, which is connected to the trigger cable assembly, to the Ext Trig terminal on the rear panel of the DMM.
7. Click **Continue**.
8. Connect the BNC terminals of the BNC cables from the output terminals of the pulse source to the specified HF n port.
9. Click **Continue**. Then the pulse levels from the pulse source are evaluated.
10. Repeat steps 8. and 9. according to the displayed instruction in the pop-up window, if the non-evaluated pulse sources are present.

Figure 2-19 Connection of Pulse Level Test



Pulse Parameter Test

The pulse parameter test confirms the pulse wave capability output from the pulse sources.

The pulse level test takes about 0 to 41 minutes (about 4 minutes for one channel).

Required Equipment

Agilent 54750A/54751A or Agilent 86100A/86112A oscilloscope

Agilent 8493C option 020 attenuator (20 dB)

PV fixture adapter (E3190-60041)

PV pulse fixture (E3190-60021)

BNC-to-SMA cable assembly (E3190-61611)

Trigger cable assembly (E3190-61612)

Test Procedure

1. Install the PV pulse fixture on the testhead.
2. Connect the BNC terminal of the trigger cable assembly to the PV TRIGGER terminal on the trigger distributor. The trigger distributor is located inside the system cabinet.
3. Connect the SMA terminal (tagged "TO TRIGGER") of the trigger cable assembly to the Trigger terminal on the 54751A or 86100A.
4. Install the 20 dB attenuator on the channel A terminal of the 54751A or channel 1 terminal of the 86112A.
5. Connect the SMA terminal of the BNC-to-SMA cable assembly to the 20 dB attenuator.
6. Connect the BNC terminal of the BNC-to-SMA cable assembly to the specified terminal on the PV pulse fixture according to the displayed instruction. First, it is terminal P8.
7. Connect the BNC cable tagged "PGxx", which is from the pulse generators, to the HF n terminal on the testhead according to the displayed instructions.
8. Click **Continue**. The pulse parameters such as pulse width and pulse delay are evaluated.
9. Repeat steps 6. through 8. according to the displayed instruction in the pop-up window, if the non-evaluated pulse sources are present.

Figure 2-20 Connection of Pulse Parameter Test (with Agilent 54750A/54751A)

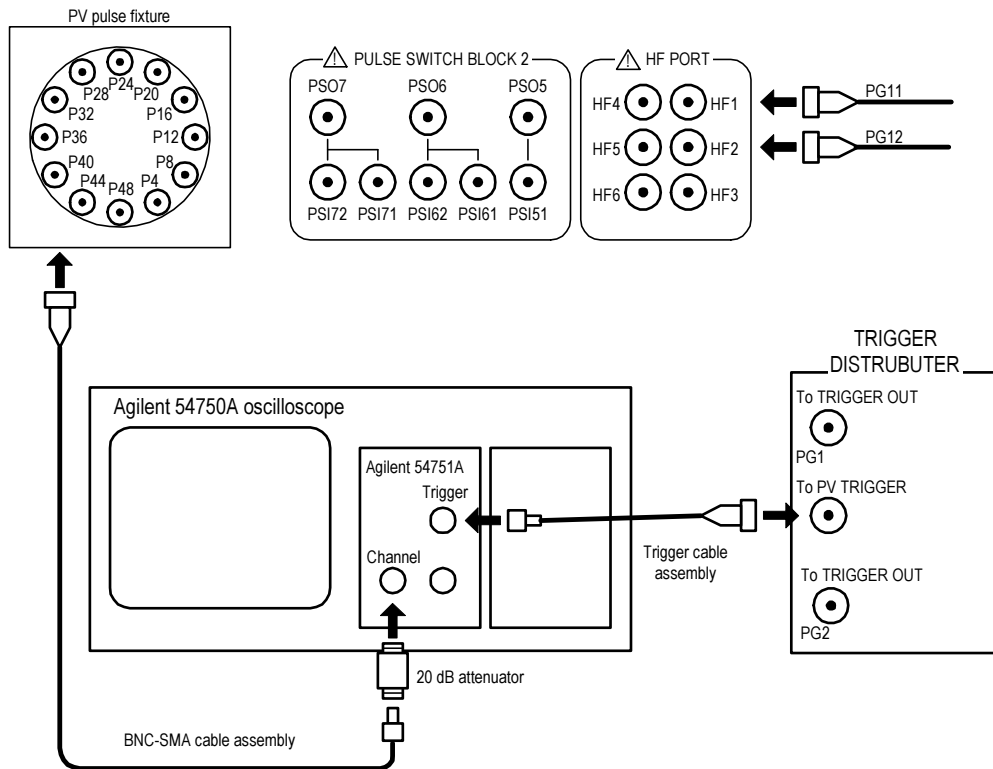
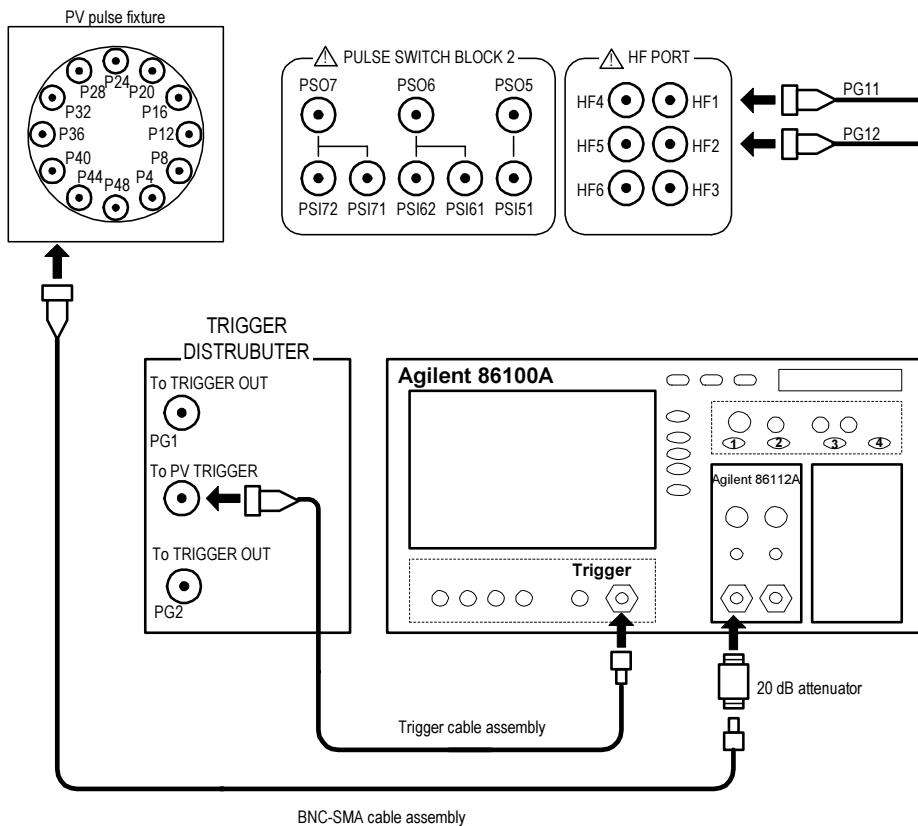


Figure 2-21 Connection of Pulse Parameter Test (with Agilent 86110A/86112A)



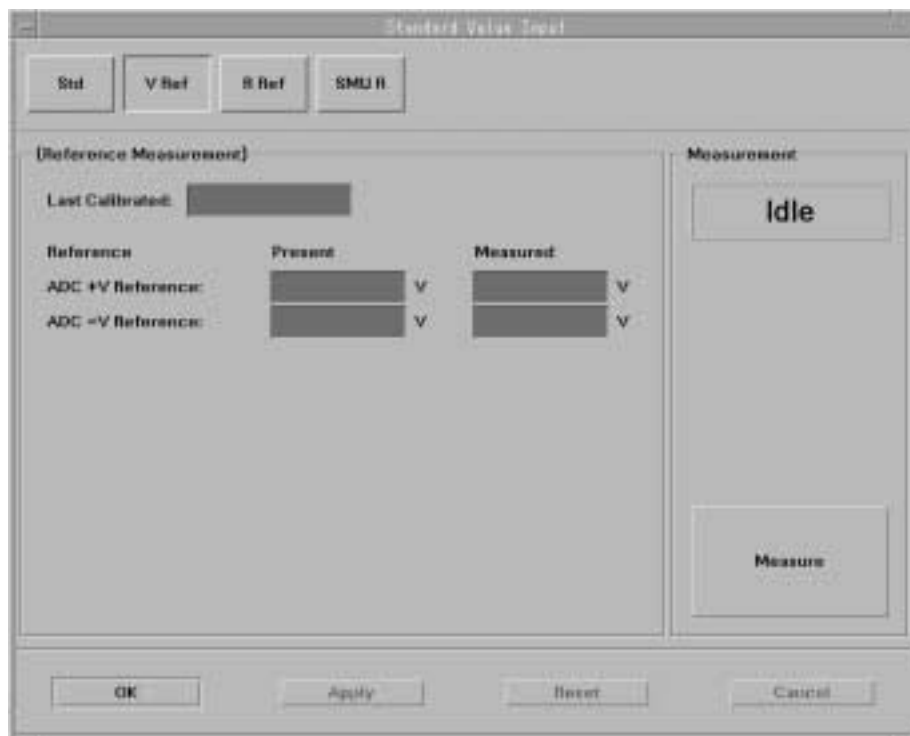
Voltage and Resistance References Calibration (V/R Calibration)

This section provides the procedures and required test equipment for V/R calibration. Perform the V/R calibration according to the instructions described in this section.

Calibration for Voltage References

The voltage references, on the high-resolution ADC board installed in the testhead, must be calibrated at least once a year. You can perform the voltage references calibration by clicking **V Ref** in the Standard Value Input window.

Figure 2-22 Standard Value Input Window for Voltage Reference



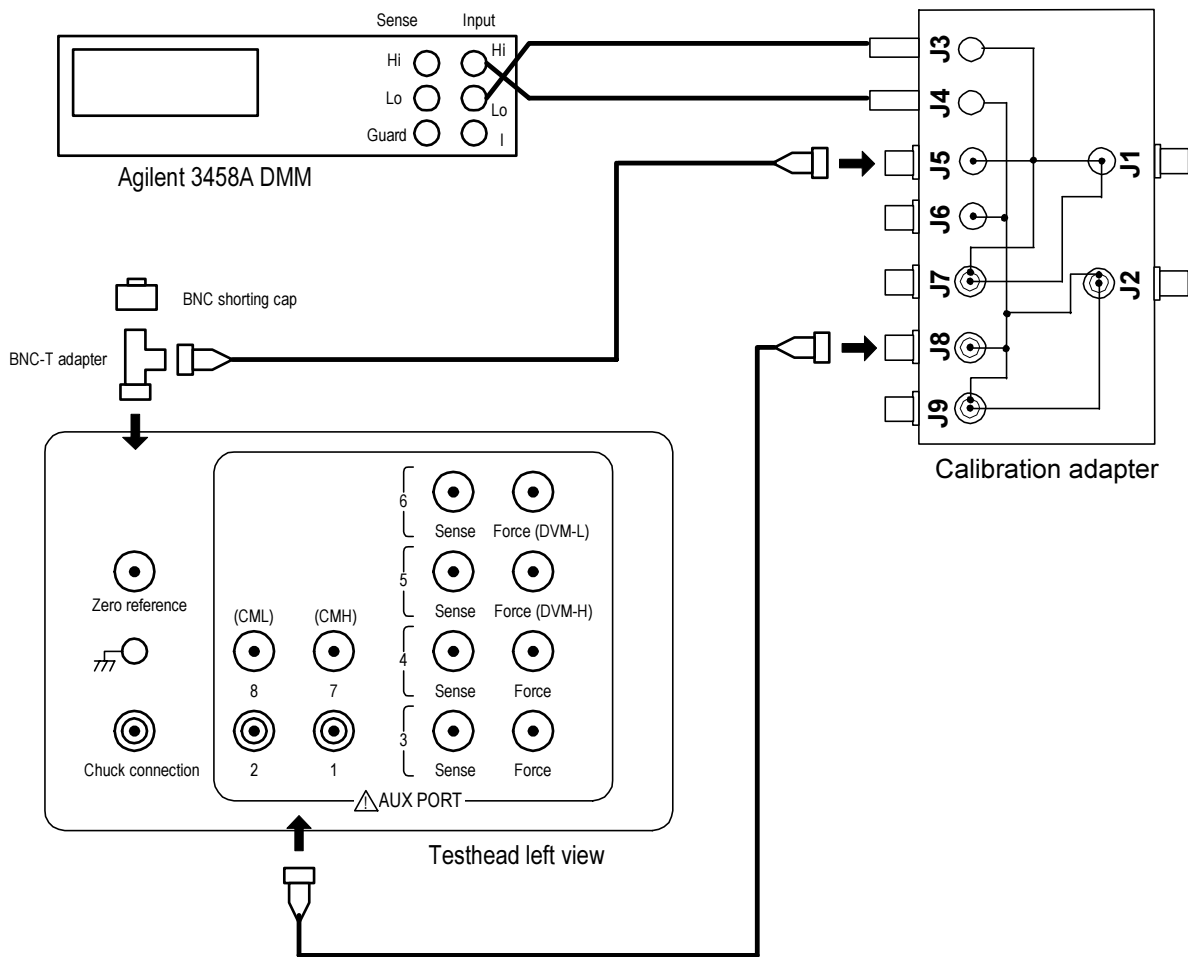
Required Equipment

- Agilent 3458A digital multimeter
- Agilent 11058A banana-to-banana cable; 2 each
- PV fixture adapter (E3190-60041)
- PV open fixture (E3190-60042)
- BNC cable (8120-1840)
- BNC-T adapter (1250-0781)
- BNC shorting cap (1250-0929)
- Triaxial cable (04142-61641)
- Calibration adapter (04155-65041)

Calibration Procedure

1. Install the PV open fixture on the testhead.
2. Connect calibration adapter J8 to the AUX port by using the triaxial cable.
3. Connect calibration adapter J5 to the zero reference port by using the BNC cable, the BNC-T adapter, and the BNC shorting cap.
4. Connect DMM-Hi to the calibration adapter J4 by using the banana-to-banana cable.
5. Connect DMM-Lo to the calibration adapter J3 by using the banana-to-banana cable.
6. Click **Continue**.

Figure 2-23 Connection of Voltage References Calibration



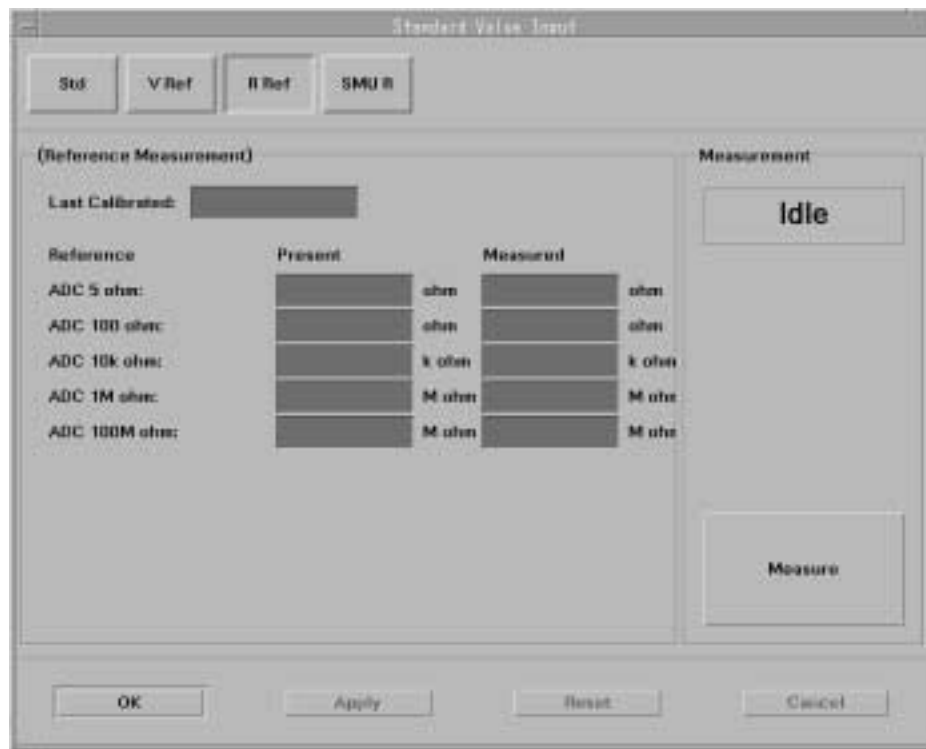
Voltage and Resistance References Calibration (V/R Calibration)**Calibration for Resistance References**

The resistance references, on the high-resolution ADC board installed in the testhead, must be calibrated at least once a year. You can perform the calibration for resistance references by clicking **R Ref** in the Standard Value Input window.

NOTE SMU 1 or SMU 2 must be installed when performing calibration for resistance references. If the 4072A/4073A does not have SMU 1 and SMU 2, you *cannot* perform the calibration for resistance references.

NOTE Before performing this calibration, the calibration for voltage references must be performed.

Figure 2-24 Standard Value Input Window for Resistance References

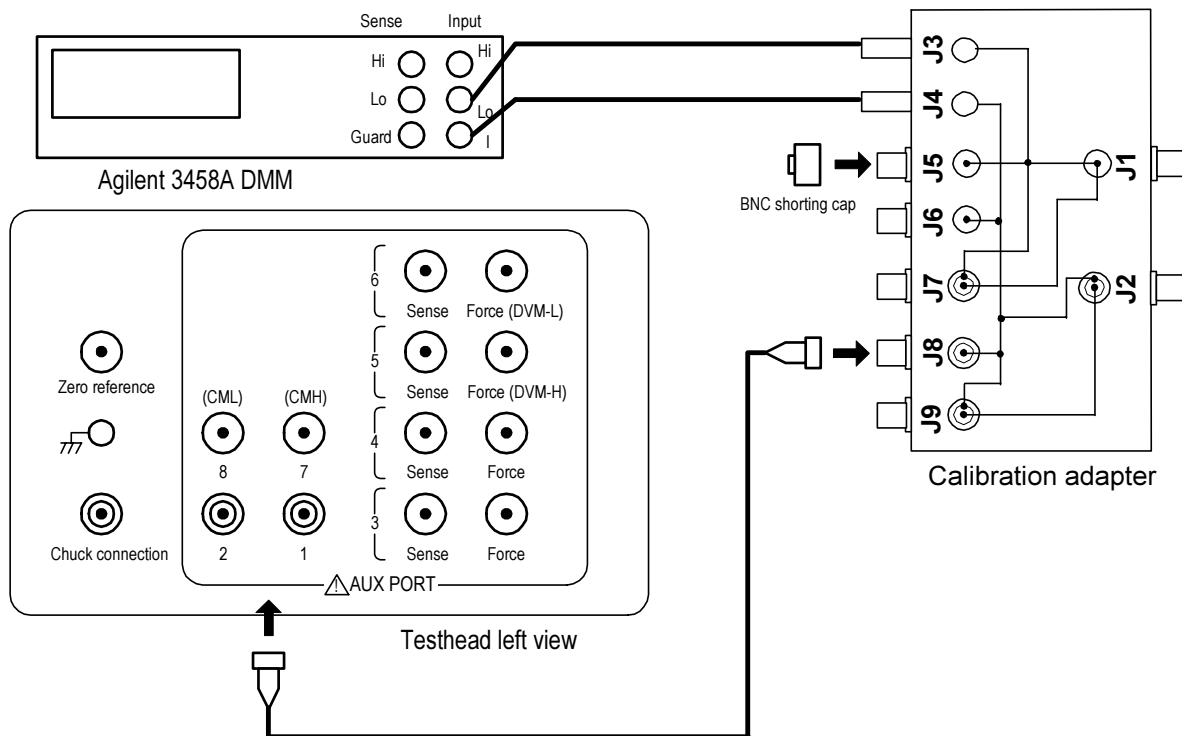
**Required Equipment**

- Agilent 3458A digital multimeter
- Agilent 11058A banana-to-banana cable; 2 each
- PV fixture adapter (E3190-60041)
- PV open fixture (E3190-60042)
- BNC shorting cap (1250-0929)
- Triaxial cable (04142-61641)

Calibration Procedure

1. Install the PV open fixture on the testhead.
2. Connect calibration adapter J8 to the AUX port by using the triaxial cable.
3. Connect the shorting cap to calibration adapter J5.
4. Connect DMM-I to calibration adapter J4 by using the banana-to-banana cable.
5. Connect DMM-Lo to calibration adapter J3 by using the banana-to-banana cable.
6. Click **Continue**.

Figure 2-25 Connection of Resistance References Calibration

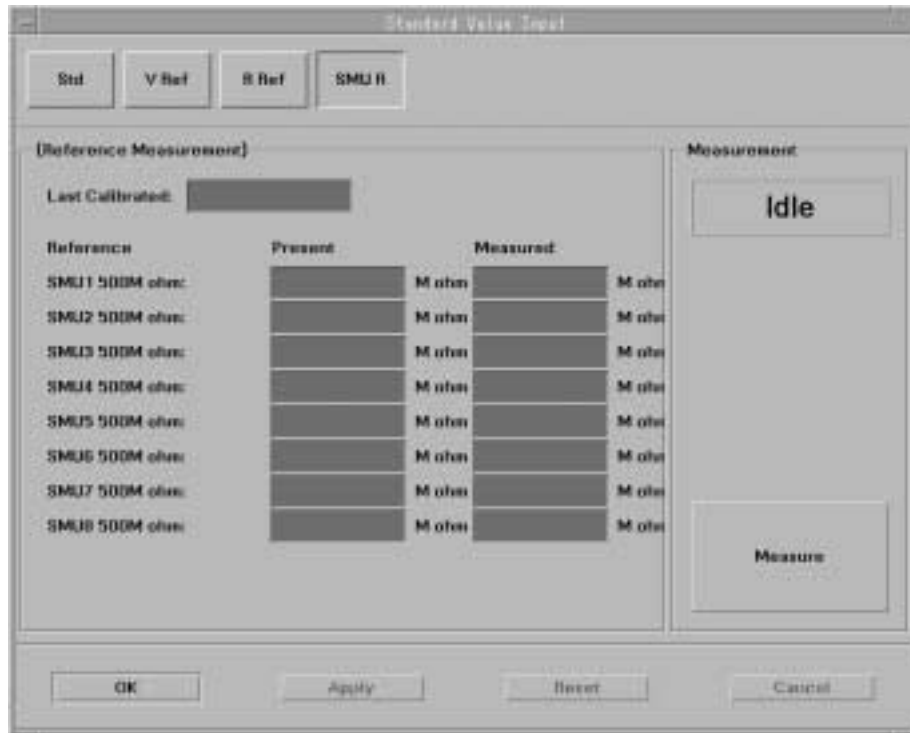


Calibration for SMU Range Resistor

You can perform the calibration for SMU range resistor by clicking **SMU R** in the standard value input window.

NOTE *Only* if the SMU current force and measurement test failed, calibrate the SMU range resistance by using the following procedure.

Figure 2-26 Standard Value Input Window for SMU Range Resistor



Required Equipment

- PV fixture adapter (E3190-60041)
- PV open fixture (E3190-60042)

Calibration Procedure

1. Install the PV open fixture on the testhead.
2. Click **Start**.

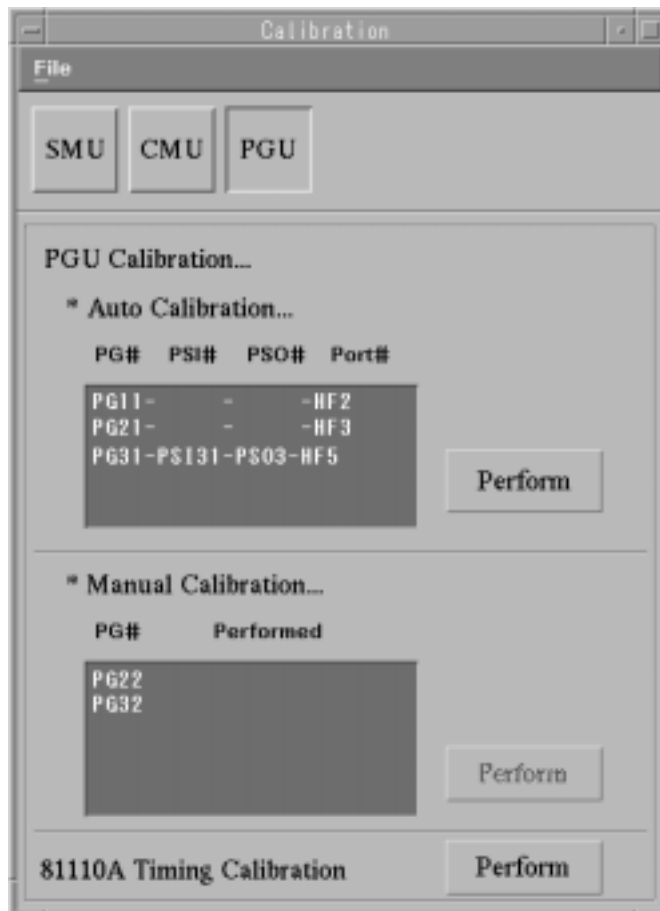
Measurement for PG Level Error Compensation Data

You can measure the PG level error compensation data by executing the `cal4070` command.

1. Start the `cal4070` by one of the following instructions:
 - Execute the `cal4070` command in the `dterm` window as follows:

```
$ cal4070 Return
```
 - Click the **Tools** menu and select **Calibration...** in the pull-down menu of the Performance Verification Main window.
2. Click the **PGU** button.
3. Click the **Perform** button in the Auto Calibration area. Then the measurements are executed.
4. Click the **Perform** button in the Manual Calibration area. Then the instructions where the PGxx must be connected are displayed in the pop-up window.
5. When the Agilent 81110A is exist, the 81110A Timing Calibration is sensitive. Click the **Perform** button in the 81110A area. Then the timing calibration is executed on all of the 81110A in 4072A/4073A.
6. Follow the displayed instructions. Then the measurements are executed.

Figure 2-27 Calibration Window for PG Level Calibration

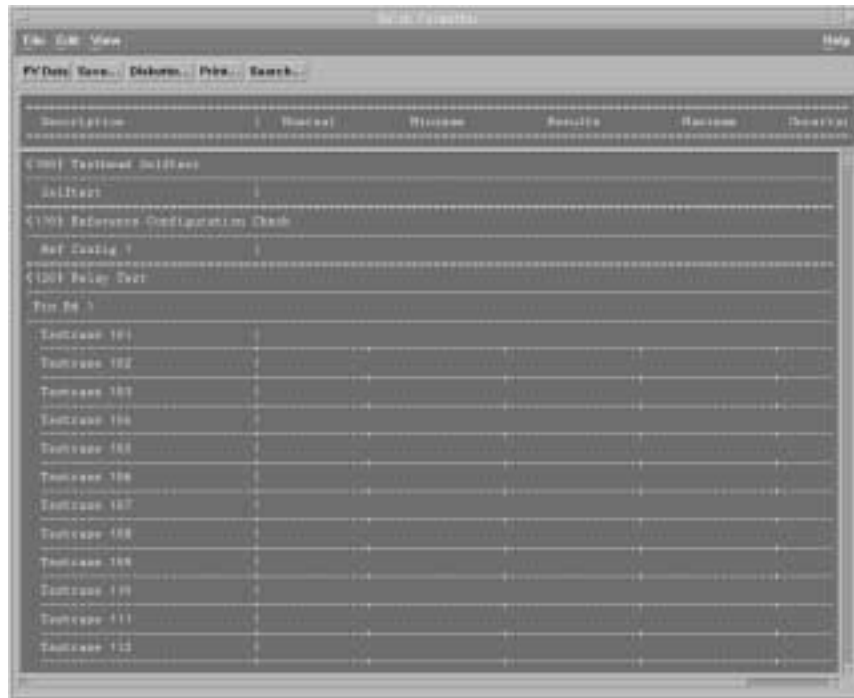


Reporting Test Results

The test results can be printed out on the printer or can be shown on the display. To report the test results, use the following procedure.

1. Click **Quick Formatter...** in the performance verification window or execute the `view4070` command in the `dterm` window.

Figure 2-28 Quick Formatter Window



2. Choose the **File: Load: File** menu in the quick formatter window, and select the data file. The PV data files are stored in the `/var/opt/hp4070/diag` directory. Up to ten PV data files are stored like PVdata, PVdata-1, PVdata-2..., PVdata-9.(PVdata is the newest data.)
3. To print out the performance verification results displayed in the quick formatter window, use the following procedure.
 - a. Click **Print...** in the quick formatter window.
The print window appears.
 - b. Enter the printer name.
 - c. Click **OK**.
4. To store the formatted data in a text file, use the following procedure.
 - a. Click **Print...** in the quick formatter window.
The print window appears.
 - b. Enter as follows:

```
cat > File Name
```

Figure 2-29 Agilent 4072A Test Record Example

```

Performance Test Record for the HP 4070

Test Facility:
Agilent Technologies
-----
Semicon Department
-----
-----

Report Number: 001
-----
Date: Apr 5, 1999
-----
Customer Name: John Smith
-----
Operator Name: Jack Daniel
-----

Ambient temperature: 23.5 deg C      Relative Humidity:      55%      Line Frequency:      50Hz
-----

System Configuration:
System Model No.: 4072A      Serial No.: JP10G20100      System Rev.: B.02.00
-----
Firmware Rev.: 01.24
-----
System Options: 001x36 002x1 011 012 050 200 500 550x2 552
-----

SMU Slot Configuration:
Slot 1: MP SMU      Slot 6: MP SMU
Slot 2: MP SMU      Slot 7: MP SMU
Slot 3:
Slot 4:      Slot 8:
Slot 5:      Slot 9:
Slot 6:      Slot 10:

Pin Configuration:
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 Chuck

CMU Model No.: HP4284A      Serial No.: 2940J07824      Rev.: REV01.20
-----
CMU Options: 001 006
-----

DVM Model No.: HP3458A      Serial No.: 2823A16148      Rev.: 8,2
-----
DVM Options:
-----

PG1 Model No.: HP8114A      Serial No.: DE33700974      Rev.: REV 01.14.00
-----
PG1 Options: 001 UN2
-----

PG2 Model No.: HP8110A      Serial No.: ExchG00015      Rev.: REV 02.02.00
-----
PG2 Options: UN2
-----

PG3 Model No.: HP8110A      Serial No.: DE38704634      Rev.: REV 02.02.00
-----
PG3 Options: UN2
-----

PG4 Model No.:      Serial No.:      Rev.:
-----
PG4 Options:
-----

PG5 Model No.:      Serial No.:      Rev.:
-----
PG5 Options:
-----

Special Notes:

```

Operating Procedure
Reporting Test Results

Test Equipment Used:			
Description	Model No.	Trace No.	Cal Due Date
1. Digital Multi Meter	3458A	33-0134	09 SEP 1999
2. Standard Resistor	16353A	33-0228	16 JUN 1999
3. Standard Capacitor	16380A	33-0239	10 AUG 1999
4. Standard Capacitor	16380C	33-0230	25 JAN 2000
5. Standard Resistor	42037A	33-0235	02 DEC 1999
6. Digitizing Oscilloscope	54750A	33-0198	25 OCT 1999
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			

Description	Nominal	Minimum	Results	Maximum	Uncertainty	Fail
(221) Measurement Pin Location Test						
Pin Bd 1						
Testcase 1						
Pin Bd 2						
Testcase 1						
Pin Bd 3						
Testcase 1						
Pin Bd 4						
Testcase 1						
Pin Bd 5						
Testcase 1						
Pin Bd 6						
Testcase 1						
Pin Bd 7						
Testcase 1						
Pin Bd 8						
Testcase 1						
Pin Bd 9						
Testcase 1						
Pin Bd 10						
Testcase 1						
Pin Bd 11						
Testcase 1						
Pin Bd 12						
Testcase 1						
Pin Bd 13						
Testcase 1						
Pin Bd 14						
Testcase 1						
Pin Bd 15						
Testcase 1						
Pin Bd 16						
Testcase 1						
Pin Bd 17						
Testcase 1						
Pin Bd 18						
Testcase 1						
Pin Bd 19						
Testcase 1						
.						
.						
.						

Operating Procedure
Reporting Test Results

```

=====
(222) Residual Resistance Test
-----
AUX1:Pin Bd 1
-----
|          0.000000E+00 OHM  3.923235E-01 OHM  7.000000E-01 OHM          |
-----
AUX1:Pin Bd 2
-----
|          0.000000E+00 OHM  3.993074E-01 OHM  7.000000E-01 OHM          |
-----
AUX1:Pin Bd 3
-----
|          0.000000E+00 OHM  3.990920E-01 OHM  7.000000E-01 OHM          |
-----
. . . . .
-----
AUX1:Pin Bd 48
-----
|          0.000000E+00 OHM  4.478105E-01 OHM  7.000000E-01 OHM          |
-----
AUX1:Pin Bd 49
-----
|          0.000000E+00 OHM  2.583761E-01 OHM  8.000000E-01 OHM          |
-----
AUX2:Pin Bd 1
-----
|          0.000000E+00 OHM  4.622865E-01 OHM  7.000000E-01 OHM          |
-----
AUX2:Pin Bd 2
-----
|          0.000000E+00 OHM  4.575457E-01 OHM  7.000000E-01 OHM          |
-----
AUX2:Pin Bd 3
-----
|          0.000000E+00 OHM  4.802337E-01 OHM  7.000000E-01 OHM          |
-----
. . . . .
-----
AUX2:Pin Bd 48
-----
|          0.000000E+00 OHM  4.058952E-01 OHM  7.000000E-01 OHM          |
-----
AUX2:Pin Bd 49
-----
|          0.000000E+00 OHM  3.538839E-01 OHM  8.000000E-01 OHM          |
-----
AUX3 Force:Pin Bd 1
-----
|          0.000000E+00 OHM  8.483211E-01 OHM  1.000000E+00 OHM          |
-----
AUX3 Force:Pin Bd 2
-----
|          0.000000E+00 OHM  8.381064E-01 OHM  1.000000E+00 OHM          |
-----
AUX3 Force:Pin Bd 3
-----
|          0.000000E+00 OHM  8.347631E-01 OHM  1.000000E+00 OHM          |
-----
. . . . .
-----
AUX3 Force:Pin Bd 48
-----
|          0.000000E+00 OHM  8.355780E-01 OHM  1.000000E+00 OHM          |
-----
AUX3 Force:Pin Bd 49
-----
|          0.000000E+00 OHM  6.064889E-01 OHM  1.100000E+00 OHM          |
-----
AUX3 Sense:Pin Bd 1
-----
|          0.000000E+00 OHM  1.462709E+00 OHM  2.500000E+00 OHM          |
-----
AUX3 Sense:Pin Bd 2
-----
|          0.000000E+00 OHM  1.419540E+00 OHM  2.500000E+00 OHM          |
-----

```

AUX3 Sense:Pin Bd 3		0.000000E+00 OHM	1.403234E+00 OHM	2.500000E+00 OHM	
.....					
AUX3 Sense:Pin Bd 48		0.000000E+00 OHM	1.681108E+00 OHM	2.500000E+00 OHM	
AUX3 Sense:Pin Bd 49		0.000000E+00 OHM	8.148304E-01 OHM	2.600000E+00 OHM	
AUX4 Force:Pin Bd 1		0.000000E+00 OHM	7.356988E-01 OHM	1.000000E+00 OHM	
AUX4 Force:Pin Bd 2		0.000000E+00 OHM	7.248427E-01 OHM	1.000000E+00 OHM	
AUX4 Force:Pin Bd 3		0.000000E+00 OHM	7.188599E-01 OHM	1.000000E+00 OHM	
.....					
AUX4 Force:Pin Bd 48		0.000000E+00 OHM	6.828477E-01 OHM	1.000000E+00 OHM	
AUX4 Force:Pin Bd 49		0.000000E+00 OHM	4.897607E-01 OHM	1.100000E+00 OHM	
AUX4 Sense:Pin Bd 1		0.000000E+00 OHM	1.501857E+00 OHM	2.500000E+00 OHM	
AUX4 Sense:Pin Bd 2		0.000000E+00 OHM	1.457405E+00 OHM	2.500000E+00 OHM	
AUX4 Sense:Pin Bd 3				
AUX4 Sense:Pin Bd 48		0.000000E+00 OHM	1.482823E+00 OHM	2.500000E+00 OHM	
AUX4 Sense:Pin Bd 49		0.000000E+00 OHM	6.221309E-01 OHM	2.600000E+00 OHM	
AUX5 Force:Pin Bd 1		0.000000E+00 OHM	5.190513E-01 OHM	1.000000E+00 OHM	
AUX5 Force:Pin Bd 2		0.000000E+00 OHM	5.176163E-01 OHM	1.000000E+00 OHM	
AUX5 Force:Pin Bd 3		0.000000E+00 OHM	5.042399E-01 OHM	1.000000E+00 OHM	
.....					
AUX8:Pin Bd 49		0.000000E+00 OHM	2.729026E-01 OHM	1.100000E+00 OHM	

Operating Procedure
Reporting Test Results

```

=====
(223) Isolation and Offset Current Test
-----
SMU1:Pin Bd 1
-----
Offset I (0.0V Force) | -4.000000E-12 A -3.050000E-12 A 4.000000E-12 A |
-----
Leak I (-100.0V Force) | -6.500000E-12 A 1.000000E-12 A 6.500000E-12 A |
-----
Leak I (100.0V Force) | -6.500000E-12 A -2.000000E-13 A 6.500000E-12 A |
-----
SMU1:Pin Bd 2
-----
Offset I (0.0V Force) | -4.000000E-12 A -3.050000E-12 A 4.000000E-12 A |
-----
Leak I (-100.0V Force) | -6.500000E-12 A 1.000000E-12 A 6.500000E-12 A |
-----
Leak I (100.0V Force) | -6.500000E-12 A -2.000000E-13 A 6.500000E-12 A |
-----
SMU1:Pin Bd 3
-----
Offset I (0.0V Force) | -4.000000E-12 A -3.050000E-12 A 4.000000E-12 A |
-----
Leak I (-100.0V Force) | -6.500000E-12 A 1.000000E-12 A 6.500000E-12 A |
-----
Leak I (100.0V Force) | -6.500000E-12 A -2.000000E-13 A 6.500000E-12 A |
-----
. . . . .
. . . . .
. . . . .
. . . . .
-----
SMU1:Pin Bd 48
-----
Offset I (0.0V Force) | -4.000000E-12 A -1.850000E-12 A 4.000000E-12 A |
-----
Leak I (-100.0V Force) | -6.500000E-12 A 2.000000E-12 A 6.500000E-12 A |
-----
Leak I (100.0V Force) | -6.500000E-12 A 2.800000E-12 A 6.500000E-12 A |
-----
SMU1:Pin Bd 49
-----
Offset I (0.0V Force) | -4.000000E-12 A -8.000000E-13 A 4.000000E-12 A |
-----
Leak I (-100.0V Force) | -6.500000E-12 A -3.000000E-13 A 6.500000E-12 A |
-----
Leak I (100.0V Force) | -6.500000E-12 A -1.750000E-12 A 6.500000E-12 A |
-----
SMU2:Pin Bd 1
-----
Offset I (0.0V Force) | -4.000000E-12 A -6.500000E-13 A 4.000000E-12 A |
-----
Leak I (-100.0V Force) | -6.500000E-12 A 1.450000E-12 A 6.500000E-12 A |
-----
Leak I (100.0V Force) | -6.500000E-12 A 1.750000E-12 A 6.500000E-12 A |
-----
SMU2:Pin Bd 2
-----
Offset I (0.0V Force) | -4.000000E-12 A -6.500000E-13 A 4.000000E-12 A |
-----
Leak I (-100.0V Force) | -6.500000E-12 A 1.450000E-12 A 6.500000E-12 A |
-----
Leak I (100.0V Force) | -6.500000E-12 A 1.750000E-12 A 6.500000E-12 A |
-----
SMU2:Pin Bd 3
-----
Offset I (0.0V Force) | -4.000000E-12 A -6.500000E-13 A 4.000000E-12 A |
-----
Leak I (-100.0V Force) | -6.500000E-12 A 1.450000E-12 A 6.500000E-12 A |
-----
Leak I (100.0V Force) | -6.500000E-12 A 1.750000E-12 A 6.500000E-12 A |
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-----
SMU2:Pin Bd 49
-----
Offset I (0.0V Force) | -4.000000E-12 A -4.500000E-13 A 4.000000E-12 A |
-----
Leak I (-100.0V Force) | -6.500000E-12 A 9.500000E-13 A 6.500000E-12 A |
-----

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Leak I (100.0V Force)		-6.500000E-12 A	1.300000E-12 A	6.500000E-12 A	

SMU3:Pin Bd 1					
Offset I (0.0V Force)		-4.000000E-10 A	-1.380000E-11 A	4.000000E-10 A	
Leak I (-100.0V Force)		-1.450000E-09 A	-1.770000E-11 A	1.450000E-09 A	
Leak I (100.0V Force)		-1.450000E-09 A	2.685000E-11 A	1.450000E-09 A	

SMU3:Pin Bd 2					
Offset I (0.0V Force)		-4.000000E-10 A	-1.380000E-11 A	4.000000E-10 A	
Leak I (-100.0V Force)		-1.450000E-09 A	-1.770000E-11 A	1.450000E-09 A	
Leak I (100.0V Force)		-1.450000E-09 A	2.685000E-11 A	1.450000E-09 A	

SMU3:Pin Bd 3					
Offset I (0.0V Force)		-4.000000E-10 A	-1.380000E-11 A	4.000000E-10 A	
Leak I (-100.0V Force)		-1.450000E-09 A	-1.770000E-11 A	1.450000E-09 A	
Leak I (100.0V Force)		-1.450000E-09 A	2.685000E-11 A	1.450000E-09 A	

.					

SMU3:Pin Bd 48					
Offset I (0.0V Force)		-4.000000E-10 A	1.010000E-11 A	4.000000E-10 A	
Leak I (-100.0V Force)		-1.450000E-09 A	-2.320000E-11 A	1.450000E-09 A	
Leak I (100.0V Force)		-1.450000E-09 A	1.990000E-11 A	1.450000E-09 A	

SMU3:Pin Bd 49					
Offset I (0.0V Force)		-4.000000E-10 A	-9.850000E-12 A	4.000000E-10 A	
Leak I (-100.0V Force)		-1.450000E-09 A	-2.000000E-11 A	1.450000E-09 A	
Leak I (100.0V Force)		-1.450000E-09 A	3.035000E-11 A	1.450000E-09 A	

SMU4:Pin Bd 1					
Offset I (0.0V Force)		-4.000000E-10 A	-1.020000E-11 A	4.000000E-10 A	
Leak I (-100.0V Force)		-1.450000E-09 A	-1.560000E-11 A	1.450000E-09 A	
Leak I (100.0V Force)		-1.450000E-09 A	2.515000E-11 A	1.450000E-09 A	

SMU4:Pin Bd 2					
Offset I (0.0V Force)		-4.000000E-10 A	-1.020000E-11 A	4.000000E-10 A	
Leak I (-100.0V Force)		-1.450000E-09 A	-1.560000E-11 A	1.450000E-09 A	
Leak I (100.0V Force)		-1.450000E-09 A	2.515000E-11 A	1.450000E-09 A	

SMU4:Pin Bd 3					
Offset I (0.0V Force)		-4.000000E-10 A	-1.020000E-11 A	4.000000E-10 A	
Leak I (-100.0V Force)		-1.450000E-09 A	-1.560000E-11 A	1.450000E-09 A	
Leak I (100.0V Force)		-1.450000E-09 A	2.515000E-11 A	1.450000E-09 A	

.					

SMU4:Pin Bd 49					
Offset I (0.0V Force)		-4.000000E-10 A	-1.100000E-11 A	4.000000E-10 A	
Leak I (-100.0V Force)		-1.450000E-09 A	-1.820000E-11 A	1.450000E-09 A	
Leak I (100.0V Force)		-1.450000E-09 A	2.845000E-11 A	1.450000E-09 A	

Operating Procedure

Reporting Test Results

=====		
(224) HF Matrix Relay Test		

Manual Test		

Testcase 21- 4-1-1-1		
Testcase 21- 4-1-2-1		
Testcase 21- 4-1-3-1		
Testcase 21- 4-1-4-1		
Testcase 21- 4-1-5-1		
Testcase 21- 4-1-6-1		
Testcase 21- 4-1-7-1		
Testcase 21- 4-1-8-1		
Testcase 21-12-2-1-2		
Testcase 21-12-2-2-2		
Testcase 21-12-2-3-2		
Testcase 21-12-2-4-2		
Testcase 21-12-2-5-2		
Testcase 21-12-2-6-2		
Testcase 21-12-2-7-2		
Testcase 21-12-2-8-2		
Testcase 21-20-3-1-3		
Testcase 21-20-3-2-3		
Testcase 21-20-3-3-3		
Testcase 21-20-3-4-3		
Testcase 21-20-3-5-3		
Testcase 21-20-3-6-3		
Testcase 21-20-3-7-3		
Testcase 21-20-3-8-3		
Testcase 21-44-6-1-1		
Testcase 21-44-6-2-1		
Testcase 21-44-6-3-1		
Testcase 21-44-6-4-1		
Testcase 21-44-6-5-1		
Testcase 21-44-6-6-1		
Testcase 21-44-6-7-1		
Testcase 21-44-6-8-1		
Testcase 21-36-5-1-2		
Testcase 21-36-5-2-2		
Testcase 21-36-5-3-2		
Testcase 21-36-5-4-2		
Testcase 21-36-5-5-2		
Testcase 21-36-5-6-2		
Testcase 21-36-5-7-2		
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Testcase 21-36-5-8-2							
Testcase 21-28-4-1-3							
Testcase 21-28-4-2-3							
Testcase 21-28-4-3-3							
Testcase 21-28-4-4-3							
Testcase 21-28-4-5-3							
Testcase 21-28-4-6-3							
Testcase 21-28-4-7-3							
Testcase 21-28-4-8-3							
=====							
(230) GNDU Output Voltage Test							

GNDU:Pin Bd 4							

		0.000E+00 V	-2.000000E-04 V	-3.531006E-05 V	2.000000E-04 V	8.120E-06 V	
=====							
(231) SMU Voltage Force and Measurement Test							

SMU1:Pin Bd 4							

2V Range (DVM)		-2.000E+00 V	-2.002000E+00 V	-1.999928E+00 V	-1.998000E+00 V	5.010E-05 V	
2V Range (Per Ch AD)		-2.000E+00 V	-2.001528E+00 V	-2.000100E+00 V	-1.998328E+00 V	6.760E-05 V	
2V Range (Ref AD)		-2.000E+00 V	-2.001528E+00 V	-1.999966E+00 V	-1.998328E+00 V	6.760E-05 V	
2V Range (DVM)		0.000E+00 V	-1.000000E-03 V	-5.302316E-05 V	1.000000E-03 V	9.300E-06 V	
2V Range (Per Ch AD)		0.000E+00 V	-8.530444E-04 V	-1.000000E-04 V	7.469981E-04 V	4.620E-05 V	
2V Range (Ref AD)		0.000E+00 V	-8.530444E-04 V	-8.800000E-05 V	7.469981E-04 V	4.620E-05 V	
2V Range (DVM)		2.000E+00 V	1.998000E+00 V	1.999965E+00 V	2.002000E+00 V	5.010E-05 V	
2V Range (Per Ch AD)		2.000E+00 V	1.998365E+00 V	2.000100E+00 V	2.001565E+00 V	6.760E-05 V	
2V Range (Ref AD)		2.000E+00 V	1.998365E+00 V	1.999942E+00 V	2.001565E+00 V	6.760E-05 V	
20V Range (DVM)		-2.000E+01 V	-2.002000E+01 V	-1.999959E+01 V	-1.998000E+01 V	6.940E-04 V	
20V Range (Per Ch AD)		-2.000E+01 V	-2.001559E+01 V	-2.000100E+01 V	-1.998359E+01 V	6.960E-04 V	
20V Range (Ref AD)		-2.000E+01 V	-2.001559E+01 V	-1.999948E+01 V	-1.998359E+01 V	6.960E-04 V	
20V Range (DVM)		0.000E+00 V	-1.000000E-02 V	2.107885E-04 V	1.000000E-02 V	1.520E-04 V	
20V Range (Per Ch AD)		0.000E+00 V	-7.789296E-03 V	0.000000E+00 V	8.210873E-03 V	1.580E-04 V	
20V Range (Ref AD)		0.000E+00 V	-7.789296E-03 V	2.600000E-04 V	8.210873E-03 V	1.580E-04 V	
20V Range (DVM)		2.000E+01 V	1.998000E+01 V	2.000023E+01 V	2.002000E+01 V	6.940E-04 V	
20V Range (Per Ch AD)		2.000E+01 V	1.998423E+01 V	2.000200E+01 V	2.001623E+01 V	6.960E-04 V	
20V Range (Ref AD)		2.000E+01 V	1.998423E+01 V	2.000042E+01 V	2.001623E+01 V	6.960E-04 V	
40V Range (DVM)		-4.000E+01 V	-4.004000E+01 V	-3.999967E+01 V	-3.996000E+01 V	1.240E-03 V	
40V Range (Per Ch AD)		-4.000E+01 V	-4.003167E+01 V	-4.000200E+01 V	-3.996768E+01 V	1.240E-03 V	
40V Range (Ref AD)		-4.000E+01 V	-4.003167E+01 V	-3.999936E+01 V	-3.996768E+01 V	1.240E-03 V	
40V Range (DVM)		0.000E+00 V	-2.000000E-02 V	-4.233410E-05 V	2.000000E-02 V	1.520E-04 V	
40V Range (Per Ch AD)		0.000E+00 V	-1.604235E-02 V	0.000000E+00 V	1.595768E-02 V	1.580E-04 V	
40V Range (Ref AD)		0.000E+00 V	-1.604235E-02 V	2.000000E-04 V	1.595768E-02 V	1.580E-04 V	
40V Range (DVM)		4.000E+01 V	3.996000E+01 V	4.000025E+01 V	4.004000E+01 V	1.240E-03 V	
40V Range (Per Ch AD)		4.000E+01 V	3.996825E+01 V	4.000400E+01 V	4.003225E+01 V	1.240E-03 V	
40V Range (Ref AD)		4.000E+01 V	3.996825E+01 V	4.000060E+01 V	4.003225E+01 V	1.240E-03 V	
100V Range (DVM)		-1.000E+02 V	-1.001000E+02 V	-9.999698E+01 V	-9.990000E+01 V	2.870E-03 V	

Operating Procedure
Reporting Test Results

100V Range (Per Ch AD)	-1.000E+02 V	-1.000770E+02 V	-1.000050E+02 V	-9.991698E+01 V	2.870E-03 V	
100V Range (Ref AD)	-1.000E+02 V	-1.000770E+02 V	-9.999570E+01 V	-9.991698E+01 V	2.870E-03 V	
100V Range (DVM)	0.000E+00 V	-5.000000E-02 V	1.450649E-03 V	5.000000E-02 V	1.520E-04 V	
100V Range (Per Ch AD)	0.000E+00 V	-3.854993E-02 V	0.000000E+00 V	4.145123E-02 V	1.580E-04 V	
100V Range (Ref AD)	0.000E+00 V	-3.854993E-02 V	1.900000E-03 V	4.145123E-02 V	1.580E-04 V	
100V Range (DVM)	1.000E+02 V	9.990000E+01 V	1.000025E+02 V	1.001000E+02 V	2.870E-03 V	
100V Range (Per Ch AD)	1.000E+02 V	9.992250E+01 V	1.000100E+02 V	1.000825E+02 V	2.870E-03 V	
100V Range (Ref AD)	1.000E+02 V	9.992250E+01 V	1.000028E+02 V	1.000825E+02 V	2.870E-03 V	
SMU2:Pin Bd 4						
2V Range (DVM)	-2.000E+00 V	-2.002000E+00 V	-2.000132E+00 V	-1.998000E+00 V	5.010E-05 V	
2V Range (Per Ch AD)	-2.000E+00 V	-2.001732E+00 V	-2.000300E+00 V	-1.998532E+00 V	6.760E-05 V	
2V Range (Ref AD)	-2.000E+00 V	-2.001732E+00 V	-2.000188E+00 V	-1.998532E+00 V	6.760E-05 V	
2V Range (DVM)	0.000E+00 V	-1.000000E-03 V	-3.694005E-05 V	1.000000E-03 V	9.300E-06 V	
2V Range (Per Ch AD)	0.000E+00 V	-8.369548E-04 V	0.000000E+00 V	7.630747E-04 V	4.620E-05 V	
2V Range (Ref AD)	0.000E+00 V	-8.369548E-04 V	-9.000000E-05 V	7.630747E-04 V	4.620E-05 V	
2V Range (DVM)	2.000E+00 V	1.998000E+00 V	1.999888E+00 V	2.002000E+00 V	5.010E-05 V	
2V Range (Per Ch AD)	2.000E+00 V	1.998288E+00 V	2.000000E+00 V	2.001488E+00 V	6.760E-05 V	
2V Range (Ref AD)	2.000E+00 V	1.998288E+00 V	1.999852E+00 V	2.001488E+00 V	6.760E-05 V	
20V Range (DVM)	-2.000E+01 V	-2.002000E+01 V	-2.000124E+01 V	-1.998000E+01 V	6.940E-04 V	
20V Range (Per Ch AD)	-2.000E+01 V	-2.001725E+01 V	-2.000200E+01 V	-1.998524E+01 V	6.960E-04 V	
20V Range (Ref AD)	-2.000E+01 V	-2.001725E+01 V	-2.000114E+01 V	-1.998524E+01 V	6.960E-04 V	
20V Range (DVM)	0.000E+00 V	-1.000000E-02 V	3.743040E-04 V	1.000000E-02 V	1.520E-04 V	
20V Range (Per Ch AD)	0.000E+00 V	-7.625846E-03 V	0.000000E+00 V	8.374454E-03 V	1.580E-04 V	
20V Range (Ref AD)	0.000E+00 V	-7.625846E-03 V	4.000000E-04 V	8.374454E-03 V	1.580E-04 V	
20V Range (DVM)	2.000E+01 V	1.998000E+01 V	1.999931E+01 V	2.002000E+01 V	6.940E-04 V	
20V Range (Per Ch AD)	2.000E+01 V	1.998331E+01 V	2.000100E+01 V	2.001531E+01 V	6.960E-04 V	
20V Range (Ref AD)	2.000E+01 V	1.998331E+01 V	1.999940E+01 V	2.001531E+01 V	6.960E-04 V	
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100V Range (Ref AD)	1.000E+02 V	9.991450E+01 V	9.999380E+01 V	1.000745E+02 V	2.870E-03 V	
SMU3:Pin Bd 4						
2V Range (DVM)	-2.000E+00 V	-2.002000E+00 V	-2.000119E+00 V	-1.998000E+00 V	5.010E-05 V	
2V Range (Per Ch AD)	-2.000E+00 V	-2.001719E+00 V	-2.000300E+00 V	-1.998519E+00 V	6.760E-05 V	
2V Range (Ref AD)	-2.000E+00 V	-2.001719E+00 V	-2.000134E+00 V	-1.998519E+00 V	6.760E-05 V	
2V Range (DVM)	0.000E+00 V	-1.000000E-03 V	-5.531320E-06 V	1.000000E-03 V	9.300E-06 V	
2V Range (Per Ch AD)	0.000E+00 V	-8.055335E-04 V	-1.000000E-04 V	7.944709E-04 V	4.620E-05 V	
2V Range (Ref AD)	0.000E+00 V	-8.055335E-04 V	-2.200000E-05 V	7.944709E-04 V	4.620E-05 V	
2V Range (DVM)	2.000E+00 V	1.998000E+00 V	1.999886E+00 V	2.002000E+00 V	5.010E-05 V	
2V Range (Per Ch AD)	2.000E+00 V	1.998286E+00 V	2.000100E+00 V	2.001486E+00 V	6.760E-05 V	
2V Range (Ref AD)	2.000E+00 V	1.998286E+00 V	1.999894E+00 V	2.001486E+00 V	6.760E-05 V	
20V Range (DVM)	-2.000E+01 V	-2.002000E+01 V	-2.000116E+01 V	-1.998000E+01 V	6.940E-04 V	

20V Range (Per Ch AD)	-2.000E+01 V	-2.001716E+01 V	-2.000300E+01 V	-1.998516E+01 V	6.960E-04 V	
20V Range (Ref AD)	-2.000E+01 V	-2.001716E+01 V	-2.000098E+01 V	-1.998516E+01 V	6.960E-04 V	
20V Range (DVM)	0.000E+00 V	-1.000000E-02 V	4.120519E-04 V	1.000000E-02 V	1.520E-04 V	
20V Range (Per Ch AD)	0.000E+00 V	-7.588113E-03 V	0.000000E+00 V	8.412217E-03 V	1.580E-04 V	
20V Range (Ref AD)	0.000E+00 V	-7.588113E-03 V	4.600000E-04 V	8.412217E-03 V	1.580E-04 V	
20V Range (DVM)	2.000E+01 V	1.998000E+01 V	1.999978E+01 V	2.002000E+01 V	6.940E-04 V	
20V Range (Per Ch AD)	2.000E+01 V	1.998378E+01 V	2.000200E+01 V	2.001578E+01 V	6.960E-04 V	
20V Range (Ref AD)	2.000E+01 V	1.998378E+01 V	1.999992E+01 V	2.001578E+01 V	6.960E-04 V	
40V Range (DVM)	-4.000E+01 V	-4.004000E+01 V	-4.000268E+01 V	-3.996000E+01 V	1.240E-03 V	
40V Range (Per Ch AD)	-4.000E+01 V	-4.003468E+01 V	-4.000600E+01 V	-3.997068E+01 V	1.240E-03 V	
40V Range (Ref AD)	-4.000E+01 V	-4.003468E+01 V	-4.000224E+01 V	-3.997068E+01 V	1.240E-03 V	
40V Range (DVM)	0.000E+00 V	-2.000000E-02 V	1.217105E-03 V	2.000000E-02 V	1.520E-04 V	
40V Range (Per Ch AD)	0.000E+00 V	-1.478338E-02 V	2.000000E-03 V	1.721759E-02 V	1.580E-04 V	
40V Range (Ref AD)	0.000E+00 V	-1.478338E-02 V	1.400000E-03 V	1.721759E-02 V	1.580E-04 V	
40V Range (DVM)	4.000E+01 V	3.996000E+01 V	3.999925E+01 V	4.004000E+01 V	1.240E-03 V	
40V Range (Per Ch AD)	4.000E+01 V	3.996725E+01 V	4.000400E+01 V	4.003124E+01 V	1.240E-03 V	
40V Range (Ref AD)	4.000E+01 V	3.996725E+01 V	3.999948E+01 V	4.003124E+01 V	1.240E-03 V	
100V Range (DVM)	-1.000E+02 V	-1.001000E+02 V	-1.000058E+02 V	-9.990000E+01 V	2.870E-03 V	
100V Range (Per Ch AD)	-1.000E+02 V	-1.000858E+02 V	-1.000100E+02 V	-9.992584E+01 V	2.870E-03 V	
100V Range (Ref AD)	-1.000E+02 V	-1.000858E+02 V	-1.000035E+02 V	-9.992584E+01 V	2.870E-03 V	
100V Range (DVM)	0.000E+00 V	-5.000000E-02 V	-1.225925E-04 V	5.000000E-02 V	1.520E-04 V	
100V Range (Per Ch AD)	0.000E+00 V	-4.012264E-02 V	0.000000E+00 V	3.987746E-02 V	1.580E-04 V	
100V Range (Ref AD)	0.000E+00 V	-4.012264E-02 V	4.000000E-04 V	3.987746E-02 V	1.580E-04 V	
100V Range (DVM)	1.000E+02 V	9.990000E+01 V	1.000022E+02 V	1.001000E+02 V	2.870E-03 V	
100V Range (Per Ch AD)	1.000E+02 V	9.992216E+01 V	1.000100E+02 V	1.000822E+02 V	2.870E-03 V	
100V Range (Ref AD)	1.000E+02 V	9.992216E+01 V	1.000015E+02 V	1.000822E+02 V	2.870E-03 V	
SMU4:Pin Bd 4						
2V Range (DVM)	-2.000E+00 V	-2.002000E+00 V	-1.999907E+00 V	-1.998000E+00 V	5.010E-05 V	
2V Range (Per Ch AD)	-2.000E+00 V	-2.001507E+00 V	-2.000000E+00 V	-1.998308E+00 V	6.760E-05 V	
2V Range (Ref AD)	-2.000E+00 V	-2.001507E+00 V	-1.999904E+00 V	-1.998308E+00 V	6.760E-05 V	
2V Range (DVM)	0.000E+00 V	-1.000000E-03 V	-3.170820E-06 V	1.000000E-03 V	9.300E-06 V	
2V Range (Per Ch AD)	0.000E+00 V	-8.031721E-04 V	0.000000E+00 V	7.968304E-04 V	4.620E-05 V	
2V Range (Ref AD)	0.000E+00 V	-8.031721E-04 V	0.000000E+00 V	7.968304E-04 V	4.620E-05 V	
2V Range (DVM)	2.000E+00 V	1.998000E+00 V	2.000094E+00 V	2.002000E+00 V	5.010E-05 V	
2V Range (Per Ch AD)	2.000E+00 V	1.998494E+00 V	2.000200E+00 V	2.001694E+00 V	6.760E-05 V	
2V Range (Ref AD)	2.000E+00 V	1.998494E+00 V	2.000112E+00 V	2.001694E+00 V	6.760E-05 V	
.						
100V Range (DVM)	1.000E+02 V	9.990000E+01 V	1.000068E+02 V	1.001000E+02 V	2.870E-03 V	
100V Range (Per Ch AD)	1.000E+02 V	9.992682E+01 V	1.000150E+02 V	1.000868E+02 V	2.870E-03 V	
100V Range (Ref AD)	1.000E+02 V	9.992682E+01 V	1.000068E+02 V	1.000868E+02 V	2.870E-03 V	

Operating Procedure
Reporting Test Results

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(232) SMU Current Force and Measurement Test
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SMU1:Pin Bd 8/GNDU:Pin Bd 16
-----
100nA Range (G-F) | 0.000E+00 V -2.000000E-03 V 1.348643E-04 V 2.000000E-03 V 0.000E+00 V |
-----
100nA Range (G-F) | 0.000E+00 V -2.000000E-03 V 1.315193E-04 V 2.000000E-03 V 0.000E+00 V |
-----
100nA Range (G-F) | 0.000E+00 V -2.000000E-03 V 1.312826E-04 V 2.000000E-03 V 0.000E+00 V |
-----
100nA Range (G-F) | 0.000E+00 V -2.000000E-03 V 1.303869E-04 V 2.000000E-03 V 0.000E+00 V |
-----
1uA Range (G-F) | 0.000E+00 V -2.000000E-03 V 1.264677E-04 V 2.000000E-03 V 0.000E+00 V |
-----
1uA Range (G-F) | 0.000E+00 V -2.000000E-03 V 1.259993E-04 V 2.000000E-03 V 0.000E+00 V |
-----
1uA Range (G-F) | 0.000E+00 V -2.000000E-03 V 1.248112E-04 V 2.000000E-03 V 0.000E+00 V |
-----
1uA Range (G-F) | 0.000E+00 V -2.000000E-03 V 1.245900E-04 V 2.000000E-03 V 0.000E+00 V |
-----
1nA Range (DVM) | -1.000E-09 A -1.014000E-09 A -1.001257E-09 A -9.860000E-10 A 7.030E-13 A |
-----
1nA Range (Per Ch AD) | -1.000E-09 A -1.015269E-09 A -1.000150E-09 A -9.872442E-10 A 7.130E-13 A |
-----
1nA Range (Ref AD) | -1.000E-09 A -1.015269E-09 A -1.000029E-09 A -9.872442E-10 A 7.130E-13 A |
-----
1nA Range (DVM) | -1.000E-10 A -1.050000E-10 A -1.002523E-10 A -9.500000E-11 A 2.420E-13 A |
-----
1nA Range (Per Ch AD) | -1.000E-10 A -1.052548E-10 A -1.000000E-10 A -9.524977E-11 A 2.820E-13 A |
-----
1nA Range (Ref AD) | -1.000E-10 A -1.052548E-10 A -1.000200E-10 A -9.524977E-11 A 2.820E-13 A |
-----
1nA Range (DVM) | 1.000E-10 A 9.500000E-11 A 1.002937E-10 A 1.050000E-10 A 2.420E-13 A |
-----
1nA Range (Per Ch AD) | 1.000E-10 A 9.529076E-11 A 1.000500E-10 A 1.052966E-10 A 2.820E-13 A |
-----
1nA Range (Ref AD) | 1.000E-10 A 9.529076E-11 A 1.000230E-10 A 1.052966E-10 A 2.820E-13 A |
-----
1nA Range (DVM) | 1.000E-09 A 9.860000E-10 A 1.001419E-09 A 1.014000E-09 A 7.030E-13 A |
-----
1nA Range (Per Ch AD) | 1.000E-09 A 9.874051E-10 A 1.000100E-09 A 1.015433E-09 A 7.130E-13 A |
-----
1nA Range (Ref AD) | 1.000E-09 A 9.874051E-10 A 1.000031E-09 A 1.015433E-09 A 7.130E-13 A |
-----
10nA Range (DVM) | -1.000E-08 A -1.011300E-08 A -1.001247E-08 A -9.887000E-09 A 6.440E-12 A |
-----
10nA Range (Per Ch AD) | -1.000E-08 A -1.012560E-08 A -1.000100E-08 A -9.899349E-09 A 6.440E-12 A |
-----
10nA Range (Ref AD) | -1.000E-08 A -1.012560E-08 A -1.000028E-08 A -9.899349E-09 A 6.440E-12 A |
-----
10nA Range (DVM) | -1.000E-09 A -1.023000E-09 A -1.001186E-09 A -9.770000E-10 A 1.430E-12 A |
-----
10nA Range (Per Ch AD) | -1.000E-09 A -1.024198E-09 A -1.000000E-09 A -9.781739E-10 A 1.440E-12 A |
-----
10nA Range (Ref AD) | -1.000E-09 A -1.024198E-09 A -1.000240E-09 A -9.781739E-10 A 1.440E-12 A |
-----
10nA Range (DVM) | 1.000E-09 A 9.770000E-10 A 1.001263E-09 A 1.023000E-09 A 1.430E-12 A |
-----
10nA Range (Per Ch AD) | 1.000E-09 A 9.782508E-10 A 1.000500E-09 A 1.024276E-09 A 1.440E-12 A |
-----
10nA Range (Ref AD) | 1.000E-09 A 9.782508E-10 A 1.000050E-09 A 1.024276E-09 A 1.440E-12 A |
-----
10nA Range (DVM) | 1.000E-08 A 9.887000E-09 A 1.001284E-08 A 1.011300E-08 A 6.440E-12 A |
-----
10nA Range (Per Ch AD) | 1.000E-08 A 9.899715E-09 A 1.000100E-08 A 1.012597E-08 A 6.440E-12 A |
-----
10nA Range (Ref AD) | 1.000E-08 A 9.899715E-09 A 1.000015E-08 A 1.012597E-08 A 6.440E-12 A |
-----
100nA Range (DVM) | -1.000E-07 A -1.003000E-07 A -1.000007E-07 A -9.970000E-08 A 1.690E-11 A |
-----
100nA Range (Per Ch AD) | -1.000E-07 A -1.002507E-07 A -1.000100E-07 A -9.975066E-08 A 1.690E-11 A |
-----
100nA Range (Ref AD) | -1.000E-07 A -1.002507E-07 A -1.000026E-07 A -9.975066E-08 A 1.690E-11 A |
-----
100nA Range (DVM) | -1.000E-08 A -1.012000E-08 A -1.000375E-08 A -9.880000E-09 A 1.180E-11 A |
-----
100nA Range (Per Ch AD) | -1.000E-08 A -1.007375E-08 A -1.000500E-08 A -9.933738E-09 A 1.190E-11 A |
-----
100nA Range (Ref AD) | -1.000E-08 A -1.007375E-08 A -1.000420E-08 A -9.933738E-09 A 1.190E-11 A |
-----
100nA Range (DVM) | 1.000E-08 A 9.880000E-09 A 9.999680E-09 A 1.012000E-08 A 1.180E-11 A |
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100nA Range (Per Ch AD)	1.000E-08 A	9.929680E-09 A	9.995000E-09 A	1.006968E-08 A	1.190E-11 A	
100nA Range (Ref AD)	1.000E-08 A	9.929680E-09 A	9.998000E-09 A	1.006968E-08 A	1.190E-11 A	
100nA Range (DVM)	1.000E-07 A	9.970000E-08 A	1.000020E-07 A	1.003000E-07 A	1.690E-11 A	
100nA Range (Per Ch AD)	1.000E-07 A	9.975197E-08 A	1.000050E-07 A	1.002520E-07 A	1.690E-11 A	
100nA Range (Ref AD)	1.000E-07 A	9.975197E-08 A	1.000008E-07 A	1.002520E-07 A	1.690E-11 A	
1uA Range (DVM)	-1.000E-06 A	-1.003000E-06 A	-1.000014E-06 A	-9.970000E-07 A	1.550E-10 A	
1uA Range (Per Ch AD)	-1.000E-06 A	-1.002514E-06 A	-1.000050E-06 A	-9.975136E-07 A	1.550E-10 A	
1uA Range (Ref AD)	-1.000E-06 A	-1.002514E-06 A	-9.999960E-07 A	-9.975136E-07 A	1.550E-10 A	
1uA Range (DVM)	-1.000E-07 A	-1.012000E-07 A	-1.000378E-07 A	-9.880000E-08 A	1.170E-10 A	
1uA Range (Per Ch AD)	-1.000E-07 A	-1.007379E-07 A	-1.000500E-07 A	-9.933773E-08 A	1.170E-10 A	
1uA Range (Ref AD)	-1.000E-07 A	-1.007379E-07 A	-1.000290E-07 A	-9.933773E-08 A	1.170E-10 A	
1uA Range (DVM)	1.000E-07 A	9.880000E-08 A	1.000131E-07 A	1.012000E-07 A	1.170E-10 A	
1uA Range (Per Ch AD)	1.000E-07 A	9.931308E-08 A	1.000500E-07 A	1.007131E-07 A	1.170E-10 A	
1uA Range (Ref AD)	1.000E-07 A	9.931308E-08 A	1.000190E-07 A	1.007131E-07 A	1.170E-10 A	
1uA Range (DVM)	1.000E-06 A	9.970000E-07 A	1.000001E-06 A	1.003000E-06 A	1.550E-10 A	
1uA Range (Per Ch AD)	1.000E-06 A	9.975013E-07 A	1.000050E-06 A	1.002501E-06 A	1.550E-10 A	
1uA Range (Ref AD)	1.000E-06 A	9.975013E-07 A	9.999900E-07 A	1.002501E-06 A	1.550E-10 A	
10uA Range (DVM)	-1.000E-05 A	-1.002200E-05 A	-1.000014E-05 A	-9.978000E-06 A	1.470E-09 A	
10uA Range (Per Ch AD)	-1.000E-05 A	-1.001514E-05 A	-1.000100E-05 A	-9.985144E-06 A	1.470E-09 A	
10uA Range (Ref AD)	-1.000E-05 A	-1.001514E-05 A	-1.000035E-05 A	-9.985144E-06 A	1.470E-09 A	
10uA Range (DVM)	-1.000E-06 A	-1.011200E-06 A	-1.000272E-06 A	-9.888000E-07 A	1.170E-09 A	
10uA Range (Per Ch AD)	-1.000E-06 A	-1.006272E-06 A	-1.000000E-06 A	-9.942713E-07 A	1.180E-09 A	
10uA Range (Ref AD)	-1.000E-06 A	-1.006272E-06 A	-1.000180E-06 A	-9.942713E-07 A	1.180E-09 A	
10uA Range (DVM)	1.000E-06 A	9.888000E-07 A	1.000185E-06 A	1.011200E-06 A	1.170E-09 A	
10uA Range (Per Ch AD)	1.000E-06 A	9.941845E-07 A	1.000500E-06 A	1.006185E-06 A	1.180E-09 A	
10uA Range (Ref AD)	1.000E-06 A	9.941845E-07 A	1.000220E-06 A	1.006185E-06 A	1.180E-09 A	
10uA Range (DVM)	1.000E-05 A	9.978000E-06 A	1.000012E-05 A	1.002200E-05 A	1.470E-09 A	
10uA Range (Per Ch AD)	1.000E-05 A	9.985123E-06 A	1.000100E-05 A	1.001512E-05 A	1.470E-09 A	
10uA Range (Ref AD)	1.000E-05 A	9.985123E-06 A	1.000041E-05 A	1.001512E-05 A	1.470E-09 A	
100uA Range (DVM)	-1.000E-04 A	-1.002200E-04 A	-9.999924E-05 A	-9.978000E-05 A	1.120E-08 A	
100uA Range (Per Ch AD)	-1.000E-04 A	-1.001492E-04 A	-1.000050E-04 A	-9.984924E-05 A	1.120E-08 A	
100uA Range (Ref AD)	-1.000E-04 A	-1.001492E-04 A	-9.999990E-05 A	-9.984924E-05 A	1.120E-08 A	
100uA Range (DVM)	-1.000E-05 A	-1.011200E-05 A	-1.000122E-05 A	-9.888000E-06 A	5.100E-09 A	
100uA Range (Per Ch AD)	-1.000E-05 A	-1.006122E-05 A	-1.000000E-05 A	-9.941214E-06 A	5.110E-09 A	
100uA Range (Ref AD)	-1.000E-05 A	-1.006122E-05 A	-1.000080E-05 A	-9.941214E-06 A	5.110E-09 A	
100uA Range (DVM)	1.000E-05 A	9.888000E-06 A	1.000143E-05 A	1.011200E-05 A	5.100E-09 A	
100uA Range (Per Ch AD)	1.000E-05 A	9.941431E-06 A	1.000500E-05 A	1.006143E-05 A	5.110E-09 A	
100uA Range (Ref AD)	1.000E-05 A	9.941431E-06 A	1.000150E-05 A	1.006143E-05 A	5.110E-09 A	
100uA Range (DVM)	1.000E-04 A	9.978000E-05 A	1.000009E-04 A	1.002200E-04 A	1.120E-08 A	
100uA Range (Per Ch AD)	1.000E-04 A	9.985086E-05 A	1.000100E-04 A	1.001509E-04 A	1.120E-08 A	
100uA Range (Ref AD)	1.000E-04 A	9.985086E-05 A	1.000016E-04 A	1.001509E-04 A	1.120E-08 A	
1mA Range (DVM)	-1.000E-03 A	-1.002200E-03 A	-1.000038E-03 A	-9.978000E-04 A	1.120E-07 A	

Operating Procedure
Reporting Test Results

1mA Range (Per Ch AD)	-1.000E-03 A	-1.001538E-03 A	-1.000100E-03 A	-9.985380E-04 A	1.120E-07 A	
1mA Range (Ref AD)	-1.000E-03 A	-1.001538E-03 A	-1.000018E-03 A	-9.985380E-04 A	1.120E-07 A	
1mA Range (DVM)	-1.000E-04 A	-1.011200E-04 A	-9.999843E-05 A	-9.888000E-05 A	3.860E-08 A	
1mA Range (Per Ch AD)	-1.000E-04 A	-1.005984E-04 A	-1.000000E-04 A	-9.939843E-05 A	3.860E-08 A	
1mA Range (Ref AD)	-1.000E-04 A	-1.005984E-04 A	-9.999900E-05 A	-9.939843E-05 A	3.860E-08 A	
1mA Range (DVM)	1.000E-04 A	9.888000E-05 A	1.000229E-04 A	1.011200E-04 A	3.860E-08 A	
1mA Range (Per Ch AD)	1.000E-04 A	9.942289E-05 A	1.000000E-04 A	1.006229E-04 A	3.860E-08 A	
1mA Range (Ref AD)	1.000E-04 A	9.942289E-05 A	1.000220E-04 A	1.006229E-04 A	3.860E-08 A	
1mA Range (DVM)	1.000E-03 A	9.978000E-04 A	1.000080E-03 A	1.002200E-03 A	1.120E-07 A	
1mA Range (Per Ch AD)	1.000E-03 A	9.985799E-04 A	1.000100E-03 A	1.001580E-03 A	1.120E-07 A	
1mA Range (Ref AD)	1.000E-03 A	9.985799E-04 A	1.000048E-03 A	1.001580E-03 A	1.120E-07 A	
10mA Range (DVM)	-1.000E-02 A	-1.002200E-02 A	-1.000054E-02 A	-9.978000E-03 A	1.370E-06 A	
10mA Range (Per Ch AD)	-1.000E-02 A	-1.001554E-02 A	-1.000100E-02 A	-9.985535E-03 A	1.570E-06 A	
10mA Range (Ref AD)	-1.000E-02 A	-1.001554E-02 A	-1.000010E-02 A	-9.985535E-03 A	1.570E-06 A	
10mA Range (DVM)	-1.000E-03 A	-1.011200E-03 A	-9.998642E-04 A	-9.888000E-04 A	3.850E-07 A	
10mA Range (Per Ch AD)	-1.000E-03 A	-1.005864E-03 A	-1.000000E-03 A	-9.938643E-04 A	3.860E-07 A	
10mA Range (Ref AD)	-1.000E-03 A	-1.005864E-03 A	-9.999000E-04 A	-9.938643E-04 A	3.860E-07 A	
10mA Range (DVM)	1.000E-03 A	9.888000E-04 A	1.000011E-03 A	1.011200E-03 A	3.850E-07 A	
10mA Range (Per Ch AD)	1.000E-03 A	9.940113E-04 A	1.000500E-03 A	1.006011E-03 A	3.860E-07 A	
10mA Range (Ref AD)	1.000E-03 A	9.940113E-04 A	1.000010E-03 A	1.006011E-03 A	3.860E-07 A	
10mA Range (DVM)	1.000E-02 A	9.978000E-03 A	1.000074E-02 A	1.002200E-02 A	1.370E-06 A	
10mA Range (Per Ch AD)	1.000E-02 A	9.985739E-03 A	1.000100E-02 A	1.001574E-02 A	1.570E-06 A	
10mA Range (Ref AD)	1.000E-02 A	9.985739E-03 A	1.000029E-02 A	1.001574E-02 A	1.570E-06 A	
100mA Range (DVM)	-1.000E-01 A	-1.002200E-01 A	-9.999771E-02 A	-9.978000E-02 A	1.940E-05 A	
100mA Range (Per Ch AD)	-1.000E-01 A	-1.001477E-01 A	-1.000050E-01 A	-9.984771E-02 A	2.150E-05 A	
100mA Range (Ref AD)	-1.000E-01 A	-1.001477E-01 A	-9.999910E-02 A	-9.984771E-02 A	2.150E-05 A	
100mA Range (DVM)	-1.000E-02 A	-1.011200E-02 A	-9.997378E-03 A	-9.888000E-03 A	4.250E-06 A	
100mA Range (Per Ch AD)	-1.000E-02 A	-1.005738E-02 A	-1.000000E-02 A	-9.937380E-03 A	4.250E-06 A	
100mA Range (Ref AD)	-1.000E-02 A	-1.005738E-02 A	-9.999000E-03 A	-9.937380E-03 A	4.250E-06 A	
100mA Range (DVM)	1.000E-02 A	9.888000E-03 A	1.000290E-02 A	1.011200E-02 A	4.250E-06 A	
100mA Range (Per Ch AD)	1.000E-02 A	9.942901E-03 A	1.000000E-02 A	1.006291E-02 A	4.250E-06 A	
100mA Range (Ref AD)	1.000E-02 A	9.942901E-03 A	1.000130E-02 A	1.006291E-02 A	4.250E-06 A	
100mA Range (DVM)	1.000E-01 A	9.978000E-02 A	1.000046E-01 A	1.002200E-01 A	1.940E-05 A	
100mA Range (Per Ch AD)	1.000E-01 A	9.985463E-02 A	1.000050E-01 A	1.001546E-01 A	2.150E-05 A	
100mA Range (Ref AD)	1.000E-01 A	9.985463E-02 A	1.000016E-01 A	1.001546E-01 A	2.150E-05 A	
SMU2:Pin Bd 8/GNDU:Pin Bd 16						
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-2.267389E-05 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-2.542811E-05 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-2.606896E-05 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-2.786551E-05 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-3.516098E-05 V	2.000000E-03 V	0.000E+00 V	

1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-3.693887E-05 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-3.731958E-05 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-3.746778E-05 V	2.000000E-03 V	0.000E+00 V	
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100mA Range (DVM)	1.000E-02 A	9.888000E-03 A	1.000499E-02 A	1.011200E-02 A	4.250E-06 A	
100mA Range (Per Ch AD)	1.000E-02 A	9.944985E-03 A	1.000500E-02 A	1.006499E-02 A	4.250E-06 A	
100mA Range (Ref AD)	1.000E-02 A	9.944985E-03 A	1.000470E-02 A	1.006499E-02 A	4.250E-06 A	
100mA Range (DVM)	1.000E-01 A	9.978000E-02 A	1.000118E-01 A	1.002200E-01 A	1.940E-05 A	
100mA Range (Per Ch AD)	1.000E-01 A	9.986177E-02 A	1.000100E-01 A	1.001618E-01 A	2.150E-05 A	
100mA Range (Ref AD)	1.000E-01 A	9.986177E-02 A	1.000055E-01 A	1.001618E-01 A	2.150E-05 A	
SMU3:Pin Bd 8/GNDU:Pin Bd 16						
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.271295E-04 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.256411E-04 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.257772E-04 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.250824E-04 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.194557E-04 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.173508E-04 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.151498E-04 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.163738E-04 V	2.000000E-03 V	0.000E+00 V	
100nA Range (DVM)	-1.000E-07 A	-1.006000E-07 A	-9.999766E-08 A	-9.940000E-08 A	1.690E-11 A	
100nA Range (Per Ch AD)	-1.000E-07 A	-1.005477E-07 A	-1.000050E-07 A	-9.944767E-08 A	1.690E-11 A	
100nA Range (Ref AD)	-1.000E-07 A	-1.005477E-07 A	-1.000006E-07 A	-9.944767E-08 A	1.690E-11 A	
100nA Range (DVM)	-1.000E-08 A	-1.042000E-08 A	-1.000206E-08 A	-9.580000E-09 A	1.180E-11 A	
100nA Range (Per Ch AD)	-1.000E-08 A	-1.037207E-08 A	-1.000000E-08 A	-9.632059E-09 A	1.190E-11 A	
100nA Range (Ref AD)	-1.000E-08 A	-1.037207E-08 A	-1.000100E-08 A	-9.632059E-09 A	1.190E-11 A	
100nA Range (DVM)	1.000E-08 A	9.580000E-09 A	1.000142E-08 A	1.042000E-08 A	1.180E-11 A	
100nA Range (Per Ch AD)	1.000E-08 A	9.631418E-09 A	1.000500E-08 A	1.037142E-08 A	1.190E-11 A	
100nA Range (Ref AD)	1.000E-08 A	9.631418E-09 A	1.000120E-08 A	1.037142E-08 A	1.190E-11 A	
100nA Range (DVM)	1.000E-07 A	9.940000E-08 A	9.999658E-08 A	1.006000E-07 A	1.690E-11 A	
100nA Range (Per Ch AD)	1.000E-07 A	9.944659E-08 A	1.000050E-07 A	1.005466E-07 A	1.690E-11 A	
100nA Range (Ref AD)	1.000E-07 A	9.944659E-08 A	9.999890E-08 A	1.005466E-07 A	1.690E-11 A	
1uA Range (DVM)	-1.000E-06 A	-1.003300E-06 A	-1.000021E-06 A	-9.967000E-07 A	1.550E-10 A	
1uA Range (Per Ch AD)	-1.000E-06 A	-1.002821E-06 A	-1.000100E-06 A	-9.972208E-07 A	1.550E-10 A	
1uA Range (Ref AD)	-1.000E-06 A	-1.002821E-06 A	-1.000024E-06 A	-9.972208E-07 A	1.550E-10 A	
1uA Range (DVM)	-1.000E-07 A	-1.015000E-07 A	-1.000171E-07 A	-9.850000E-08 A	1.170E-10 A	
1uA Range (Per Ch AD)	-1.000E-07 A	-1.010171E-07 A	-1.000500E-07 A	-9.901705E-08 A	1.170E-10 A	
1uA Range (Ref AD)	-1.000E-07 A	-1.010171E-07 A	-1.000370E-07 A	-9.901705E-08 A	1.170E-10 A	
1uA Range (DVM)	1.000E-07 A	9.850000E-08 A	1.000059E-07 A	1.015000E-07 A	1.170E-10 A	
1uA Range (Per Ch AD)	1.000E-07 A	9.900592E-08 A	1.000000E-07 A	1.010059E-07 A	1.170E-10 A	
1uA Range (Ref AD)	1.000E-07 A	9.900592E-08 A	9.998000E-08 A	1.010059E-07 A	1.170E-10 A	

Operating Procedure
Reporting Test Results

1uA Range (DVM)	1.000E-06 A	9.967000E-07 A	1.000041E-06 A	1.003300E-06 A	1.550E-10 A	
1uA Range (Per Ch AD)	1.000E-06 A	9.972405E-07 A	1.000050E-06 A	1.002841E-06 A	1.550E-10 A	
1uA Range (Ref AD)	1.000E-06 A	9.972405E-07 A	9.999920E-07 A	1.002841E-06 A	1.550E-10 A	
10uA Range (DVM)	-1.000E-05 A	-1.002200E-05 A	-9.999541E-06 A	-9.978000E-06 A	1.470E-09 A	
10uA Range (Per Ch AD)	-1.000E-05 A	-1.001454E-05 A	-1.000100E-05 A	-9.984542E-06 A	1.470E-09 A	
10uA Range (Ref AD)	-1.000E-05 A	-1.001454E-05 A	-9.999970E-06 A	-9.984542E-06 A	1.470E-09 A	
10uA Range (DVM)	-1.000E-06 A	-1.011200E-06 A	-9.997625E-07 A	-9.888000E-07 A	1.170E-09 A	
10uA Range (Per Ch AD)	-1.000E-06 A	-1.005762E-06 A	-1.000000E-06 A	-9.937627E-07 A	1.180E-09 A	
10uA Range (Ref AD)	-1.000E-06 A	-1.005762E-06 A	-9.999500E-07 A	-9.937627E-07 A	1.180E-09 A	
10uA Range (DVM)	1.000E-06 A	9.888000E-07 A	1.000339E-06 A	1.011200E-06 A	1.170E-09 A	
10uA Range (Per Ch AD)	1.000E-06 A	9.943390E-07 A	1.000500E-06 A	1.006340E-06 A	1.180E-09 A	
10uA Range (Ref AD)	1.000E-06 A	9.943390E-07 A	1.000140E-06 A	1.006340E-06 A	1.180E-09 A	
10uA Range (DVM)	1.000E-05 A	9.978000E-06 A	1.000033E-05 A	1.002200E-05 A	1.470E-09 A	
10uA Range (Per Ch AD)	1.000E-05 A	9.985330E-06 A	1.000100E-05 A	1.001533E-05 A	1.470E-09 A	
10uA Range (Ref AD)	1.000E-05 A	9.985330E-06 A	1.000034E-05 A	1.001533E-05 A	1.470E-09 A	
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100mA Range (DVM)	1.000E-02 A	9.888000E-03 A	1.000009E-02 A	1.011200E-02 A	4.250E-06 A	
100mA Range (Per Ch AD)	1.000E-02 A	9.940086E-03 A	1.000500E-02 A	1.006009E-02 A	4.250E-06 A	
100mA Range (Ref AD)	1.000E-02 A	9.940086E-03 A	9.999000E-03 A	1.006009E-02 A	4.250E-06 A	
100mA Range (DVM)	1.000E-01 A	9.978000E-02 A	1.000041E-01 A	1.002200E-01 A	1.940E-05 A	
100mA Range (Per Ch AD)	1.000E-01 A	9.985410E-02 A	1.000100E-01 A	1.001541E-01 A	2.150E-05 A	
100mA Range (Ref AD)	1.000E-01 A	9.985410E-02 A	1.000013E-01 A	1.001541E-01 A	2.150E-05 A	
SMU4:Pin Bd 8/GNDU:Pin Bd 16						
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-9.688868E-06 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-9.334382E-06 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-8.625411E-06 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-8.965288E-06 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-1.260150E-05 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-1.144053E-05 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-1.134900E-05 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	-1.089085E-05 V	2.000000E-03 V	0.000E+00 V	
100nA Range (DVM)	-1.000E-07 A	-1.006000E-07 A	-1.000007E-07 A	-9.940000E-08 A	1.690E-11 A	
100nA Range (Per Ch AD)	-1.000E-07 A	-1.005507E-07 A	-1.000050E-07 A	-9.945069E-08 A	1.690E-11 A	
100nA Range (Ref AD)	-1.000E-07 A	-1.005507E-07 A	-9.999990E-08 A	-9.945069E-08 A	1.690E-11 A	
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100mA Range (Per Ch AD)	1.000E-02 A	9.940744E-03 A	1.000000E-02 A	1.006075E-02 A	4.250E-06 A	
100mA Range (Ref AD)	1.000E-02 A	9.940744E-03 A	1.000110E-02 A	1.006075E-02 A	4.250E-06 A	
100mA Range (DVM)	1.000E-01 A	9.978000E-02 A	1.000069E-01 A	1.002200E-01 A	1.940E-05 A	
100mA Range (Per Ch AD)	1.000E-01 A	9.985685E-02 A	1.000100E-01 A	1.001569E-01 A	2.150E-05 A	
100mA Range (Ref AD)	1.000E-01 A	9.985685E-02 A	1.000016E-01 A	1.001569E-01 A	2.150E-05 A	

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(233) SMU Output Resistance Test
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SMU1:Pin Bd 4
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| 0.000000E+00 OHM 3.517038E-01 OHM 7.000000E-01 OHM |
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SMU2:Pin Bd 4
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| 0.000000E+00 OHM 3.942626E-01 OHM 7.000000E-01 OHM |
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SMU3:Pin Bd 4
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| -1.000000E-03 OHM 1.546951E-04 OHM 3.000000E-03 OHM |
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SMU4:Pin Bd 4
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| -1.000000E-03 OHM 1.437460E-04 OHM 3.000000E-03 OHM |
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(240) CMU Capacitance and Conductance Test
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CMH:Pin Bd 4/CML:Pin Bd 8
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16383A 100pF Standard, 1MHz | 1.000E-10 F 9.890099E-11 F 1.000691E-10 F 1.011010E-10 F 1.300E-13 F |
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16383A 100pF Standard, 1MHz | 0.000E+00 S -5.670038E-06 S 7.279750E-07 S 5.670038E-06 S 5.460E-07 S |
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16383A 100pF Standard, 100kHz | 1.000E-10 F 9.939801E-11 F 1.000118E-10 F 1.005980E-10 F 5.641E-14 F |
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16383A 100pF Standard, 100kHz | 0.000E+00 S -3.779962E-07 S 5.876113E-10 S 3.779962E-07 S 2.570E-08 S |
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16383A 100pF Standard, 10kHz | 1.000E-10 F 9.949801E-11 F 1.000037E-10 F 1.004980E-10 F 5.631E-14 F |
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16383A 100pF Standard, 10kHz | 0.000E+00 S -3.149962E-08 S -3.643954E-10 S 3.149962E-08 S 2.520E-09 S |
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16383A 100pF Standard, 1kHz | 1.000E-10 F 9.909801E-11 F 9.998780E-11 F 1.008980E-10 F 5.810E-14 F |
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16383A 100pF Standard, 1kHz | 0.000E+00 S -5.669950E-09 S -2.132805E-11 S 5.669950E-09 S 2.520E-10 S |
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CMH:Pin Bd 36/CML:Pin Bd 40
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16384A 1000pF Standard, 1MHz | 1.000E-09 F 9.833940E-10 F 9.974680E-10 F 1.017406E-09 F 1.990E-12 F |
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16384A 1000pF Standard, 1MHz | 0.000E+00 S -1.512554E-04 S 9.745801E-06 S 1.512554E-04 S 4.990E-06 S |
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16384A 1000pF Standard, 100k | 1.000E-09 F 9.951196E-10 F 9.998924E-10 F 1.005120E-09 F 7.120E-13 F |
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16384A 1000pF Standard, 100k | 0.000E+00 S -3.780302E-06 S 1.756517E-08 S 3.780302E-06 S 2.560E-07 S |
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16384A 1000pF Standard, 10kHz | 1.000E-09 F 9.961196E-10 F 9.999094E-10 F 1.004120E-09 F 7.100E-13 F |
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16384A 1000pF Standard, 10kHz | 0.000E+00 S -2.520227E-07 S 8.722580E-10 S 2.520227E-07 S 2.570E-08 S |
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16384A 1000pF Standard, 1kHz | 1.000E-09 F 9.961196E-10 F 1.000133E-09 F 1.004120E-09 F 7.250E-13 F |
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16384A 1000pF Standard, 1kHz | 0.000E+00 S -2.520227E-08 S 6.295535E-10 S 2.520227E-08 S 2.520E-09 S |
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CMH:Pin Bd 36/CML:Pin Bd 40
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16385A 0.01uF Standard, 100k | 1.000E-08 F 9.930965E-09 F 9.994544E-09 F 1.007103E-08 F 5.970E-12 F |
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16385A 0.01uF Standard, 100k | 1.885E-06 S -6.113309E-05 S -1.127485E-06 S 6.490338E-05 S 3.930E-06 S |
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16385A 0.01uF Standard, 10kHz | 9.999E-09 F 9.959202E-09 F 9.996142E-09 F 1.003920E-08 F 3.610E-12 F |
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16385A 0.01uF Standard, 10kHz | 0.000E+00 S -2.519849E-06 S 5.295970E-08 S 2.519849E-06 S 2.520E-07 S |
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16385A 0.01uF Standard, 1kHz | 1.000E-08 F 9.959897E-09 F 1.000261E-08 F 1.003990E-08 F 3.120E-12 F |
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16385A 0.01uF Standard, 1kHz | 6.283E-09 S -2.457338E-07 S -5.385984E-09 S 2.583001E-07 S 2.520E-08 S |
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CMH:Pin Bd 4/CML:Pin Bd 8
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16386A 0.1uF Standard, 10kHz | 9.996E-08 F 9.956491E-08 F 9.994723E-08 F 1.003651E-07 F 3.670E-11 F |
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16386A 0.1uF Standard, 10kHz | 1.256E-06 S -4.913716E-05 S 7.157860E-06 S 5.164956E-05 S 2.740E-06 S |
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16386A 0.1uF Standard, 1kHz | 9.998E-08 F 9.958199E-08 F 9.997676E-08 F 1.003820E-07 F 3.880E-11 F |
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16386A 0.1uF Standard, 1kHz | 1.256E-07 S -2.394396E-06 S 1.911274E-07 S 2.645678E-06 S 1.260E-07 S |
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CMH:Pin Bd 4/CML:Pin Bd 8
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Operating Procedure
Reporting Test Results

42037A 1kohm Standard, 1MHz	1.910E-13 F	-1.063113E-12 F	-1.064183E-13 F	1.445085E-12 F	1.990E-13 F	
42037A 1kohm Standard, 1MHz	1.000E-03 S	9.903012E-04 S	1.001364E-03 S	1.010099E-03 S	1.410E-06 S	
42037A 1kohm Standard, 100kHz	1.592E-13 F	-8.191164E-12 F	-4.274491E-13 F	8.509474E-12 F	1.960E-13 F	
42037A 1kohm Standard, 100kHz	1.000E-03 S	9.958393E-04 S	9.999068E-04 S	1.004361E-03 S	8.140E-07 S	
42037A 1kohm Standard, 10kHz	1.800E-13 F	-5.744578E-11 F	-4.043643E-12 F	5.780578E-11 F	3.020E-13 F	
42037A 1kohm Standard, 10kHz	1.000E-03 S	9.964996E-04 S	9.998203E-04 S	1.003760E-03 S	2.500E-07 S	
42037A 1kohm Standard, 1kHz	1.800E-13 F	-5.760729E-10 F	-3.367731E-11 F	5.764329E-10 F	9.020E-13 F	
42037A 1kohm Standard, 1kHz	1.000E-03 S	9.964996E-04 S	9.998400E-04 S	1.003760E-03 S	2.880E-07 S	
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(241) CMU DC Bias Output Voltage Test						

CMH:Pin Bd 8/CML:Pin Bd 16						

-40.0V Force	-4.000E+01 V	-4.005000E+01 V	-3.999978E+01 V	-3.995000E+01 V	1.650E-03 V	
0.0V Force	0.000E+00 V	-1.000000E-02 V	-1.892667E-04 V	1.000000E-02 V	1.520E-04 V	
40.0V Force	4.000E+01 V	3.995000E+01 V	3.999978E+01 V	4.005000E+01 V	1.650E-03 V	
=====						
(250) DVM Differential Voltage Measurement Test						

DVMH:Pin Bd 32/DVML:Pin Bd 16/SMU2:Pin Bd 4/GNDU:Pin Bd 8						

100.0V Range -100.0V Measure	-1.000E+02 V	-1.000279E+02 V	-1.000074E+02 V	-9.998594E+01 V	2.870E-03 V	
100.0V Range 0.0V Measure	-1.177E-03 V	-2.177300E-03 V	-1.143121E-03 V	-1.768290E-04 V	2.070E-04 V	
100.0V Range 100.0V Measure	9.999E+01 V	9.997351E+01 V	9.999501E+01 V	1.000155E+02 V	2.870E-03 V	
10.0V Range -10.0V Measure	-1.000E+01 V	-1.000220E+01 V	-1.000099E+01 V	-9.999595E+00 V	2.220E-04 V	
10.0V Range 0.0V Measure	3.692E-04 V	6.916985E-05 V	3.664765E-04 V	6.692437E-04 V	2.980E-05 V	
10.0V Range 10.0V Measure	9.999E+00 V	9.997264E+00 V	9.998657E+00 V	9.999863E+00 V	2.220E-04 V	
1.0V Range -1.0V Measure	-1.000E+00 V	-1.000431E+00 V	-1.000042E+00 V	-9.996313E-01 V	2.900E-05 V	
1.0V Range 0.0V Measure	6.397E-05 V	-2.360348E-04 V	6.160203E-05 V	3.639780E-04 V	9.830E-06 V	
1.0V Range 1.0V Measure	1.000E+00 V	9.995697E-01 V	9.999776E-01 V	1.000370E+00 V	2.900E-05 V	
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(262) Pulse Switch Test						

PSI11 - PS01						

Switch:ON		0.000000E+00 OHM	1.398212E+00 OHM	5.000000E+00 OHM		
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM			

PSI12 - PS01						

Switch:ON		0.000000E+00 OHM	1.578737E+00 OHM	5.000000E+00 OHM		
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM			

PSI21 - PS02						

Switch:ON		0.000000E+00 OHM	1.462815E+00 OHM	5.000000E+00 OHM		
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM			

PSI31 - PS03						

Switch:ON		0.000000E+00 OHM	1.462421E+00 OHM	5.000000E+00 OHM		
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM			

PSI41 - PS04						

Switch:ON		0.000000E+00 OHM	1.461167E+00 OHM	5.000000E+00 OHM		
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM			

PSI51 - PS05						

Switch:ON		0.000000E+00 OHM	1.384150E+00 OHM	5.000000E+00 OHM		

Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM				
PSI61 - PSO6							
Switch:ON		0.000000E+00 OHM	1.521016E+00 OHM	5.000000E+00 OHM			
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM				
PSI62 - PSO6							
Switch:ON		0.000000E+00 OHM	1.428398E+00 OHM	5.000000E+00 OHM			
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM				
PSI71 - PSO7							
Switch:ON		0.000000E+00 OHM	1.424200E+00 OHM	5.000000E+00 OHM			
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM				
PSI72 - PSO7							
Switch:ON		0.000000E+00 OHM	1.449194E+00 OHM	5.000000E+00 OHM			
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM				
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(270) Pulse Level Test							

PG11:HF port 1:Pin Bd 8							
Amplitude: +2.0V		2.000E+00 V	1.760000E+00 V	2.010295E+00 V	2.240000E+00 V	1.300E-02 V	
Amplitude: +5.0V		5.000E+00 V	4.700000E+00 V	5.030688E+00 V	5.300000E+00 V	1.300E-02 V	
Amplitude: +10.0V		1.000E+01 V	9.600000E+00 V	1.005405E+01 V	1.040000E+01 V	1.300E-02 V	
Amplitude: +20.0V		2.000E+01 V	1.940000E+01 V	2.014922E+01 V	2.060000E+01 V	1.300E-02 V	
Amplitude: +50.0V		5.000E+01 V	4.880000E+01 V	5.042937E+01 V	5.120000E+01 V	1.300E-02 V	
Baseline: -49.9V		-4.990E+01 V	-5.111800E+01 V	-5.042081E+01 V	-4.868200E+01 V	9.460E-03 V	
Baseline: -40.0V		-4.000E+01 V	-4.102000E+01 V	-4.044825E+01 V	-3.898000E+01 V	9.450E-03 V	
Baseline: -20.0V		-2.000E+01 V	-2.062000E+01 V	-2.027481E+01 V	-1.938000E+01 V	9.440E-03 V	
Baseline: -10.0V		-1.000E+01 V	-1.042000E+01 V	-1.020161E+01 V	-9.580000E+00 V	9.220E-03 V	
Baseline: -4.0V		-4.000E+00 V	-4.300000E+00 V	-4.147879E+00 V	-3.700000E+00 V	9.220E-03 V	
Baseline: +0.0V		0.000E+00 V	-2.200000E-01 V	-2.213412E-02 V	2.200000E-01 V	9.220E-03 V	
Baseline: +4.0V		4.000E+00 V	3.700000E+00 V	3.887434E+00 V	4.300000E+00 V	9.220E-03 V	
Baseline: +10.0V		1.000E+01 V	9.580000E+00 V	9.943229E+00 V	1.042000E+01 V	9.220E-03 V	
Baseline: +20.0V		2.000E+01 V	1.938000E+01 V	2.002119E+01 V	2.062000E+01 V	9.440E-03 V	
Baseline: +40.0V		4.000E+01 V	3.898000E+01 V	4.022652E+01 V	4.102000E+01 V	9.450E-03 V	
Baseline: +48.0V		4.800E+01 V	4.682000E+01 V	4.831991E+01 V	4.918000E+01 V	9.460E-03 V	

PG21:HF port 2:Pin Bd 8							
Amplitude: +19.0V		1.900E+01 V	1.847000E+01 V	1.894219E+01 V	1.953000E+01 V	9.440E-03 V	
Amplitude: +10.0V		1.000E+01 V	9.650000E+00 V	9.960522E+00 V	1.035000E+01 V	9.220E-03 V	
Amplitude: +6.0V		6.000E+00 V	5.730000E+00 V	5.990601E+00 V	6.270000E+00 V	9.220E-03 V	
Amplitude: +2.0V		2.000E+00 V	1.810000E+00 V	1.997710E+00 V	2.190000E+00 V	9.220E-03 V	
Amplitude: +1.0V		1.000E+00 V	8.300000E-01 V	9.932061E-01 V	1.170000E+00 V	9.220E-03 V	
Amplitude: +0.2V		2.000E-01 V	4.600000E-02 V	1.884628E-01 V	3.540000E-01 V	9.220E-03 V	
Amplitude: -0.2V		-2.000E-01 V	-3.540000E-01 V	-2.042963E-01 V	-4.600000E-02 V	9.220E-03 V	
Amplitude: -1.0V		-1.000E+00 V	-1.170000E+00 V	-1.003872E+00 V	-8.300000E-01 V	9.220E-03 V	
Amplitude: -2.0V		-2.000E+00 V	-2.190000E+00 V	-2.007442E+00 V	-1.810000E+00 V	9.220E-03 V	

Operating Procedure
Reporting Test Results

Amplitude: -6.0V	-6.000E+00 V	-6.270000E+00 V	-5.997264E+00 V	-5.730000E+00 V	9.220E-03 V	
Amplitude: -10.0V	-1.000E+01 V	-1.035000E+01 V	-9.990655E+00 V	-9.650000E+00 V	9.220E-03 V	
Amplitude: -19.0V	-1.900E+01 V	-1.953000E+01 V	-1.882016E+01 V	-1.847000E+01 V	9.440E-03 V	
PG22:HF port 3:Pin Bd 8						
Amplitude: +19.0V	1.900E+01 V	1.847000E+01 V	1.899061E+01 V	1.953000E+01 V	9.440E-03 V	
Amplitude: +10.0V	1.000E+01 V	9.650000E+00 V	9.992528E+00 V	1.035000E+01 V	9.220E-03 V	
Amplitude: +6.0V	6.000E+00 V	5.730000E+00 V	6.030017E+00 V	6.270000E+00 V	9.220E-03 V	
Amplitude: +2.0V	2.000E+00 V	1.810000E+00 V	2.027730E+00 V	2.190000E+00 V	9.220E-03 V	
Amplitude: +1.0V	1.000E+00 V	8.300000E-01 V	1.027008E+00 V	1.170000E+00 V	9.220E-03 V	
Amplitude: +0.2V	2.000E-01 V	4.600000E-02 V	2.253771E-01 V	3.540000E-01 V	9.220E-03 V	
Amplitude: -0.2V	-2.000E-01 V	-3.540000E-01 V	-1.700255E-01 V	-4.600000E-02 V	9.220E-03 V	
Amplitude: -1.0V	-1.000E+00 V	-1.170000E+00 V	-9.654562E-01 V	-8.300000E-01 V	9.220E-03 V	
Amplitude: -2.0V	-2.000E+00 V	-2.190000E+00 V	-1.966097E+00 V	-1.810000E+00 V	9.220E-03 V	
Amplitude: -6.0V	-6.000E+00 V	-6.270000E+00 V	-5.960425E+00 V	-5.730000E+00 V	9.220E-03 V	
Amplitude: -10.0V	-1.000E+01 V	-1.035000E+01 V	-9.946276E+00 V	-9.650000E+00 V	9.220E-03 V	
Amplitude: -19.0V	-1.900E+01 V	-1.953000E+01 V	-1.880928E+01 V	-1.847000E+01 V	9.440E-03 V	
PG31:HF port 4:Pin Bd 40						
Amplitude: +19.0V	1.900E+01 V	1.847000E+01 V	1.888988E+01 V	1.953000E+01 V	9.440E-03 V	
Amplitude: +10.0V	1.000E+01 V	9.650000E+00 V	9.928954E+00 V	1.035000E+01 V	9.220E-03 V	
Amplitude: +6.0V	6.000E+00 V	5.730000E+00 V	5.984931E+00 V	6.270000E+00 V	9.220E-03 V	
Amplitude: +2.0V	2.000E+00 V	1.810000E+00 V	1.990599E+00 V	2.190000E+00 V	9.220E-03 V	
Amplitude: +1.0V	1.000E+00 V	8.300000E-01 V	1.007208E+00 V	1.170000E+00 V	9.220E-03 V	
Amplitude: +0.2V	2.000E-01 V	4.600000E-02 V	2.066806E-01 V	3.540000E-01 V	9.220E-03 V	
Amplitude: -0.2V	-2.000E-01 V	-3.540000E-01 V	-1.921508E-01 V	-4.600000E-02 V	9.220E-03 V	
Amplitude: -1.0V	-1.000E+00 V	-1.170000E+00 V	-9.882584E-01 V	-8.300000E-01 V	9.220E-03 V	
Amplitude: -2.0V	-2.000E+00 V	-2.190000E+00 V	-1.985312E+00 V	-1.810000E+00 V	9.220E-03 V	
Amplitude: -6.0V	-6.000E+00 V	-6.270000E+00 V	-5.995951E+00 V	-5.730000E+00 V	9.220E-03 V	
Amplitude: -10.0V	-1.000E+01 V	-1.035000E+01 V	-9.969919E+00 V	-9.650000E+00 V	9.220E-03 V	
Amplitude: -19.0V	-1.900E+01 V	-1.953000E+01 V	-1.885048E+01 V	-1.847000E+01 V	9.440E-03 V	
PG32:HF port 5:Pin Bd 40						
Amplitude: +19.0V	1.900E+01 V	1.847000E+01 V	1.893165E+01 V	1.953000E+01 V	9.440E-03 V	
Amplitude: +10.0V	1.000E+01 V	9.650000E+00 V	9.965834E+00 V	1.035000E+01 V	9.220E-03 V	
Amplitude: +6.0V	6.000E+00 V	5.730000E+00 V	6.007037E+00 V	6.270000E+00 V	9.220E-03 V	
Amplitude: +2.0V	2.000E+00 V	1.810000E+00 V	1.980808E+00 V	2.190000E+00 V	9.220E-03 V	
Amplitude: +1.0V	1.000E+00 V	8.300000E-01 V	9.943197E-01 V	1.170000E+00 V	9.220E-03 V	
Amplitude: +0.2V	2.000E-01 V	4.600000E-02 V	1.934661E-01 V	3.540000E-01 V	9.220E-03 V	
Amplitude: -0.2V	-2.000E-01 V	-3.540000E-01 V	-2.128320E-01 V	-4.600000E-02 V	9.220E-03 V	
Amplitude: -1.0V	-1.000E+00 V	-1.170000E+00 V	-1.002105E+00 V	-8.300000E-01 V	9.220E-03 V	
Amplitude: -2.0V	-2.000E+00 V	-2.190000E+00 V	-1.991768E+00 V	-1.810000E+00 V	9.220E-03 V	
Amplitude: -6.0V	-6.000E+00 V	-6.270000E+00 V	-6.009595E+00 V	-5.730000E+00 V	9.220E-03 V	
Amplitude: -10.0V	-1.000E+01 V	-1.035000E+01 V	-9.983071E+00 V	-9.650000E+00 V	9.220E-03 V	
Amplitude: -19.0V	-1.900E+01 V	-1.953000E+01 V	-1.886414E+01 V	-1.847000E+01 V	9.440E-03 V	

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(271) Pulse Parameter Test
-----
PG11:HF port 1:Pin Bd 8
-----
Width: 150.0 ns | 1.500E-07 s | 1.365000E-07 s | 1.497000E-07 s | 1.635000E-07 s | 9.120E-10 s |
-----
Width: 199.0 ns | 1.990E-07 s | 1.830500E-07 s | 2.001000E-07 s | 2.149500E-07 s | 9.480E-10 s |
-----
Width: 200.0 ns | 2.000E-07 s | 1.865000E-07 s | 2.010000E-07 s | 2.135000E-07 s | 9.490E-10 s |
-----
Width: 500.0 ns | 5.000E-07 s | 4.715000E-07 s | 5.022000E-07 s | 5.285000E-07 s | 1.320E-09 s |
-----
Width: 1.0 us | 1.000E-06 s | 9.465000E-07 s | 1.001000E-06 s | 1.053500E-06 s | 2.180E-09 s |
-----
Width: 5.0 us | 5.000E-06 s | 4.746500E-06 s | 5.011000E-06 s | 5.253500E-06 s | 1.000E-08 s |
-----
Width: 50.0 us | 5.000E-05 s | 4.749650E-05 s | 5.016000E-05 s | 5.250350E-05 s | 1.000E-07 s |
-----
Width: 500.0 us | 5.000E-04 s | 4.749965E-04 s | 5.020000E-04 s | 5.250035E-04 s | 1.000E-06 s |
-----
Width: 5.0 ms | 5.000E-03 s | 4.749996E-03 s | 5.025000E-03 s | 5.250004E-03 s | 1.000E-05 s |
-----
Width: 50.0 ms | 5.000E-02 s | 4.750000E-02 s | 5.025000E-02 s | 5.250000E-02 s | 1.000E-04 s |
-----
Width: 500.0 ms | 5.000E-01 s | 4.750000E-01 s | 5.025000E-01 s | 5.250000E-01 s | 1.000E-03 s |
-----
Delay: 5.0 ns | 5.000E-09 s | 3.750000E-09 s | 5.016000E-09 s | 6.250000E-09 s | 6.010E-10 s |
-----
Delay: 10.0 ns | 1.000E-08 s | 8.500000E-09 s | 1.011000E-08 s | 1.150000E-08 s | 6.010E-10 s |
-----
Delay: 50.0 ns | 5.000E-08 s | 4.650000E-08 s | 5.005000E-08 s | 5.350000E-08 s | 8.560E-10 s |
-----
Delay: 100.0 ns | 1.000E-07 s | 9.400000E-08 s | 1.002000E-07 s | 1.060000E-07 s | 8.730E-10 s |
-----
Delay: 500.0 ns | 5.000E-07 s | 4.740000E-07 s | 5.000000E-07 s | 5.260000E-07 s | 1.280E-09 s |
-----
Delay: 1.0 us | 1.000E-06 s | 9.490000E-07 s | 9.960000E-07 s | 1.051000E-06 s | 2.170E-09 s |
-----
Delay: 5.0 us | 5.000E-06 s | 4.749000E-06 s | 4.994000E-06 s | 5.251000E-06 s | 1.000E-08 s |
-----
Delay: 50.0 us | 5.000E-05 s | 4.749900E-05 s | 5.004000E-05 s | 5.250100E-05 s | 6.940E-08 s |
-----
Delay: 500.0 us | 5.000E-04 s | 4.749990E-04 s | 5.010000E-04 s | 5.250010E-04 s | 1.000E-06 s |
-----
Delay: 5.0 ms | 5.000E-03 s | 4.749999E-03 s | 5.015000E-03 s | 5.250001E-03 s | 6.920E-06 s |
-----
Delay: 50.0 ms | 5.000E-02 s | 4.750000E-02 s | 5.015000E-02 s | 5.250000E-02 s | 1.000E-04 s |
-----
Delay: 500.0 ms | 5.000E-01 s | 4.750000E-01 s | 5.016000E-01 s | 5.250000E-01 s | 6.920E-04 s |
-----
Tran(leading) : 65.0 ns | 6.500E-08 s | 4.500000E-08 s | 6.400000E-08 s | 8.500000E-08 s | 7.190E-09 s |
-----
Tran(trailing): 65.0 ns | 6.500E-08 s | 4.500000E-08 s | 6.490000E-08 s | 8.500000E-08 s | 7.190E-09 s |
-----
Overshoot(leading) : +5.0 V | | | -4.127598E-02 | 5.406000E-02 | 1.020E-02 |
-----
Overshoot(trailing): +5.0 V | | | -4.516647E-02 | 5.406000E-02 | 9.270E-03 |
-----
PG21:HF port 2:Pin Bd 8
-----
Width: 50.0 ns | 5.000E-08 s | 4.550000E-08 s | 5.080000E-08 s | 5.450000E-08 s | 4.370E-10 s |
-----
Width: 99.9 ns | 9.990E-08 s | 9.290500E-08 s | 1.015000E-07 s | 1.068950E-07 s | 4.700E-10 s |
-----
Width: 100.0 ns | 1.000E-07 s | 9.300000E-08 s | 1.015000E-07 s | 1.070000E-07 s | 4.700E-10 s |
-----
Width: 500.0 ns | 5.000E-07 s | 4.730000E-07 s | 5.050000E-07 s | 5.270000E-07 s | 1.090E-09 s |
-----
Width: 1.0 us | 1.000E-06 s | 9.480000E-07 s | 1.017000E-06 s | 1.052000E-06 s | 2.050E-09 s |
-----
Width: 5.0 us | 5.000E-06 s | 4.748000E-06 s | 5.030000E-06 s | 5.252000E-06 s | 1.000E-08 s |
-----
Width: 50.0 us | 5.000E-05 s | 4.749800E-05 s | 5.038000E-05 s | 5.250200E-05 s | 1.000E-07 s |
-----
Width: 500.0 us | 5.000E-04 s | 4.749980E-04 s | 5.040000E-04 s | 5.250020E-04 s | 1.000E-06 s |
-----
Width: 5.0 ms | 5.000E-03 s | 4.749998E-03 s | 5.040000E-03 s | 5.250002E-03 s | 1.000E-05 s |
-----
Width: 50.0 ms | 5.000E-02 s | 4.750000E-02 s | 5.040000E-02 s | 5.250000E-02 s | 1.000E-04 s |
-----
Width: 500.0 ms | 5.000E-01 s | 4.750000E-01 s | 5.040000E-01 s | 5.250000E-01 s | 1.000E-03 s |
-----

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Operating Procedure
Reporting Test Results

Delay: 5.0 ns	5.000E-09 s	3.750000E-09 s	5.047000E-09 s	6.250000E-09 s	4.200E-10 s
Delay: 10.0 ns	9.990E-09 s	8.490500E-09 s	9.980000E-09 s	1.148950E-08 s	4.200E-10 s
Delay: 50.0 ns	5.000E-08 s	4.650000E-08 s	4.990000E-08 s	5.350000E-08 s	4.320E-10 s
Delay: 99.9 ns	9.990E-08 s	9.390500E-08 s	9.980000E-08 s	1.058950E-07 s	4.650E-10 s
Delay: 100.0 ns	1.000E-07 s	9.400000E-08 s	9.970000E-08 s	1.060000E-07 s	4.650E-10 s
Delay: 500.0 ns	5.000E-07 s	4.740000E-07 s	4.993000E-07 s	5.260000E-07 s	1.050E-09 s
Delay: 1.0 us	1.000E-06 s	9.490000E-07 s	1.002000E-06 s	1.051000E-06 s	2.040E-09 s
Delay: 5.0 us	5.000E-06 s	4.749000E-06 s	4.986000E-06 s	5.251000E-06 s	1.000E-08 s
Delay: 50.0 us	5.000E-05 s	4.749900E-05 s	4.988000E-05 s	5.250100E-05 s	6.940E-08 s
Delay: 500.0 us	5.000E-04 s	4.749990E-04 s	4.990000E-04 s	5.250010E-04 s	1.000E-06 s
Delay: 5.0 ms	5.000E-03 s	4.749999E-03 s	4.993000E-03 s	5.250001E-03 s	6.920E-06 s
Delay: 50.0 ms	5.000E-02 s	4.750000E-02 s	4.989000E-02 s	5.250000E-02 s	1.000E-04 s
Delay: 500.0 ms	5.000E-01 s	4.750000E-01 s	4.993000E-01 s	5.250000E-01 s	6.920E-04 s
Tran(leading) : 20.0 ns	2.000E-08 s	1.800000E-08 s	2.232000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(trailing) : 20.0 ns	2.000E-08 s	1.800000E-08 s	2.204000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(leading) : 50.0 ns	5.000E-08 s	4.500000E-08 s	5.230000E-08 s	7.500000E-08 s	7.190E-09 s
Tran(trailing) : 50.0 ns	5.000E-08 s	4.500000E-08 s	5.170000E-08 s	7.500000E-08 s	7.190E-09 s
Tran(leading) : 500.0 ns	5.000E-07 s	4.500000E-07 s	5.030000E-07 s	5.700000E-07 s	8.420E-09 s
Tran(trailing) : 500.0 ns	5.000E-07 s	4.500000E-07 s	4.990000E-07 s	5.700000E-07 s	8.420E-09 s
Tran(leading) : 5.0 us	5.000E-06 s	4.500000E-06 s	4.880000E-06 s	5.520000E-06 s	5.880E-08 s
Tran(trailing) : 5.0 us	5.000E-06 s	4.500000E-06 s	4.810000E-06 s	5.520000E-06 s	5.880E-08 s
Tran(leading) : 50.0 us	5.000E-05 s	4.500000E-05 s	4.810000E-05 s	5.502000E-05 s	5.840E-07 s
Tran(trailing) : 50.0 us	5.000E-05 s	4.500000E-05 s	4.750000E-05 s	5.502000E-05 s	5.840E-07 s
Tran(leading) : 500.0 us	5.000E-04 s	4.500000E-04 s	4.810000E-04 s	5.500200E-04 s	5.830E-06 s
Tran(trailing) : 500.0 us	5.000E-04 s	4.500000E-04 s	4.820000E-04 s	5.500200E-04 s	5.830E-06 s
Tran(leading) : 50.0 ms	5.000E-02 s	4.500000E-02 s	4.540000E-02 s	5.500002E-02 s	5.830E-04 s
Tran(trailing) : 50.0 ms	5.000E-02 s	4.500000E-02 s	4.520000E-02 s	5.500002E-02 s	5.830E-04 s
Overshoot(leading) : +5.0 V			-3.315631E-02	5.408832E-02	1.020E-02
Overshoot(trailing) : +5.0 V			-3.024665E-02	5.408832E-02	9.270E-03
Overshoot(leading) : +0.5 V			-4.429189E-02	9.056219E-02	1.820E-02
Overshoot(trailing) : +0.5 V			-1.254183E-02	9.056219E-02	1.820E-02
PG22:HF port 3:Pin Bd 8					
Width: 50.0 ns	5.000E-08 s	4.550000E-08 s	5.109000E-08 s	5.450000E-08 s	4.370E-10 s
Width: 99.9 ns	9.990E-08 s	9.290500E-08 s	1.006000E-07 s	1.068950E-07 s	4.700E-10 s
Width: 100.0 ns	1.000E-07 s	9.300000E-08 s	1.008000E-07 s	1.070000E-07 s	4.700E-10 s
Width: 500.0 ns	5.000E-07 s	4.730000E-07 s	4.962000E-07 s	5.270000E-07 s	1.090E-09 s
Width: 1.0 us	1.000E-06 s	9.480000E-07 s	9.980000E-07 s	1.052000E-06 s	2.050E-09 s
Width: 5.0 us	5.000E-06 s	4.748000E-06 s	4.933000E-06 s	5.252000E-06 s	1.000E-08 s
Width: 50.0 us	5.000E-05 s	4.749800E-05 s	4.938000E-05 s	5.250200E-05 s	1.000E-07 s
Width: 500.0 us	5.000E-04 s	4.749980E-04 s	4.940000E-04 s	5.250020E-04 s	1.000E-06 s
Width: 5.0 ms	5.000E-03 s	4.749998E-03 s	4.940000E-03 s	5.250002E-03 s	1.000E-05 s
Width: 50.0 ms	5.000E-02 s	4.750000E-02 s	4.940000E-02 s	5.250000E-02 s	1.000E-04 s

Width: 500.0 ms	5.000E-01 s	4.750000E-01 s	4.939000E-01 s	5.250000E-01 s	1.000E-03 s
Delay: 5.0 ns	5.000E-09 s	3.750000E-09 s	4.968000E-09 s	6.250000E-09 s	4.200E-10 s
Delay: 10.0 ns	9.990E-09 s	8.490500E-09 s	9.950000E-09 s	1.148950E-08 s	4.200E-10 s
Delay: 50.0 ns	5.000E-08 s	4.650000E-08 s	4.999000E-08 s	5.350000E-08 s	4.320E-10 s
Delay: 99.9 ns	9.990E-08 s	9.390500E-08 s	9.980000E-08 s	1.058950E-07 s	4.650E-10 s
Delay: 100.0 ns	1.000E-07 s	9.400000E-08 s	1.000000E-07 s	1.060000E-07 s	4.650E-10 s
Delay: 500.0 ns	5.000E-07 s	4.740000E-07 s	4.992000E-07 s	5.260000E-07 s	1.050E-09 s
Delay: 1.0 us	1.000E-06 s	9.490000E-07 s	1.000000E-06 s	1.051000E-06 s	2.040E-09 s
Delay: 5.0 us	5.000E-06 s	4.749000E-06 s	4.991000E-06 s	5.251000E-06 s	1.000E-08 s
Delay: 50.0 us	5.000E-05 s	4.749900E-05 s	4.993000E-05 s	5.250100E-05 s	6.940E-08 s
Delay: 500.0 us	5.000E-04 s	4.749990E-04 s	4.995000E-04 s	5.250010E-04 s	1.000E-06 s
Delay: 5.0 ms	5.000E-03 s	4.749999E-03 s	4.997000E-03 s	5.250001E-03 s	6.920E-06 s
Delay: 50.0 ms	5.000E-02 s	4.750000E-02 s	4.995000E-02 s	5.250000E-02 s	1.000E-04 s
Delay: 500.0 ms	5.000E-01 s	4.750000E-01 s	4.998000E-01 s	5.250000E-01 s	6.920E-04 s
Tran(leading) : 20.0 ns	2.000E-08 s	1.800000E-08 s	2.368000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(trailing): 20.0 ns	2.000E-08 s	1.800000E-08 s	2.452000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(leading) : 50.0 ns	5.000E-08 s	4.500000E-08 s	5.140000E-08 s	7.500000E-08 s	7.190E-09 s
Tran(trailing): 50.0 ns	5.000E-08 s	4.500000E-08 s	5.540000E-08 s	7.500000E-08 s	7.190E-09 s
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Tran(leading) : 20.0 ns	2.000E-08 s	1.800000E-08 s	2.404000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(trailing): 20.0 ns	2.000E-08 s	1.800000E-08 s	2.329000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(leading) : 50.0 ns	5.000E-08 s	4.500000E-08 s	5.380000E-08 s	7.500000E-08 s	7.190E-09 s
Tran(trailing): 50.0 ns	5.000E-08 s	4.500000E-08 s	5.350000E-08 s	7.500000E-08 s	7.190E-09 s
Tran(leading) : 500.0 ns	5.000E-07 s	4.500000E-07 s	5.150000E-07 s	5.700000E-07 s	8.420E-09 s
Tran(trailing): 500.0 ns	5.000E-07 s	4.500000E-07 s	5.140000E-07 s	5.700000E-07 s	8.420E-09 s
Tran(leading) : 5.0 us	5.000E-06 s	4.500000E-06 s	5.040000E-06 s	5.520000E-06 s	5.880E-08 s
Tran(trailing): 5.0 us	5.000E-06 s	4.500000E-06 s	5.030000E-06 s	5.520000E-06 s	5.880E-08 s
Tran(leading) : 50.0 us	5.000E-05 s	4.500000E-05 s	4.990000E-05 s	5.502000E-05 s	5.840E-07 s
Tran(trailing): 50.0 us	5.000E-05 s	4.500000E-05 s	4.990000E-05 s	5.502000E-05 s	5.840E-07 s
Tran(leading) : 500.0 us	5.000E-04 s	4.500000E-04 s	4.960000E-04 s	5.500200E-04 s	5.830E-06 s
Tran(trailing): 500.0 us	5.000E-04 s	4.500000E-04 s	4.990000E-04 s	5.500200E-04 s	5.830E-06 s
Tran(leading) : 50.0 ms	5.000E-02 s	4.500000E-02 s	4.950000E-02 s	5.500002E-02 s	5.830E-04 s
Tran(trailing): 50.0 ms	5.000E-02 s	4.500000E-02 s	4.960000E-02 s	5.500002E-02 s	5.830E-04 s
Overshoot(leading) : +5.0 V			-3.906438E-02	5.405064E-02	1.020E-02
Overshoot(trailing): +5.0 V			-3.558124E-02	5.405064E-02	9.270E-03
Overshoot(leading) : +0.5 V			-4.816152E-02	9.056219E-02	1.820E-02
Overshoot(trailing): +0.5 V			-1.672785E-02	9.056219E-02	1.820E-02

Operating Procedure
Reporting Test Results

Figure 2-30 Agilent 4073A Test Record Example

```

Performance Test Record for the Agilent 4070

Test Facility:
Agilent Technologies
-----
Semicon Department
-----
-----

Report Number: 001
-----
Date: Jul 5, 2000
-----
Customer Name: John Smith
-----
Operator Name: Jack Daniel
-----

Ambient temperature: 23.5 deg C      Relative Humidity: 50%      Line Frequency: 50Hz
-----

System Configuration:
System Model No.: 4073A              Serial No.: JP10G20100      System Rev.: B.03.00
-----
Firmware Rev.: 01.35
-----
System Options: 001x36 002x1 011 012 050 200 500 550x2 552
-----

SMU Slot Configuration:
Slot 1:                               Slot 6: HR SMU
Slot 2: MP SMU                        Slot 7: MP SMU
Slot 3:                               Slot 8:
Slot 4:                               Slot 9:
Slot 5:                               Slot 10:

Pin Configuration:
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 Chuck

CMU Model No.: HP 4284A              Serial No.: 2940J07824      Rev.: REV01.20
-----
CMU Options: 001 006
-----

DVM Model No.: HP 3458A              Serial No.: 2823A16148      Rev.: 8,2
-----
DVM Options:
-----

PG1 Model No.: HP8114A              Serial No.: DE33700974      Rev.: REV 01.14.00
-----
PG1 Options: 001 UN2
-----

PG2 Model No.: HP81110A             Serial No.: ExchG00015      Rev.: REV 02.02.00
-----
PG2 Options: UN2
-----

PG3 Model No.: HP81110A             Serial No.: DE38704634      Rev.: REV 02.02.00
-----
PG3 Options: UN2
-----

PG4 Model No.:                      Serial No.:                  Rev.:
-----

PG4 Options:
-----

PG5 Model No.:                      Serial No.:                  Rev.:
-----

PG5 Options:
-----

Special Notes:

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Test Equipment Used:

Description	Model No.	Trace No.	Cal Due Date
1. Digital Multi Meter	HP 3458A	33-0134	09 SEP 2000
2. Standard Resistor	HP 16353A	33-0228	16 JUN 2001
3. Standard Capacitor	HP 16380A	33-0239	10 AUG 2000
4. Standard Capacitor	HP 16380C	33-0230	25 JAN 2001
5. Standard Resistor	HP 42037A	33-0235	02 DEC 2000
6. Digitizing Oscilloscope	HP 54750A	33-0198	25 OCT 2000
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			

Operating Procedure
Reporting Test Results

Description	Nominal	Minimum	Results	Maximum	Uncertainty	Fail
(221) Measurement Pin Location Test						
Pin Bd 1						
Testcase 1						
Pin Bd 2						
Testcase 1						
Pin Bd 3						
Testcase 1						
Pin Bd 4						
Testcase 1						
Pin Bd 5						
Testcase 1						
Pin Bd 6						
Testcase 1						
Pin Bd 7						
Testcase 1						
Pin Bd 8						
Testcase 1						
Pin Bd 9						
Testcase 1						
Pin Bd 10						
Testcase 1						
Pin Bd 11						
Testcase 1						
Pin Bd 12						
Testcase 1						
Pin Bd 13						
Testcase 1						
Pin Bd 14						
Testcase 1						
Pin Bd 15						
Testcase 1						
Pin Bd 16						
Testcase 1						
Pin Bd 17						
Testcase 1						
Pin Bd 18						
Testcase 1						
Pin Bd 19						
Testcase 1						
.						
.						
.						

Description	Nominal	Minimum	Results	Maximum	Uncertainty	Fail
(222) Residual Resistance Test						
AUX1:Pin Bd 1		0.000000E+00 OHM	4.996088E-01 OHM	1.000000E+00 OHM		
AUX1:Pin Bd 2		0.000000E+00 OHM	5.008853E-01 OHM	1.000000E+00 OHM		
AUX1:Pin Bd 3		0.000000E+00 OHM	5.044431E-01 OHM	1.000000E+00 OHM		
.						
AUX1:Pin Bd 48		0.000000E+00 OHM	5.615481E-01 OHM	1.000000E+00 OHM		
AUX1:Pin Bd 49		0.000000E+00 OHM	4.497118E-01 OHM	1.100000E+00 OHM		
AUX2:Pin Bd 1		0.000000E+00 OHM	5.529065E-01 OHM	1.000000E+00 OHM		
AUX2:Pin Bd 2		0.000000E+00 OHM	5.523187E-01 OHM	1.000000E+00 OHM		
AUX2:Pin Bd 3		0.000000E+00 OHM	5.526571E-01 OHM	1.000000E+00 OHM		
.						
AUX2:Pin Bd 48		0.000000E+00 OHM	5.078703E-01 OHM	1.000000E+00 OHM		
AUX2:Pin Bd 49		0.000000E+00 OHM	5.418852E-01 OHM	1.100000E+00 OHM		
AUX3 Force:Pin Bd 1		0.000000E+00 OHM	5.945380E-01 OHM	1.000000E+00 OHM		
AUX3 Force:Pin Bd 2		0.000000E+00 OHM	5.998520E-01 OHM	1.000000E+00 OHM		
AUX3 Force:Pin Bd 3		0.000000E+00 OHM	5.899290E-01 OHM	1.000000E+00 OHM		
.						
AUX3 Force:Pin Bd 48		0.000000E+00 OHM	5.506347E-01 OHM	1.000000E+00 OHM		
AUX3 Force:Pin Bd 49		0.000000E+00 OHM	4.542429E-01 OHM	1.100000E+00 OHM		
AUX3 Sense:Pin Bd 1		0.000000E+00 OHM	1.561720E+00 OHM	2.500000E+00 OHM		
AUX3 Sense:Pin Bd 2		0.000000E+00 OHM	1.529387E+00 OHM	2.500000E+00 OHM		

Operating Procedure
Reporting Test Results

AUX3 Sense:Pin Bd 3			
.....			
AUX3 Sense:Pin Bd 48			
		0.000000E+00 OHM	1.656514E+00 OHM 2.500000E+00 OHM
AUX3 Sense:Pin Bd 49			
		0.000000E+00 OHM	1.021374E+00 OHM 2.600000E+00 OHM
AUX4 Force:Pin Bd 1			
		0.000000E+00 OHM	6.346237E-01 OHM 1.000000E+00 OHM
AUX4 Force:Pin Bd 2			
		0.000000E+00 OHM	6.225243E-01 OHM 1.000000E+00 OHM
AUX4 Force:Pin Bd 3			
		0.000000E+00 OHM	6.128394E-01 OHM 1.000000E+00 OHM
.....			
AUX4 Force:Pin Bd 48			
		0.000000E+00 OHM	5.590887E-01 OHM 1.000000E+00 OHM
AUX4 Force:Pin Bd 49			
		0.000000E+00 OHM	4.776605E-01 OHM 1.100000E+00 OHM
AUX4 Sense:Pin Bd 1			
		0.000000E+00 OHM	1.864898E+00 OHM 2.500000E+00 OHM
AUX4 Sense:Pin Bd 2			
		0.000000E+00 OHM	1.831322E+00 OHM 2.500000E+00 OHM
AUX4 Sense:Pin Bd 3			
		0.000000E+00 OHM	1.820006E+00 OHM 2.500000E+00 OHM
.....			
AUX4 Sense:Pin Bd 48			
		0.000000E+00 OHM	1.593904E+00 OHM 2.500000E+00 OHM
AUX4 Sense:Pin Bd 49			
		0.000000E+00 OHM	1.083145E+00 OHM 2.600000E+00 OHM
AUX5 Force:Pin Bd 1			
		0.000000E+00 OHM	6.055751E-01 OHM 1.000000E+00 OHM
AUX5 Force:Pin Bd 2			
		0.000000E+00 OHM	6.085855E-01 OHM 1.000000E+00 OHM
AUX5 Force:Pin Bd 3			
		0.000000E+00 OHM	6.040423E-01 OHM 1.000000E+00 OHM
.....			
AUX8:Pin Bd 48			
		0.000000E+00 OHM	6.091647E-01 OHM 1.000000E+00 OHM
AUX8:Pin Bd 49			
		0.000000E+00 OHM	4.370770E-01 OHM 1.100000E+00 OHM
=====			

```

=====
(223) Isolation and Offset Current Test
-----
SMU2:Pin Bd 1
-----
Offset I (0.0V Force) | -5.500000E-13 A -4.000000E-13 A 5.500000E-13 A |
-----+-----+-----+-----+
Leak I (-100.0V Force) | -6.510000E-13 A 1.000000E-13 A 6.510000E-13 A |
-----+-----+-----+-----+
Leak I (100.0V Force) | -6.510000E-13 A -4.500000E-13 A 6.510000E-13 A |
-----
SMU2:Pin Bd 2
-----
Offset I (0.0V Force) | -5.500000E-13 A -4.000000E-13 A 5.500000E-13 A |
-----+-----+-----+-----+
Leak I (-100.0V Force) | -6.510000E-13 A -1.000000E-13 A 6.510000E-13 A |
-----+-----+-----+-----+
Leak I (100.0V Force) | -6.510000E-13 A -3.000000E-13 A 6.510000E-13 A |
-----
SMU2:Pin Bd 3
-----
Offset I (0.0V Force) | -5.500000E-13 A -4.000000E-13 A 5.500000E-13 A |
-----+-----+-----+-----+
Leak I (-100.0V Force) | -6.510000E-13 A 1.500000E-13 A 6.510000E-13 A |
-----+-----+-----+-----+
Leak I (100.0V Force) | -6.510000E-13 A -1.500000E-13 A 6.510000E-13 A |
-----
. . . . .
. . . . .
. . . . .
-----
SMU2:Pin Bd 48
-----
Offset I (0.0V Force) | -5.500000E-13 A -3.500000E-13 A 5.500000E-13 A |
-----+-----+-----+-----+
Leak I (-100.0V Force) | -6.510000E-13 A 2.000000E-13 A 6.510000E-13 A |
-----+-----+-----+-----+
Leak I (100.0V Force) | -6.510000E-13 A -1.500000E-13 A 6.510000E-13 A |
-----
SMU2:Pin Bd 49
-----
Offset I (0.0V Force) | -5.500000E-13 A 1.500000E-13 A 5.500000E-13 A |
-----+-----+-----+-----+
Leak I (-100.0V Force) | -6.510000E-13 A -1.000000E-13 A 6.510000E-13 A |
-----+-----+-----+-----+
Leak I (100.0V Force) | -6.510000E-13 A 0.000000E+00 A 6.510000E-13 A |
-----
SMU3:Pin Bd 1
-----
Offset I (0.0V Force) | -4.000000E-10 A -1.270000E-11 A 4.000000E-10 A |
-----+-----+-----+-----+
Leak I (-100.0V Force) | -1.450000E-09 A 2.455000E-11 A 1.450000E-09 A |
-----+-----+-----+-----+
Leak I (100.0V Force) | -1.450000E-09 A -1.470000E-11 A 1.450000E-09 A |
-----
SMU3:Pin Bd 2
-----
Offset I (0.0V Force) | -4.000000E-10 A -1.270000E-11 A 4.000000E-10 A |
-----+-----+-----+-----+
Leak I (-100.0V Force) | -1.450000E-09 A 2.455000E-11 A 1.450000E-09 A |
-----+-----+-----+-----+
Leak I (100.0V Force) | -1.450000E-09 A -1.470000E-11 A 1.450000E-09 A |
-----
. . . . .
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. . . . .
-----
SMU3:Pin Bd 48
-----
Offset I (0.0V Force) | -4.000000E-10 A -4.950000E-12 A 4.000000E-10 A |
-----+-----+-----+-----+
Leak I (-100.0V Force) | -1.450000E-09 A -2.195000E-11 A 1.450000E-09 A |
-----+-----+-----+-----+
Leak I (100.0V Force) | -1.450000E-09 A 1.350000E-12 A 1.450000E-09 A |
-----
SMU3:Pin Bd 49
-----
Offset I (0.0V Force) | -4.000000E-10 A -6.400000E-12 A 4.000000E-10 A |
-----+-----+-----+-----+
Leak I (-100.0V Force) | -1.450000E-09 A 1.130000E-11 A 1.450000E-09 A |
-----+-----+-----+-----+
Leak I (100.0V Force) | -1.450000E-09 A 4.500000E-13 A 1.450000E-09 A |
=====

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Operating Procedure
Reporting Test Results

=====		
(224) HF Matrix Relay Test		

Manual Test		

Testcase 21- 4-1-1-1		
Testcase 21- 4-1-2-1		
Testcase 21- 4-1-3-1		
Testcase 21- 4-1-4-1		
Testcase 21- 4-1-5-1		
Testcase 21- 4-1-6-1		
Testcase 21- 4-1-7-1		
Testcase 21- 4-1-8-1		
Testcase 21-12-2-1-2		
Testcase 21-12-2-2-2		
Testcase 21-12-2-3-2		
Testcase 21-12-2-4-2		
Testcase 21-12-2-5-2		
Testcase 21-12-2-6-2		
Testcase 21-12-2-7-2		
Testcase 21-12-2-8-2		
Testcase 21-20-3-1-3		
Testcase 21-20-3-2-3		
Testcase 21-20-3-3-3		
Testcase 21-20-3-4-3		
Testcase 21-20-3-5-3		
Testcase 21-20-3-6-3		
Testcase 21-20-3-7-3		
Testcase 21-20-3-8-3		
Testcase 21-44-6-1-1		
Testcase 21-44-6-2-1		
Testcase 21-44-6-3-1		
Testcase 21-44-6-4-1		
Testcase 21-44-6-5-1		
Testcase 21-44-6-6-1		
Testcase 21-44-6-7-1		
Testcase 21-44-6-8-1		
Testcase 21-36-5-1-2		
Testcase 21-36-5-2-2		
Testcase 21-36-5-3-2		
Testcase 21-36-5-4-2		
Testcase 21-36-5-5-2		
Testcase 21-36-5-6-2		
Testcase 21-36-5-7-2		
-----	-----	-----

Testcase 21-36-5-8-2							
Testcase 21-28-4-1-3							
Testcase 21-28-4-2-3							
Testcase 21-28-4-3-3							
Testcase 21-28-4-4-3							
Testcase 21-28-4-5-3							
Testcase 21-28-4-6-3							
Testcase 21-28-4-7-3							
Testcase 21-28-4-8-3							
=====							
(230) GNDU Output Voltage Test							
=====							
GNDU:Pin Bd 4							
=====							
		0.000E+00 V	-2.000000E-04 V	-3.531006E-05 V	2.000000E-04 V	8.120E-06 V	
=====							
(231) SMU Voltage Force and Measurement Test							
=====							
SMU2:Pin Bd 4							
=====							
2V Range (DVM)		-2.000E+00 V	-2.001300E+00 V	-2.000051E+00 V	-1.998700E+00 V	6.760E-05 V	
2V Range (Per Ch AD)		-2.000E+00 V	-2.001351E+00 V	-2.000100E+00 V	-1.998751E+00 V	6.760E-05 V	
2V Range (Ref AD)		-2.000E+00 V	-2.000951E+00 V	-1.999986E+00 V	-1.999151E+00 V	6.760E-05 V	
2V Range (DVM)		0.000E+00 V	-7.000000E-04 V	-1.197165E-04 V	7.000000E-04 V	4.620E-05 V	
2V Range (Per Ch AD)		0.000E+00 V	-8.197524E-04 V	-1.000000E-04 V	5.803195E-04 V	4.620E-05 V	
2V Range (Ref AD)		0.000E+00 V	-6.197404E-04 V	-4.200000E-05 V	3.803075E-04 V	4.620E-05 V	
2V Range (DVM)		2.000E+00 V	1.998700E+00 V	1.999806E+00 V	2.001300E+00 V	6.760E-05 V	
2V Range (Per Ch AD)		2.000E+00 V	1.998506E+00 V	2.000100E+00 V	2.001106E+00 V	6.760E-05 V	
2V Range (Ref AD)		2.000E+00 V	1.998906E+00 V	1.999920E+00 V	2.000706E+00 V	6.760E-05 V	
20V Range (DVM)		-2.000E+01 V	-2.001000E+01 V	-2.000042E+01 V	-1.999000E+01 V	6.960E-04 V	
20V Range (Per Ch AD)		-2.000E+01 V	-2.001042E+01 V	-2.000200E+01 V	-1.999042E+01 V	6.960E-04 V	
20V Range (Ref AD)		-2.000E+01 V	-2.000742E+01 V	-2.000026E+01 V	-1.999342E+01 V	6.960E-04 V	
20V Range (DVM)		0.000E+00 V	-4.000000E-03 V	-4.921368E-04 V	4.000000E-03 V	1.580E-04 V	
20V Range (Per Ch AD)		0.000E+00 V	-4.492284E-03 V	-1.000000E-03 V	3.508011E-03 V	1.580E-04 V	
20V Range (Ref AD)		0.000E+00 V	-3.492235E-03 V	-3.200000E-04 V	2.507962E-03 V	1.580E-04 V	
20V Range (DVM)		2.000E+01 V	1.999000E+01 V	1.999949E+01 V	2.001000E+01 V	6.960E-04 V	
20V Range (Per Ch AD)		2.000E+01 V	1.998949E+01 V	2.000100E+01 V	2.000949E+01 V	6.960E-04 V	
20V Range (Ref AD)		2.000E+01 V	1.999249E+01 V	1.999992E+01 V	2.000649E+01 V	6.960E-04 V	
40V Range (DVM)		-4.000E+01 V	-4.002000E+01 V	-4.000051E+01 V	-3.998000E+01 V	1.240E-03 V	
40V Range (Per Ch AD)		-4.000E+01 V	-4.002051E+01 V	-4.000200E+01 V	-3.998051E+01 V	1.240E-03 V	
40V Range (Ref AD)		-4.000E+01 V	-4.001451E+01 V	-4.000016E+01 V	-3.998651E+01 V	1.240E-03 V	
40V Range (DVM)		0.000E+00 V	-8.000000E-03 V	3.183896E-04 V	8.000000E-03 V	1.580E-04 V	
40V Range (Per Ch AD)		0.000E+00 V	-7.681706E-03 V	0.000000E+00 V	8.318485E-03 V	1.580E-04 V	
40V Range (Ref AD)		0.000E+00 V	-5.681674E-03 V	5.600000E-04 V	6.318453E-03 V	1.580E-04 V	
40V Range (DVM)		4.000E+01 V	3.998000E+01 V	3.999925E+01 V	4.002000E+01 V	1.240E-03 V	
40V Range (Per Ch AD)		4.000E+01 V	3.997925E+01 V	4.000200E+01 V	4.001924E+01 V	1.240E-03 V	
40V Range (Ref AD)		4.000E+01 V	3.998525E+01 V	3.999996E+01 V	4.001324E+01 V	1.240E-03 V	
100V Range (DVM)		-1.000E+02 V	-1.000500E+02 V	-9.999984E+01 V	-9.995000E+01 V	2.870E-03 V	

Operating Procedure
Reporting Test Results

100V Range (Per Ch AD)		-1.000E+02 V	-1.000498E+02 V	-1.000050E+02 V	-9.994984E+01 V	2.870E-03 V	
100V Range (Ref AD)		-1.000E+02 V	-1.000348E+02 V	-9.999830E+01 V	-9.996484E+01 V	2.870E-03 V	
100V Range (DVM)		0.000E+00 V	-2.000000E-02 V	3.208591E-04 V	2.000000E-02 V	1.580E-04 V	
100V Range (Per Ch AD)		0.000E+00 V	-1.967924E-02 V	0.000000E+00 V	2.032096E-02 V	1.580E-04 V	
100V Range (Ref AD)		0.000E+00 V	-1.467921E-02 V	1.000000E-03 V	1.532092E-02 V	1.580E-04 V	
100V Range (DVM)		1.000E+02 V	9.995000E+01 V	1.000006E+02 V	1.000500E+02 V	2.870E-03 V	
100V Range (Per Ch AD)		1.000E+02 V	9.995060E+01 V	1.000050E+02 V	1.000506E+02 V	2.870E-03 V	
100V Range (Ref AD)		1.000E+02 V	9.996560E+01 V	1.000014E+02 V	1.000356E+02 V	2.870E-03 V	
SMU3:Pin Bd 4							
2V Range (DVM)		-2.000E+00 V	-2.002000E+00 V	-2.000203E+00 V	-1.998000E+00 V	6.760E-05 V	
2V Range (Per Ch AD)		-2.000E+00 V	-2.001803E+00 V	-2.000300E+00 V	-1.998603E+00 V	6.760E-05 V	
2V Range (Ref AD)		-2.000E+00 V	-2.001803E+00 V	-2.000154E+00 V	-1.998603E+00 V	6.760E-05 V	
2V Range (DVM)		0.000E+00 V	-1.000000E-03 V	-9.574146E-05 V	1.000000E-03 V	4.620E-05 V	
2V Range (Per Ch AD)		0.000E+00 V	-8.957798E-04 V	0.000000E+00 V	7.042968E-04 V	4.620E-05 V	
2V Range (Ref AD)		0.000E+00 V	-8.957798E-04 V	-2.200000E-05 V	7.042968E-04 V	4.620E-05 V	
2V Range (DVM)		2.000E+00 V	1.998000E+00 V	1.999755E+00 V	2.002000E+00 V	6.760E-05 V	
2V Range (Per Ch AD)		2.000E+00 V	1.998155E+00 V	2.000000E+00 V	2.001355E+00 V	6.760E-05 V	
2V Range (Ref AD)		2.000E+00 V	1.998155E+00 V	1.999860E+00 V	2.001355E+00 V	6.760E-05 V	
20V Range (DVM)		-2.000E+01 V	-2.002000E+01 V	-2.000091E+01 V	-1.998000E+01 V	6.960E-04 V	
20V Range (Per Ch AD)		-2.000E+01 V	-2.001691E+01 V	-2.000200E+01 V	-1.998491E+01 V	6.960E-04 V	
20V Range (Ref AD)		-2.000E+01 V	-2.001691E+01 V	-2.000082E+01 V	-1.998491E+01 V	6.960E-04 V	
20V Range (DVM)		0.000E+00 V	-1.000000E-02 V	-3.437902E-04 V	1.000000E-02 V	1.580E-04 V	
20V Range (Per Ch AD)		0.000E+00 V	-8.343928E-03 V	0.000000E+00 V	7.656347E-03 V	1.580E-04 V	
20V Range (Ref AD)		0.000E+00 V	-8.343928E-03 V	-2.200000E-04 V	7.656347E-03 V	1.580E-04 V	
20V Range (DVM)		2.000E+01 V	1.998000E+01 V	1.999914E+01 V	2.002000E+01 V	6.960E-04 V	
20V Range (Per Ch AD)		2.000E+01 V	1.998314E+01 V	2.000100E+01 V	2.001514E+01 V	6.960E-04 V	
20V Range (Ref AD)		2.000E+01 V	1.998314E+01 V	1.999952E+01 V	2.001514E+01 V	6.960E-04 V	
40V Range (DVM)		-4.000E+01 V	-4.004000E+01 V	-4.000032E+01 V	-3.996000E+01 V	1.240E-03 V	
40V Range (Per Ch AD)		-4.000E+01 V	-4.003232E+01 V	-4.000400E+01 V	-3.996832E+01 V	1.240E-03 V	
40V Range (Ref AD)		-4.000E+01 V	-4.003232E+01 V	-3.999992E+01 V	-3.996832E+01 V	1.240E-03 V	
40V Range (DVM)		0.000E+00 V	-2.000000E-02 V	8.010012E-04 V	2.000000E-02 V	1.580E-04 V	
40V Range (Per Ch AD)		0.000E+00 V	-1.519932E-02 V	2.000000E-03 V	1.680132E-02 V	1.580E-04 V	
40V Range (Ref AD)		0.000E+00 V	-1.519932E-02 V	1.080000E-03 V	1.680132E-02 V	1.580E-04 V	
40V Range (DVM)		4.000E+01 V	3.996000E+01 V	3.999786E+01 V	4.004000E+01 V	1.240E-03 V	
40V Range (Per Ch AD)		4.000E+01 V	3.996586E+01 V	4.000200E+01 V	4.002986E+01 V	1.240E-03 V	
40V Range (Ref AD)		4.000E+01 V	3.996586E+01 V	3.999840E+01 V	4.002986E+01 V	1.240E-03 V	
100V Range (DVM)		-1.000E+02 V	-1.001000E+02 V	-1.000058E+02 V	-9.990000E+01 V	2.870E-03 V	
100V Range (Per Ch AD)		-1.000E+02 V	-1.000858E+02 V	-1.000150E+02 V	-9.992584E+01 V	2.870E-03 V	
100V Range (Ref AD)		-1.000E+02 V	-1.000858E+02 V	-1.000042E+02 V	-9.992584E+01 V	2.870E-03 V	
100V Range (DVM)		0.000E+00 V	-5.000000E-02 V	1.897108E-03 V	5.000000E-02 V	1.580E-04 V	
100V Range (Per Ch AD)		0.000E+00 V	-3.810365E-02 V	5.000000E-03 V	4.189787E-02 V	1.580E-04 V	
100V Range (Ref AD)		0.000E+00 V	-3.810365E-02 V	2.500000E-03 V	4.189787E-02 V	1.580E-04 V	

100V Range (DVM)	1.000E+02 V	9.990000E+01 V	9.999168E+01 V	1.001000E+02 V	2.870E-03 V	
100V Range (Per Ch AD)	1.000E+02 V	9.991168E+01 V	1.000000E+02 V	1.000717E+02 V	2.870E-03 V	
100V Range (Ref AD)	1.000E+02 V	9.991168E+01 V	9.999180E+01 V	1.000717E+02 V	2.870E-03 V	
200V Range (DVM)	-2.000E+02 V	-2.002000E+02 V	-2.000192E+02 V	-1.998000E+02 V	6.700E-03 V	
200V Range (Per Ch AD)	-2.000E+02 V	-2.001893E+02 V	-2.000300E+02 V	-1.998492E+02 V	6.700E-03 V	
200V Range (Ref AD)	-2.000E+02 V	-2.001893E+02 V	-2.000170E+02 V	-1.998492E+02 V	6.700E-03 V	
200V Range (DVM)	0.000E+00 V	-1.000000E-01 V	3.630973E-03 V	1.000000E-01 V	1.180E-03 V	
200V Range (Per Ch AD)	0.000E+00 V	-7.637066E-02 V	1.000000E-02 V	8.363261E-02 V	1.180E-03 V	
200V Range (Ref AD)	0.000E+00 V	-7.637066E-02 V	4.600000E-03 V	8.363261E-02 V	1.180E-03 V	
200V Range (DVM)	2.000E+02 V	1.998000E+02 V	1.999903E+02 V	2.002000E+02 V	6.700E-03 V	
200V Range (Per Ch AD)	2.000E+02 V	1.998203E+02 V	2.000100E+02 V	2.001603E+02 V	6.700E-03 V	
200V Range (Ref AD)	2.000E+02 V	1.998203E+02 V	1.999894E+02 V	2.001603E+02 V	6.700E-03 V	
SMU4:Pin Bd 4						
2V Range (DVM)	-2.000E+00 V	-2.002000E+00 V	-1.999946E+00 V	-1.998000E+00 V	6.760E-05 V	
2V Range (Per Ch AD)	-2.000E+00 V	-2.001546E+00 V	-2.000300E+00 V	-1.998346E+00 V	6.760E-05 V	
2V Range (Ref AD)	-2.000E+00 V	-2.001546E+00 V	-2.000084E+00 V	-1.998346E+00 V	6.760E-05 V	
2V Range (DVM)	0.000E+00 V	-1.000000E-03 V	8.668698E-05 V	1.000000E-03 V	4.620E-05 V	
2V Range (Per Ch AD)	0.000E+00 V	-7.133477E-04 V	-1.000000E-04 V	8.867217E-04 V	4.620E-05 V	
2V Range (Ref AD)	0.000E+00 V	-7.133477E-04 V	-3.400000E-05 V	8.867217E-04 V	4.620E-05 V	
2V Range (DVM)	2.000E+00 V	1.998000E+00 V	2.000022E+00 V	2.002000E+00 V	6.760E-05 V	
2V Range (Per Ch AD)	2.000E+00 V	1.998422E+00 V	2.000000E+00 V	2.001622E+00 V	6.760E-05 V	
2V Range (Ref AD)	2.000E+00 V	1.998422E+00 V	1.999936E+00 V	2.001622E+00 V	6.760E-05 V	
20V Range (DVM)	-2.000E+01 V	-2.002000E+01 V	-2.000010E+01 V	-1.998000E+01 V	6.960E-04 V	
20V Range (Per Ch AD)	-2.000E+01 V	-2.001610E+01 V	-2.000100E+01 V	-1.998410E+01 V	6.960E-04 V	
20V Range (Ref AD)	-2.000E+01 V	-2.001610E+01 V	-2.000030E+01 V	-1.998410E+01 V	6.960E-04 V	
20V Range (DVM)	0.000E+00 V	-1.000000E-02 V	4.215796E-04 V	1.000000E-02 V	1.580E-04 V	
20V Range (Per Ch AD)	0.000E+00 V	-7.578589E-03 V	0.000000E+00 V	8.421748E-03 V	1.580E-04 V	
20V Range (Ref AD)	0.000E+00 V	-7.578589E-03 V	3.600000E-04 V	8.421748E-03 V	1.580E-04 V	
20V Range (DVM)	2.000E+01 V	1.998000E+01 V	1.999951E+01 V	2.002000E+01 V	6.960E-04 V	
20V Range (Per Ch AD)	2.000E+01 V	1.998351E+01 V	2.000100E+01 V	2.001551E+01 V	6.960E-04 V	
20V Range (Ref AD)	2.000E+01 V	1.998351E+01 V	1.999968E+01 V	2.001551E+01 V	6.960E-04 V	
40V Range (DVM)	-4.000E+01 V	-4.004000E+01 V	-3.999952E+01 V	-3.996000E+01 V	1.240E-03 V	
40V Range (Per Ch AD)	-4.000E+01 V	-4.003151E+01 V	-4.000200E+01 V	-3.996752E+01 V	1.240E-03 V	
40V Range (Ref AD)	-4.000E+01 V	-4.003151E+01 V	-3.999964E+01 V	-3.996752E+01 V	1.240E-03 V	
40V Range (DVM)	0.000E+00 V	-2.000000E-02 V	-7.396164E-04 V	2.000000E-02 V	1.580E-04 V	
40V Range (Per Ch AD)	0.000E+00 V	-1.673991E-02 V	0.000000E+00 V	1.526068E-02 V	1.580E-04 V	
40V Range (Ref AD)	0.000E+00 V	-1.673991E-02 V	-8.400000E-04 V	1.526068E-02 V	1.580E-04 V	
.						
100V Range (DVM)	1.000E+02 V	9.990000E+01 V	9.999559E+01 V	1.001000E+02 V	2.870E-03 V	
100V Range (Per Ch AD)	1.000E+02 V	9.991560E+01 V	1.000050E+02 V	1.000756E+02 V	2.870E-03 V	
100V Range (Ref AD)	1.000E+02 V	9.991560E+01 V	9.999550E+01 V	1.000756E+02 V	2.870E-03 V	

Operating Procedure
Reporting Test Results

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(232) SMU Current Force and Measurement Test
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SMU2:Pin Bd 8/GNDU:Pin Bd 16
-----
100nA Range (G-F) | 0.000E+00 V -2.000000E-03 V -1.586447E-04 V 2.000000E-03 V 0.000E+00 V |
-----
100nA Range (G-F) | 0.000E+00 V -2.000000E-03 V -1.605742E-04 V 2.000000E-03 V 0.000E+00 V |
-----
100nA Range (G-F) | 0.000E+00 V -2.000000E-03 V -1.611353E-04 V 2.000000E-03 V 0.000E+00 V |
-----
100nA Range (G-F) | 0.000E+00 V -2.000000E-03 V -1.617489E-04 V 2.000000E-03 V 0.000E+00 V |
-----
1uA Range (G-F) | 0.000E+00 V -2.000000E-03 V -1.617892E-04 V 2.000000E-03 V 0.000E+00 V |
-----
1uA Range (G-F) | 0.000E+00 V -2.000000E-03 V -1.581497E-04 V 2.000000E-03 V 0.000E+00 V |
-----
1uA Range (G-F) | 0.000E+00 V -2.000000E-03 V -1.611386E-04 V 2.000000E-03 V 0.000E+00 V |
-----
1uA Range (G-F) | 0.000E+00 V -2.000000E-03 V -1.626304E-04 V 2.000000E-03 V 0.000E+00 V |
-----
10pA Range (DVM) | -1.000E-11 A -1.130000E-11 A -9.980571E-12 A -8.700000E-12 A 7.400E-14 A |
-----
10pA Range (Per Ch AD) | -1.000E-11 A -1.092979E-11 A -1.000050E-11 A -9.031348E-12 A 7.990E-14 A |
-----
10pA Range (Ref AD) | -1.000E-11 A -1.092979E-11 A -9.999990E-12 A -9.031348E-12 A 7.990E-14 A |
-----
10pA Range (DVM) | -1.000E-12 A -1.940000E-12 A -1.087579E-12 A -6.000000E-14 A 3.500E-14 A |
-----
10pA Range (Per Ch AD) | -1.000E-12 A -1.681082E-12 A -1.000500E-12 A -4.940759E-13 A 5.210E-14 A |
-----
10pA Range (Ref AD) | -1.000E-12 A -1.681082E-12 A -1.000120E-12 A -4.940759E-13 A 5.210E-14 A |
-----
10pA Range (DVM) | 1.000E-12 A 6.000000E-14 A 1.003117E-12 A 1.940000E-12 A 3.500E-14 A |
-----
10pA Range (Per Ch AD) | 1.000E-12 A 4.129928E-13 A 1.000500E-12 A 1.593242E-12 A 5.210E-14 A |
-----
10pA Range (Ref AD) | 1.000E-12 A 4.129928E-13 A 1.000150E-12 A 1.593242E-12 A 5.210E-14 A |
-----
10pA Range (DVM) | 1.000E-11 A 8.700000E-12 A 1.001602E-11 A 1.130000E-11 A 7.400E-14 A |
-----
10pA Range (Per Ch AD) | 1.000E-11 A 9.065378E-12 A 1.000100E-11 A 1.096666E-11 A 7.990E-14 A |
-----
10pA Range (Ref AD) | 1.000E-11 A 9.065378E-12 A 1.000020E-11 A 1.096666E-11 A 7.990E-14 A |
-----
100pA Range (DVM) | -1.000E-10 A -1.049000E-10 A -9.964181E-11 A -9.510000E-11 A 5.420E-13 A |
-----
100pA Range (Per Ch AD) | -1.000E-10 A -1.041775E-10 A -1.000050E-10 A -9.510614E-11 A 5.430E-13 A |
-----
100pA Range (Ref AD) | -1.000E-10 A -1.041775E-10 A -1.000013E-10 A -9.510614E-11 A 5.430E-13 A |
-----
100pA Range (DVM) | -1.000E-11 A -1.130000E-11 A -9.937638E-12 A -8.700000E-12 A 7.400E-14 A |
-----
100pA Range (Per Ch AD) | -1.000E-11 A -1.088514E-11 A -1.000000E-11 A -8.990133E-12 A 7.990E-14 A |
-----
100pA Range (Ref AD) | -1.000E-11 A -1.088514E-11 A -1.000120E-11 A -8.990133E-12 A 7.990E-14 A |
-----
100pA Range (DVM) | 1.000E-11 A 8.700000E-12 A 9.973968E-12 A 1.130000E-11 A 7.400E-14 A |
-----
100pA Range (Per Ch AD) | 1.000E-11 A 9.025009E-12 A 1.000500E-11 A 1.092293E-11 A 7.990E-14 A |
-----
100pA Range (Ref AD) | 1.000E-11 A 9.025009E-12 A 1.000070E-11 A 1.092293E-11 A 7.990E-14 A |
-----
100pA Range (DVM) | 1.000E-10 A 9.510000E-11 A 9.961812E-11 A 1.049000E-10 A 5.420E-13 A |
-----
100pA Range (Per Ch AD) | 1.000E-10 A 9.508340E-11 A 1.000050E-10 A 1.041528E-10 A 5.430E-13 A |
-----
100pA Range (Ref AD) | 1.000E-10 A 9.508340E-11 A 1.000007E-10 A 1.041528E-10 A 5.430E-13 A |
-----
1nA Range (DVM) | -1.000E-09 A -1.013700E-09 A -9.995815E-10 A -9.863000E-10 A 7.030E-13 A |
-----
1nA Range (Per Ch AD) | -1.000E-09 A -1.012977E-09 A -1.000050E-09 A -9.861857E-10 A 7.130E-13 A |
-----
1nA Range (Ref AD) | -1.000E-09 A -1.012977E-09 A -1.000013E-09 A -9.861857E-10 A 7.130E-13 A |
-----
1nA Range (DVM) | -1.000E-10 A -1.047000E-10 A -9.992762E-11 A -9.530000E-11 A 2.420E-13 A |
-----
1nA Range (Per Ch AD) | -1.000E-10 A -1.043269E-10 A -1.000000E-10 A -9.552835E-11 A 2.820E-13 A |
-----
1nA Range (Ref AD) | -1.000E-10 A -1.043269E-10 A -9.999900E-11 A -9.552835E-11 A 2.820E-13 A |
-----
1nA Range (DVM) | 1.000E-10 A 9.530000E-11 A 1.000213E-10 A 1.047000E-10 A 2.420E-13 A |
-----
1nA Range (Per Ch AD) | 1.000E-10 A 9.562106E-11 A 1.000000E-10 A 1.044215E-10 A 2.820E-13 A |
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1nA Range (Ref AD)	1.000E-10 A	9.562106E-11 A	9.999800E-11 A	1.044215E-10 A	2.820E-13 A	
1nA Range (DVM)	1.000E-09 A	9.863000E-10 A	9.996033E-10 A	1.013700E-09 A	7.030E-13 A	
1nA Range (Per Ch AD)	1.000E-09 A	9.862072E-10 A	1.000050E-09 A	1.012999E-09 A	7.130E-13 A	
1nA Range (Ref AD)	1.000E-09 A	9.862072E-10 A	1.000009E-09 A	1.012999E-09 A	7.130E-13 A	
10nA Range (DVM)	-1.000E-08 A	-1.010800E-08 A	-9.995097E-09 A	-9.892000E-09 A	6.440E-12 A	
10nA Range (Per Ch AD)	-1.000E-08 A	-1.010105E-08 A	-1.000050E-08 A	-9.889146E-09 A	6.440E-12 A	
10nA Range (Ref AD)	-1.000E-08 A	-1.010105E-08 A	-1.000002E-08 A	-9.889146E-09 A	6.440E-12 A	
10nA Range (DVM)	-1.000E-09 A	-1.018000E-09 A	-9.991352E-10 A	-9.820000E-10 A	1.430E-12 A	
10nA Range (Per Ch AD)	-1.000E-09 A	-1.015127E-09 A	-1.000000E-09 A	-9.831439E-10 A	1.440E-12 A	
10nA Range (Ref AD)	-1.000E-09 A	-1.015127E-09 A	-9.998700E-10 A	-9.831439E-10 A	1.440E-12 A	
10nA Range (DVM)	1.000E-09 A	9.820000E-10 A	9.992303E-10 A	1.018000E-09 A	1.430E-12 A	
10nA Range (Per Ch AD)	1.000E-09 A	9.832380E-10 A	9.995000E-10 A	1.015223E-09 A	1.440E-12 A	
10nA Range (Ref AD)	1.000E-09 A	9.832380E-10 A	9.995300E-10 A	1.015223E-09 A	1.440E-12 A	
10nA Range (DVM)	1.000E-08 A	9.892000E-09 A	9.995127E-09 A	1.010800E-08 A	6.440E-12 A	
10nA Range (Per Ch AD)	1.000E-08 A	9.889176E-09 A	1.000000E-08 A	1.010108E-08 A	6.440E-12 A	
10nA Range (Ref AD)	1.000E-08 A	9.889176E-09 A	9.999680E-09 A	1.010108E-08 A	6.440E-12 A	
100nA Range (DVM)	-1.000E-07 A	-1.001600E-07 A	-9.999306E-08 A	-9.984000E-08 A	1.690E-11 A	
100nA Range (Per Ch AD)	-1.000E-07 A	-1.001281E-07 A	-1.000100E-07 A	-9.985807E-08 A	1.690E-11 A	
100nA Range (Ref AD)	-1.000E-07 A	-1.001281E-07 A	-1.000014E-07 A	-9.985807E-08 A	1.690E-11 A	
100nA Range (DVM)	-1.000E-08 A	-1.005200E-08 A	-9.996441E-09 A	-9.948000E-09 A	1.180E-11 A	
100nA Range (Per Ch AD)	-1.000E-08 A	-1.004144E-08 A	-1.000000E-08 A	-9.951444E-09 A	1.190E-11 A	
100nA Range (Ref AD)	-1.000E-08 A	-1.004144E-08 A	-1.000110E-08 A	-9.951444E-09 A	1.190E-11 A	
100nA Range (DVM)	1.000E-08 A	9.948000E-09 A	1.000144E-08 A	1.005200E-08 A	1.180E-11 A	
100nA Range (Per Ch AD)	1.000E-08 A	9.956438E-09 A	1.000000E-08 A	1.004644E-08 A	1.190E-11 A	
100nA Range (Ref AD)	1.000E-08 A	9.956438E-09 A	9.998000E-09 A	1.004644E-08 A	1.190E-11 A	
100nA Range (DVM)	1.000E-07 A	9.984000E-08 A	1.000026E-07 A	1.001600E-07 A	1.690E-11 A	
100nA Range (Per Ch AD)	1.000E-07 A	9.986756E-08 A	1.000050E-07 A	1.001376E-07 A	1.690E-11 A	
100nA Range (Ref AD)	1.000E-07 A	9.986756E-08 A	1.000022E-07 A	1.001376E-07 A	1.690E-11 A	
1uA Range (DVM)	-1.000E-06 A	-1.001600E-06 A	-9.999406E-07 A	-9.984000E-07 A	1.550E-10 A	
1uA Range (Per Ch AD)	-1.000E-06 A	-1.001291E-06 A	-1.000050E-06 A	-9.985907E-07 A	1.550E-10 A	
1uA Range (Ref AD)	-1.000E-06 A	-1.001291E-06 A	-9.999990E-07 A	-9.985907E-07 A	1.550E-10 A	
1uA Range (DVM)	-1.000E-07 A	-1.005200E-07 A	-9.994402E-08 A	-9.948000E-08 A	1.170E-10 A	
1uA Range (Per Ch AD)	-1.000E-07 A	-1.003940E-07 A	-9.995000E-08 A	-9.949408E-08 A	1.170E-10 A	
1uA Range (Ref AD)	-1.000E-07 A	-1.003940E-07 A	-9.996800E-08 A	-9.949408E-08 A	1.170E-10 A	
1uA Range (DVM)	1.000E-07 A	9.948000E-08 A	9.999161E-08 A	1.005200E-07 A	1.170E-10 A	
1uA Range (Per Ch AD)	1.000E-07 A	9.954162E-08 A	1.000000E-07 A	1.004416E-07 A	1.170E-10 A	
1uA Range (Ref AD)	1.000E-07 A	9.954162E-08 A	9.997100E-08 A	1.004416E-07 A	1.170E-10 A	
1uA Range (DVM)	1.000E-06 A	9.984000E-07 A	1.000001E-06 A	1.001600E-06 A	1.550E-10 A	
1uA Range (Per Ch AD)	1.000E-06 A	9.986508E-07 A	1.000050E-06 A	1.001351E-06 A	1.550E-10 A	
1uA Range (Ref AD)	1.000E-06 A	9.986508E-07 A	9.999980E-07 A	1.001351E-06 A	1.550E-10 A	
10uA Range (DVM)	-1.000E-05 A	-1.007400E-05 A	-9.999367E-06 A	-9.926000E-06 A	1.470E-09 A	
10uA Range (Per Ch AD)	-1.000E-05 A	-1.000787E-05 A	-1.000050E-05 A	-9.990867E-06 A	1.470E-09 A	

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10uA Range (Ref AD)	-1.000E-05 A	-1.000787E-05 A	-1.000014E-05 A	-9.990867E-06 A	1.470E-09 A	
10uA Range (DVM)	-1.000E-06 A	-1.011000E-06 A	-9.994762E-07 A	-9.890000E-07 A	1.170E-09 A	
10uA Range (Per Ch AD)	-1.000E-06 A	-1.003476E-06 A	-1.000000E-06 A	-9.954765E-07 A	1.180E-09 A	
10uA Range (Ref AD)	-1.000E-06 A	-1.003476E-06 A	-9.998800E-07 A	-9.954765E-07 A	1.180E-09 A	
10uA Range (DVM)	1.000E-06 A	9.890000E-07 A	1.000302E-06 A	1.011000E-06 A	1.170E-09 A	
10uA Range (Per Ch AD)	1.000E-06 A	9.963014E-07 A	1.000000E-06 A	1.004302E-06 A	1.180E-09 A	
10uA Range (Ref AD)	1.000E-06 A	9.963014E-07 A	9.999700E-07 A	1.004302E-06 A	1.180E-09 A	
10uA Range (DVM)	1.000E-05 A	9.926000E-06 A	1.000016E-05 A	1.007400E-05 A	1.470E-09 A	
10uA Range (Per Ch AD)	1.000E-05 A	9.991655E-06 A	1.000050E-05 A	1.000866E-05 A	1.470E-09 A	
10uA Range (Ref AD)	1.000E-05 A	9.991655E-06 A	1.000015E-05 A	1.000866E-05 A	1.470E-09 A	
100uA Range (DVM)	-1.000E-04 A	-1.007400E-04 A	-9.999885E-05 A	-9.926000E-05 A	1.120E-08 A	
100uA Range (Per Ch AD)	-1.000E-04 A	-1.000839E-04 A	-1.000050E-04 A	-9.991385E-05 A	1.120E-08 A	
100uA Range (Ref AD)	-1.000E-04 A	-1.000839E-04 A	-1.000009E-04 A	-9.991385E-05 A	1.120E-08 A	
100uA Range (DVM)	-1.000E-05 A	-1.011000E-05 A	-1.000171E-05 A	-9.890000E-06 A	5.100E-09 A	
100uA Range (Per Ch AD)	-1.000E-05 A	-1.004171E-05 A	-1.000000E-05 A	-9.961709E-06 A	5.110E-09 A	
100uA Range (Ref AD)	-1.000E-05 A	-1.004171E-05 A	-1.000220E-05 A	-9.961709E-06 A	5.110E-09 A	
100uA Range (DVM)	1.000E-05 A	9.890000E-06 A	9.999264E-06 A	1.011000E-05 A	5.100E-09 A	
100uA Range (Per Ch AD)	1.000E-05 A	9.959264E-06 A	1.000000E-05 A	1.003926E-05 A	5.110E-09 A	
100uA Range (Ref AD)	1.000E-05 A	9.959264E-06 A	9.999000E-06 A	1.003926E-05 A	5.110E-09 A	
100uA Range (DVM)	1.000E-04 A	9.926000E-05 A	1.000011E-04 A	1.007400E-04 A	1.120E-08 A	
100uA Range (Per Ch AD)	1.000E-04 A	9.991605E-05 A	1.000100E-04 A	1.000861E-04 A	1.120E-08 A	
100uA Range (Ref AD)	1.000E-04 A	9.991605E-05 A	1.000012E-04 A	1.000861E-04 A	1.120E-08 A	
1mA Range (DVM)	-1.000E-03 A	-1.006400E-03 A	-1.000021E-03 A	-9.936000E-04 A	1.120E-07 A	
1mA Range (Per Ch AD)	-1.000E-03 A	-1.000721E-03 A	-1.000100E-03 A	-9.993208E-04 A	1.120E-07 A	
1mA Range (Ref AD)	-1.000E-03 A	-1.000721E-03 A	-1.000063E-03 A	-9.993208E-04 A	1.120E-07 A	
1mA Range (DVM)	-1.000E-04 A	-1.010000E-04 A	-1.000281E-04 A	-9.900000E-05 A	3.860E-08 A	
1mA Range (Per Ch AD)	-1.000E-04 A	-1.003681E-04 A	-1.000500E-04 A	-9.968805E-05 A	3.860E-08 A	
1mA Range (Ref AD)	-1.000E-04 A	-1.003681E-04 A	-1.000490E-04 A	-9.968805E-05 A	3.860E-08 A	
1mA Range (DVM)	1.000E-04 A	9.900000E-05 A	1.000052E-04 A	1.010000E-04 A	3.860E-08 A	
1mA Range (Per Ch AD)	1.000E-04 A	9.966521E-05 A	1.000000E-04 A	1.003452E-04 A	3.860E-08 A	
1mA Range (Ref AD)	1.000E-04 A	9.966521E-05 A	9.998800E-05 A	1.003452E-04 A	3.860E-08 A	
1mA Range (DVM)	1.000E-03 A	9.936000E-04 A	1.000040E-03 A	1.006400E-03 A	1.120E-07 A	
1mA Range (Per Ch AD)	1.000E-03 A	9.993402E-04 A	1.000100E-03 A	1.000740E-03 A	1.120E-07 A	
1mA Range (Ref AD)	1.000E-03 A	9.993402E-04 A	1.000035E-03 A	1.000740E-03 A	1.120E-07 A	
10mA Range (DVM)	-1.000E-02 A	-1.006400E-02 A	-1.000047E-02 A	-9.936000E-03 A	1.370E-06 A	
10mA Range (Per Ch AD)	-1.000E-02 A	-1.000747E-02 A	-1.000100E-02 A	-9.993465E-03 A	1.570E-06 A	
10mA Range (Ref AD)	-1.000E-02 A	-1.000747E-02 A	-1.000021E-02 A	-9.993465E-03 A	1.570E-06 A	
10mA Range (DVM)	-1.000E-03 A	-1.010000E-03 A	-9.998950E-04 A	-9.900000E-04 A	3.850E-07 A	
10mA Range (Per Ch AD)	-1.000E-03 A	-1.003295E-03 A	-1.000000E-03 A	-9.964950E-04 A	3.860E-07 A	
10mA Range (Ref AD)	-1.000E-03 A	-1.003295E-03 A	-9.999900E-04 A	-9.964950E-04 A	3.860E-07 A	
10mA Range (DVM)	1.000E-03 A	9.900000E-04 A	9.996946E-04 A	1.010000E-03 A	3.850E-07 A	
10mA Range (Per Ch AD)	1.000E-03 A	9.962947E-04 A	1.000000E-03 A	1.003094E-03 A	3.860E-07 A	

10mA Range (Ref AD)	1.000E-03 A	9.962947E-04 A	9.996300E-04 A	1.003094E-03 A	3.860E-07 A	
10mA Range (DVM)	1.000E-02 A	9.936000E-03 A	1.000069E-02 A	1.006400E-02 A	1.370E-06 A	
10mA Range (Per Ch AD)	1.000E-02 A	9.993692E-03 A	1.000100E-02 A	1.000769E-02 A	1.570E-06 A	
10mA Range (Ref AD)	1.000E-02 A	9.993692E-03 A	1.000022E-02 A	1.000769E-02 A	1.570E-06 A	
100mA Range (DVM)	-1.000E-01 A	-1.001600E-01 A	-9.999095E-02 A	-9.984000E-02 A	1.940E-05 A	
100mA Range (Per Ch AD)	-1.000E-01 A	-1.001209E-01 A	-1.000100E-01 A	-9.986096E-02 A	2.150E-05 A	
100mA Range (Ref AD)	-1.000E-01 A	-1.001209E-01 A	-1.000056E-01 A	-9.986096E-02 A	2.150E-05 A	
100mA Range (DVM)	-1.000E-02 A	-1.005200E-02 A	-9.998029E-03 A	-9.948000E-03 A	4.250E-06 A	
100mA Range (Per Ch AD)	-1.000E-02 A	-1.003803E-02 A	-1.000000E-02 A	-9.958031E-03 A	4.250E-06 A	
100mA Range (Ref AD)	-1.000E-02 A	-1.003803E-02 A	-1.000240E-02 A	-9.958031E-03 A	4.250E-06 A	
100mA Range (DVM)	1.000E-02 A	9.948000E-03 A	1.000117E-02 A	1.005200E-02 A	4.250E-06 A	
100mA Range (Per Ch AD)	1.000E-02 A	9.961172E-03 A	1.000000E-02 A	1.004117E-02 A	4.250E-06 A	
100mA Range (Ref AD)	1.000E-02 A	9.961172E-03 A	9.999500E-03 A	1.004117E-02 A	4.250E-06 A	
100mA Range (DVM)	1.000E-01 A	9.984000E-02 A	9.999752E-02 A	1.001600E-01 A	1.940E-05 A	
100mA Range (Per Ch AD)	1.000E-01 A	9.986752E-02 A	1.000100E-01 A	1.001275E-01 A	2.150E-05 A	
100mA Range (Ref AD)	1.000E-01 A	9.986752E-02 A	1.000026E-01 A	1.001275E-01 A	2.150E-05 A	
SMU3:Pin Bd 8/GNDU:Pin Bd 16						
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.595123E-04 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.577841E-04 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.588552E-04 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.597120E-04 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.608729E-04 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.627066E-04 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.634804E-04 V	2.000000E-03 V	0.000E+00 V	
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.654728E-04 V	2.000000E-03 V	0.000E+00 V	
100nA Range (DVM)	-1.000E-07 A	-1.006000E-07 A	-9.999695E-08 A	-9.940000E-08 A	1.690E-11 A	
100nA Range (Per Ch AD)	-1.000E-07 A	-1.005469E-07 A	-1.000050E-07 A	-9.944696E-08 A	1.690E-11 A	
100nA Range (Ref AD)	-1.000E-07 A	-1.005469E-07 A	-1.000019E-07 A	-9.944696E-08 A	1.690E-11 A	
100nA Range (DVM)	-1.000E-08 A	-1.042000E-08 A	-1.000205E-08 A	-9.580000E-09 A	1.180E-11 A	
100nA Range (Per Ch AD)	-1.000E-08 A	-1.037205E-08 A	-1.000000E-08 A	-9.632046E-09 A	1.190E-11 A	
100nA Range (Ref AD)	-1.000E-08 A	-1.037205E-08 A	-1.000120E-08 A	-9.632046E-09 A	1.190E-11 A	
100nA Range (DVM)	1.000E-08 A	9.580000E-09 A	9.996659E-09 A	1.042000E-08 A	1.180E-11 A	
100nA Range (Per Ch AD)	1.000E-08 A	9.626666E-09 A	1.000000E-08 A	1.036665E-08 A	1.190E-11 A	
100nA Range (Ref AD)	1.000E-08 A	9.626666E-09 A	9.997900E-09 A	1.036665E-08 A	1.190E-11 A	
100nA Range (DVM)	1.000E-07 A	9.940000E-08 A	9.999773E-08 A	1.006000E-07 A	1.690E-11 A	
100nA Range (Per Ch AD)	1.000E-07 A	9.944774E-08 A	1.000100E-07 A	1.005477E-07 A	1.690E-11 A	
100nA Range (Ref AD)	1.000E-07 A	9.944774E-08 A	1.000025E-07 A	1.005477E-07 A	1.690E-11 A	
1uA Range (DVM)	-1.000E-06 A	-1.003300E-06 A	-9.999415E-07 A	-9.967000E-07 A	1.550E-10 A	
1uA Range (Per Ch AD)	-1.000E-06 A	-1.002741E-06 A	-1.000050E-06 A	-9.971417E-07 A	1.550E-10 A	
1uA Range (Ref AD)	-1.000E-06 A	-1.002741E-06 A	-9.999890E-07 A	-9.971417E-07 A	1.550E-10 A	
1uA Range (DVM)	-1.000E-07 A	-1.015000E-07 A	-9.998567E-08 A	-9.850000E-08 A	1.170E-10 A	
1uA Range (Per Ch AD)	-1.000E-07 A	-1.009856E-07 A	-1.000000E-07 A	-9.898570E-08 A	1.170E-10 A	

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1uA Range (Ref AD)	-1.000E-07 A	-1.009856E-07 A	-1.000020E-07 A	-9.898570E-08 A	1.170E-10 A	
1uA Range (DVM)	1.000E-07 A	9.850000E-08 A	9.998484E-08 A	1.015000E-07 A	1.170E-10 A	
1uA Range (Per Ch AD)	1.000E-07 A	9.898487E-08 A	1.000000E-07 A	1.009848E-07 A	1.170E-10 A	
1uA Range (Ref AD)	1.000E-07 A	9.898487E-08 A	9.997800E-08 A	1.009848E-07 A	1.170E-10 A	
1uA Range (DVM)	1.000E-06 A	9.967000E-07 A	9.999872E-07 A	1.003300E-06 A	1.550E-10 A	
1uA Range (Per Ch AD)	1.000E-06 A	9.971872E-07 A	1.000100E-06 A	1.002787E-06 A	1.550E-10 A	
1uA Range (Ref AD)	1.000E-06 A	9.971872E-07 A	1.000007E-06 A	1.002787E-06 A	1.550E-10 A	
10uA Range (DVM)	-1.000E-05 A	-1.002200E-05 A	-9.999936E-06 A	-9.978000E-06 A	1.470E-09 A	
10uA Range (Per Ch AD)	-1.000E-05 A	-1.001494E-05 A	-1.000100E-05 A	-9.984936E-06 A	1.470E-09 A	
10uA Range (Ref AD)	-1.000E-05 A	-1.001494E-05 A	-1.000044E-05 A	-9.984936E-06 A	1.470E-09 A	
10uA Range (DVM)	-1.000E-06 A	-1.011200E-06 A	-9.997464E-07 A	-9.888000E-07 A	1.170E-09 A	
10uA Range (Per Ch AD)	-1.000E-06 A	-1.005746E-06 A	-1.000000E-06 A	-9.937466E-07 A	1.180E-09 A	
10uA Range (Ref AD)	-1.000E-06 A	-1.005746E-06 A	-1.000010E-06 A	-9.937466E-07 A	1.180E-09 A	
10uA Range (DVM)	1.000E-06 A	9.888000E-07 A	1.000080E-06 A	1.011200E-06 A	1.170E-09 A	
10uA Range (Per Ch AD)	1.000E-06 A	9.940796E-07 A	1.000000E-06 A	1.006080E-06 A	1.180E-09 A	
10uA Range (Ref AD)	1.000E-06 A	9.940796E-07 A	9.999000E-07 A	1.006080E-06 A	1.180E-09 A	
10uA Range (DVM)	1.000E-05 A	9.978000E-06 A	9.999986E-06 A	1.002200E-05 A	1.470E-09 A	
10uA Range (Per Ch AD)	1.000E-05 A	9.984986E-06 A	1.000050E-05 A	1.001499E-05 A	1.470E-09 A	
10uA Range (Ref AD)	1.000E-05 A	9.984986E-06 A	9.999930E-06 A	1.001499E-05 A	1.470E-09 A	
100uA Range (DVM)	-1.000E-04 A	-1.002200E-04 A	-1.000021E-04 A	-9.978000E-05 A	1.120E-08 A	
100uA Range (Per Ch AD)	-1.000E-04 A	-1.001521E-04 A	-1.000100E-04 A	-9.985206E-05 A	1.120E-08 A	
100uA Range (Ref AD)	-1.000E-04 A	-1.001521E-04 A	-1.000026E-04 A	-9.985206E-05 A	1.120E-08 A	
100uA Range (DVM)	-1.000E-05 A	-1.011200E-05 A	-9.998936E-06 A	-9.888000E-06 A	5.100E-09 A	
100uA Range (Per Ch AD)	-1.000E-05 A	-1.005893E-05 A	-1.000000E-05 A	-9.938937E-06 A	5.110E-09 A	
100uA Range (Ref AD)	-1.000E-05 A	-1.005893E-05 A	-9.999300E-06 A	-9.938937E-06 A	5.110E-09 A	
100uA Range (DVM)	1.000E-05 A	9.888000E-06 A	9.998822E-06 A	1.011200E-05 A	5.100E-09 A	
100uA Range (Per Ch AD)	1.000E-05 A	9.938823E-06 A	1.000000E-05 A	1.005882E-05 A	5.110E-09 A	
100uA Range (Ref AD)	1.000E-05 A	9.938823E-06 A	9.998300E-06 A	1.005882E-05 A	5.110E-09 A	
100uA Range (DVM)	1.000E-04 A	9.978000E-05 A	9.999962E-05 A	1.002200E-04 A	1.120E-08 A	
100uA Range (Per Ch AD)	1.000E-04 A	9.984962E-05 A	1.000050E-04 A	1.001496E-04 A	1.120E-08 A	
100uA Range (Ref AD)	1.000E-04 A	9.984962E-05 A	9.999820E-05 A	1.001496E-04 A	1.120E-08 A	
1mA Range (DVM)	-1.000E-03 A	-1.002200E-03 A	-1.000038E-03 A	-9.978000E-04 A	1.120E-07 A	
1mA Range (Per Ch AD)	-1.000E-03 A	-1.001538E-03 A	-1.000100E-03 A	-9.985375E-04 A	1.120E-07 A	
1mA Range (Ref AD)	-1.000E-03 A	-1.001538E-03 A	-1.000065E-03 A	-9.985375E-04 A	1.120E-07 A	
1mA Range (DVM)	-1.000E-04 A	-1.011200E-04 A	-1.000285E-04 A	-9.888000E-05 A	3.860E-08 A	
1mA Range (Per Ch AD)	-1.000E-04 A	-1.006286E-04 A	-1.000500E-04 A	-9.942851E-05 A	3.860E-08 A	
1mA Range (Ref AD)	-1.000E-04 A	-1.006286E-04 A	-1.000420E-04 A	-9.942851E-05 A	3.860E-08 A	
1mA Range (DVM)	1.000E-04 A	9.888000E-05 A	1.000044E-04 A	1.011200E-04 A	3.860E-08 A	
1mA Range (Per Ch AD)	1.000E-04 A	9.940436E-05 A	1.000000E-04 A	1.006044E-04 A	3.860E-08 A	
1mA Range (Ref AD)	1.000E-04 A	9.940436E-05 A	9.999400E-05 A	1.006044E-04 A	3.860E-08 A	
1mA Range (DVM)	1.000E-03 A	9.978000E-04 A	1.000052E-03 A	1.002200E-03 A	1.120E-07 A	
1mA Range (Per Ch AD)	1.000E-03 A	9.985518E-04 A	1.000150E-03 A	1.001552E-03 A	1.120E-07 A	

1mA Range (Ref AD)	1.000E-03 A	9.985518E-04 A	1.000046E-03 A	1.001552E-03 A	1.120E-07 A	
10mA Range (DVM)	-1.000E-02 A	-1.002200E-02 A	-1.000048E-02 A	-9.978000E-03 A	1.370E-06 A	
10mA Range (Per Ch AD)	-1.000E-02 A	-1.001548E-02 A	-1.000100E-02 A	-9.985479E-03 A	1.570E-06 A	
10mA Range (Ref AD)	-1.000E-02 A	-1.001548E-02 A	-1.000019E-02 A	-9.985479E-03 A	1.570E-06 A	
10mA Range (DVM)	-1.000E-03 A	-1.011200E-03 A	-9.999455E-04 A	-9.888000E-04 A	3.850E-07 A	
10mA Range (Per Ch AD)	-1.000E-03 A	-1.005945E-03 A	-1.000000E-03 A	-9.939455E-04 A	3.860E-07 A	
10mA Range (Ref AD)	-1.000E-03 A	-1.005945E-03 A	-1.000030E-03 A	-9.939455E-04 A	3.860E-07 A	
10mA Range (DVM)	1.000E-03 A	9.888000E-04 A	9.996594E-04 A	1.011200E-03 A	3.850E-07 A	
10mA Range (Per Ch AD)	1.000E-03 A	9.936597E-04 A	9.995000E-04 A	1.005659E-03 A	3.860E-07 A	
10mA Range (Ref AD)	1.000E-03 A	9.936597E-04 A	9.995700E-04 A	1.005659E-03 A	3.860E-07 A	
10mA Range (DVM)	1.000E-02 A	9.978000E-03 A	1.000057E-02 A	1.002200E-02 A	1.370E-06 A	
10mA Range (Per Ch AD)	1.000E-02 A	9.985567E-03 A	1.000100E-02 A	1.001557E-02 A	1.570E-06 A	
10mA Range (Ref AD)	1.000E-02 A	9.985567E-03 A	1.000007E-02 A	1.001557E-02 A	1.570E-06 A	
100mA Range (DVM)	-1.000E-01 A	-1.002200E-01 A	-1.000104E-01 A	-9.978000E-02 A	1.940E-05 A	
100mA Range (Per Ch AD)	-1.000E-01 A	-1.001604E-01 A	-1.000100E-01 A	-9.986041E-02 A	2.150E-05 A	
100mA Range (Ref AD)	-1.000E-01 A	-1.001604E-01 A	-1.000064E-01 A	-9.986041E-02 A	2.150E-05 A	
100mA Range (DVM)	-1.000E-02 A	-1.011200E-02 A	-1.000486E-02 A	-9.888000E-03 A	4.250E-06 A	
100mA Range (Per Ch AD)	-1.000E-02 A	-1.006487E-02 A	-1.000500E-02 A	-9.944857E-03 A	4.250E-06 A	
100mA Range (Ref AD)	-1.000E-02 A	-1.006487E-02 A	-1.000430E-02 A	-9.944857E-03 A	4.250E-06 A	
100mA Range (DVM)	1.000E-02 A	9.888000E-03 A	9.998935E-03 A	1.011200E-02 A	4.250E-06 A	
100mA Range (Per Ch AD)	1.000E-02 A	9.938936E-03 A	1.000000E-02 A	1.005893E-02 A	4.250E-06 A	
100mA Range (Ref AD)	1.000E-02 A	9.938936E-03 A	9.999200E-03 A	1.005893E-02 A	4.250E-06 A	
100mA Range (DVM)	1.000E-01 A	9.978000E-02 A	1.000093E-01 A	1.002200E-01 A	1.940E-05 A	
100mA Range (Per Ch AD)	1.000E-01 A	9.985934E-02 A	1.000100E-01 A	1.001594E-01 A	2.150E-05 A	
100mA Range (Ref AD)	1.000E-01 A	9.985934E-02 A	1.000051E-01 A	1.001594E-01 A	2.150E-05 A	
1A Range (DVM)	-1.000E+00 A	-1.006000E+00 A	-1.000126E+00 A	-9.940000E-01 A	2.860E-04 A	
1A Range (Per Ch AD)	-1.000E+00 A	-1.005627E+00 A	-1.000050E+00 A	-9.946253E-01 A	2.860E-04 A	
1A Range (Ref AD)	-1.000E+00 A	-1.005627E+00 A	-1.000017E+00 A	-9.946253E-01 A	2.860E-04 A	
1A Range (DVM)	-1.000E-01 A	-1.015000E-01 A	-1.000312E-01 A	-9.850000E-02 A	5.690E-05 A	
1A Range (Per Ch AD)	-1.000E-01 A	-1.010314E-01 A	-1.000500E-01 A	-9.903107E-02 A	5.690E-05 A	
1A Range (Ref AD)	-1.000E-01 A	-1.010314E-01 A	-1.000360E-01 A	-9.903107E-02 A	5.690E-05 A	
1A Range (DVM)	1.000E-01 A	9.850000E-02 A	9.999995E-02 A	1.015000E-01 A	5.690E-05 A	
1A Range (Per Ch AD)	1.000E-01 A	9.899995E-02 A	1.000000E-01 A	1.009999E-01 A	5.690E-05 A	
1A Range (Ref AD)	1.000E-01 A	9.899995E-02 A	9.998400E-02 A	1.009999E-01 A	5.690E-05 A	
1A Range (DVM)	1.000E+00 A	9.940000E-01 A	1.000133E+00 A	1.006000E+00 A	2.860E-04 A	
1A Range (Per Ch AD)	1.000E+00 A	9.946322E-01 A	1.000100E+00 A	1.005634E+00 A	2.860E-04 A	
1A Range (Ref AD)	1.000E+00 A	9.946322E-01 A	1.000001E+00 A	1.005634E+00 A	2.860E-04 A	
SMU4:Pin Bd 8/GNDU:Pin Bd 16						
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.764685E-04 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.765537E-04 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.768586E-04 V	2.000000E-03 V	0.000E+00 V	
100nA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.763096E-04 V	2.000000E-03 V	0.000E+00 V	

Operating Procedure
Reporting Test Results

1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.744804E-04 V	2.000000E-03 V	0.000E+00 V
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.752297E-04 V	2.000000E-03 V	0.000E+00 V
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.760345E-04 V	2.000000E-03 V	0.000E+00 V
1uA Range (G-F)	0.000E+00 V	-2.000000E-03 V	1.768598E-04 V	2.000000E-03 V	0.000E+00 V
100nA Range (DVM)	-1.000E-07 A	-1.006000E-07 A	-9.999784E-08 A	-9.940000E-08 A	1.690E-11 A
100nA Range (Per Ch AD)	-1.000E-07 A	-1.005478E-07 A	-1.000100E-07 A	-9.944785E-08 A	1.690E-11 A
100nA Range (Ref AD)	-1.000E-07 A	-1.005478E-07 A	-1.000018E-07 A	-9.944785E-08 A	1.690E-11 A
100nA Range (DVM)	-1.000E-08 A	-1.042000E-08 A	-1.000134E-08 A	-9.580000E-09 A	1.180E-11 A
100nA Range (Per Ch AD)	-1.000E-08 A	-1.037134E-08 A	-1.000500E-08 A	-9.631334E-09 A	1.190E-11 A
100nA Range (Ref AD)	-1.000E-08 A	-1.037134E-08 A	-1.000250E-08 A	-9.631334E-09 A	1.190E-11 A
100nA Range (DVM)	1.000E-08 A	9.580000E-09 A	1.000231E-08 A	1.042000E-08 A	1.180E-11 A
100nA Range (Per Ch AD)	1.000E-08 A	9.632302E-09 A	1.000000E-08 A	1.037231E-08 A	1.190E-11 A
100nA Range (Ref AD)	1.000E-08 A	9.632302E-09 A	1.000140E-08 A	1.037231E-08 A	1.190E-11 A
100nA Range (DVM)	1.000E-07 A	9.940000E-08 A	1.000028E-07 A	1.006000E-07 A	1.690E-11 A
100nA Range (Per Ch AD)	1.000E-07 A	9.945278E-08 A	1.000100E-07 A	1.005528E-07 A	1.690E-11 A
100nA Range (Ref AD)	1.000E-07 A	9.945278E-08 A	1.000039E-07 A	1.005528E-07 A	1.690E-11 A
1uA Range (DVM)	-1.000E-06 A	-1.003300E-06 A	-1.000053E-06 A	-9.967000E-07 A	1.550E-10 A
1uA Range (Per Ch AD)	-1.000E-06 A	-1.002853E-06 A	-1.000100E-06 A	-9.972533E-07 A	1.550E-10 A
1uA Range (Ref AD)	-1.000E-06 A	-1.002853E-06 A	-1.000026E-06 A	-9.972533E-07 A	1.550E-10 A
1uA Range (DVM)	-1.000E-07 A	-1.015000E-07 A	-1.000131E-07 A	-9.850000E-08 A	1.170E-10 A
1uA Range (Per Ch AD)	-1.000E-07 A	-1.010131E-07 A	-1.000500E-07 A	-9.901309E-08 A	1.170E-10 A
1uA Range (Ref AD)	-1.000E-07 A	-1.010131E-07 A	-1.000170E-07 A	-9.901309E-08 A	1.170E-10 A
1uA Range (DVM)	1.000E-07 A	9.850000E-08 A	9.998659E-08 A	1.015000E-07 A	1.170E-10 A
1uA Range (Per Ch AD)	1.000E-07 A	9.898661E-08 A	1.000000E-07 A	1.009866E-07 A	1.170E-10 A
1uA Range (Ref AD)	1.000E-07 A	9.898661E-08 A	9.997700E-08 A	1.009866E-07 A	1.170E-10 A
1uA Range (DVM)	1.000E-06 A	9.967000E-07 A	1.000036E-06 A	1.003300E-06 A	1.550E-10 A
1uA Range (Per Ch AD)	1.000E-06 A	9.972360E-07 A	1.000100E-06 A	1.002836E-06 A	1.550E-10 A
1uA Range (Ref AD)	1.000E-06 A	9.972360E-07 A	9.999880E-07 A	1.002836E-06 A	1.550E-10 A
10uA Range (DVM)	-1.000E-05 A	-1.002200E-05 A	-9.999730E-06 A	-9.978000E-06 A	1.470E-09 A
10uA Range (Per Ch AD)	-1.000E-05 A	-1.001473E-05 A	-1.000100E-05 A	-9.984730E-06 A	1.470E-09 A
10uA Range (Ref AD)	-1.000E-05 A	-1.001473E-05 A	-1.000027E-05 A	-9.984730E-06 A	1.470E-09 A
10uA Range (DVM)	-1.000E-06 A	-1.011200E-06 A	-9.998302E-07 A	-9.888000E-07 A	1.170E-09 A
10uA Range (Per Ch AD)	-1.000E-06 A	-1.005830E-06 A	-1.000000E-06 A	-9.938304E-07 A	1.180E-09 A
10uA Range (Ref AD)	-1.000E-06 A	-1.005830E-06 A	-1.000030E-06 A	-9.938304E-07 A	1.180E-09 A
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100mA Range (DVM)	1.000E-02 A	9.888000E-03 A	9.996921E-03 A	1.011200E-02 A	4.250E-06 A
100mA Range (Per Ch AD)	1.000E-02 A	9.936924E-03 A	1.000000E-02 A	1.005692E-02 A	4.250E-06 A
100mA Range (Ref AD)	1.000E-02 A	9.936924E-03 A	9.996900E-03 A	1.005692E-02 A	4.250E-06 A
100mA Range (DVM)	1.000E-01 A	9.978000E-02 A	9.999677E-02 A	1.002200E-01 A	1.940E-05 A
100mA Range (Per Ch AD)	1.000E-01 A	9.984677E-02 A	1.000050E-01 A	1.001468E-01 A	2.150E-05 A
100mA Range (Ref AD)	1.000E-01 A	9.984677E-02 A	9.999830E-02 A	1.001468E-01 A	2.150E-05 A

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(233) SMU Output Resistance Test
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SMU2:Pin Bd 4
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| 0.000000E+00 OHM 5.574119E-01 OHM 7.000000E-01 OHM |
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SMU3:Pin Bd 4
-----
| -1.000000E-03 OHM 2.672585E-04 OHM 3.000000E-03 OHM |
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SMU4:Pin Bd 4
-----
| -1.000000E-03 OHM 3.355777E-04 OHM 3.000000E-03 OHM |
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(240) CMU Capacitance and Conductance Test
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CMH:Pin Bd 4/CML:Pin Bd 8
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16383A 100pF Standard, 1MHz | 1.000E-10 F 9.890099E-11 F 1.000691E-10 F 1.011010E-10 F 1.300E-13 F |
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16383A 100pF Standard, 1MHz | 0.000E+00 S -5.670038E-06 S 7.279750E-07 S 5.670038E-06 S 5.460E-07 S |
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16383A 100pF Standard, 100kHz | 1.000E-10 F 9.939801E-11 F 1.000118E-10 F 1.005980E-10 F 5.641E-14 F |
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16383A 100pF Standard, 100kHz | 0.000E+00 S -3.779962E-07 S 5.876113E-10 S 3.779962E-07 S 2.570E-08 S |
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16383A 100pF Standard, 10kHz | 1.000E-10 F 9.949801E-11 F 1.000037E-10 F 1.004980E-10 F 5.631E-14 F |
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16383A 100pF Standard, 10kHz | 0.000E+00 S -3.149962E-08 S -3.643954E-10 S 3.149962E-08 S 2.520E-09 S |
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16383A 100pF Standard, 1kHz | 1.000E-10 F 9.909801E-11 F 9.998780E-11 F 1.008980E-10 F 5.810E-14 F |
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16383A 100pF Standard, 1kHz | 0.000E+00 S -5.669950E-09 S -2.132805E-11 S 5.669950E-09 S 2.520E-10 S |
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CMH:Pin Bd 36/CML:Pin Bd 40
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16384A 1000pF Standard, 1MHz | 1.000E-09 F 9.833940E-10 F 9.974680E-10 F 1.017406E-09 F 1.990E-12 F |
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16384A 1000pF Standard, 1MHz | 0.000E+00 S -1.512554E-04 S 9.745801E-06 S 1.512554E-04 S 4.990E-06 S |
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16384A 1000pF Standard, 100k | 1.000E-09 F 9.951196E-10 F 9.998924E-10 F 1.005120E-09 F 7.120E-13 F |
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16384A 1000pF Standard, 100k | 0.000E+00 S -3.780302E-06 S 1.756517E-08 S 3.780302E-06 S 2.560E-07 S |
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16384A 1000pF Standard, 10kHz | 1.000E-09 F 9.961196E-10 F 9.999094E-10 F 1.004120E-09 F 7.100E-13 F |
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16384A 1000pF Standard, 10kHz | 0.000E+00 S -2.520227E-07 S 8.722580E-10 S 2.520227E-07 S 2.570E-08 S |
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16384A 1000pF Standard, 1kHz | 1.000E-09 F 9.961196E-10 F 1.000133E-09 F 1.004120E-09 F 7.250E-13 F |
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16384A 1000pF Standard, 1kHz | 0.000E+00 S -2.520227E-08 S 6.295535E-10 S 2.520227E-08 S 2.520E-09 S |
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CMH:Pin Bd 36/CML:Pin Bd 40
-----
16385A 0.01uF Standard, 100k | 1.000E-08 F 9.930965E-09 F 9.994544E-09 F 1.007103E-08 F 5.970E-12 F |
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16385A 0.01uF Standard, 100k | 1.885E-06 S -6.113309E-05 S -1.127485E-06 S 6.490338E-05 S 3.930E-06 S |
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16385A 0.01uF Standard, 10kHz | 9.999E-09 F 9.959202E-09 F 9.996142E-09 F 1.003920E-08 F 3.610E-12 F |
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16385A 0.01uF Standard, 10kHz | 0.000E+00 S -2.519849E-06 S 5.295970E-08 S 2.519849E-06 S 2.520E-07 S |
-----
16385A 0.01uF Standard, 1kHz | 1.000E-08 F 9.959897E-09 F 1.000261E-08 F 1.003990E-08 F 3.120E-12 F |
-----
16385A 0.01uF Standard, 1kHz | 6.283E-09 S -2.457338E-07 S -5.385984E-09 S 2.583001E-07 S 2.520E-08 S |
-----
CMH:Pin Bd 4/CML:Pin Bd 8
-----
16386A 0.1uF Standard, 10kHz | 9.996E-08 F 9.956491E-08 F 9.994723E-08 F 1.003651E-07 F 3.670E-11 F |
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16386A 0.1uF Standard, 10kHz | 1.256E-06 S -4.913716E-05 S 7.157860E-06 S 5.164956E-05 S 2.740E-06 S |
-----
16386A 0.1uF Standard, 1kHz | 9.998E-08 F 9.958199E-08 F 9.997676E-08 F 1.003820E-07 F 3.880E-11 F |
-----
16386A 0.1uF Standard, 1kHz | 1.256E-07 S -2.394396E-06 S 1.911274E-07 S 2.645678E-06 S 1.260E-07 S |
-----
CMH:Pin Bd 4/CML:Pin Bd 8
-----
42037A 1kohm Standard, 1MHz | 1.910E-13 F -1.063113E-12 F -1.064183E-13 F 1.445085E-12 F 1.990E-13 F |
-----
42037A 1kohm Standard, 1MHz | 1.000E-03 S 9.903012E-04 S 1.001364E-03 S 1.010099E-03 S 1.410E-06 S |
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42037A 1kohm Standard, 100kHz | 1.592E-13 F -8.191164E-12 F -4.274491E-13 F 8.509474E-12 F 1.960E-13 F |

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Operating Procedure
Reporting Test Results

42037A 1kohm Standard, 100kHz	1.000E-03 S	9.958393E-04 S	9.999068E-04 S	1.004361E-03 S	8.140E-07 S	
42037A 1kohm Standard, 10kHz	1.800E-13 F	-5.744578E-11 F	-4.043643E-12 F	5.780578E-11 F	3.020E-13 F	
42037A 1kohm Standard, 10kHz	1.000E-03 S	9.964996E-04 S	9.998203E-04 S	1.003760E-03 S	2.500E-07 S	
42037A 1kohm Standard, 1kHz	1.800E-13 F	-5.760729E-10 F	-3.367731E-11 F	5.764329E-10 F	9.020E-13 F	
42037A 1kohm Standard, 1kHz	1.000E-03 S	9.964996E-04 S	9.998400E-04 S	1.003760E-03 S	2.880E-07 S	
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(241) CMU DC Bias Output Voltage Test						

CMH:Pin Bd 8/CML:Pin Bd 16						

-40.0V Force	-4.000E+01 V	-4.005000E+01 V	-3.999978E+01 V	-3.995000E+01 V	1.650E-03 V	
0.0V Force	0.000E+00 V	-1.000000E-02 V	-1.892667E-04 V	1.000000E-02 V	1.520E-04 V	
40.0V Force	4.000E+01 V	3.995000E+01 V	3.999978E+01 V	4.005000E+01 V	1.650E-03 V	
=====						
(250) DVM Differential Voltage Measurement Test						

DVMH:Pin Bd 32/DVML:Pin Bd 16/SMU2:Pin Bd 4/GNDU:Pin Bd 8						

100.0V Range -100.0V Measure	-1.000E+02 V	-1.000154E+02 V	-1.000024E+02 V	-9.999021E+01 V	2.870E-03 V	
100.0V Range 0.0V Measure	-9.775E-05 V	-6.977601E-04 V	-1.249528E-04 V	5.022634E-04 V	2.070E-04 V	
100.0V Range 100.0V Measure	1.000E+02 V	9.998781E+01 V	9.999988E+01 V	1.000130E+02 V	2.870E-03 V	
10.0V Range -10.0V Measure	-9.999E+00 V	-9.999543E+00 V	-9.998917E+00 V	-9.998223E+00 V	2.220E-04 V	
10.0V Range 0.0V Measure	-3.165E-04 V	-3.764796E-04 V	-3.251806E-04 V	-2.564417E-04 V	2.980E-05 V	
10.0V Range 10.0V Measure	1.000E+01 V	9.999471E+00 V	1.000016E+01 V	1.000079E+01 V	2.220E-04 V	
1.0V Range -1.0V Measure	-1.000E+00 V	-1.000101E+00 V	-9.999890E-01 V	-9.998611E-01 V	2.900E-05 V	
1.0V Range 0.0V Measure	-6.711E-05 V	-1.271168E-04 V	-7.390118E-05 V	-7.108756E-06 V	9.830E-06 V	
1.0V Range 1.0V Measure	1.000E+00 V	9.998429E-01 V	9.999597E-01 V	1.000083E+00 V	2.900E-05 V	
0.1V Range -0.1V Measure	-1.000E-01 V	-1.001033E-01 V	-1.000427E-01 V	-9.997130E-02 V	2.900E-05 V	
0.1V Range 0.0V Measure	-6.671E-05 V	-1.267169E-04 V	-7.329470E-05 V	-6.708904E-06 V	9.830E-06 V	
0.1V Range 0.1V Measure	9.998E-02 V	9.991041E-02 V	9.996961E-02 V	1.000424E-01 V	2.900E-05 V	
=====						
(262) Pulse Switch Test						

PSI11 - PS01						

Switch:ON		0.000000E+00 OHM	1.398212E+00 OHM	5.000000E+00 OHM		
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM			

PSI12 - PS01						

Switch:ON		0.000000E+00 OHM	1.578737E+00 OHM	5.000000E+00 OHM		
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM			

PSI21 - PS02						

Switch:ON		0.000000E+00 OHM	1.462815E+00 OHM	5.000000E+00 OHM		
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM			

PSI31 - PS03						

Switch:ON		0.000000E+00 OHM	1.462421E+00 OHM	5.000000E+00 OHM		
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM			

PSI41 - PS04						

Switch:ON		0.000000E+00 OHM	1.461167E+00 OHM	5.000000E+00 OHM		
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM			

PSI51 - PS05						

Switch:ON		0.000000E+00 OHM	1.384150E+00 OHM	5.000000E+00 OHM		

Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM				
PSI61 - PSO6							
Switch:ON		0.000000E+00 OHM	1.521016E+00 OHM	5.000000E+00 OHM			
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM				
PSI62 - PSO6							
Switch:ON		0.000000E+00 OHM	1.428398E+00 OHM	5.000000E+00 OHM			
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM				
PSI71 - PSO7							
Switch:ON		0.000000E+00 OHM	1.424200E+00 OHM	5.000000E+00 OHM			
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM				
PSI72 - PSO7							
Switch:ON		0.000000E+00 OHM	1.449194E+00 OHM	5.000000E+00 OHM			
Switch:OFF		1.000000E+06 OHM	1.000000E+38 OHM				
=====							
(270) Pulse Level Test							

PG11:HF port 1:Pin Bd 8							
Amplitude: +2.0V		2.000E+00 V	1.760000E+00 V	2.010295E+00 V	2.240000E+00 V	1.300E-02 V	
Amplitude: +5.0V		5.000E+00 V	4.700000E+00 V	5.030688E+00 V	5.300000E+00 V	1.300E-02 V	
Amplitude: +10.0V		1.000E+01 V	9.600000E+00 V	1.005405E+01 V	1.040000E+01 V	1.300E-02 V	
Amplitude: +20.0V		2.000E+01 V	1.940000E+01 V	2.014922E+01 V	2.060000E+01 V	1.300E-02 V	
Amplitude: +50.0V		5.000E+01 V	4.880000E+01 V	5.042937E+01 V	5.120000E+01 V	1.300E-02 V	
Baseline: -49.9V		-4.990E+01 V	-5.111800E+01 V	-5.042081E+01 V	-4.868200E+01 V	9.460E-03 V	
Baseline: -40.0V		-4.000E+01 V	-4.102000E+01 V	-4.044825E+01 V	-3.898000E+01 V	9.450E-03 V	
Baseline: -20.0V		-2.000E+01 V	-2.062000E+01 V	-2.027481E+01 V	-1.938000E+01 V	9.440E-03 V	
Baseline: -10.0V		-1.000E+01 V	-1.042000E+01 V	-1.020161E+01 V	-9.580000E+00 V	9.220E-03 V	
Baseline: -4.0V		-4.000E+00 V	-4.300000E+00 V	-4.147879E+00 V	-3.700000E+00 V	9.220E-03 V	
Baseline: +0.0V		0.000E+00 V	-2.200000E-01 V	-2.213412E-02 V	2.200000E-01 V	9.220E-03 V	
Baseline: +4.0V		4.000E+00 V	3.700000E+00 V	3.887434E+00 V	4.300000E+00 V	9.220E-03 V	
Baseline: +10.0V		1.000E+01 V	9.580000E+00 V	9.943229E+00 V	1.042000E+01 V	9.220E-03 V	
Baseline: +20.0V		2.000E+01 V	1.938000E+01 V	2.002119E+01 V	2.062000E+01 V	9.440E-03 V	
Baseline: +40.0V		4.000E+01 V	3.898000E+01 V	4.022652E+01 V	4.102000E+01 V	9.450E-03 V	
Baseline: +48.0V		4.800E+01 V	4.682000E+01 V	4.831991E+01 V	4.918000E+01 V	9.460E-03 V	

PG21:HF port 2:Pin Bd 8							
Amplitude: +19.0V		1.900E+01 V	1.847000E+01 V	1.894219E+01 V	1.953000E+01 V	9.440E-03 V	
Amplitude: +10.0V		1.000E+01 V	9.650000E+00 V	9.960522E+00 V	1.035000E+01 V	9.220E-03 V	
Amplitude: +6.0V		6.000E+00 V	5.730000E+00 V	5.990601E+00 V	6.270000E+00 V	9.220E-03 V	
Amplitude: +2.0V		2.000E+00 V	1.810000E+00 V	1.997710E+00 V	2.190000E+00 V	9.220E-03 V	
Amplitude: +1.0V		1.000E+00 V	8.300000E-01 V	9.932061E-01 V	1.170000E+00 V	9.220E-03 V	
Amplitude: +0.2V		2.000E-01 V	4.600000E-02 V	1.884628E-01 V	3.540000E-01 V	9.220E-03 V	
Amplitude: -0.2V		-2.000E-01 V	-3.540000E-01 V	-2.042963E-01 V	-4.600000E-02 V	9.220E-03 V	
Amplitude: -1.0V		-1.000E+00 V	-1.170000E+00 V	-1.003872E+00 V	-8.300000E-01 V	9.220E-03 V	
Amplitude: -2.0V		-2.000E+00 V	-2.190000E+00 V	-2.007442E+00 V	-1.810000E+00 V	9.220E-03 V	

Operating Procedure
Reporting Test Results

Amplitude: -6.0V	-6.000E+00 V	-6.270000E+00 V	-5.997264E+00 V	-5.730000E+00 V	9.220E-03 V	
Amplitude: -10.0V	-1.000E+01 V	-1.035000E+01 V	-9.990655E+00 V	-9.650000E+00 V	9.220E-03 V	
Amplitude: -19.0V	-1.900E+01 V	-1.953000E+01 V	-1.882016E+01 V	-1.847000E+01 V	9.440E-03 V	
PG22:HF port 3:Pin Bd 8						
Amplitude: +19.0V	1.900E+01 V	1.847000E+01 V	1.899061E+01 V	1.953000E+01 V	9.440E-03 V	
Amplitude: +10.0V	1.000E+01 V	9.650000E+00 V	9.992528E+00 V	1.035000E+01 V	9.220E-03 V	
Amplitude: +6.0V	6.000E+00 V	5.730000E+00 V	6.030017E+00 V	6.270000E+00 V	9.220E-03 V	
Amplitude: +2.0V	2.000E+00 V	1.810000E+00 V	2.027730E+00 V	2.190000E+00 V	9.220E-03 V	
Amplitude: +1.0V	1.000E+00 V	8.300000E-01 V	1.027008E+00 V	1.170000E+00 V	9.220E-03 V	
Amplitude: +0.2V	2.000E-01 V	4.600000E-02 V	2.253771E-01 V	3.540000E-01 V	9.220E-03 V	
Amplitude: -0.2V	-2.000E-01 V	-3.540000E-01 V	-1.700255E-01 V	-4.600000E-02 V	9.220E-03 V	
Amplitude: -1.0V	-1.000E+00 V	-1.170000E+00 V	-9.654562E-01 V	-8.300000E-01 V	9.220E-03 V	
Amplitude: -2.0V	-2.000E+00 V	-2.190000E+00 V	-1.966097E+00 V	-1.810000E+00 V	9.220E-03 V	
Amplitude: -6.0V	-6.000E+00 V	-6.270000E+00 V	-5.960425E+00 V	-5.730000E+00 V	9.220E-03 V	
Amplitude: -10.0V	-1.000E+01 V	-1.035000E+01 V	-9.946276E+00 V	-9.650000E+00 V	9.220E-03 V	
Amplitude: -19.0V	-1.900E+01 V	-1.953000E+01 V	-1.880928E+01 V	-1.847000E+01 V	9.440E-03 V	
PG31:HF port 4:Pin Bd 40						
Amplitude: +19.0V	1.900E+01 V	1.847000E+01 V	1.888988E+01 V	1.953000E+01 V	9.440E-03 V	
Amplitude: +10.0V	1.000E+01 V	9.650000E+00 V	9.928954E+00 V	1.035000E+01 V	9.220E-03 V	
Amplitude: +6.0V	6.000E+00 V	5.730000E+00 V	5.984931E+00 V	6.270000E+00 V	9.220E-03 V	
Amplitude: +2.0V	2.000E+00 V	1.810000E+00 V	1.990599E+00 V	2.190000E+00 V	9.220E-03 V	
Amplitude: +1.0V	1.000E+00 V	8.300000E-01 V	1.007208E+00 V	1.170000E+00 V	9.220E-03 V	
Amplitude: +0.2V	2.000E-01 V	4.600000E-02 V	2.066806E-01 V	3.540000E-01 V	9.220E-03 V	
Amplitude: -0.2V	-2.000E-01 V	-3.540000E-01 V	-1.921508E-01 V	-4.600000E-02 V	9.220E-03 V	
Amplitude: -1.0V	-1.000E+00 V	-1.170000E+00 V	-9.882584E-01 V	-8.300000E-01 V	9.220E-03 V	
Amplitude: -2.0V	-2.000E+00 V	-2.190000E+00 V	-1.985312E+00 V	-1.810000E+00 V	9.220E-03 V	
Amplitude: -6.0V	-6.000E+00 V	-6.270000E+00 V	-5.995951E+00 V	-5.730000E+00 V	9.220E-03 V	
Amplitude: -10.0V	-1.000E+01 V	-1.035000E+01 V	-9.969919E+00 V	-9.650000E+00 V	9.220E-03 V	
Amplitude: -19.0V	-1.900E+01 V	-1.953000E+01 V	-1.885048E+01 V	-1.847000E+01 V	9.440E-03 V	
PG32:HF port 5:Pin Bd 40						
Amplitude: +19.0V	1.900E+01 V	1.847000E+01 V	1.893165E+01 V	1.953000E+01 V	9.440E-03 V	
Amplitude: +10.0V	1.000E+01 V	9.650000E+00 V	9.965834E+00 V	1.035000E+01 V	9.220E-03 V	
Amplitude: +6.0V	6.000E+00 V	5.730000E+00 V	6.007037E+00 V	6.270000E+00 V	9.220E-03 V	
Amplitude: +2.0V	2.000E+00 V	1.810000E+00 V	1.980808E+00 V	2.190000E+00 V	9.220E-03 V	
Amplitude: +1.0V	1.000E+00 V	8.300000E-01 V	9.943197E-01 V	1.170000E+00 V	9.220E-03 V	
Amplitude: +0.2V	2.000E-01 V	4.600000E-02 V	1.934661E-01 V	3.540000E-01 V	9.220E-03 V	
Amplitude: -0.2V	-2.000E-01 V	-3.540000E-01 V	-2.128320E-01 V	-4.600000E-02 V	9.220E-03 V	
Amplitude: -1.0V	-1.000E+00 V	-1.170000E+00 V	-1.002105E+00 V	-8.300000E-01 V	9.220E-03 V	
Amplitude: -2.0V	-2.000E+00 V	-2.190000E+00 V	-1.991768E+00 V	-1.810000E+00 V	9.220E-03 V	
Amplitude: -6.0V	-6.000E+00 V	-6.270000E+00 V	-6.009595E+00 V	-5.730000E+00 V	9.220E-03 V	
Amplitude: -10.0V	-1.000E+01 V	-1.035000E+01 V	-9.983071E+00 V	-9.650000E+00 V	9.220E-03 V	
Amplitude: -19.0V	-1.900E+01 V	-1.953000E+01 V	-1.886414E+01 V	-1.847000E+01 V	9.440E-03 V	

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(271) Pulse Parameter Test
-----
PG11:HF port 1:Pin Bd 8
-----
Width: 150.0 ns | 1.500E-07 s | 1.365000E-07 s | 1.497000E-07 s | 1.635000E-07 s | 9.120E-10 s |
-----
Width: 199.0 ns | 1.990E-07 s | 1.830500E-07 s | 2.001000E-07 s | 2.149500E-07 s | 9.480E-10 s |
-----
Width: 200.0 ns | 2.000E-07 s | 1.865000E-07 s | 2.010000E-07 s | 2.135000E-07 s | 9.490E-10 s |
-----
Width: 500.0 ns | 5.000E-07 s | 4.715000E-07 s | 5.022000E-07 s | 5.285000E-07 s | 1.320E-09 s |
-----
Width: 1.0 us | 1.000E-06 s | 9.465000E-07 s | 1.001000E-06 s | 1.053500E-06 s | 2.180E-09 s |
-----
Width: 5.0 us | 5.000E-06 s | 4.746500E-06 s | 5.011000E-06 s | 5.253500E-06 s | 1.000E-08 s |
-----
Width: 50.0 us | 5.000E-05 s | 4.749650E-05 s | 5.016000E-05 s | 5.250350E-05 s | 1.000E-07 s |
-----
Width: 500.0 us | 5.000E-04 s | 4.749965E-04 s | 5.020000E-04 s | 5.250035E-04 s | 1.000E-06 s |
-----
Width: 5.0 ms | 5.000E-03 s | 4.749996E-03 s | 5.025000E-03 s | 5.250004E-03 s | 1.000E-05 s |
-----
Width: 50.0 ms | 5.000E-02 s | 4.750000E-02 s | 5.025000E-02 s | 5.250000E-02 s | 1.000E-04 s |
-----
Width: 500.0 ms | 5.000E-01 s | 4.750000E-01 s | 5.025000E-01 s | 5.250000E-01 s | 1.000E-03 s |
-----
Delay: 5.0 ns | 5.000E-09 s | 3.750000E-09 s | 5.016000E-09 s | 6.250000E-09 s | 6.010E-10 s |
-----
Delay: 10.0 ns | 1.000E-08 s | 8.500000E-09 s | 1.011000E-08 s | 1.150000E-08 s | 6.010E-10 s |
-----
Delay: 50.0 ns | 5.000E-08 s | 4.650000E-08 s | 5.005000E-08 s | 5.350000E-08 s | 8.560E-10 s |
-----
Delay: 100.0 ns | 1.000E-07 s | 9.400000E-08 s | 1.002000E-07 s | 1.060000E-07 s | 8.730E-10 s |
-----
Delay: 500.0 ns | 5.000E-07 s | 4.740000E-07 s | 5.000000E-07 s | 5.260000E-07 s | 1.280E-09 s |
-----
Delay: 1.0 us | 1.000E-06 s | 9.490000E-07 s | 9.960000E-07 s | 1.051000E-06 s | 2.170E-09 s |
-----
Delay: 5.0 us | 5.000E-06 s | 4.749000E-06 s | 4.994000E-06 s | 5.251000E-06 s | 1.000E-08 s |
-----
Delay: 50.0 us | 5.000E-05 s | 4.749900E-05 s | 5.004000E-05 s | 5.250100E-05 s | 6.940E-08 s |
-----
Delay: 500.0 us | 5.000E-04 s | 4.749990E-04 s | 5.010000E-04 s | 5.250010E-04 s | 1.000E-06 s |
-----
Delay: 5.0 ms | 5.000E-03 s | 4.749999E-03 s | 5.015000E-03 s | 5.250001E-03 s | 6.920E-06 s |
-----
Delay: 50.0 ms | 5.000E-02 s | 4.750000E-02 s | 5.015000E-02 s | 5.250000E-02 s | 1.000E-04 s |
-----
Delay: 500.0 ms | 5.000E-01 s | 4.750000E-01 s | 5.016000E-01 s | 5.250000E-01 s | 6.920E-04 s |
-----
Tran(leading) : 65.0 ns | 6.500E-08 s | 4.500000E-08 s | 6.400000E-08 s | 8.500000E-08 s | 7.190E-09 s |
-----
Tran(trailing): 65.0 ns | 6.500E-08 s | 4.500000E-08 s | 6.490000E-08 s | 8.500000E-08 s | 7.190E-09 s |
-----
Overshoot(leading) : +5.0 V | | | -4.127598E-02 | 5.406000E-02 | 1.020E-02 |
-----
Overshoot(trailing): +5.0 V | | | -4.516647E-02 | 5.406000E-02 | 9.270E-03 |
-----
PG21:HF port 2:Pin Bd 8
-----
Width: 50.0 ns | 5.000E-08 s | 4.550000E-08 s | 5.080000E-08 s | 5.450000E-08 s | 4.370E-10 s |
-----
Width: 99.9 ns | 9.990E-08 s | 9.290500E-08 s | 1.015000E-07 s | 1.068950E-07 s | 4.700E-10 s |
-----
Width: 100.0 ns | 1.000E-07 s | 9.300000E-08 s | 1.015000E-07 s | 1.070000E-07 s | 4.700E-10 s |
-----
Width: 500.0 ns | 5.000E-07 s | 4.730000E-07 s | 5.050000E-07 s | 5.270000E-07 s | 1.090E-09 s |
-----
Width: 1.0 us | 1.000E-06 s | 9.480000E-07 s | 1.017000E-06 s | 1.052000E-06 s | 2.050E-09 s |
-----
Width: 5.0 us | 5.000E-06 s | 4.748000E-06 s | 5.030000E-06 s | 5.252000E-06 s | 1.000E-08 s |
-----
Width: 50.0 us | 5.000E-05 s | 4.749800E-05 s | 5.038000E-05 s | 5.250200E-05 s | 1.000E-07 s |
-----
Width: 500.0 us | 5.000E-04 s | 4.749980E-04 s | 5.040000E-04 s | 5.250020E-04 s | 1.000E-06 s |
-----
Width: 5.0 ms | 5.000E-03 s | 4.749998E-03 s | 5.040000E-03 s | 5.250002E-03 s | 1.000E-05 s |
-----
Width: 50.0 ms | 5.000E-02 s | 4.750000E-02 s | 5.040000E-02 s | 5.250000E-02 s | 1.000E-04 s |
-----
Width: 500.0 ms | 5.000E-01 s | 4.750000E-01 s | 5.040000E-01 s | 5.250000E-01 s | 1.000E-03 s |
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Operating Procedure
Reporting Test Results

Delay: 5.0 ns	5.000E-09 s	3.750000E-09 s	5.047000E-09 s	6.250000E-09 s	4.200E-10 s
Delay: 10.0 ns	9.990E-09 s	8.490500E-09 s	9.980000E-09 s	1.148950E-08 s	4.200E-10 s
Delay: 50.0 ns	5.000E-08 s	4.650000E-08 s	4.990000E-08 s	5.350000E-08 s	4.320E-10 s
Delay: 99.9 ns	9.990E-08 s	9.390500E-08 s	9.980000E-08 s	1.058950E-07 s	4.650E-10 s
Delay: 100.0 ns	1.000E-07 s	9.400000E-08 s	9.970000E-08 s	1.060000E-07 s	4.650E-10 s
Delay: 500.0 ns	5.000E-07 s	4.740000E-07 s	4.993000E-07 s	5.260000E-07 s	1.050E-09 s
Delay: 1.0 us	1.000E-06 s	9.490000E-07 s	1.002000E-06 s	1.051000E-06 s	2.040E-09 s
Delay: 5.0 us	5.000E-06 s	4.749000E-06 s	4.986000E-06 s	5.251000E-06 s	1.000E-08 s
Delay: 50.0 us	5.000E-05 s	4.749900E-05 s	4.988000E-05 s	5.250100E-05 s	6.940E-08 s
Delay: 500.0 us	5.000E-04 s	4.749990E-04 s	4.990000E-04 s	5.250010E-04 s	1.000E-06 s
Delay: 5.0 ms	5.000E-03 s	4.749999E-03 s	4.993000E-03 s	5.250001E-03 s	6.920E-06 s
Delay: 50.0 ms	5.000E-02 s	4.750000E-02 s	4.989000E-02 s	5.250000E-02 s	1.000E-04 s
Delay: 500.0 ms	5.000E-01 s	4.750000E-01 s	4.993000E-01 s	5.250000E-01 s	6.920E-04 s
Tran(leading) : 20.0 ns	2.000E-08 s	1.800000E-08 s	2.232000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(trailing) : 20.0 ns	2.000E-08 s	1.800000E-08 s	2.204000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(leading) : 50.0 ns	5.000E-08 s	4.500000E-08 s	5.230000E-08 s	7.500000E-08 s	7.190E-09 s
Tran(trailing) : 50.0 ns	5.000E-08 s	4.500000E-08 s	5.170000E-08 s	7.500000E-08 s	7.190E-09 s
Tran(leading) : 500.0 ns	5.000E-07 s	4.500000E-07 s	5.030000E-07 s	5.700000E-07 s	8.420E-09 s
Tran(trailing) : 500.0 ns	5.000E-07 s	4.500000E-07 s	4.990000E-07 s	5.700000E-07 s	8.420E-09 s
Tran(leading) : 5.0 us	5.000E-06 s	4.500000E-06 s	4.880000E-06 s	5.520000E-06 s	5.880E-08 s
Tran(trailing) : 5.0 us	5.000E-06 s	4.500000E-06 s	4.810000E-06 s	5.520000E-06 s	5.880E-08 s
Tran(leading) : 50.0 us	5.000E-05 s	4.500000E-05 s	4.810000E-05 s	5.502000E-05 s	5.840E-07 s
Tran(trailing) : 50.0 us	5.000E-05 s	4.500000E-05 s	4.750000E-05 s	5.502000E-05 s	5.840E-07 s
Tran(leading) : 500.0 us	5.000E-04 s	4.500000E-04 s	4.810000E-04 s	5.500200E-04 s	5.830E-06 s
Tran(trailing) : 500.0 us	5.000E-04 s	4.500000E-04 s	4.820000E-04 s	5.500200E-04 s	5.830E-06 s
Tran(leading) : 50.0 ms	5.000E-02 s	4.500000E-02 s	4.540000E-02 s	5.500002E-02 s	5.830E-04 s
Tran(trailing) : 50.0 ms	5.000E-02 s	4.500000E-02 s	4.520000E-02 s	5.500002E-02 s	5.830E-04 s
Overshoot(leading) : +5.0 V			-3.315631E-02	5.408832E-02	1.020E-02
Overshoot(trailing) : +5.0 V			-3.024665E-02	5.408832E-02	9.270E-03
Overshoot(leading) : +0.5 V			-4.429189E-02	9.056219E-02	1.820E-02
Overshoot(trailing) : +0.5 V			-1.254183E-02	9.056219E-02	1.820E-02
PG22:HF port 3:Pin Bd 8					
Width: 50.0 ns	5.000E-08 s	4.550000E-08 s	5.109000E-08 s	5.450000E-08 s	4.370E-10 s
Width: 99.9 ns	9.990E-08 s	9.290500E-08 s	1.006000E-07 s	1.068950E-07 s	4.700E-10 s
Width: 100.0 ns	1.000E-07 s	9.300000E-08 s	1.008000E-07 s	1.070000E-07 s	4.700E-10 s
Width: 500.0 ns	5.000E-07 s	4.730000E-07 s	4.962000E-07 s	5.270000E-07 s	1.090E-09 s
Width: 1.0 us	1.000E-06 s	9.480000E-07 s	9.980000E-07 s	1.052000E-06 s	2.050E-09 s
Width: 5.0 us	5.000E-06 s	4.748000E-06 s	4.933000E-06 s	5.252000E-06 s	1.000E-08 s
Width: 50.0 us	5.000E-05 s	4.749800E-05 s	4.938000E-05 s	5.250200E-05 s	1.000E-07 s
Width: 500.0 us	5.000E-04 s	4.749980E-04 s	4.940000E-04 s	5.250020E-04 s	1.000E-06 s
Width: 5.0 ms	5.000E-03 s	4.749998E-03 s	4.940000E-03 s	5.250002E-03 s	1.000E-05 s
Width: 50.0 ms	5.000E-02 s	4.750000E-02 s	4.940000E-02 s	5.250000E-02 s	1.000E-04 s

Width: 500.0 ms	5.000E-01 s	4.750000E-01 s	4.939000E-01 s	5.250000E-01 s	1.000E-03 s
Delay: 5.0 ns	5.000E-09 s	3.750000E-09 s	4.968000E-09 s	6.250000E-09 s	4.200E-10 s
Delay: 10.0 ns	9.990E-09 s	8.490500E-09 s	9.950000E-09 s	1.148950E-08 s	4.200E-10 s
Delay: 50.0 ns	5.000E-08 s	4.650000E-08 s	4.999000E-08 s	5.350000E-08 s	4.320E-10 s
Delay: 99.9 ns	9.990E-08 s	9.390500E-08 s	9.980000E-08 s	1.058950E-07 s	4.650E-10 s
Delay: 100.0 ns	1.000E-07 s	9.400000E-08 s	1.000000E-07 s	1.060000E-07 s	4.650E-10 s
Delay: 500.0 ns	5.000E-07 s	4.740000E-07 s	4.992000E-07 s	5.260000E-07 s	1.050E-09 s
Delay: 1.0 us	1.000E-06 s	9.490000E-07 s	1.000000E-06 s	1.051000E-06 s	2.040E-09 s
Delay: 5.0 us	5.000E-06 s	4.749000E-06 s	4.991000E-06 s	5.251000E-06 s	1.000E-08 s
Delay: 50.0 us	5.000E-05 s	4.749900E-05 s	4.993000E-05 s	5.250100E-05 s	6.940E-08 s
Delay: 500.0 us	5.000E-04 s	4.749990E-04 s	4.995000E-04 s	5.250010E-04 s	1.000E-06 s
Delay: 5.0 ms	5.000E-03 s	4.749999E-03 s	4.997000E-03 s	5.250001E-03 s	6.920E-06 s
Delay: 50.0 ms	5.000E-02 s	4.750000E-02 s	4.995000E-02 s	5.250000E-02 s	1.000E-04 s
Delay: 500.0 ms	5.000E-01 s	4.750000E-01 s	4.998000E-01 s	5.250000E-01 s	6.920E-04 s
Tran(leading) : 20.0 ns	2.000E-08 s	1.800000E-08 s	2.368000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(trailing): 20.0 ns	2.000E-08 s	1.800000E-08 s	2.452000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(leading) : 50.0 ns	5.000E-08 s	4.500000E-08 s	5.140000E-08 s	7.500000E-08 s	7.190E-09 s
Tran(trailing): 50.0 ns	5.000E-08 s	4.500000E-08 s	5.540000E-08 s	7.500000E-08 s	7.190E-09 s
.
.
.
.
.
Tran(leading) : 20.0 ns	2.000E-08 s	1.800000E-08 s	2.404000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(trailing): 20.0 ns	2.000E-08 s	1.800000E-08 s	2.329000E-08 s	4.200000E-08 s	5.140E-09 s
Tran(leading) : 50.0 ns	5.000E-08 s	4.500000E-08 s	5.380000E-08 s	7.500000E-08 s	7.190E-09 s
Tran(trailing): 50.0 ns	5.000E-08 s	4.500000E-08 s	5.350000E-08 s	7.500000E-08 s	7.190E-09 s
Tran(leading) : 500.0 ns	5.000E-07 s	4.500000E-07 s	5.150000E-07 s	5.700000E-07 s	8.420E-09 s
Tran(trailing): 500.0 ns	5.000E-07 s	4.500000E-07 s	5.140000E-07 s	5.700000E-07 s	8.420E-09 s
Tran(leading) : 5.0 us	5.000E-06 s	4.500000E-06 s	5.040000E-06 s	5.520000E-06 s	5.880E-08 s
Tran(trailing): 5.0 us	5.000E-06 s	4.500000E-06 s	5.030000E-06 s	5.520000E-06 s	5.880E-08 s
Tran(leading) : 50.0 us	5.000E-05 s	4.500000E-05 s	4.990000E-05 s	5.502000E-05 s	5.840E-07 s
Tran(trailing): 50.0 us	5.000E-05 s	4.500000E-05 s	4.990000E-05 s	5.502000E-05 s	5.840E-07 s
Tran(leading) : 500.0 us	5.000E-04 s	4.500000E-04 s	4.960000E-04 s	5.500200E-04 s	5.830E-06 s
Tran(trailing): 500.0 us	5.000E-04 s	4.500000E-04 s	4.990000E-04 s	5.500200E-04 s	5.830E-06 s
Tran(leading) : 50.0 ms	5.000E-02 s	4.500000E-02 s	4.950000E-02 s	5.500002E-02 s	5.830E-04 s
Tran(trailing): 50.0 ms	5.000E-02 s	4.500000E-02 s	4.960000E-02 s	5.500002E-02 s	5.830E-04 s
Overshoot(leading) : +5.0 V			-3.906438E-02	5.405064E-02	1.020E-02
Overshoot(trailing): +5.0 V			-3.558124E-02	5.405064E-02	9.270E-03
Overshoot(leading) : +0.5 V			-4.816152E-02	9.056219E-02	1.820E-02
Overshoot(trailing): +0.5 V			-1.672785E-02	9.056219E-02	1.820E-02

3 Operating Theory

Operating Theory

This chapter provides the operating theory for the performance verification program (PV4070). The theory of operation for each test, the test limits, and the calculation method for the test limits are also included.

This chapter consists of the following sections:

- “Performance Verification”
- “Voltage and Resistance References Calibration (V/R Calibration)”
- “PG Level Error Compensation”

Performance Verification

This section provides the operating theory for performance verification, the test limits for each test, and the calculation method for test limits.

The following sub-tests are including in the performance verification for the Agilent 4072A/4073A tester:

- “Measurement Pin Location Test”
- “Residual Resistance Test”
- “HF Matrix Relay Test”
- “Isolation and Offset Current Test”
- “GNDU Output Voltage Test”
- “SMU Voltage Force and Measurement Test”
- “SMU Current Force and Measurement Test”
- “SMU Output Resistance Test”
- “CMU Capacitance and Conductance (C-G) Test”
- “CMU dc Bias Output Voltage Test”
- “DVM Differential Voltage Measurement Test”
- “Pulse Switch Test”
- “Pulse Level Test”
- “Pulse Parameter Test”

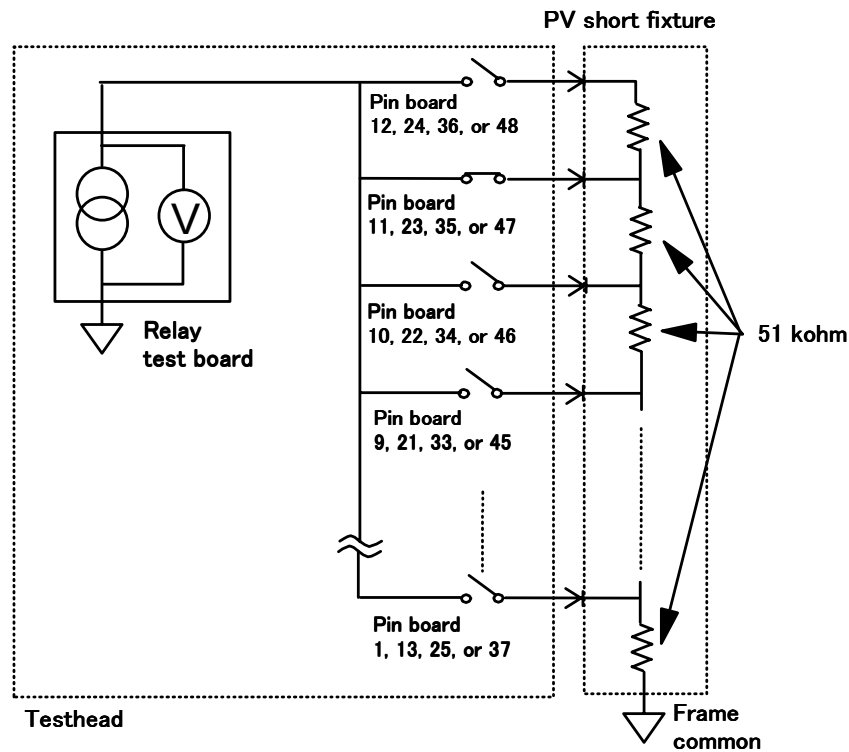
NOTE The Relay Test of the PV4070 is necessary only for the 4071A tester. Since the system software supports the 4071A, 4072A, and 4073A testers, the Relay Test appears in the subtest menu of the PV4070. However, it is not activated when the PV4070 is executed with the 4072A/4073A tester.

Measurement Pin Location Test

The measurement pin location test confirms that the measurement pin socket is installed in the proper position. This test also confirms the guard pin contact and the broken wire (guard) between the PC board and the pin socket of the pin board.

Figure 3-1 shows a simplified test circuit.

Figure 3-1 Measurement Pin Location Test Circuit



Theory of Operation

The measurement pin location test is performed by using 51 kohm resistors on the guard line of the PV short fixture. These resistors form the four groups that consist of 12 resistors, pin 1–12, 13–24, 25–36, and 37–48. The resistance between the first pin and the frame common is about 51 kohm, the second one is about 102 kohm, and the 12th one is about 612 kohm.

The signal path is made from the current source on the relay test board to the frame common, through the pin board and the PV short fixture. The current source on the relay test board forces a constant current (3.7 μA), and the voltage drop is measured by the voltage monitor function.

The resistance is calculated from the output current and measurement value. The measurement pin location test checks if the socket position is correct. If the socket position is incorrect, the resistance value is different from the expected value. This test also can confirm the pin contact of the guard and the broken guard wire.

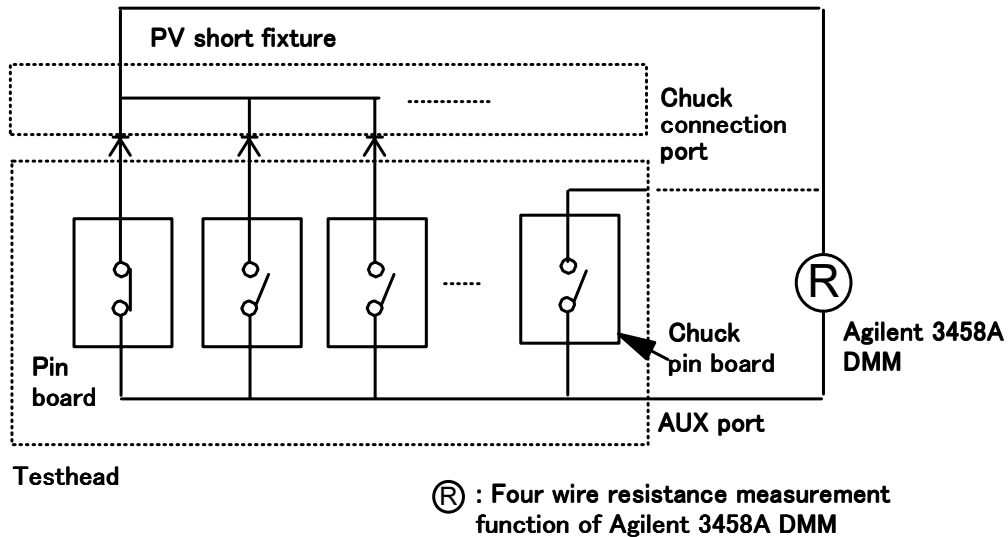
This sequence repeats until the locations of all the pin boards are tested.

Residual Resistance Test

The residual resistance test confirms the residual resistance between the AUX ports and the pin boards. This test also confirms the sense and force pin contact and the broken wire (sense and force) between the PC board and the pin socket of the pin board.

Figure 3-2 shows a simplified test circuit.

Figure 3-2 Residual Resistance Test Circuit



Theory of Operation

The residual resistance test connects an AUX port to a pin board, then measures residual resistance between the AUX port and the pin board, by the four wire resistance measurement function of DMM. The measurement value is compared against the test limits.

This sequence repeats until all pin boards and all AUX ports are tested.

Test Limits

Table 3-1 Residual Resistance Test Limits

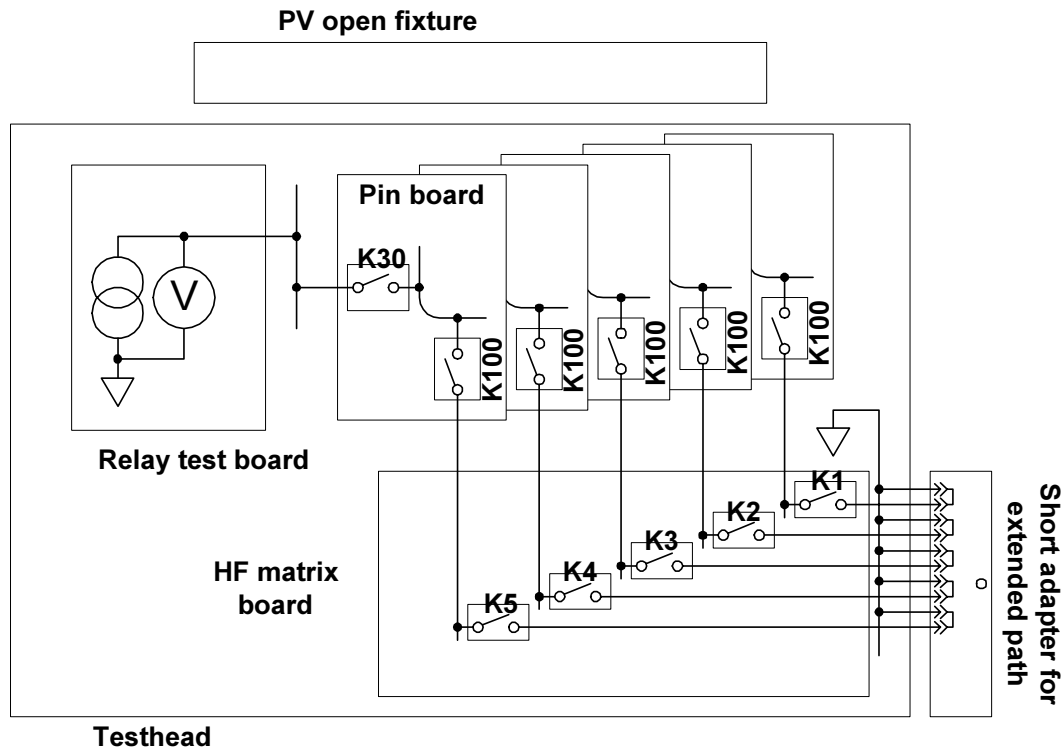
Port		4072A		4073A	
		Pin Board	Chuck Pin Board	Pin Board	Chuck Pin Board
Low Current Port (Port 1 or 2)		0.7 Ω	0.8 Ω	1.0 Ω	1.1 Ω
Kelvin Port (Port 3, 4, 5, or 6)	Force	1.0 Ω	1.1 Ω	1.0 Ω	1.1 Ω
	Sense	2.5 Ω	2.6 Ω	2.5 Ω	2.6 Ω
Non-Kelvin Port (Port 7 or 8)		1.0 Ω	1.1 Ω	1.0 Ω	1.1 Ω

HF Matrix Relay Test

The HF matrix relay test confirms the operation of relays K1 to K8 on the HF matrix board. These relays are the first relays from the extended path connector. Hence, the operation of these relays cannot be checked without shorting the terminals of the extended path connector. This test also performs cleaning of the relay contact, and checks the relays that are not checked in the DIAG4070.

Figure 3-3 shows a simplified test circuit.

Figure 3-3 HF Matrix Relay Test Circuit



Theory of Operation

The signal path is made from the current source of the relay test board to the extended path port through a pin board and a HF matrix board. The force line of port 3 is used between the relay test board and the pin board.

First, wet switching is executed for the relay (K1 to K8 for each HF matrix board). The wet switching cleans the relay contact. Next, the current source on the relay test board forces a constant current, and the voltage monitor measures the voltage drop. The resistance of the signal path is calculated from the output current and measurement value, and the closed relay contact (K1 to K8 relays on the HF matrix boards) is checked. After the closed relay check, the relay is set to open, and the sticking relay is checked.

This sequence repeats until all relays for the extended path are tested.

Table 3-2 shows the tested relays on the HF matrix board and their pin board numbers. For example, the K100 relay on the pin board installed in slot 14 is connected to K6 on the HF matrix board installed in slot 2.

Table 3-2 Tested Relay IDs on HF Matrix Board and Pin Board Numbers

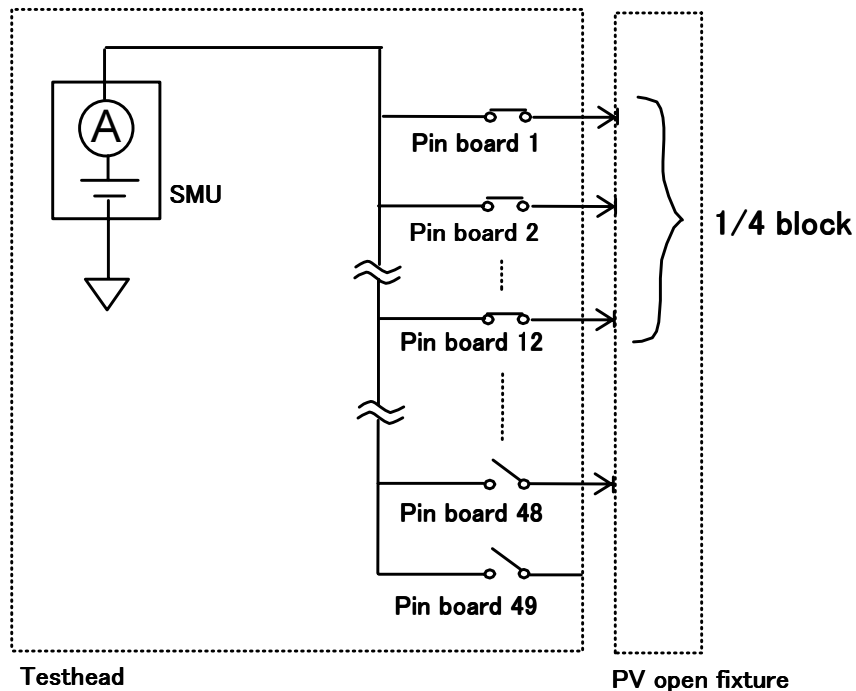
Block #	Pin #	HF #	Relay ID	Block #	Pin #	HF #	Relay ID
1	1	1	K1	2	25	4	K1
	2		K2		26		K2
	3		K3		27		K3
	4		K4		28		K4
	5		K5		29		K5
	6		K6		30		K6
	7		K7		31		K7
	8		K8		32		K8
	9	2	K1	33	5	K1	
	10		K2	34		K2	
	11		K3	35		K3	
	12		K4	36		K4	
	13		K5	37		K5	
	14		K6	38		K6	
	15		K7	39		K7	
	16		K8	40		K8	
	17	3	K1	41	6	K1	
	18		K2	42		K2	
	19		K3	43		K3	
	20		K4	44		K4	
	21		K5	45		K5	
	22		K6	46		K6	
	23		K7	47		K7	
	24		K8	48		K8	

Isolation and Offset Current Test

The isolation and offset current test confirms the isolation and offset current between one of the SMU ports and the pin boards.

Figure 3-4 shows a simplified test circuit.

Figure 3-4 Isolation and Offset Current Test Circuit



Theory of Operation

All relays on the pin boards installed in a quarter block are set to close, and are connected to the SMU being tested. The SMU forces 0 V, and measures the offset current after waiting time. Then the SMU forces +100 V and –100V, and measures the leakage current after waiting time. The measurement values are compared against the test limits.

If the offset or leakage current exceeds the test limits, however, the isolation and offset current test is repeated for each pin board installed in a quarter block of the testhead.

This sequence repeats until all SMUs and all quarter blocks are tested.

Test Limits

Table 3-3 Isolation and Offset Current Test Limits

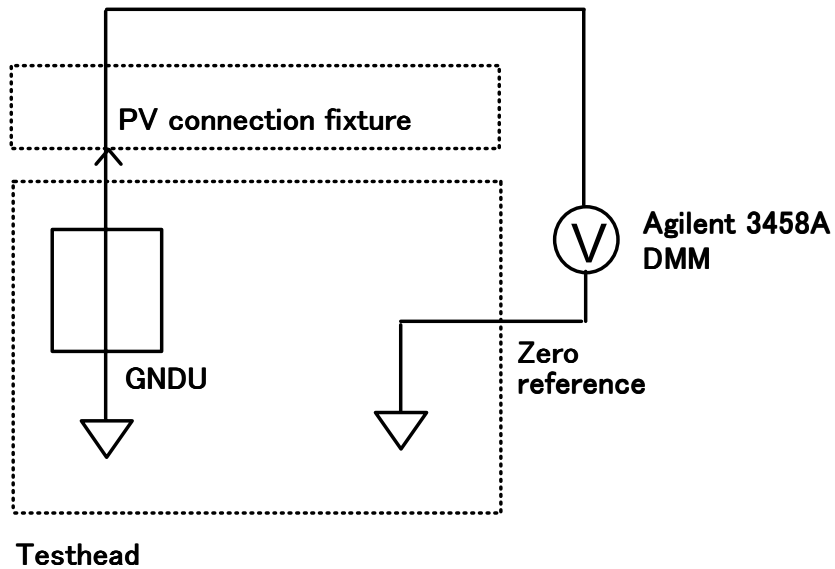
Port	Current Type	Waiting Time	Forced Voltage	4072A Accuracy	4073A Accuracy
Low Current Port (Port 1 or 2)	Offset current	10 seconds	0 V	±4 pA	±550 fA
	Leak current	30 seconds	±100 V	±6.5 pA	±651 fA
Non-Low Current Port (Port 3, 4, 5, 6, 7, or 8)	Offset current	10 seconds	0 V	±400 pA	±400 pA
	Leak current	30 seconds	±100 V	±1.45 nA	±1.45 nA

GNDU Output Voltage Test

The GNDU output voltage test confirms the output voltage of the GNDU.

Figure 3-5 shows a simplified test circuit.

Figure 3-5 GNDU Output Voltage Test Circuit



Theory of Operation

The signal path is made from GNDU to the PV connection fixture through a pin board. The DMM measures the output voltage of GNDU using the voltage measurement function. The measurement value is compared against the test limits.

Test Limits

Table 3-4 GNDU Output Voltage Test Limits

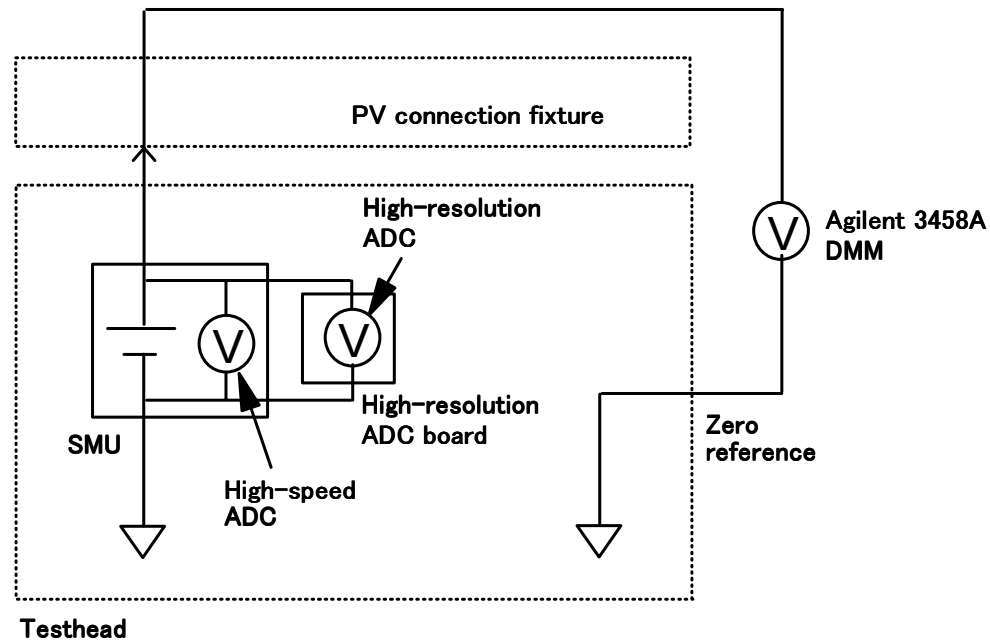
Nominal Value	Accuracy	Uncertainty
0 V	$\pm 200 \mu\text{V}$	$8.12 \mu\text{V}$

SMU Voltage Force and Measurement Test

The SMU voltage force and measurement test confirms the output voltage and the voltage measurement capability of SMUs.

Figure 3-6 shows a simplified test circuit.

Figure 3-6 SMU Voltage Force and Measurement Test Circuit



Theory of Operation

The SMU voltage force and measurement test consists of the following subtests performed in the order listed.

1. The signal path is made from an SMU to the zero reference port through a pin board, PV connection fixture, and the DMM.
2. The voltage force test is performed.

The SMU is set to the voltage force mode and forces a certain voltage. The DMM measures the SMU output voltage using the voltage measurement function. This measured value is also used as the reference value for the voltage measurement test.

3. The voltage measurement test is performed.

This subtest uses the high-speed ADC on each SMU and the high-resolution ADC on the high-resolution ADC board. The SMU forces the same voltage again, and the SMU measures its own output voltage by using the high-speed ADC and the high-resolution ADC.

4. The measurement values of the DMM and the SMU are compared against the test limits.
5. This sequence repeats until all SMUs are tested.

Test Limits

Table 3-5 SMU Voltage Force and Measurement Test Limits (MPSMU and HPSMU)

Full Scale Voltage Range	Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{volt})$		Nominal Value	Uncertainty		
	Force	Measure		Force	Measure	
$\pm 2 \text{ V}$	$0.05\% + 0.05\% + (R_{\text{mat}} \times I_{\text{o}}^{\text{a}})$	$0.04\% + 0.04\% + (R_{\text{mat}} \times I_{\text{o}}^{\text{a}})$	0.0 V	9.30 μV	46.2 μV	
			$\pm 2 \text{ V}$	50.1 μV	67.6 μV	
$\pm 20 \text{ V}$			0.0 V	152 μV	158 μV	
			$\pm 20 \text{ V}$	694 μV	696 μV	
$\pm 40 \text{ V}$			0.0 V	152 μV	158 μV	
			$\pm 40 \text{ V}$	1.24 mV	1.24 mV	
$\pm 100 \text{ V}$			0.0 V	152 μV	158 μV	
			$\pm 100 \text{ V}$	2.87 mV	2.87 mV	
$\pm 200 \text{ V}^{\text{b}}$			$0.045\% + 0.04\% + (R_{\text{mat}} \times I_{\text{o}}^{\text{a}})$	0.0 V	1.18 mV	1.18 mV
				$\pm 200 \text{ V}$	6.70 mV	6.70 mV

a. I_{o} refers to current output

$I_{\text{o}} \approx 0$

b. This range is tested only when the HPSMU is installed in the testhead.

NOTE

R_{mat} is different at each port:

4072A low current port (SMU1, SMU2): 0.7 Ω

4073A low current port (SMU1, SMU2): 1.0 Ω

4072A/4073A Kelvin port (SMU3 to SMU6): 3 m Ω

4072A/4073A non-Kelvin port (SMU7, SMU8): 1.0 Ω

When using chuck connection pin, add 0.1 Ω to R_{mat} .

Table 3-6 SMU Voltage Force and Measurement Test Limits (HRSMU)

Full Scale Voltage Range	Accuracy ±(%reading + %range + volt)		Nominal Value	Uncertainty	
	Force	Measure		Force	Measure
±2 V	0.03% + 0.035% + (Rmat × Io ^a)	0.02% + 0.025% + (Rmat × Io ^a)	0.0 V	9.00 μV	46.0 μV
			±2 V	50.0 μV	68.0 μV
±20 V	0.03% + 0.02% + (Rmat × Io ^a)	0.02% + 0.015% + (Rmat × Io ^a)	0.0 V	152 μV	158 μV
			±20 V	694 μV	696 μV
±40 V			0.0 V	152 μV	158 μV
			±40 V	1.237 mV	1.238 mV
±100 V			0.0 V	152 μV	158 μV
			±100 V	2.866 mV	2.867 mV

a. Io refers to current output
Io ≈ 0

NOTE

Rmat is different at each port:

Low current port (SMU1, SMU2): 1.0 Ω

Kelvin port (SMU3 to SMU6): 3 mΩ

Non-Kelvin port (SMU7, SMU8): 1.0 Ω

When using chuck connection pin, add 0.1 Ω to *Rmat*.

Calculation Method of Test Limits

This is an example of how to calculate the limit values for the 2 V range test of the 4072A.

Description	Nominal	Minimum	Results	Maximum	Uncertainty	Fail
(231) SMU Voltage Force and Measurement Test						
SMU2:Pin Bd 4						
2V Range (DVM)	2.000E+00 V	1.998000E+00 V	1.999888E+00 V	2.002000E+00 V	5.010E-05 V	
2V Range (Per Ch AD)	2.000E+00 V	1.998288E+00 V	2.000000E+00 V	2.001488E+00 V	6.760E-05 V	
2V Range (Ref AD)	2.000E+00 V	1.998288E+00 V	1.999852E+00 V	2.001488E+00 V	6.760E-05 V	

DVM refers to the SMU voltage force test.

Per Ch AD refers to the SMU voltage measurement test using high-speed ADC on each SMU.

Ref AD refers to the SMU voltage measurement test high-resolution ADC on the high-resolution ADC board.

Voltage Force:

$$\begin{aligned}
 \text{Force Accuracy} &= \text{Reading} \times 0.05\% + \text{Range} \times 0.05\% \\
 &= 2 \times 0.05 \times 10^{-2} + 2 \times 0.05 \times 10^{-2} \\
 &= 0.001 + 0.001 \\
 &= 0.002
 \end{aligned}$$

$$\begin{aligned}
 \text{Maximum Limit} &= 2 + 0.002 \\
 &= 2.002
 \end{aligned}$$

$$\begin{aligned}
 \text{Minimum Limit} &= 2 - 0.002 \\
 &= 1.998
 \end{aligned}$$

Voltage Measure:

$$\begin{aligned}
 \text{Measure Accuracy} &= \text{Reading} \times 0.04\% + \text{Range} \times 0.04\% \\
 &= 1.999888 \times 0.04 \times 10^{-2} + 2 \times 0.04 \times 10^{-2} \\
 &= 0.00079996 + 0.0008 \\
 &= 0.00159996
 \end{aligned}$$

$$\begin{aligned}
 \text{Maximum Limit} &= 1.999888 + 0.00159996 \\
 &\approx 2.001488
 \end{aligned}$$

$$\begin{aligned}
 \text{Minimum Limit} &= 1.999888 - 0.00159996 \\
 &\approx 1.998288
 \end{aligned}$$

SMU Current Force and Measurement Test

The SMU current force and measurement test confirms the output current from and the current measurement capability of SMUs.

Figure 3-7 and figure 3-8 are simplified test circuits.

Theory of Operation

The SMU current force and measurement test consists of the following subtests, performed in the order listed.

1. Less than or equal to 10 μA
 - a. The offset pre-measurement is performed.

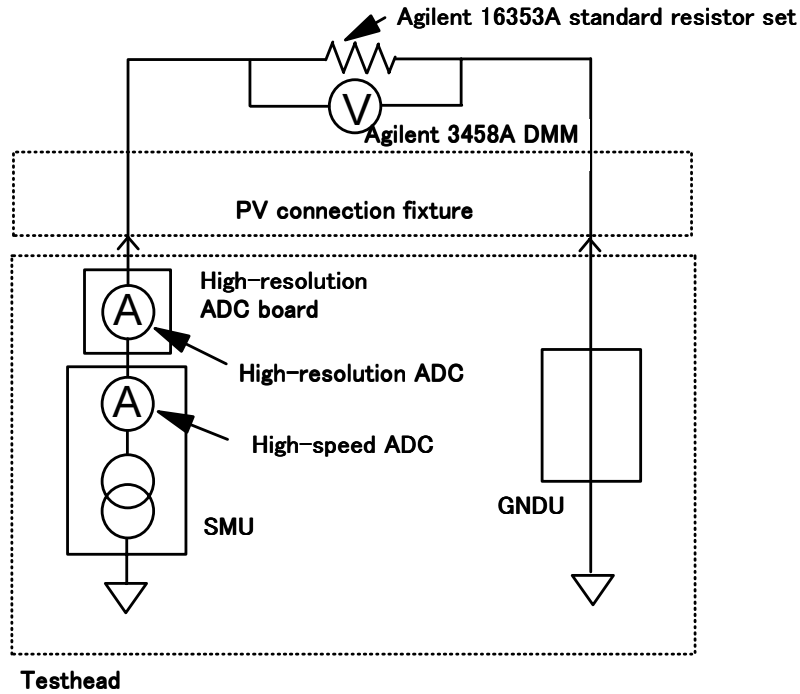
The offset voltage between force and guard is measured. Because the currents in this subtest are too low to measure the force line voltage directly using the DMM, the DMM measures the guard line voltage. In pre-measurement, the offset voltage is measured and used for error compensation for the following tests.
 - b. The current force test is performed.

The SMU is set to the current force mode, and forces a certain current. The DMM measures the voltage drop of the known resistance using the voltage measurement function. The output current is calculated from the measurement value and the known resistance. This calculated value is also used as the reference value for the Current Measurement Test.

The 100 kohm, 1 Mohm, 10 Mohm, 100 Mohm, and 1 Gohm resistors are used as the known resistance for the 4072A/4073A. In addition, the 10 Gohm resistor is used as the known resistance for the 4073A.
 - c. The current measurement test is performed.

This subtest uses the high-speed ADC on each SMU and the high-resolution ADC on the high-resolution ADC board. The SMU forces the same current again, and the SMU measures its own output current by using the high-speed ADC and high-resolution ADC.
 - d. The measurement value of the DMM and the calculated current value are compared to the test limits.

Figure 3-7 SMU Current Force and Measurement Test Circuit ($\leq 10 \mu\text{A}$)



Performance Verification

2. Greater than or equal to 100 μ A

- a. The current force test is performed.

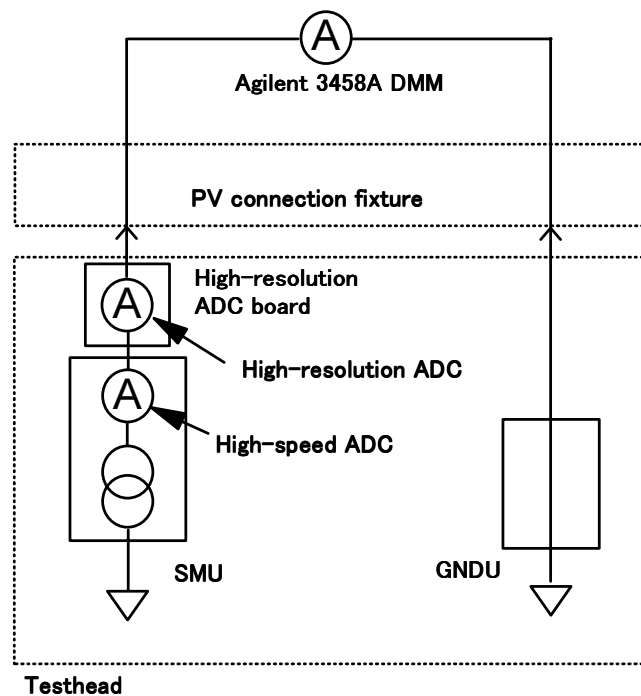
The SMU is set to the current force mode and forces a certain current. The DMM measures the SMU output current using the current measurement function. This measured value is also used as the reference value for the current measurement test.

- b. The current measurement test is performed.

The SMU forces the same current again, and then measures its own output current using the high-speed ADC and the high-resolution ADC.

- c. The measurement values of the DMM and the SMU are compared to the test limits.

Figure 3-8 SMU Current Force and Measurement Test Circuit ($\geq 100 \mu$ A)



- 3. This sequence repeats until all SMUs are tested.

Test Limits

Table 3-7 SMU Current Force and Measurement Test Limits (MPSMU:Port 1 and Port 2)

Full Scale Current Range	Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{volt})$		Nominal Value	Uncertainty	
	Force	Measure		Force	Measure
$\pm 100 \text{ mA}$	0.12% $+ [0.1 + (0.0005 \times V_o^a)]\%$	0.1% $+ [0.05 + (0.0005 \times V_o^a)]\%$	$\pm 10 \text{ mA}$	4.25 μA	4.25 μA
			$\pm 100 \text{ mA}$	19.5 μA	21.5 μA
$\pm 10 \text{ mA}$			$\pm 1 \text{ mA}$	385 nA	386 nA
			$\pm 10 \text{ mA}$	1.37 μA	1.57 μA
$\pm 1 \text{ mA}$			$\pm 100 \mu\text{A}$	38.6 nA	38.6 nA
			$\pm 1 \text{ mA}$	112 nA	112 nA
$\pm 100 \mu\text{A}$			$\pm 10 \mu\text{A}$	5.1 nA	5.11 nA
			$\pm 100 \mu\text{A}$	11.2 nA	11.2 nA
$\pm 10 \mu\text{A}$			$\pm 1 \mu\text{A}$	1.17 nA	1.18 nA
			$\pm 10 \mu\text{A}$	1.47 nA	1.47 nA
$\pm 1 \mu\text{A}$	0.2% $+ [0.1 + (0.0005 \times V_o^a)]\%$ $+ (0.02 \text{ pA/V} \times V_o^a)$	0.2% $+ [0.05 + (0.0005 \times V_o^a)]\%$ $+ (0.02 \text{ pA/V} \times V_o^a)$	$\pm 100 \text{ nA}$	117 pA	117 pA
			$\pm 1 \mu\text{A}$	155 pA	155 pA
$\pm 100 \text{ nA}$			$\pm 10 \text{ nA}$	11.8 pA	11.9 pA
			$\pm 100 \text{ nA}$	16.9 pA	16.9 pA
$\pm 10 \text{ nA}$	1% $+ [0.1 + (0.0005 \times V_o^a)]\%$ $+ 3 \text{ pA} + (0.02 \text{ pA/V} \times V_o^a)$	1% $+ [0.1 + (0.0005 \times V_o^a)]\%$ $+ 3 \text{ pA} + (0.02 \text{ pA/V} \times V_o^a)$	$\pm 1 \text{ nA}$	1.43 pA	1.44 pA
			$\pm 10 \text{ nA}$	6.44 pA	6.44 pA
$\pm 1 \text{ nA}$			$\pm 100 \text{ pA}$	242 fA	282 fA
			$\pm 1 \text{ nA}$	703 fA	713 fA

a. V_o refers to output voltage
 $V_o \approx 0$

Table 3-8 SMU Current Force and Measurement Test Limits (HRSMU:Port 1 and Port 2)

Full Scale Current Range	Accuracy ±(%reading + %range + volt)		Nominal Value	Uncertainty	
	Force	Measure		Force	Measure
±100 mA	0.12% + [0.05 + (0.0001 × Vo ^a)]%	0.1% + [0.04 + (0.0001 × Vo ^a)]%	±10 mA	4.25 μA	4.25 μA
			±100 mA	19.4 μA	19.4 μA
±10 mA	0.06% + [0.04 + (0.0001 × Vo ^a)]%	0.06% + [0.03 + (0.0001 × Vo ^a)]%	±1 mA	385 nA	386 nA
			±10 mA	1.37 μA	1.37 μA
±1 mA	0.06% + [0.05 + (0.0001 × Vo ^a)]%	0.06% + [0.04 + (0.0001 × Vo ^a)]%	±100 μA	38.6 nA	38.6 nA
			±1 mA	112 nA	112 nA
±100 μA	0.07% + [0.04 + (0.0001 × Vo ^a)]%	0.06% + [0.035 + (0.0001 × Vo ^a)]%	±10 μA	5.1 nA	5.12 nA
			±100 μA	11.2 nA	11.3 nA
±10 μA	0.07% + [0.05 + (0.0001 × Vo ^a)]%	0.06% + [0.04 + (0.0001 × Vo ^a)]%	±1 μA	766 pA	761 pA
			±10 μA	1.16 nA	1.14 nA
±1 μA	0.12% + [0.04 + (0.0001 × Vo ^a)]%	0.12% + [0.035 + (0.0001 × Vo ^a)]%	±100 nA	75.9 pA	77.5 pA
			±1 μA	127 pA	127 pA
±100 nA	0.12% + [0.05 + (0.0001 × Vo ^a)]% + (1 fA/V × Vo ^a)	0.12% + [0.04 + (0.0001 × Vo ^a)]% + (1 fA/V × Vo ^a)	±10 nA	7.71 pA	7.65 pA
			±100 nA	14.3 pA	14.1 pA
±10 nA	1% + [0.05 + (0.0001 × Vo ^a)]% + 3 pA + (1 fA/V × Vo ^a)	1% + [0.04 + (0.0001 × Vo ^a)]% + 3 pA + (1 fA/V × Vo ^a)	±1 nA	1.08 pA	995 fA
			±10 nA	6.38 pA	6.29 pA
±1 nA	1% + [0.07 + (0.0001 × Vo ^a)]% + 3 pA + (1 fA/V × Vo ^a)	1% + [0.04 + (0.0001 × Vo ^a)]% + 3 pA + (1 fA/V × Vo ^a)	±100 pA	613 fA	159 fA
			±1 nA	117 fA	614 fA
±100 pA	4% + [0.4 + (0.0001 × Vo ^a)]% + 500 fA + (1 fA/V × Vo ^a)	4% + [0.12 + (0.0001 × Vo ^a)]% + 500 fA + (1 fA/V × Vo ^a)	±10 pA	73.2 fA	69.1 fA
			±100 pA	542 fA	532 fA
±10 pA	4% + [4.0 + (0.0001 × Vo ^a)]% + 500 fA + (1 fA/V × Vo ^a)	4% + [1.0 + (0.0001 × Vo ^a)]% + 500 fA + (1 fA/V × Vo ^a)	±1 pA	31.6 fA	40.6 fA
			±10 pA	73.2 fA	69.1 fA

a. Vo refers to output voltage
Vo ≈ 0

Table 3-9 SMU Current Force and Measurement Test Limits (Port 3 through Port 8)

Full Scale Current Range	Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{volt})$		Nominal Value	Uncertainty	
	Force	Measure		Force	Measure
1 A	0.5% + [0.1 + (0.0005 × Vo ^a)]%	0.1% + [0.05 + (0.0005 × Vo ^a)]%	±100 mA	56.9 μA	56.9 μA
			±1 A	286 μA	286 μA
±100 mA	0.12% + [0.1 + (0.0005 × Vo ^a)]%	0.1% + [0.05 + (0.0005 × Vo ^a)]%	±10 mA	4.25 μA	4.25 μA
±10 mA			±100 mA	19.5 μA	21.5 μA
			±1 mA	385 nA	386 nA
±1 mA			±10 mA	1.37 μA	1.57 μA
			±100 μA	38.6 nA	38.6 nA
±100 μA			±1 mA	112 nA	112 nA
			±10 μA	5.1 nA	5.11 nA
±10 μA			±100 μA	11.2 nA	11.2 nA
	±1 μA	1.17 nA	1.18 nA		
±1 μA	0.2% + [0.1 + (0.0005 × Vo ^a)]% + (10 pA/V × Vo ^a + 300 pA)	0.2% + [0.05 + (0.0005 × Vo ^a)]% + (10 pA/V × Vo ^a + 300 pA)	±100 nA	117 pA	117 pA
			±1 μA	155 pA	155 pA
±100 nA			±10 nA	11.8 pA	11.9 pA
			±100 nA	16.9 pA	16.9 pA
±10 nA	1% + [0.1 + (0.0005 × Vo ^a)]% + 303 pA + (10 pA/V × Vo ^a)	1% + [0.1 + (0.0005 × Vo ^a)]% + 303 pA + (10 pA/V × Vo ^a)	±1 nA	1.43 pA	1.44 pA
±1 nA			±10 nA	6.44 pA	6.44 pA
			±100 pA	242 fA	282 fA
±1 nA			±1 nA	703 fA	713 fA

a. Vo refers to output voltage
Vo ≈ 0

Calculation Method of Test Limits

This is an example of how to calculate the limit values for the 1 nA range test of the 4072A.

Description	Nominal	Minimum	Results	Maximum	Uncertainty	Fail
(232) SMU Current Force and Measurement Test						
SMU2:Pin Bd 8/GNDU:Pin Bd 16						
1nA Range (DVM)	1.000E-10 A	9.500000E-11 A	1.002024E-10 A	1.050000E-10 A	2.420E-13 A	
1nA Range (Per Ch AD)	1.000E-10 A	9.520037E-11 A	1.000000E-10 A	1.052044E-10 A	2.820E-13 A	
1nA Range (Ref AD)	1.000E-10 A	9.520037E-11 A	1.000350E-10 A	1.052044E-10 A	2.820E-13 A	

DVM refers to the SMU current force test.

Per Ch AD refers to the SMU current measurement test using the high-speed ADC on each SMU.

Ref AD refers to the SMU current measurement test using the high-resolution ADC on the high-resolution ADC board.

Current Force:

$$\begin{aligned}
 \text{Force Accuracy} &= \text{Reading} \times 1\% + \text{Range} \times 0.1\% + 3\text{pA} \\
 &= 1.00 \times 10^{-10} \times 0.01 + 1 \times 10^{-9} \times 0.001 + 3 \times 10^{-12} \\
 &= 1 \times 10^{-12} + 1 \times 10^{-12} + 3 \times 10^{-12} \\
 &= 5 \times 10^{-12}
 \end{aligned}$$

$$\begin{aligned}
 \text{Maximum Limit} &= 1 \times 10^{-10} + 5 \times 10^{-12} \\
 &= 1.05 \times 10^{-10}
 \end{aligned}$$

$$\begin{aligned}
 \text{Minimum Limit} &= 1 \times 10^{-10} - 5 \times 10^{-12} \\
 &= 9.95 \times 10^{-11}
 \end{aligned}$$

Current Measure:

$$\begin{aligned}
 \text{Measure Accuracy} &= \text{Reading} \times 1\% + \text{Range} \times 0.1\% + 3\text{pA} \\
 &= 1.002024 \times 10^{-10} \times 0.01 + 1 \times 10^{-9} \times 0.001 + 3 \times 10^{-12} \\
 &= 1.002024 \times 10^{-12} + 1 \times 10^{-12} + 3 \times 10^{-12} \\
 &= 5.002024 \times 10^{-12}
 \end{aligned}$$

$$\begin{aligned}
 \text{Maximum Limit} &= 1.002024 \times 10^{-10} + 5.002024 \times 10^{-12} \\
 &= 1.05204424 \times 10^{-10} \\
 &\approx 1.05244 \times 10^{-10}
 \end{aligned}$$

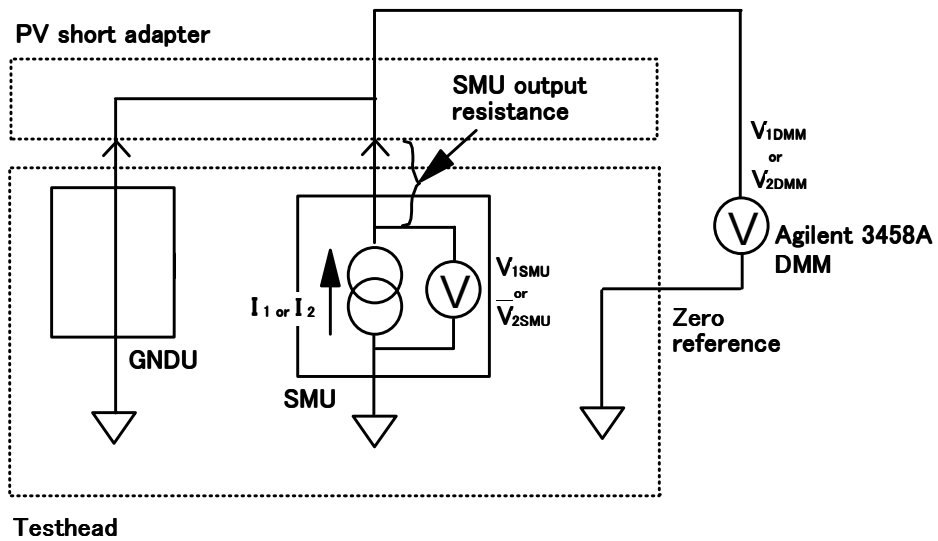
$$\begin{aligned}
 \text{Minimum Limit} &= 1.002024 \times 10^{-10} - 5.002024 \times 10^{-12} \\
 &= 9.95200376 \times 10^{-11} \\
 &\approx 9.9520037 \times 10^{-11}
 \end{aligned}$$

SMU Output Resistance Test

The SMU output resistance test confirms the output resistance between the SMU and the pin tip.

Figure 3-9 shows a simplified test circuit.

Figure 3-9 SMU Output Resistance Test Circuit

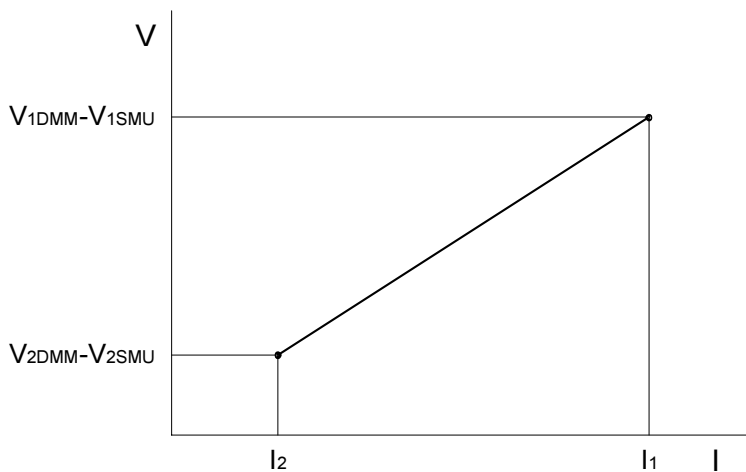


Theory of Operation

The signal path is made from SMU to GNDU through the pin board and the PV short adapter. The SMU is set to the current force (voltage measure) mode. At first, The SMU forces the constant current (I_1), and measures the voltage value(V_{1SMU}). The next, DMM also measures the voltage value(V_{1DMM}). In the same way, the SMU forces the current(I_2), and measures the voltage values(V_{2SMU} and V_{2DMM}).

PV4070 calculates the voltage drop between the SMU and the pin tip and subtracts the measurement value of the SMU from the measurement value of the DMM. The SMU output resistance is calculated from the SMU output current and the voltage drop, and this value is compared against the test limits.

Figure 3-10 Relation between SMU Output Current and Voltage Drop



$$\text{SMU Output Resistance} = \frac{(V_{1DMM} - V_{1SMU}) - (V_{2DMM} - V_{2SMU})}{I_1 - I_2}$$

This sequence repeats until the output resistance of all SMUs are tested.

Test Limits

Table 3-10 SMU Output Resistance Test Limits

SMU	Resistance
SMU1 or 2	0 Ω to 700 m Ω
SMU3, 4, 5, or 6	-1 m Ω to 3 m Ω
SMU7 or 8	0 Ω to 1 Ω

CMU Capacitance and Conductance (C-G) Test

The CMU C-G test confirms the capacitance and conductance measurement accuracy of the Agilent 4284A.

Theory of Operation

The CMU C-G test consists of the following subtests, performed in the order listed.

1. System L-R error measurement The CMU measures the inductance and resistance error of each pin that is used in the C-G measurement test. If the CMU error compensation data is measured correctly, each pin has little dispersion.
2. Capacitance and conductance pre-measurement The CMU measures the stray capacitance and conductance, including the cable for the C-STD connection. Stray capacitance and conductance is generated each time the PV connection fixture and the cable for the C-STD connection are installed on the testhead.

The open measurement of the inductance and resistance pre-measurement is also performed at this time.

3. Inductance and resistance pre-measurement The short measurement for the inductance and resistance pre-measurement is performed. The CMU measures the inductance and resistance, including the cable for the C-STD connection.

NOTE The measurement values of the system L-R error measurement, the capacitance and conductance pre-measurement, and the inductance and resistance pre-measurement are not displayed in the test record of the performance verification. The results of these pre-measurements are used for error compensation in the C-G measurement test.

4. C-G measurement test
 - a. The CMU measures the capacitance of the 100 pF, 1000 pF, 0.01 μ F, and 0.1 μ F capacitors and the 1 kohm resistor. The measurement is performed at frequencies of 1 kHz, 10 kHz, 100 kHz, and 1 MHz. The measurement values are compared with the calibrated values of the standard capacitor and standard resistor.
 - b. The CMU measures the conductance of the 100 pF, 1000 pF, 0.01 μ F, and 0.1 μ F capacitors and the 1 kohm resistor. The measurement is performed at frequencies of 1 kHz, 10 kHz, 100 kHz, and 1 MHz. The measurement values are compared to the test limits.

Test Limits

Table 3-11 CMU Capacitance and Conductance Measurement Test Limits

Nominal Value	Frequency	Range	Accuracy (Capacitance/Conductance) ±(%reading + %range)	Uncertainty (C/G)
100 pF	1 MHz	100 pF 630 μS	0.8% + [0.3 + (0.6 × Gm/630 μS)]% 0.8% + [0.3 + (0.6 × Cm/100 pF)]%	130 fF 546 nS
	100 kHz	100 pF 63 μS	0.3% + [0.3 + (0.3 × Gm/63 μS)]% 0.3% + [0.3 + (0.3 × Cm/100 pF)]%	56.406 fF 25.7 nS
	10 kHz	100 pF 6.3 μS	0.3% + [0.2 + (0.3 × Gm/6.3 μS)]% 0.3% + [0.2 + (0.3 × Cm/100 pF)]%	56.309 fF 2.52 nS
	1 kHz	100 pF 0.63 μS	0.4% + [0.5 + (0.4 × Gm/0.63 μS)]% 0.4% + [0.5 + (0.4 × Cm/100 pF)]%	58.097 fF 252 pS
1 nF	1 MHz	1 nF 6.3 mS	1.5% + [0.2 + (1.7 × Gm/6.3 mS)]% 1.3% + [0.2 + (2.2 × Cm/1 nF)]%	1.99 pF 4.99 S
	100 kHz	1 nF 630 μS	0.3% + [0.2 + (0.4 × Gm/630 μS)]% 0.3% + [0.2 + (0.4 × Cm/1 nF)]%	712 fF 256 nS
	10 kHz	1 nF 63 μS	0.3% + [0.1 + (0.3 × Gm/63 μS)]% 0.3% + [0.1 + (0.3 × Cm/1 nF)]%	710 fF 25.7 nS
	1 kHz	1 nF 6.3 μS	0.3% + [0.1 + (0.3 × Gm/6.3 μS)]% 0.3% + [0.1 + (0.3 × Cm/1 nF)]%	725 fF 2.52 nS
10 nF	100 kHz	10 nF 6.3 mS	0.5% + [0.2 + (1.0 × Gm/6.3 mS)]% 0.7% + [0.2 + (0.8 × Cm/10 nF)]%	5.97 pF 3.93 S
	10 kHz	10 nF 630 μS	0.3% + [0.1 + (0.3 × Gm/630 μS)]% 0.3% + [0.1 + (0.3 × Cm/10 nF)]%	3.61 pF 252 nS
	1 kHz	10 nF 63 μS	0.3% + [0.1 + (0.3 × Gm/63 μS)]% 0.3% + [0.1 + (0.3 × Cm/10 nF)]%	3.12 pF 25.2 nS
100 nF	10 kHz	100 nF 6.3 mS	0.3% + [0.1 + (1.0 × Gm/6.3 mS)]% 0.7% + [0.1 + (0.7 × Cm/100 nF)]%	36.7 pF 2.74 S
	1 kHz	100 nF 630 μS	0.3% + [0.1 + (0.3 × Gm/630 μS)]% 0.3% + [0.1 + (0.3 × Cm/100 nF)]%	38.8 pF 126 nS
1 kΩ (1 mS)	1 MHz	100 pF 630 μS	0.8% + [0.3 + (0.6 × Gm/630 μS)]% 0.8% + [0.3 + (0.6 × Cm/100 pF)]%	199 fF 1.41 S
	100 kHz	1 nF 630 μS	0.3% + [0.2 + (0.4 × Gm/630 μS)]% 0.3% + [0.2 + (0.4 × Cm/1 nF)]%	196 fF 814 nS
	10 kHz	10 nF 630 μS	0.3% + [0.1 + (0.3 × Gm/630 μS)]% 0.3% + [0.1 + (0.3 × Cm/10 nF)]%	302 fF 250 nS
	1 kHz	10 nF 63 μS	0.3% + [0.1 + (0.3 × Gm/63 μS)]% 0.3% + [0.1 + (0.3 × Cm/10 nF)]%	902 fF 288 nS

Calculation Method of Test Limits

An example of how to calculate the limit values for measuring the 100 pF standard capacitor, using the 100 pF range at 1 MHz of measurement frequency, is shown below.

Description	Nominal	Minimum	Results	Maximum	Uncertainty	Fail
(240) CMU Capacitance and Conductance Test						
CMH:Pin Bd 4/CML:Pin Bd 8						
16383A 100pF Standard, 1MHz	1.000E-10 F	9.890099E-11 F	1.000691E-10 F	1.011010E-10 F	1.300E-13 F	
16383A 100pF Standard, 1MHz	0.000E+00 S	-5.670038E-06 S	7.279750E-07 S	5.670038E-06 S	5.460E-07 S	

Capacitance:

$$\begin{aligned}
 C \text{ Accuracy} &= \text{Reading} \times 0.8\% + \text{Range} \times \left(0.3 + 0.6 \times \frac{G_m}{630\mu\text{S}}\right)\% \\
 &= 1.0000099 \times 10^{-10} \times 0.008 + 1.00 \times 10^{-10} \times \left(0.3 + 0.6 \times \frac{0}{630 \times 10^{-6}}\right) \times 10^{-2} \\
 &= 0.80000792 \times 10^{-12} + 0.3 \times 10^{-12} \\
 &= 1.10000792 \times 10^{-12} \\
 \text{Maximum Limit} &= 1.0000099 \times 10^{-10} + 1.10000792 \times 10^{-12} \\
 &= 1.01100992 \times 10^{-10} \\
 &\approx 1.011010 \times 10^{-10} \\
 \text{Minimum Limit} &= 1.0000099 \times 10^{-10} - 1.10000792 \times 10^{-12} \\
 &= 0.98900988 \times 10^{-10} \\
 &\approx 9.890099 \times 10^{-11}
 \end{aligned}$$

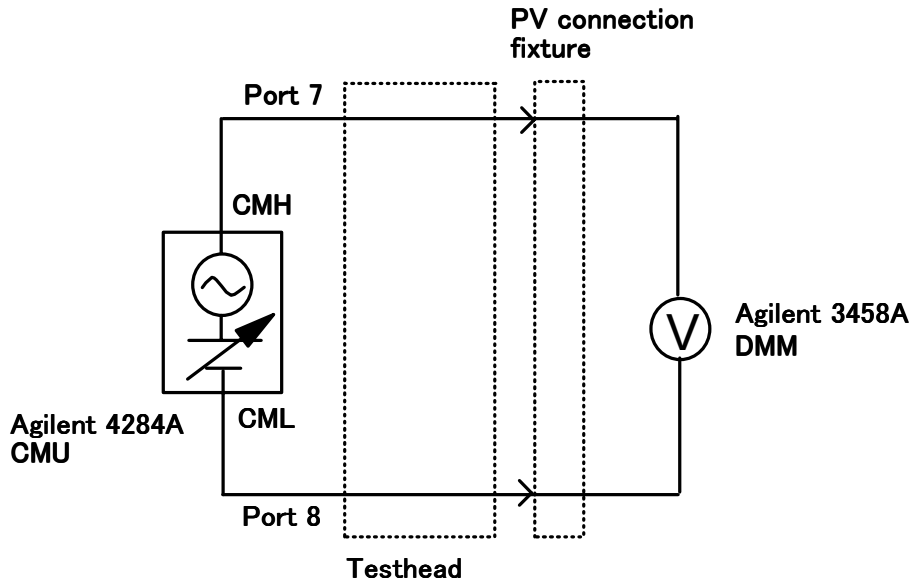
Conductance:

$$\begin{aligned}
 G \text{ Accuracy} &= \text{Reading} \times 0.8\% + \text{Range} \times \left(0.3 + 0.6 \times \frac{C_m}{100 \times 10^{-12}}\right)\% \\
 &= 0 \times 0.008 + 630 \times 10^{-6} \times \left(0.3 + 0.6 \times \frac{100.000099 \times 10^{-12}}{100 \times 10^{-12}}\right) \times 10^{-2} \\
 &= 0 + 630 \times 10^{-6} \times 0.9000059 \times 10^{-2} \\
 &= 5.6700371 \times 10^{-6} \\
 \text{Maximum Limit} &= 0 + 5.6700371 \times 10^{-6} \\
 &\approx 0.5670038 \times 10^{-6} \\
 \text{Minimum Limit} &= 0 - 5.6700371 \times 10^{-6} \\
 &\approx -5.670038 \times 10^{-6}
 \end{aligned}$$

CMU dc Bias Output Voltage Test

The CMU dc bias output voltage test confirms the dc bias of the CMU. This test also executes the CMU self-test. Figure 3-11 shows a simplified test circuit.

Figure 3-11 CMU DC Bias Output Voltage Test Circuit



Theory of Operation

The signal path is made from CMH and CML to DMM, through the pin boards and the PV connection fixture. The CMU is set to a 30 mVrms signal level and a 1 MHz frequency, then forces the 0 V, +40 V, and -40 V dc bias. The voltage measurement function of the DMM measures the dc bias that is forced from the CMU. The measurement values are compared against the test limits.

Test Limits

Table 3-12 CMU dc Bias Output Voltage Test Limits

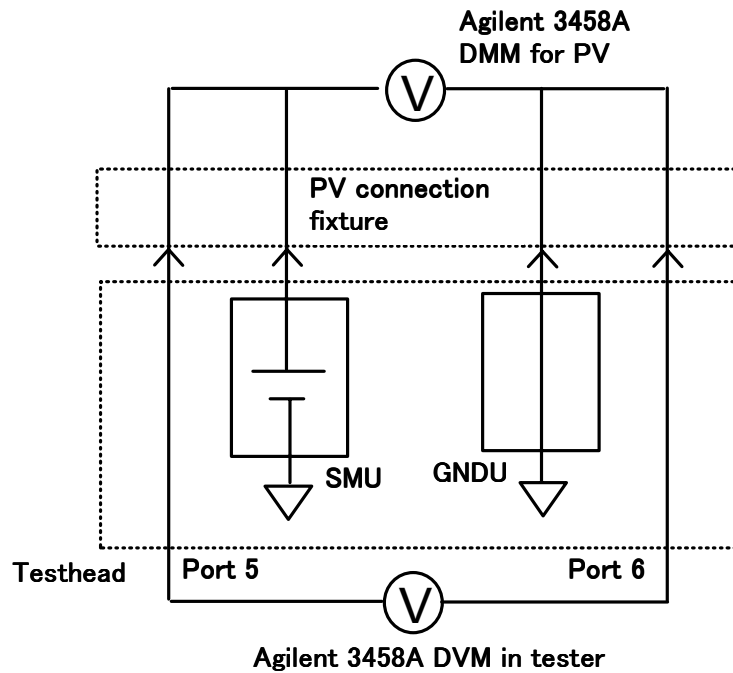
Nominal Value	CMU Range	Force Accuracy	Uncertainty
0.0 V	4 V	±10 mV	152 μV
±40.0 V	±40 V	±50 mV	1.65 mV

DVM Differential Voltage Measurement Test

The DVM differential voltage measurement test confirms the differential voltage measurement capability of the DVM. This test also executes the DVM self-test.

Figure 3-12 shows a simplified test circuit.

Figure 3-12 DVM Differential Voltage Measurement Test Circuit



Theory of Operation

The SMU is set to the voltage force mode, then forces a certain voltage. The DMM for PV and the DVM in tester measure the voltage. The test limits are calculated from the measurement value of the DMM for PV. The measurement value of the DVM in tester is compared to the test limits.

Test Limits

Table 3-13 DVM Differential Voltage Measurement Test Limits for 4072A

Full Scale Voltage Range	Resolution	Accuracy (% of reading + volt)	Nominal Value	Uncertainty
100 V	100 μ V	0.02% + 1 mV	0.0 V \pm 100 V	207 μ V 2.87 mV
10 V	10 μ V	0.01% + 300 μ V	0.0 V \pm 10 V	29.8 μ V 222 μ V
1 V	1 μ V	0.01% + 300 μ V	0.0 V \pm 1 V	9.83 μ V 29.0 μ V

Table 3-14 DVM Differential Voltage Measurement Test Limits for 4073A

Full Scale Voltage Range	Resolution	Accuracy (% of reading + volt)	Nominal Value	Uncertainty
100 V	100 μ V	0.02% + 1 mV	0.0 V \pm 100 V	207 μ V 2.87 mV
10 V	10 μ V	0.01% + 200 μ V	0.0 V \pm 10 V	29.8 μ V 222 μ V
1 V	1 μ V	0.01% + 100 μ V	0.0 V \pm 1 V	9.83 μ V 29.0 μ V
0.1 V	0.1 μ V	0.01% + 100 μ V	0.0 V \pm 0.1 V	9.83 μ V 11.3 μ V

Calculation Method of Test Limits

This is an example of how to calculate the limit value for the 4072A DVM 0V measurement using the 100 V range.

Description	Nominal	Minimum	Results	Maximum	Uncertainty	Fail
(250) DVM Differential Voltage Measurement Test						
DVMH:Pin Bd 32/DVML:Pin Bd 16/SMU2:Pin Bd 4/GNDU:Pin Bd 8						
100.0V Range -100.0V Measure	-1.000E+02 V	-1.000279E+02 V	-1.000074E+02 V	-9.998594E+01 V	2.870E-03 V	
100.0V Range 0.0V Measure	-1.177E-03 V	-2.177300E-03 V	-1.143121E-03 V	-1.768290E-04 V	2.070E-04 V	
100.0V Range 100.0V Measure	9.999E+01 V	9.997351E+01 V	9.999501E+01 V	1.000155E+02 V	2.870E-03 V	

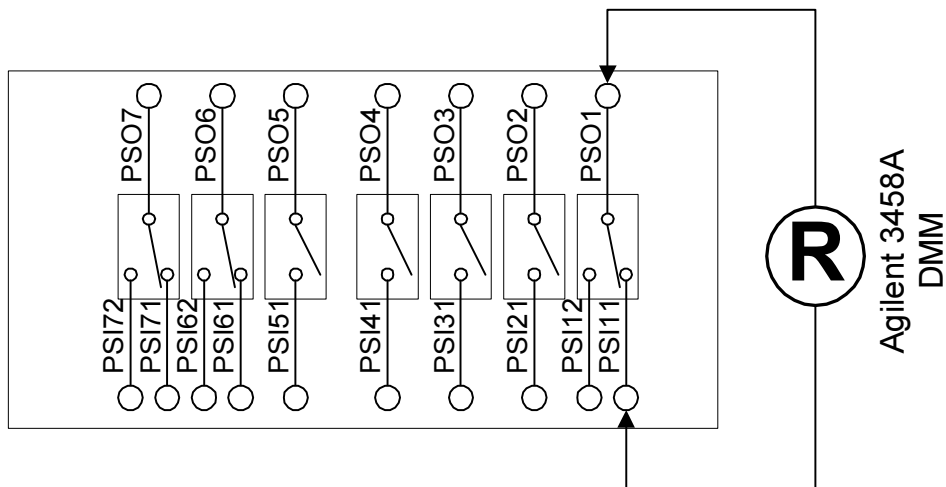
$$\begin{aligned}
 \text{Accuracy} &= \text{Reading} \times 0.02\% + 1\text{mV} \\
 &= -1.1770645 \times 10^{-3} \times 0.0002 + 1 \times 10^{-3} \\
 &= -0.00023541 \times 10^{-3} + 1 \times 10^{-3} \\
 &= -1.0002354 \times 10^{-3} \\
 \text{Maximum Limit} &= -1.1770645 \times 10^{-3} + 1.0002354 \times 10^{-3} \\
 &= -0.17682909 \times 10^{-3} \\
 &\approx -1.768290 \times 10^{-3} \\
 \text{Minimum Limit} &= -1.1770645 \times 10^{-3} - 1.0002354 \times 10^{-3} \\
 &= -2.1772999 \times 10^{-3} \\
 &\approx -2.177300 \times 10^{-3}
 \end{aligned}$$

Pulse Switch Test

The pulse switch test confirms the operations of semiconductor relays used in the pulse switch. The operations are checked by measuring resistance of relays with the DMM.

Figure 3-13 shows a simplified test circuit.

Figure 3-13 Pulse Switch Test Circuit



Theory of Operation

The pulse switch test connects the Hi terminals of the DMM to the PSI_{xy}, and connects the Lo terminals to the PSO_x. The resistance between the PSI_{xy} and PSO_x are measured when these two terminals are closed, and then measured when these two terminals are open. The measurement values are compared to the test limits.

The sequence repeats until all pulse switches are tested.

Test Limits

Table 3-15 Pulse Switch Test Limits

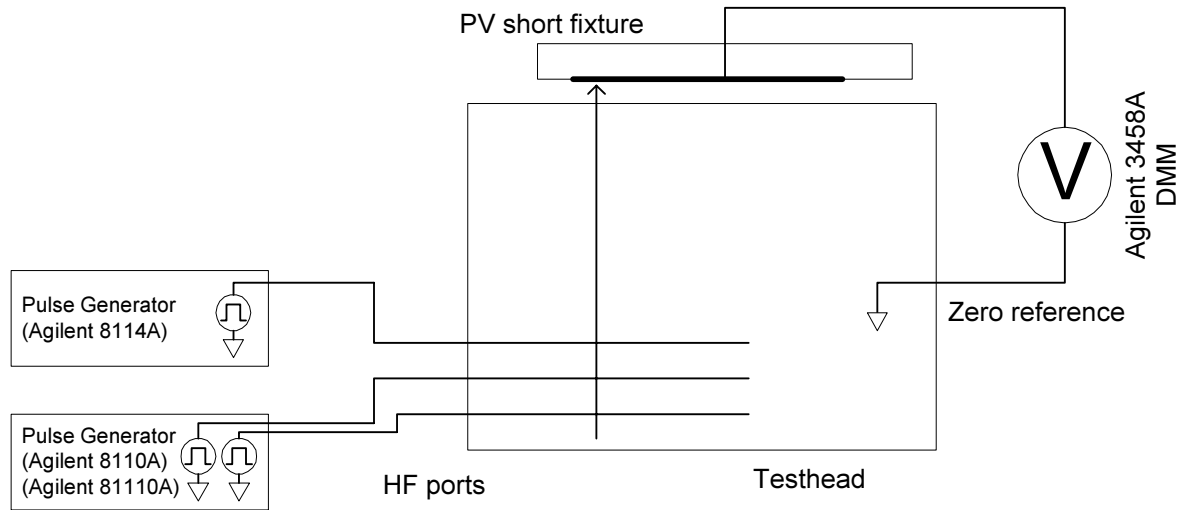
Switch Position	Pass Condition
Close (make)	$\leq 5 \Omega$
Open (break)	$\geq 1 \text{ M}\Omega$

Pulse Level Test

The pulse level test confirms the output voltage of pulse generators (Agilent 8110A, 81110A, or 8114A).

Figure 3-14 shows a simplified test circuit.

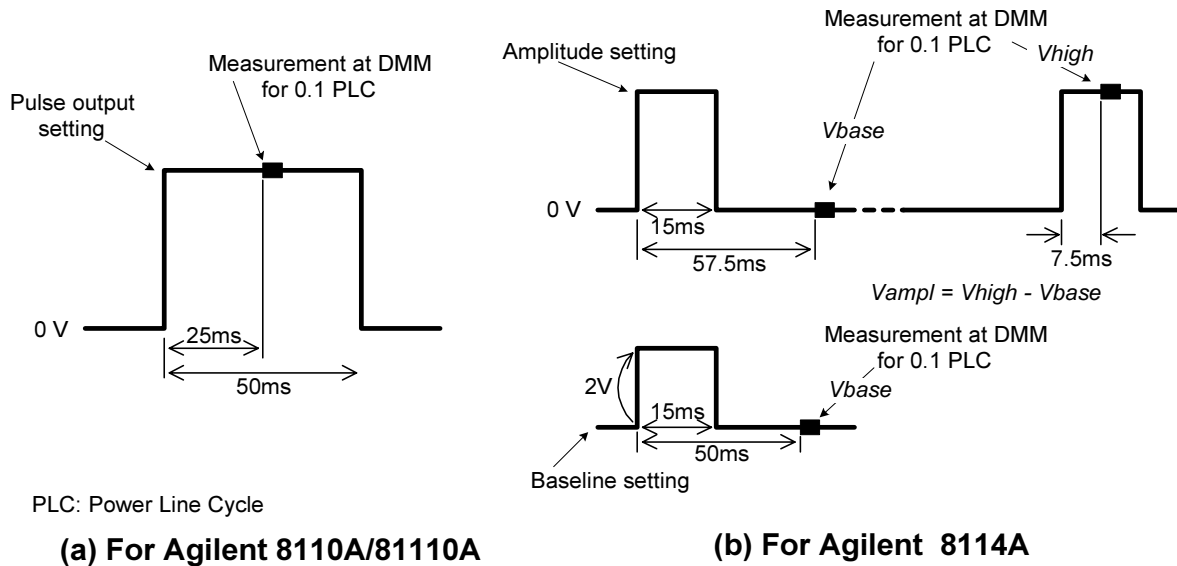
Figure 3-14 Pulse Level Test Circuit



Theory of Operation

The signal path from a pulse source in the pulse generator is made to the PV short fixture through an HF port and a pin board. The DMM measures the output voltage of the pulse source using its voltage measurement function. Figure 3-15 shows the operation of pulse measurements.

Figure 3-15 Operations of Pulse Level Test



For Agilent 8110A/81110A Pulse Generator

A pulse of 50 ms width is forced from the 8110A/81110A pulse generator. Its low voltage is set to 0 V and the high voltage is set to the nominal value. The DMM measures voltage for 0.1 PLC (power line cycle) 25 ms after the pulse ramps up.

For Agilent 8114A Pulse Generator

Two pulses of 15 ms width are forced for the amplitude test from the 8114A pulse generator. These two pulse waves are the same, and the low and high voltages are 0 V and nominal value, respectively. The DMM measures voltage as V_{base} , 42.5 ms (= 57.5 ms – 15 ms) after the first pulse ramps down. Then the DMM measures voltage as V_{high} , 7.5 ms after the second pulse ramps up. The amplitude (V_{amp1}) is calculated by subtracting V_{base} from V_{high} , and is compared against the test limits.

A pulse of 15 ms width is forced for the baseline test. The base voltage is set to the nominal value and the amplitude is set to 2 V. The DMM measures voltage 35 ms after the pulse ramps down and the measured value is compared against the test limits.

Note that the TRIG OUTPUT of the 8114A is connected to the Ext Trig of the DMM. This trigger signal is used to synchronize the pulse wave and measurement timing.

This sequence repeats until the pulse level of all pulse sources are tested.

Test Limits

Table 3-16 Pulse Level Test Limits for Agilent 8110A/81110A

Nominal Value	Accuracy	Test Limits	Uncertainty
±0.2 V	±[(2% of amplitude) + 150 mV]	±154 mV	9.22 mV
±1.0 V		±170 mV	9.22 mV
±2.0 V		±190 mV	9.22 mV
±6.0 V		±270 mV	9.22 mV
±10.0 V		±350 mV	9.22 mV
±19.0 V		±530 mV	9.44 mV

Table 3-17 Pulse Level Test Limits for Agilent 8114A

Tested Item	Nominal Value	Accuracy	Test Limits	Uncertainty
Amplitude	+2.0 V	±[(2% of amplitude) + 200 mV]	±240 mV	13 mV
	+5.0 V		±300 mV	13 mV
	+10.0 V		±400 mV	13 mV
	+20.0 V		±600 mV	13 mV
	+50.0 V		±1.20 V	13 mV
Baseline	-49.9 V	±[(2% of baseline) + (1% of amplitude) + 200 mV]	±1218 mV	9.46 mV
	-40.0 V		±1020 mV	9.45 mV
	-20.0 V		±620 mV	9.44 mV
	-10.0 V		±420 mV	9.22 mV
	-4.0 V		±300 mV	9.22 mV
	0.0 V		±220 mV	9.22 mV
	+4.0 V		±300 mV	9.22 mV
	+10.0 V		±420 mV	9.22 mV
	+20.0 V		±620 mV	9.44 mV
	+40.0 V		±1020 mV	9.45 mV
	+48.0 V		±1180 mV	9.46 mV

Calculation Method of Test Limits

An example on how to calculate the limit values for the nominal values is shown below:

Description	Nominal	Minimum	Results	Maximum	Uncertainty	Fail
(270) Pulse Level Test						
PG21:HF port 2:Pin Bd 8						
Amplitude: +19.0V	1.900E+01 V	1.847000E+01 V	1.894219E+01 V	1.953000E+01 V	9.440E-03 V	

When the nominal value of amplitude is +19.0 V, the test limit is calculated as follows:

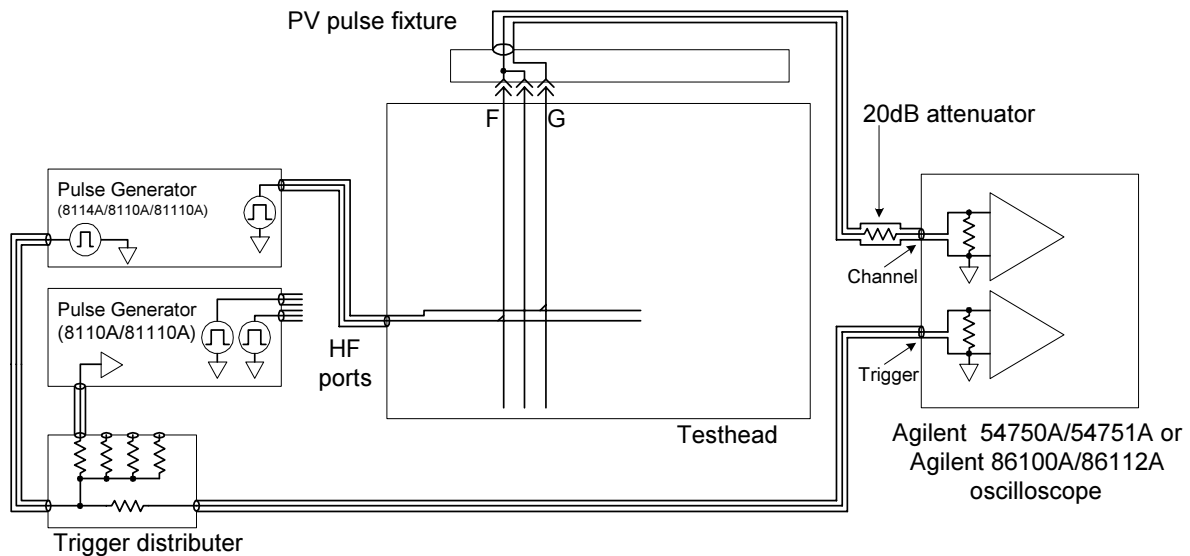
$$\begin{aligned}
 \text{Test Limit} &= \pm (2\% \text{ of amplitude} + 150 \text{ mV}) \\
 &= \pm(0.02 \times 19.0 + 0.15) \\
 &= \pm(0.38 + 0.15) \\
 &= \pm 0.53 \\
 \text{Maximum} &= 19.0 + 0.53 \\
 &= 19.53 \\
 \text{Minimum} &= 19.0 - 0.53 \\
 &= 18.47
 \end{aligned}$$

Pulse Parameter Test

The pulse parameter test confirms the accuracy of pulse wave parameters such as pulse width output from the pulse sources.

Figure 3-16 shows a simplified test circuit.

Figure 3-16 Pulse Parameter Test Circuit



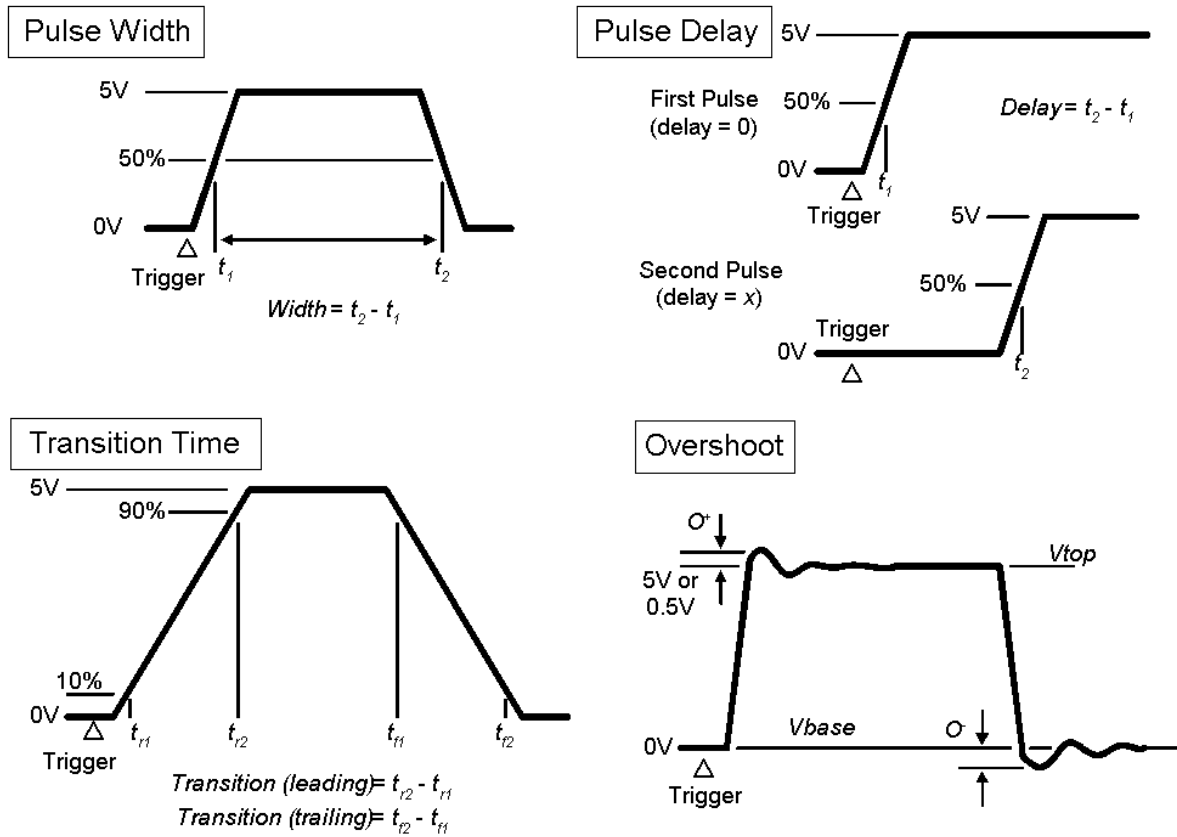
Theory of Operation

A pulse wave according to the wave setting is forced from a pulse source (PGU) and the pulse wave is observed at the measurement pins, which contact the PV pulse fixture. The oscilloscope measures the pulse wave synchronizing with the trigger signal, and calculates the pulse parameters as follows:

- Pulse width
- Pulse delay
- Transition time (leading and trailing edges)
- Overshoot (leading and trailing edges)

Figure 3-17 shows the definition for each test item.

Figure 3-17 Definition for Pulse Parameter Test



Test Limits

Table 3-18 Test Limits of Pulse Width

Model of PG	Nominal Value	Accuracy	Minimum	Maximum	Uncertainty
Agilent 8114A	150 ns	i) Width \geq 150 ns $\pm(5\%$ of setting + 6.0 ns)	136.5 ns	163.5 ns	0.912 ns
	199 ns		183.05 ns	214.95 ns	0.948 ns
	200 ns		186.5 ns	213.5 ns	0.949 ns
	500 ns	ii) Width \geq 200 ns $\pm(5\%$ of setting + 3.5 ns)	471.5 ns	528.5 ns	1.32 ns
	1 μ s		946.5 ns	1.0535 μ s	2.18 ns
	5 μ s		4.7465 μ s	5.2535 μ s	10.0 ns
	50 μ s		47.4965 μ s	52.5035 μ s	100 ns
	500 μ s		474.9965 μ s	525.0035 μ s	1.00 ms
	5 ms		4.7499965 ms	5.2500035 ms	10.0 ms
	50 ms		47.4999965 ms	52.5000035 ms	100 ms
	500 ms		474.9999965 ms	525.0000035 ms	1.00 ms
	Agilent 8110A		50 ns	$\pm(5\%$ of setting + 2 ns)	45.5 ns
99.9 ns		92.905 ns	106.895 ns		0.470 ns
100 ns		Note: in normal mode, Width \geq 50 ns	93 ns	107 ns	0.470 ns
500 ns			473 ns	527 ns	1.09 ns
1 μ s			948 ns	1.052 μ s	2.05 ns
5 μ s			4.748 μ s	5.252 μ s	10.0 ns
50 μ s			47.498 μ s	52.502 μ s	100 ns
500 μ s			474.998 μ s	525.002 μ s	1.00 ms
5 ms			4.749998 ms	5.250002 ms	10.0 ms
50 ms			47.499998 ms	52.500002 ms	100 ms
500 ms			474.999998 ms	525.000002 ms	1.00 ms
Agilent 81110A			50 ns	$\pm(3\%$ of setting + 2 ns)	46.5 ns
	99.9 ns	94.903 ns	104.897 ns		0.470 ns
	100 ns	Note: in normal mode, Width \geq 50 ns	95 ns	105 ns	0.470 ns
	500 ns		483 ns	517 ns	1.09 ns
	1 μ s		968 ns	1.032 μ s	2.05 ns
	5 μ s		4.848 μ s	5.152 μ s	10.0 ns
	50 μ s		48.498 μ s	51.502 μ s	100 ns
	500 μ s		484.998 μ s	515.002 μ s	1.00 ms
	5 ms		4.849998 ms	5.150002 ms	10.0 ms
	50 ms		48.499998 ms	51.500002 ms	100 ms
	500 ms		484.999998 ms	515.000002 ms	1.00 ms

Table 3-19 Test Limits of Pulse Delay

Model of PG	Nominal Value	Accuracy	Minimum	Maximum	Uncertainty
Agilent 8114A	5 ns	±(5% of setting + 1 ns)	3.75 ns	6.25 ns	0.601 ns
	10 ns		8.5 ns	11.5 ns	0.601 ns
	50 ns		46.5 ns	53.5 ns	0.856 ns
	100 ns		94 ns	106 ns	0.873 ns
	500 ns		474 ns	526 ns	1.28 ns
	1 μs		949 ns	1.051 μs	2.17 ns
	5 μs		4.749 μs	5.251 μs	10.0 ns
	50 μs		47.499 μs	52.501 μs	69.4 ns
	500 μs		474.999 μs	525.001 μs	1.00 ms
	5 ms		4.749999 ms	5.250001 ms	6.92 ms
	50 ms		47.499999 ms	52.500001 ms	100 ms
	500 ms		474.999999 ms	525.000001 ms	692 ms
Agilent 8110A	5 ns	±(5% of setting + 1 ns) Note: in normal mode	3.75 ns	6.25 ns	0.420 ns
	9.99 ns		8.4905 ns	11.4895 ns	0.420 ns
	50 ns		46.5 ns	53.5 ns	0.532 ns
	99.9 ns		93.905 ns	105.895 ns	0.465 ns
	100 ns		94 ns	106 ns	0.465 ns
	500 ns		474 ns	526 ns	1.05 ns
	1 μs		949 ns	1.051 ms	2.04 ns
	5 μs		4.749 μs	5.251 μs	10.0 ns
	50 μs		47.499 μs	52.501 μs	69.4 ns
	500 μs		474.999 μs	525.001 μs	1.00 ms
	5 ms		4.749999 ms	5.250001 ms	6.92 ms
	50 ms		47.499999 ms	52.500001 ms	100 ms
500 ms	474.999999 ms	525.000001 ms	692 ms		
Agilent 81110A	5 ns	±(3% of setting + 1 ns) Note: in normal mode	3.85 ns	6.15 ns	0.420 ns
	9.99 ns		8.6903 ns	11.2897 ns	0.420 ns
	50 ns		47.5 ns	52.5 ns	0.532 ns
	99.9 ns		95.903 ns	103.897 ns	0.465 ns
	100 ns		96 ns	104 ns	0.465 ns
	500 ns		484 ns	516 ns	1.05 ns
	1 μs		969 ns	1.031 ms	2.04 ns
	5 μs		4.849 μs	5.151 μs	10.0 ns
	50 μs		48.499 μs	51.501 μs	69.4 ns
	500 μs		484.999 μs	515.001 μs	1.00 ms
	5 ms		4.849999 ms	5.150001 ms	6.92 ms
	50 ms		48.499999 ms	51.500001 ms	100 ms
500 ms	478.999999 ms	515.000001 ms	692 ms		

Table 3-20 Test Limits of Transition Time

Model of PG	Nominal Value	Accuracy	Minimum	Maximum	Uncertainty
Agilent 8114A	65 ns	±20 ns	45 ns	85 ns	7.19 ns
Agilent 8110A/81110A	20 ns	(-10% of setting) to (+10% of setting + 20 ns) transition time ≥ 20 ns	18 ns	42 ns	5.14 ns
	50 ns		45 ns	75 ns	7.19 ns
	500 ns		450 ns	570 ns	8.42 ns
	5 μs		4.50 μs	5.52 μs	58.8 ns
	50 μs		45.0 μs	55.02 μs	584 ns
	500 ms		450 ms	550.02 ms	5.83 ms
	50 ms		45.0 ms	55.00002 ms	583 ms

Table 3-21 Test Limits of Overshoot

Model of PG	Pulse Output	Accuracy	Maximum	Uncertainty	
				Positive	Negative
Agilent 8114A	5 V	±(5% of amplitude + 50 mV)	$0.05 + \frac{0.050}{V_{top} - V_{base}}$	0.0102	0.00927
Agilent 8110A/81110A	0.5 V	±(5% of amplitude + 20 mV), transition time ≥ 20 ns	$0.05 + \frac{0.050}{V_{top} - V_{base}}$	0.0182	0.0182
	5 V		$0.05 + \frac{0.050}{V_{top} - V_{base}}$	0.0102	0.00927

Calculation Method of Test Limits

An example of how to calculate the limit values for the nominal values is shown below:

```

=====
Description          | Nominal      Minimum      Results      Maximum      Uncertainty  |Fail
=====
-----
PG21:HF port 2:Pin Bd 8
-----
Width:  50.0 ns      | 5.0000E-08 s  4.550000E-08 s  5.080000E-08 s  5.450000E-08 s  4.370E-10 s |
-----
. . . . .
-----
Delay:   5.0 ns      | 5.0000E-09 s  3.750000E-09 s  5.047000E-09 s  6.250000E-09 s  4.200E-10 s |
-----
. . . . .
-----
Tran(leading) : 20.0 ns | 2.000E-08 s   1.800000E-08 s  2.232000E-08 s  4.200000E-08 s  5.140E-09 s |
-----
Tran(trailing): 20.0 ns | 2.000E-08 s   1.800000E-08 s  2.204000E-08 s  4.200000E-08 s  5.140E-09 s |
-----
. . . . .
-----
Overshoot(leading) : +5.0 V |                    -3.315631E-02   5.408832E-02   1.020E-02 |
-----
Overshoot(trailing): +5.0 V |                    -3.024665E-02   5.408832E-02   9.270E-03 |
=====

```

Performance Verification

When the nominal value of the pulse width is 50.0 ns, the test limit is calculated as follows:

$$\begin{aligned}
 \text{Test Limit}_{\text{width}} &= \pm(5\% \text{ of setting}_{(= 50 \text{ ns})} + 2 \text{ ns}) \\
 &= \pm(0.05 \times 50 \times 10^{-9} + 2 \times 10^{-9}) \\
 &= \pm(2.5 \times 10^{-9} + 2 \times 10^{-9}) \\
 &= \pm 4.5 \times 10^{-9} \\
 \text{Maximum}_{\text{width}} &= 50 \times 10^{-9} + 4.5 \times 10^{-9} \\
 &= 54.5 \times 10^{-9} \\
 \text{Minimum}_{\text{width}} &= 50 \times 10^{-9} - 4.5 \times 10^{-9} \\
 &= 45.5 \times 10^{-9}
 \end{aligned}$$

When the nominal value of the pulse delay is 5.0 ns, the test limit is calculated as follows:

$$\begin{aligned}
 \text{Test Limit}_{\text{delay}} &= \pm(5\% \text{ of setting}_{(= 5 \text{ ns})} + 1 \text{ ns}) \\
 &= \pm(0.05 \times 5 \times 10^{-9} + 1 \times 10^{-9}) \\
 &= \pm(0.25 \times 10^{-9} + 1 \times 10^{-9}) \\
 &= \pm 1.25 \times 10^{-9} \\
 \text{Maximum}_{\text{delay}} &= 5 \times 10^{-9} + 1.25 \times 10^{-9} \\
 &= 6.25 \times 10^{-9} \\
 \text{Minimum}_{\text{delay}} &= 5 \times 10^{-9} - 1.25 \times 10^{-9} \\
 &= 3.75 \times 10^{-9}
 \end{aligned}$$

When the nominal value of the transition time is 20.0 ns, the test limit is calculated as follows:

$$\begin{aligned}
 \text{Test Limit}_{\text{transition}} &= \left(\begin{array}{l} -10\% \text{ of setting}_{(= 20 \text{ ns})} \\ +10\% \text{ of setting}_{(= 20 \text{ ns})} + 20 \text{ ns} \end{array} \right) \\
 &= \left(\begin{array}{l} -0.1 \times 20 \times 10^{-9} \\ 0.1 \times 20 \times 10^{-9} + 20 \times 10^{-9} \end{array} \right) \\
 &= \left(\begin{array}{l} -2.0 \times 10^{-9} \\ 2.0 \times 10^{-9} + 20 \times 10^{-9} \end{array} \right) \\
 &= \left(\begin{array}{l} -2.0 \times 10^{-9} \\ 22.0 \times 10^{-9} \end{array} \right) \\
 \text{Maximum}_{\text{transition}} &= 20 \times 10^{-9} + 22 \times 10^{-9} \\
 &= 42 \times 10^{-9} \\
 \text{Minimum}_{\text{transition}} &= 20 \times 10^{-9} - 2.0 \times 10^{-9} \\
 &= 18 \times 10^{-9}
 \end{aligned}$$

When the pulse output is 5 V, the test limit is calculated as follows:

$$\begin{aligned}
 \text{Test Limit}_{\text{overshoot}} &= 5\% \text{ of amplitude}_{(= V_{\text{top}} - V_{\text{base}})} + 20 \text{ mV} \\
 \text{Maximum}_{\text{overshoot}} &= 0.05 + \frac{0.02}{V_{\text{top}} - V_{\text{base}}}
 \end{aligned}$$

Voltage and Resistance References Calibration (V/R Calibration)

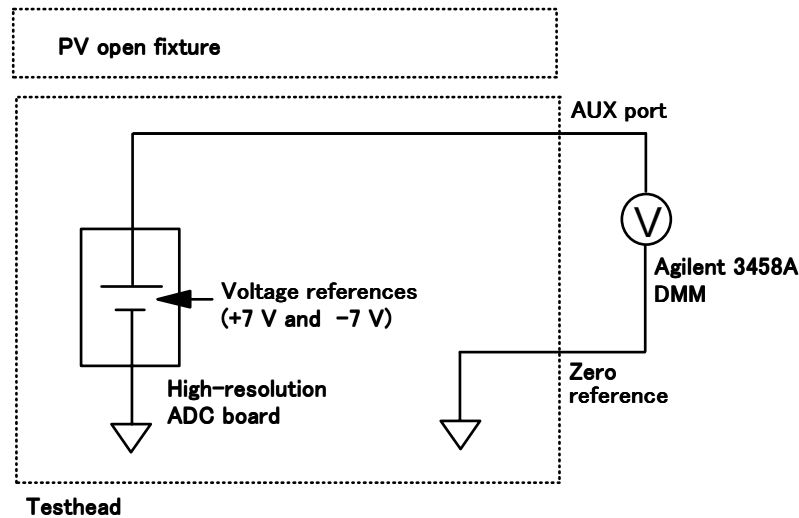
This section provides the theory for V/R calibration and limits. The limits for V/R calibration do *not* meet commercial specifications, but are important values that relate to tester performance.

Calibration for Voltage References

The high-resolution ADC board has voltage references of +7 V and -7 V. The calibration for voltage references confirms and calibrates their values.

Figure 3-18 shows a simplified test circuit.

Figure 3-18 Voltage Reference Calibration Circuit



Theory of Operation

1. The voltage references on the high-resolution ADC board are connected to an AUX port, and forces +7 V and -7 V. The output voltage is measured by the voltage measurement function of the DMM.
This procedure repeats three times, and takes an average.
2. The average value is compared against the test limits. This calibration also checks if the dispersion is less than or equal to 30 μ V.
3. After the calibration, the calibrated values and calibration date are stored in EEPROM on the high-resolution ADC board.

Test Limits

Table 3-22 Calibration for Voltage Reference Limits

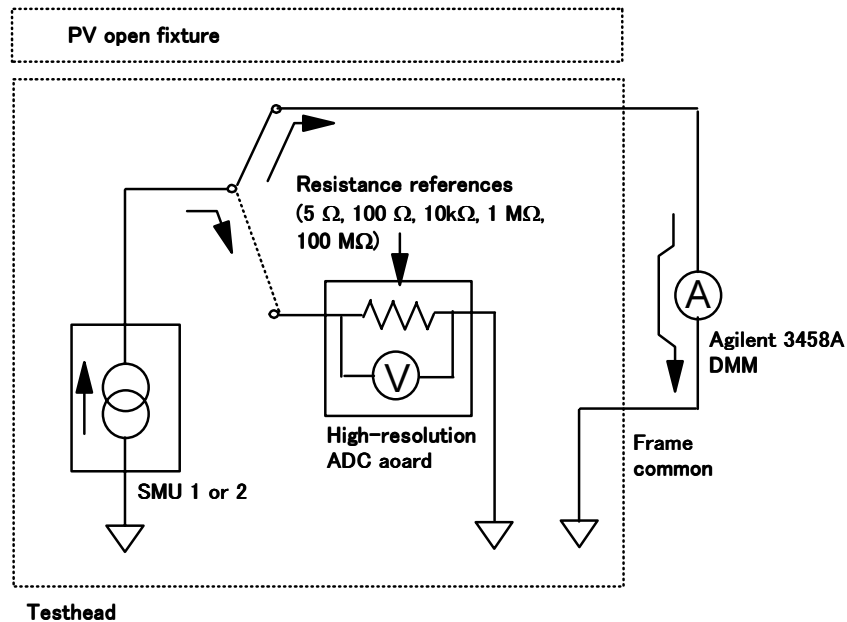
Voltage Reference	Accuracy	Dispersion
+7 V	+6.95 V \pm 0.42 V	\leq 30 μ V
-7 V	-6.95 V \pm 0.42 V	\leq 30 μ V

Calibration for Resistance Reference

The high-resolution ADC board has five resistors, 5 ohm, 100 ohm, 10 kohm, 1 Mohm, and 10 Mohm. The calibration for resistance reference confirms and calibrates the resistors.

Figure 3-19 shows a simplified test circuit.

Figure 3-19 Reference Resistor Calibration Circuit



Theory of Operation

1. The SMU is connected to an AUX port (AUX 1 or 2), and forces a constant current. The output current is confirmed by the current measurement function of the DMM.
2. After confirming the output current of the SMU, a signal path is made from SMU 1 or 2 to the resistance reference on the high-resolution ADC board. The SMU forces the same current, and the high-resolution ADC board measures the voltage drop of the resistance reference. The resistance is calculated from the output current and voltage drop.

This procedure repeats several times, and takes an average.

3. The average values are compared against the test limits. This calibration also checks if the dispersion is less than or equal to the dispersion specification.
4. This sequence repeats until all the resistance references are calibrated. After the calibration, the calibrated values and calibration date are stored in the EEPROM on the high-resolution ADC board.

Test Limits

Table 3-23 Calibration for Reference Resistor

Nominal Value	Accuracy	Dispersion
5 Ω	± 25 m Ω	≤ 1 m Ω
100 Ω	± 500 m Ω	≤ 10 m Ω
10 k Ω	± 50 Ω	≤ 500 m Ω
1 M Ω	± 5 k Ω	≤ 50 Ω
100 M Ω	± 1 M Ω	≤ 50 k Ω

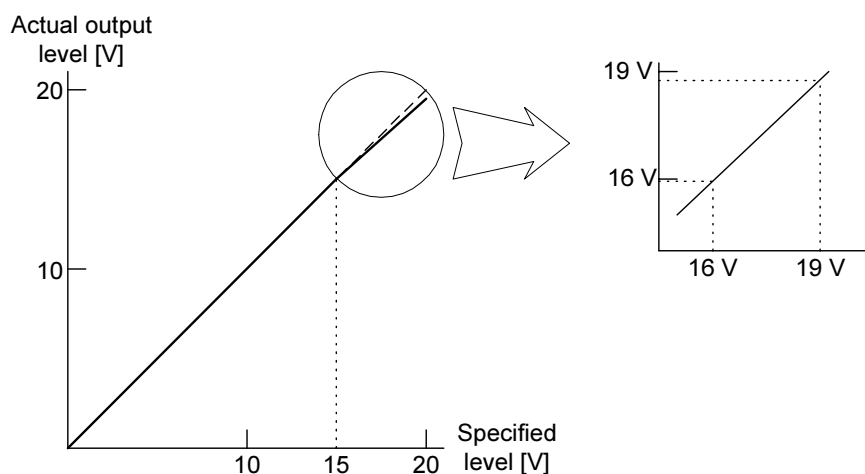
PG Level Error Compensation

This section provides the theory for PG level error compensation.

NOTE PG level error compensation is necessary for the Agilent 8110A and Agilent 81110A. The PG level error compensation is not necessary for the Agilent 8114A.

Output voltage characteristics of the 8110A/81110A do not keep linearity over ± 16 V, when the load impedance is 999 kohm. The 4072A/4073A keeps the PG level compensation data and uses it to specify the output voltage of the pulse. Figure 3-20 shows the typical output voltage characteristics of the 8110A/81110A.

Figure 3-20 Typical Output Voltage Characteristics of Agilent 8110A/81110A



When an output voltage over ± 16 V is specified to the 8110A/81110A, the actual output voltage does not reach the specified voltage. To compensate the output voltage, a value that is slightly greater than the expected value is specified to the 8110A/81110A.

The TIS automatically compensates the specified value and the output voltage setting of the 8110A/81110A. The specified value in the TIS is $V_{setting}$, and the value for the 8110A/81110A is V_{actual} . When the compensation data $cal16$ and $cal19$ are given, the TIS calculates as follows:

- $15 \geq |V_{setting}| \geq 0$

$$V_{actual} = V_{setting}$$

- $16 \geq |V_{setting}| > 15$

$$V_{actual} = V_{setting} + cal16 \times (V_{setting} - 15.0)$$

- $20 \geq |V_{setting}| > 16$

$$V_{actual} = \frac{cal19 - cal16}{3} \times (V_{setting} - 16.0) + cal16$$

- $|V_{setting}| > 20$

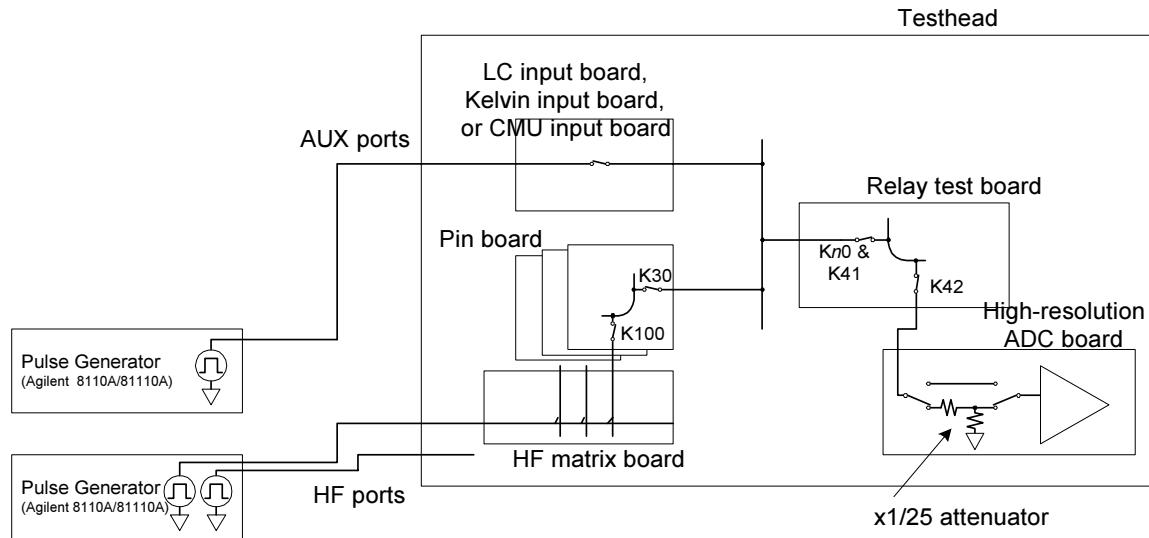
$$V_{actual} = 20.0$$

The compensation data is stored in the `/etc/opt/hp4070/pgcaldata` file.

Operating Theory of PG Level Error Compensation

Figure 3-21 shows the simplified measurement circuit for the PG level error compensation.

Figure 3-21 Measurement Circuit for PG Level Error Compensation



The compensation data is retrieved by using the following procedures:

1. Initialize the 4072A/4073A hardware.
2. Calibrate the x1/25 attenuator on the high-resolution ADC board. Its calibration procedures are as follows:
 - a. Make a signal path from an SMU to the high-resolution ADC board via the input relay board (LC input board, Kelvin input board, or CMU input board) and relay test board.
 - b. Make a signal path not through the x1/25 attenuator on the high-resolution ADC board.
 - c. Force a voltage from the SMU and measure voltage at the high-resolution ADC.
 - d. Make a signal path through the x1/25 attenuator on the high-resolution ADC board.
 - e. Force the same voltage from the SMU and measure voltage at the high-resolution ADC.
3. Make a signal path from a PGU to the high-resolution ADC board via:
 - The HF port, pin board, and relay test board.
 - The AUX port, input board (LC input, Kelvin input, or CMU input board), and relay test board.
4. Force 16.0 V from the PGU and measure voltage (V_{m16}) at the high-resolution ADC board.
5. Force 19.0 V from the PGU and measure voltage (V_{m19}) at the high-resolution ADC board.

When the **Perform** button in the Auto Calibration area is clicked, the PGUs connected to the HF ports or AUX ports are measured. When the **Perform** button in the Manual Calibration area is clicked, the PGUs connected to the pulse switches or to nothing are measured with operator interactions.

NOTE The x1/25 attenuator is necessary, because the high-resolution ADC can measure up to ± 8 V.

The compensation data *call16* and *call19* are calculated by the following equations:

Operating Theory

PG Level Error Compensation

$$call6 = \frac{16 - Vm16}{Vm16 - 15}$$

$$call9 = 3 \times \frac{19 - Vm19}{Vm19 - Vm16}$$

The following shows typical contents of the `/etc/opt/hp4070/pgcaldata`:

```
# Agilent 4070 PGU Calibration Data file
# Format Revision 1.0
# lines beginning with '#' are comment lines
# output voltage[V]:
#     PG81110A  16.000 19.000
# PG#  PG Type  Calibration Data1 Data2 ...
# DO NOT CHANGE ABOVE LINES

PG11 PG81110A 0.243276 0.513568
PG12 PG81110A 0.268845 0.557861
PG21 PG81110A 0.200670 0.462101
PG22 PG81110A 0.232486 0.495125
PG31 PG81110A 0.148919 0.400282
PG32 PG81110A 0.245373 0.491097
PG41 PG81110A 0.155162 0.411155
PG42 PG81110A 0.205147 0.453279
PG51 PG81110A 0.180131 0.412162
PG52 PG81110A 0.157028 0.383415
```

The first column is the PGU identifier, the second column is the PG model, the third column is the `call6` data, and the fourth column is the `call9` data.

A Specifications

Agilent 4072A Specifications

This section lists the 4072A specifications and supplemental characteristics.

The specifications are the performance standards or limits against which the 4072A was tested. When the 4072A is shipped from the factory, it meets the specifications.

"Supplemental Characteristics" are not specifications, but are typical characteristics included as additional information for the operator.

General Description

The 4072A advanced parametric tester is designed to perform precision dc measurement, capacitance measurement, flash memory cell testing, and other high-frequency applications. The tester supports up to eight source monitor units (SMUs), two of which may be high-power SMUs (HPSMUs). Each SMU is self-calibrating and may be individually configured to force either current or voltage and simultaneously measure either voltage or current.

External instruments can be integrated into the system via the eight auxiliary input ports or 48 extended path inputs. The 48 extended path inputs allow the user to connect external signals directly to the DUT pins. A low-leakage switching matrix connects all of the inputs to fully guarded Kelvin output pins, which are customizable from 12 to 48 output pins. One special additional pin is dedicated as a chuck connection.

In addition, the 4072A has a high-frequency switching matrix with integrated pulse generator control. The high frequency matrix is organized as two 3 by 24 matrices (6 inputs total), and furnished 1 to 2 adapters may be used on each matrix pair to create one 3 by 48 matrix (3 inputs total). The tester also has one 1.6 A ground unit (GNDU).

Measurement Functions

dc current, dc voltage, capacitance and conductance, differential voltage

- dc measurements:

Spot measurement, sweep measurement, pulse bias, and pulse sweep measurement

Measurement unit	MPSMU (medium power source monitor unit) and HP SMU (high power source monitor unit)
Measurement range (SMU1 or SMU2)	10 fA to 100 mA, 2 μ V to 100 V
Measurement range (SMU3 to SMU8)	100 fA to 1 A, 2 μ V to 100V ¹

1. Using optional HPSMU. Using MPSMU, 100 fA to 100 mA, 2 μ V to 100 V.

- Capacitance/conductance measurement (with or without dc bias voltage)

Measurement unit	Agilent 4284A (CMU)
Measurement frequencies	1 kHz, 10 kHz, 100 kHz, 1 MHz
Measurement range	1 fF to 100 nF, 0.1 nS to 7.5 mS
dc bias voltage	\pm 40 V

- Two terminal differential voltage measurement:

Measurement unit	Agilent 3458A (DVM)
Measurement range	1 μ V to 100 V

- High-frequency pulse force:

Pulse generator unit	Agilent 8110A, 81110A, or Agilent 8114A
Maximum number of installable pulse generators ¹	5 × 8110A or 5 × 81110A (without 8114A) 4 × 8110A or 4 × 81110A (with 1 × 8114A) 2 × 8110A or 2 × 81110A (with 2 × 8114A)
Pulse level (at open load)	±19 V (8110A and 81110A) –49.9 V to +50 V (8114A)
Pulse period	350 ns to 999 s (8110A and 81110A) 350 ns to 999 ms (8114A)
Pulse width	50 ns to 999 ms (8110A and 81110A) 150 ns to 150 ms (8114A)
Pulse delay	0 s to 998 ms
Transition time	20 ns to 220 ms (8110A and 81110A) 65 ns (8114A)

1. You cannot install both 8110A and 81110A in the system.

- Measurement pins

Minimum 12 pins, maximum 48 pins. (There is also an additional pin for connecting to wafer prober chuck)

- Switching matrix instrument ports:

- SMU ports (for up to 8 SMUs)
- One ground unit (GNDU) port
- AUX ports (for up to 8 external instruments)
- HF ports (for up to 6 PGUs)
- Extended path port (for up to 48 external connections)
- Pulse switch input/output ports

General Specifications

Accuracy is specified at:

- Temperature: 23°C ± 5°C
- Humidity: 5% to 70% RH
- Warm up: at least 40 minutes
- After self-calibration: N/A
- Integration time: medium or longer

NOTE

Temperature Change

The temperature change, after calibration, must be less than 3°C, otherwise the accuracy values in the following tables are doubled.

Isolation and Leakage current is specified separately.

Specifications

Agilent 4072A Specifications

- Power requirement:

Nominal Line Voltage ¹	Allowable Voltage Range	Required Maximum Current
200 Vac	180 - 220 Vac	20 A
208 Vac	188 - 228 Vac	24 A
220 Vac	198 - 242 Vac	20 A
240 Vac	216 - 252 Vac	20 A

1. Line frequency must be 48 to 63 Hz.

- Operating temperature range: 5°C to 40°C
- Operating humidity range: 5% to 70% (no-condensing)
- Storage temperature range: -20°C to 60°C (no-condensing)
- Warm up time: at least 40 minute
- Regulatory compliance:

EMC:	EMC Directive 89/336/EEC, 93/68/EEC
Safety:	Low Voltage Directive 73/23/EEC, 93/68/EEC CSA 1010, CSA Certified SEMI S2/93

- Dimensions:

System cabinet: 600 mm (W) by 900 mm (D) by 1600 mm (H)

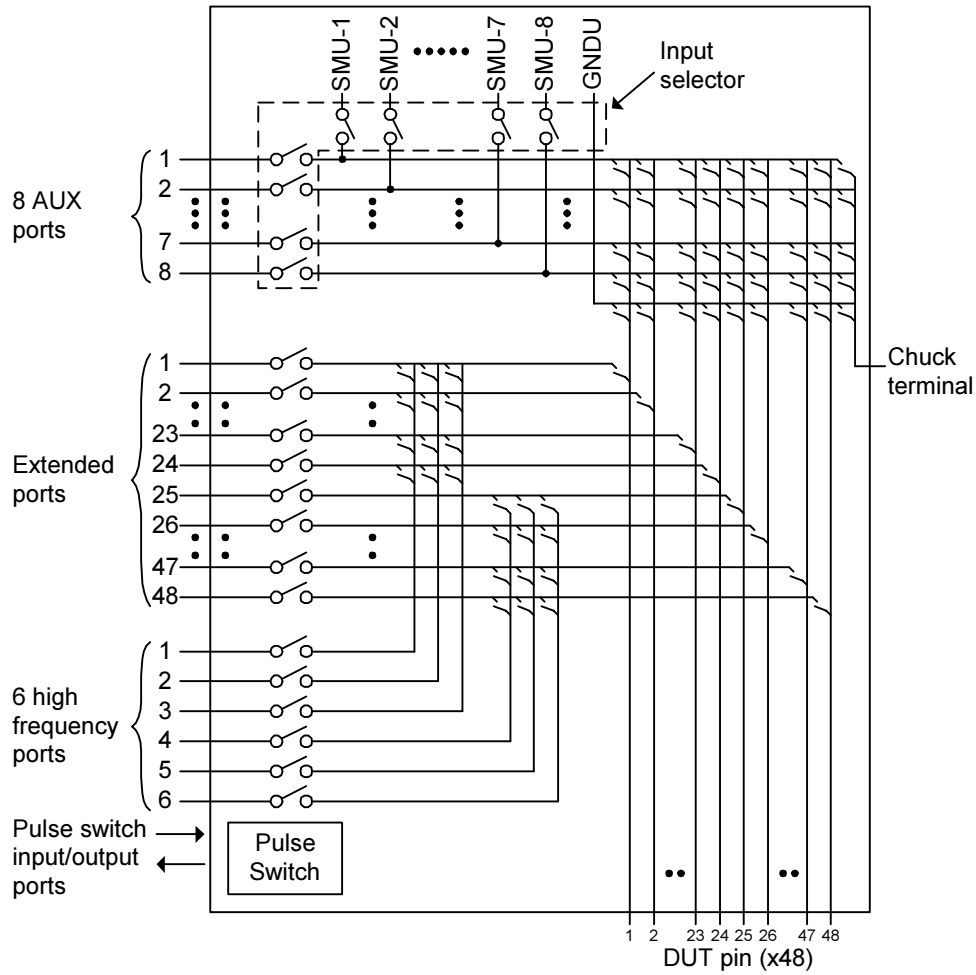
Testhead: 640 mm (W) by 642 mm (D) by 400 mm (H)

- Weight:

System cabinet: 250 kg (including 4284A, 3458A, 4 × 81110A and 8114A)

Testhead: 70 kg (including 4 SMUs and 48 pins)

Switching Matrix Subsystem



- Maximum measurement pins:
48 pins + 1 pin for prober chuck connection
- Maximum number of instrument ports:
 - SMU ports: 8 SMU + GNDU

Ports	Connection	Max. Number of Ports
Low current measurement ports	non-Kelvin	2 ports
Standard ports	Kelvin	4 ports
	non-Kelvin	2 ports
GNDU	Kelvin	1 port

Agilent 4072A Specifications

- Auxiliary (AUX) ports:

8 ports for external instruments (including CMU and DVM).

Inputs	Maximum Number of Ports
Triaxial (force/guard/common)	2 ports (AUX input ports 1 and 2)
2 BNCs (force/common, sense/common)	4 ports (AUX input ports 3 to 6)
BNC (force/common)	2 ports (AUX input ports 7 and 8)

- High frequency (HF) port:

6 for pulse generators (8110A, 81110A, and 8114A) or other external instruments.

HF ports 1 through 3 can access measurement pins 1 through 24, and HF ports 4 through 6 can access measurement pins 25 through 48pins. The user has the option of connecting any of the following HF port pairs together via a 1 to 2 adapter in order to access all (1 through 48) measurement pins: ports 1 and 4, ports 2 and 5, and ports 3 and 6.

- Pulse switch input/output ports:

See “Pulse Switch”.

- Extended path:

48 paths to the measurement pins. Each path can be connected to one measurement pin by an on/off relay switch.

- Maximum voltage at each port:

Port	Maximum Voltage
SMU	±200 V
AUX 1, 2	±200 V
AUX 3 - 8	±100 V
High frequency ports	±100 V (between force and common of each HF port) ±100 V (between two of forces of all HF ports) ±100 V (between any force of HF ports and any force of extended path)
Extended path	±100 V (between force and common of each extended path) ±100 V (between any force of HF ports and any force of extended path)

- Maximum current at each port:

Port	Maximum Current
SMU	±1.0 A
GNDU	±1.6 A
AUX	±1.0 A
High frequency port	±0.5 A
Extended path	±0.5 A

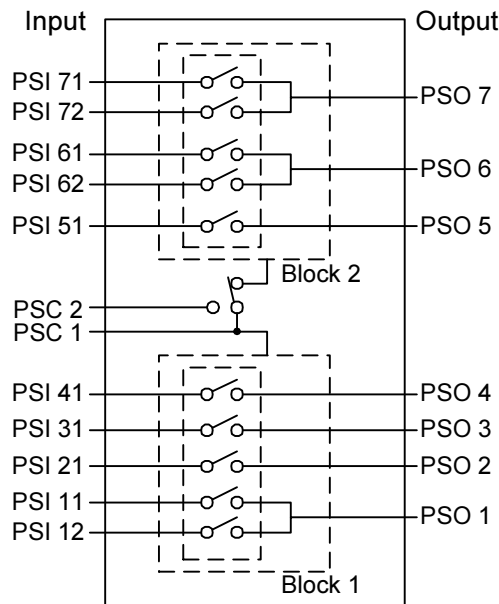
- Maximum residual resistance:

Port	Resistance
Low current port	0.7 Ω (Force)
Kelvin port	1.0 Ω (Force)
	2.5 Ω (Sense)
Non-Kelvin port	1.0 Ω (Force)
High frequency port	1.0 Ω^1

1. Supplemental characteristics

- Maximum stray capacitance between measurement pins (supplemental characteristics):
5 pF (between C measurement ports)
- Isolation resistance (supplemental characteristics):
Low current port (with guard): $5 \times 10^{13} \Omega$
- HF port bandwidth (@-3dB) (supplemental characteristics):
60 MHz (50ohm load impedance: from port to DUT pin, 3 \times 24 configuration)
- HF port crosstalk between pins (Supplemental Characteristics):
 $\pm 2\%$ (5 kohm load impedance: from port to DUT pin, 20 ns pulse transition time)

Pulse Switch



The pulse switch includes seven semiconductor switching relays, for reliable and direct control of pulse shaping by the pulse generator or CPU. The pulse switch is integrated into the 4072A testhead.

- Number of blocks: 2

Agilent 4072A Specifications

- Number of switch of each block:
 - Block 1: 3 relays (make or break, selectable type) and 1 relay (transfer type to create multi-level pulse)
 - Block 2: 1 relay (make or break, selectable type) and 2 relays (transfer type to create multi-level pulse)
- Control input port:
 - One input per each block (PSC1 and PSC2)
- Control method:
 - Both the PG and CPU can control all switches. PG or CPU control is independent for every block. In the case of PG control, block 1 can be controlled by the PSC1 input, and block can be controlled by either PSC1 or PSC2 (selectable).
- Mode of relay control:
 - Make or break, selectable type relay: Normally open or normally closed modes are selectable.
 - Transfer relay: Normally open and normally closed modes are not selectable.
- Maximum voltage:
 - ± 60 V (between force and common of each switch)
 - ± 60 V (between PSI21 and PSO2, between PSI31 and PSO3, between PSI41 and PSO4, between PSI51 and PSO5)
 - ± 60 V (between PSI11 (or PSI12) and PSO1, between PSI11 and PSI12, between PSI61 (or PSI62) and PSO6, between PSI61 and PSI62, between PSI71 (or PSI72) and PSO7, between PSI71 and PSI72)
- Maximum current:
 - ± 0.4 A (from input to output)
- Residual Resistance (supplemental characteristics):
 - Nominal 2Ω (from IN to OUT)
- OFF capacitance (supplemental characteristics):
 - 80 pF (between IN and OUT: $V_{in}-V_{out}=0$ V)
 - 100 pF (force \leftrightarrow common @ output of make or break, selectable type relay: $V_{in}-V_{out}=0$ V)
- Operating time of switching (supplemental characteristics):
 - max. 2 ms

Source and Monitor Unit (SMU)

- Voltage source/monitor range, resolution, and accuracy:

Full Scale Voltage Range	Resolution Force	Resolution Measure High Speed	Resolution Measure Precision	Force Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{volt})$	Measure Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{volt})$
$\pm 2 \text{ V}$	100 μV	100 μV	2 μV	$0.05\% + 0.05\% + (\text{Rmat}^1 \times \text{Io}^2)$	$0.04\% + 0.04\% + (\text{Rmat}^1 \times \text{Io}^2)$
$\pm 20 \text{ V}$	1 mV	1 mV	20 μV		
$\pm 40 \text{ V}$	2 mV	2 mV	40 μV		
$\pm 100 \text{ V}$	5 mV	5 mV	100 μV		
$\pm 200 \text{ V}^3$	5 mV	10 mV	100 μV		$0.045\% + 0.04\% + (\text{Rmat}^1 \times \text{Io}^2)$

- Residual resistance of matrix port force. See note below.
- Output current
- HPSMU only

NOTE

Rmat is different at each port.

Low Current Port (SMU1, SMU2): 0.7 Ω

Kelvin Port (SMU3 to SMU6): 3 m Ω

Non-Kelvin Port (SMU7, SMU8): 1.0 Ω

When using the prober chuck connection pin, add 0.1 Ω to Rmat.

Agilent 4072A Specifications

- Current source/monitor range, resolution, and accuracy (SMU1, SMU2):

Full Scale Current Range	Resolution Force	Resolution Measure High Speed	Resolution Measure Precision	Force Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{amp})$	Measure Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{amp})$
$\pm 100 \text{ mA}$	$5 \mu\text{A}$	$5 \mu\text{A}$	100 nA	$0.12\% + [0.1 + (0.0005 \times V_o^1)]\%$	$0.1\% + [0.05 + (0.0005 \times V_o^1)]\%$
$\pm 10 \text{ mA}$	500 nA	500 nA	10 nA		
$\pm 1 \text{ mA}$	50 nA	50 nA	1 nA		
$\pm 100 \mu\text{A}$	5 nA	5 nA	100 pA		
$\pm 10 \mu\text{A}$	500 pA	500 pA	10 pA		
$\pm 1 \mu\text{A}$	50 pA	50 pA	1 pA	$0.2\% + [0.1 + (0.0005 \times V_o)]\% + (2 \text{ pA/V} \times V_o)$	$0.2\% + [0.05 + (0.0005 \times V_o)]\% + (2 \text{ pA/V} \times V_o)$
$\pm 100 \text{ nA}$	5 pA	5 pA	100 fA		
$\pm 10 \text{ nA}$	500 fA	500 fA	10 fA	$1\% + [0.1 + (0.0005 \times V_o)]\% + 3 \text{ pA} + (2 \text{ pA/V} \times V_o)$	$1\% + [0.1 + (0.0005 \times V_o)]\% + 3 \text{ pA} + (2 \text{ pA/V} \times V_o)$
$\pm 1 \text{ nA}$	50 fA	50 fA	10 fA		

1. Output voltage

NOTE The HPSMU can be connected only to ports 3 or 4.

- Current source/monitor range, resolution, and accuracy (SMU3 to SMU8):

Full Scale Current Range	Force Resolution	Resolution Measure High Speed	Resolution Measure Precision	Force Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{amp})$	Measure Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{amp})$
$\pm 1 \text{ A}^1$	50 μA	50 μA	1 μA	0.5% + $[0.1 + (0.0005 \times V_o)]\%$	0.5% + $[0.05 + (0.0005 \times V_o)]\%$
$\pm 100 \text{ mA}$	5 μA	5 μA	100 nA	0.12% + $[0.1 + (0.0005 \times V_o^2)]\%$	0.1% + $[0.05 + (0.0005 \times V_o^2)]\%$
$\pm 10 \text{ mA}$	500 nA	500 nA	10 nA		
$\pm 1 \text{ mA}$	50 nA	50 nA	1 nA		
$\pm 100 \mu\text{A}$	5 nA	5 nA	100 pA		
$\pm 10 \mu\text{A}$	500 pA	500 pA	10 pA		
$\pm 1 \mu\text{A}$	50 pA	50 pA	1 pA	0.2% + $[0.1 + (0.0005 \times V_o)]\%$ + $(300 \text{ pA} + 1000 \text{ pA}/100 \text{ V} \times V_o)$	0.2% + $[0.05 + (0.0005 \times V_o)]\%$ + $(300 \text{ pA} + 1000 \text{ pA}/100 \text{ V} \times V_o)$
$\pm 100 \text{ nA}$	5 pA	5 pA	100 fA		
$\pm 10 \text{ nA}^3$	500 fA	500 fA	10 fA	1% + $[0.1 + (0.0005 \times V_o)]\%$ + 3 pA + $(300 \text{ pA} + 1000 \text{ pA}/100 \text{ V} \times V_o)$	1% + $[0.1 + (0.0005 \times V_o)]\%$ + 3 pA + $(300 \text{ pA} + 1000 \text{ pA}/100 \text{ V} \times V_o)$
$\pm 1 \text{ nA}^3$	50 fA	50 fA	10 fA		

1. Using HPSMU.
2. V_o refers to output voltage.
3. Supplemental Characteristics when using Port 3 to Port 8

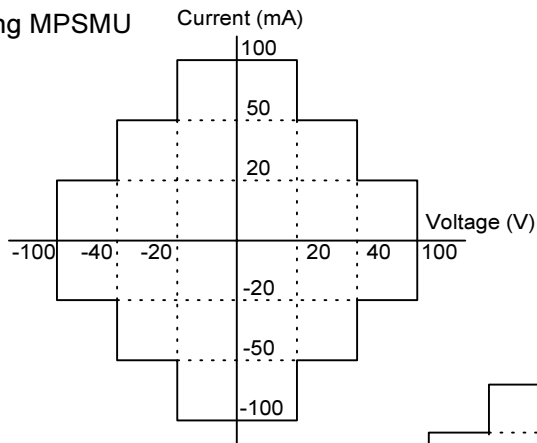
NOTE The HPSMU can be connected only to ports 3 or 4.

NOTE **Electromagnetic Fields and SMU Current Measure Accuracy**
Current measurement accuracy of SMUs may be affected by electromagnetic field strength over 3 V/m at a frequency range of 26 MHz to 1 GHz.

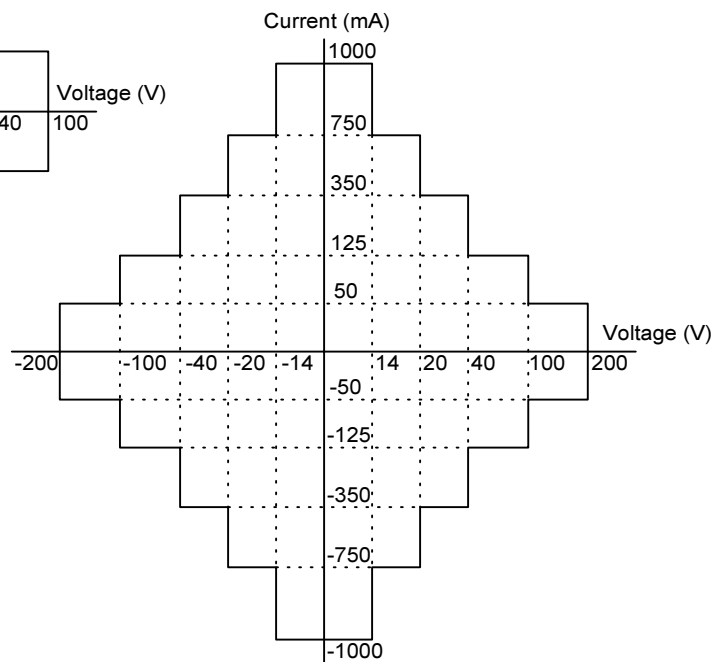
Agilent 4072A Specifications

- Maximum output voltage/current:

Using MPSMU



Using HPSMU



- Over current range: 15% of range (0% for 100 mA range of MPSMU, 0% for 1 A range of HPSMU)
- Over voltage range (V force): 0% of range
- Over voltage range (V measure): 10% of range (0% for 100 V range)
- Current compliance setting range: 1 pA to maximum current
- Accuracy of converse polar current limit (supplemental characteristics):
 - ±2% of range (100 nA to 100 mA ranges)
 - ±10% of range (1 nA and 10 nA ranges)
- Maximum capacitive load: ≤1000 pF
- Maximum allowable guard capacitance: 250 pF (between signal and guard line outside the matrix)
- Maximum slew range: 0.2 V/μs

SMU Configuration

Minimum configuration: 3 MPSMUs (default configuration)

A maximum of 2 HPSMUs can be installed and only be connected to ports 3 and 4. The first HPSMU must be connected to port 3, and the second to port 4. The default configuration of the 4072A has 3 MPSMUs connected to ports 2, 3, and 4. The default MPSMU positions must be changed if HPSMUs are added. For example, if one HPSMU is subsequently installed, it must be installed as port 3, so the MPSMU that was connected to port 3 should be moved to port 5. Similarly, if a second HPSMU is installed, it must be installed as port 4, so the MPSMU that was connected to port 4 should be moved to port 1. The following tables indicate the installation order for additional MPSMUs.

No HPSMU and 3 MPSMUs are installed:

Port Number	Installed SMU	Installation order for additional SMUs
1	MPSMU	2
2	MPSMU	Default
3	MPSMU	Default
4	MPSMU	Default
5	MPSMU	1
6	MPSMU	3
7	MPSMU	4
8	MPSMU	5

- One HPSMU and 3 MPSMUs are installed:

Port Number	Installed SMU	Installation order for additional SMUs
1	MPSMU	1
2	MPSMU	Default
3	HPSMU	Optional HPSMU
4	MPSMU	Default
5	MPSMU	Default
6	MPSMU	2
7	MPSMU	3
8	MPSMU	4

- Two HPSMUs and 3 MPSMUs are installed:

Port Number	Installed SMU	Installation order for additional SMUs
1	MPSMU	Default
2	MPSMU	Default
3	HPSMU	Optional HPSMU
4	HPSMU	Optional HPSMU
5	MPSMU	Default
6	MPSMU	1
7	MPSMU	2
8	MPSMU	3

Agilent 4072A Specifications**Ground Unit (GNDU)**

This unit is used for ground when making measurements.

Output voltage:	0 V
Maximum current:	±1.6 A
Offset voltage:	±200 μ V
Maximum capacitance load:	1 μ F (supplemental characteristics)

Digital Volt Meter (Agilent 3458A)

Voltage measurement range, resolution, and accuracy (NPCL \geq 1)

Full Scale Voltage Range	Resolution	Accuracy (% of reading + volt)
1 V	1 μ V	0.01% + 300 μ V
10 V	10 μ V	0.01% + 300 μ V
100 V	100 μ V	0.02% + 1 mV

Capacitance Measurement Unit (Agilent 4284A)

Accuracy is specified between any two output pins, except the chuck connection pin.

Measurement range:	1 fF to 1.2 nF and 10 nS to 7.5 mS (1 MHz) 1 fF to 10 nF and 1 nS to 6.3 mS (100 kHz) 1 fF to 100 nF and 0.1 nS to 6.3 mS (10 kHz) 10 fF to 100 nF and 0.1 nS to 0.63 mS (1 kHz)
Measurement frequency:	1 kHz, 10 kHz, 100 kHz, and 1 MHz
dc bias voltage:	±40 V
Measurement speed:	MEDIUM or LONG

Note: Above specifications are valid after calibration data measurement and offset are cancelled.

dc Bias Range Accuracy:

Full Scale Voltage Range	Force Accuracy \pm (% reading + %range + volt)
±40 V	0.1% + 10 mV

Accuracy is specified between CMH and CML pins.

Test signal level: 30 mV (rms)

Bias current isolation function: OFF

C/G measurement range, resolution, and accuracy:

Frequency	C Range	C Accuracy % of reading + % of range	G Range	G Accuracy % of reading + % of range
1 MHz	10 pF ¹	$0.8\% + [1.0 + (0.6 \times Gm^2 / 63 \mu S)]\%$	63 μ S	$0.8\% + [1.0 + (0.6 \times Cm^3 / 10 \text{ pF})]\%$
	100 pF	$0.8\% + [0.3 + (0.6 \times Gm/630 \mu S)]\%$	630 μ S	$0.8\% + [0.3 + (0.6 \times Cm/100 \text{ pF})]\%$
	1 nF	$1.5\% + [0.2 + (1.7 \times Gm/6.3 \text{ mS})]\%$	6.3 mS	$1.3\% + [0.2 + (2.2 \times Cm/1 \text{ nF})]\%$
100 kHz	10 pF ¹	$0.4\% + [1.0 + (0.3 \times Gm/6.3 \mu S)]\%$	6.3 μ S	$0.4\% + [1.0 + (0.4 \times Cm/10 \text{ pF})]\%$
	100 pF	$0.3\% + [0.3 + (0.3 \times Gm/63 \mu S)]\%$	63 μ S	$0.3\% + [0.3 + (0.3 \times Cm/100 \text{ pF})]\%$
	1 nF	$0.3\% + [0.2 + (0.4 \times Gm/630 \mu S)]\%$	630 μ S	$0.3\% + [0.2 + (0.4 \times Cm/1 \text{ nF})]\%$
	10 nF	$0.5\% + [0.2 + (1.0 \times Gm/6.3 \text{ mS})]\%$	6.3 mS	$0.7\% + [0.2 + (0.8 \times Cm/10 \text{ nF})]\%$
10 kHz	100 pF	$0.3\% + [0.2 + (0.3 \times Gm/6.3 \mu S)]\%$	6.3 μ S	$0.3\% + [0.2 + (0.3 \times Cm/100 \text{ pF})]\%$
	1 nF	$0.3\% + [0.1 + (0.3 \times Gm/63 \mu S)]\%$	63 μ S	$0.3\% + [0.1 + (0.3 \times Cm/1 \text{ nF})]\%$
	10 nF	$0.3\% + [0.1 + (0.3 \times Gm/630 \mu S)]\%$	630 μ S	$0.3\% + [0.1 + (0.3 \times Cm/10 \text{ nF})]\%$
	100 nF	$0.3\% + [0.1 + (1.0 \times Gm/6.3 \text{ mS})]\%$	6.3 mS	$0.7\% + [0.1 + (0.7 \times Cm/100 \text{ nF})]\%$
1 kHz	100 pF ¹	$0.4\% + [0.5 + (0.4 \times Gm/0.63 \mu S)]\%$	0.63 μ S	$0.4\% + [0.5 + (0.4 \times Cm/100 \text{ pF})]\%$
	1 nF	$0.3\% + [0.1 + (0.3 \times Gm/6.3 \mu S)]\%$	6.3 μ S	$0.3\% + [0.1 + (0.3 \times Cm/1 \text{ nF})]\%$
	10 nF	$0.3\% + [0.1 + (0.3 \times Gm/63 \mu S)]\%$	63 μ S	$0.3\% + [0.1 + (0.3 \times Cm/10 \text{ nF})]\%$
	100 nF	$0.3\% + [0.1 + (0.3 \times Gm/630 \mu S)]\%$	630 μ S	$0.3\% + [0.1 + (0.3 \times Cm/100 \text{ nF})]\%$

1. Supplemental characteristics
2. Gm is measured conductance.
3. Cm is measured capacitance.

Accuracy is specified between any DUT pins.

Stray capacitance between force and guard must be under 5 pF.

Accuracy of frequency: $\pm 0.1\%$

Test signal level: 30 mVrms \pm 5 mVrms

When measurement speed is set to SHORT, add 0.25% to the % of reading and 0.1% to the % of range.

When open/short calibration at DUT pins are carried out, accuracy is the same as in the above table. (Note: The length of cable from the output pins must be less than 1 meter and the capacitance to guard must be under 100 pF.)

Agilent 4072A Specifications**Pulse Force Unit**

Supported pulse generators: 8110A, 81110A, and 8114A

Maximum number of installable pulse generators: 5 × 8110A or 5 × 81110A (without the 8114A)

4 × 8110A or 4 × 81110A (with 1 × the 8114A)

2 × 8110A or 2 × 81110A (with 2 × the 8114A)

Pulse Force Mode

Pulse signal: 2-level and 3-level output

Burst Count: 10^9 (max.) or infinite

Output mode: Normal mode or pattern mode

Normal mode: All pulse generators (up to 5) can force synchronously

Pattern mode: All pulse generator except a master pulse generator can force synchronously (more accurate pulse width and pulse delay than normal mode).

Note the 8114A does not support pattern mode.

Load impedance: 999 k Ω (default),selectable from 2.5 Ω to 999 k Ω (8110A and 81110A)selectable from 10 Ω to 999 k Ω (8114A)**Pulse Setting Range**

- Pulse period:

Mode	PGU	Range
Normal mode	8110A, 81110A	350 ns to 999 s, Resolution: 4 digits (min. 100 ps)
	8114A	350 ns to 999 ms, Resolution: 3 digits (min. 1 ns)
Pattern mode	8110A or 81110A in a master unit	120 μ s to 999 s, Resolution, 4 digits (min. 100 ns)
	8114A in a master unit	120 ns to 999 ms, Resolution, 3 digits (min. 1 μ s)

- Pulse width

Mode	PGU	Range
Normal mode	8110A	50 ns to 999 ms, Resolution: 3 digits (min. 100 ps)
	81110A	50 ns to 999 ms, Resolution: 3.5 digits (min. 50 ps)
	8114A	150 ns to 150 ms, Resolution: 3 digits (min. 1 ns)
Pattern mode	8110A or 81110A in a master unit	50 ns to 150 ms, Resolution: 3 digits (min. 100 ps)
	8114A in a master unit	150 ns to 150 ms, Resolution: 3 digits (min. 1 ns)
	8110A or 81110A in a slave unit	100 ns to 999 ms Resolution: 1×10^{-n} (at $1000 \times 10^{-n} < T \leq 4000 \times 10^{-n}$) 2×10^{-n} (at $4000 \times 10^{-n} < T \leq 8000 \times 10^{-n}$) 2.5×10^{-n} (at $8000 \times 10^{-n} < T \leq 10000 \times 10^{-n}$) T means the maximum value of (pulse width + delay time) among all the channels. For example, if T is 250 μ s, then according to above table, the resolution is 0.1 μ s (1×10^{-7}) because $T=250 \times 10^{-6}=2500 \times 10^{-7}$.

- Pulse delay

Mode	PGU	Range
Normal mode	8110A, 8114A	0 to 998 ms, Resolution: 3 digits (min. 10 ps)
	81110A	0 to 998 ms, Resolution: 3.5 digits (min. 5 ps)
Pattern mode	8110A, 81110A, or 8114A in a master unit	0 to 998 ms, Resolution: 3 digits (min.10 ps)
	8110A or 81110A in a slave unit	100 ns to 999 ms Resolution: 1×10^{-n} (at $1000 \times 10^{-n} < T \leq 4000 \times 10^{-n}$) 2×10^{-n} (at $4000 \times 10^{-n} < T \leq 8000 \times 10^{-n}$) 2.5×10^{-n} (at $8000 \times 10^{-n} < T \leq 10000 \times 10^{-n}$) T means the maximum value of (pulse width + delay time) among all the channels. For example, if T is 250 μ s, then according to above table, the resolution is 0.1 μ s (1×10^{-7}) because $T=250 \times 10^{-6}=2500 \times 10^{-7}$.

- Transition time

8110A, 81110A	20 ns to 200 ms
8114A	65 ns (fixed)

Agilent 4072A Specifications

- Pulse level (at open load)

8110A, 81110A	±19 V (at 2 level) ±19 V (at 3 level) ¹
8114A	−49.9 V to +50 V (at 2 level) −49.9 V to +50 V (at 3 level) ²
(8110A or 81110A) + 8114A	−49.9 V to +50 V (at 3 level)

- Restriction for "3-level pulse with one PG" output mode: the sum of the absolute values of both amplitudes cannot exceed 20 V.
- There is no "3-level pulse with one PG" output mode on the 8114A because it has only one output.

- Pulse level accuracy (at open load)

8110A and 81110A level	±((2% of amplitude) + 150 mV)
8114A baseline	±((2% of amplitude) + 200 mV)
8114A amplitude:	±((2% of baseline) + (1% of amplitude) + 200 mV)

- Pulse shape accuracy (at 50 ohm load impedance)

8110A width	±(5% of setting + 2 ns) (in normal mode, width ≥ 50 ns)
81110A width	±(3% of setting + 2 ns) ±(0.5% of setting + 2 ns) ¹ after timing calibration (in normal mode, width ≥ 50 ns)
8110A delay	±(5% of setting + 1 ns) (in normal mode)
81110A delay	±(3% of setting + 1 ns) ¹ after timing calibration (in normal mode, width ≥ 50 ns)
8110A and 81110A transition	(−10% of setting) to (+10% of setting + 20 ns) (transition time ≥ 20 ns)
8110A and 81110A overshoot	±(5% of amplitude + 20 mV) (transition time ≥ 20 ns)
8114A width	±(5% of setting + 3.5 ns) (width ≥ 200 ns) ±(5% of setting + 6.0 ns) (width ≥ 150 ns)
8114A delay	±(5% of setting + 1 ns)
8114A transition	65 ns ± 20 ns
8114A overshoot	±(5% of amplitude + 50 mV)

- Supplemental characteristics

- Pulse shape accuracy (at 5 kohm load impedance: supplemental characteristics)

8110A and 81110A overshoot/ringing	$\pm(5\% \text{ of amplitude} + 20 \text{ mV})$
8114A overshoot/ringing	$(-8\% \text{ of amplitude}) \text{ to } (+4\% \text{ of amplitude})$
8110A and 81110A transition time	$\pm(10\% \text{ of setting} + 5 \text{ ns})$
8114A transition time	$56 \text{ ns} \pm 5 \text{ ns}$
Skew between pins	$\pm 10 \text{ ns}$

System Controller

- Supported computers:
 HP 9000 series 700 model 745i/100
 HP 9000 series 700 model 745/132L
 HP Visualize workstation C3600
- Operating system:
 HP-UX 10.20 (with Y2K patches) or HP-UX 11i
 BASIC/UX with SICL, or C/ANSI C with SICL
- Required memory:
 Minimum requirement is 64 MB (128 MB is recommended).
- Required disk:
 2GB is required
 4GB is recommended
- Required GPIB interface:
 Agilent Technologies recommends two external GPIB interface cards for use with:
 - Instruments controlled by the 4070 TIS commands (e.g. Agilent 4284A, Agilent 3458A)
 - Automatic wafer prober

System Software

The standard 4070 system software provides the following capabilities:

- System management
- Control of subsystems (TIS Library)
- Parameter measurement utility (PARA Library)
- Off-line debugging
- Interactive debugging panel (IDP) (includes Agilent FASTcode generating function)
- Probing pattern generation and wafer maps display (PPG, MAP)
- Prober control libraries (sample program): Electroglas, TEL, and TSK
- Application program (sample program): flash memory cell evaluation, charge pumping method
- Automatic diagnostics

Agilent Semiconductor Process Evaluation Core Software (SPECS)

Agilent SPECS is a test shell environment for the 4070 series.

Input:	User interaction occurs via a windows-based graphical interface with spreadsheet-like operation. Test plans require only four simple specifications: wafer, die, test, and probe.
Customization:	Agilent supplies basic development, engineering, and operator test shell frameworks, which users can tailor or modify to create entirely new frameworks.
Analysis and output:	All data is output into a flat ASCII file, which users can manipulate to allow for input into database software. In addition, the data management structure supports x-y graphs, histograms, and wafer maps.
UNIX:	Users have full access to the UNIX environment from within the test shell.

Agilent 4073A Specifications

This section lists the 4073A specifications and supplemental characteristics.

The specifications are the performance standards or limits against which the 4073A was tested. When the 4073A is shipped from the factory, it meets the specifications.

"Supplemental Characteristics" are not specifications, but are typical characteristics included as additional information for the operator.

General Description

The 4073A ultra advanced parametric tester is the 4070 family's new flagship product and designed to perform precise/fast dc measurement as well as capacitance measurement, flash memory cell testing, and other high-frequency applications. The system supports up to eight source monitor units (SMUs). Each SMU is self-calibrating and may be individually configured to force either current or voltage, and simultaneously measure either voltage or current.

External instruments can be integrated into the system via the eight auxiliary input ports or 48 extended path inputs. The 48 extended path inputs allow the user to connect external signals directly to the DUT pins. A low-leakage switching matrix connects all of the inputs to fully guarded Kelvin output pins, which are customizable from 12 to 48 output pins. One special additional pin is dedicated as a chuck connection.

In addition, the 4073A has a high-frequency switching matrix with integrated pulse generator control. The high-frequency matrix is organized as two 3 by 24 matrices (6 inputs total), and furnished 1 to 2 adapters may be used on each matrix pair to create one 3 by 48 matrix (3 inputs total). The system also has one 1.6 A ground unit.

Measurement Functions

dc current, dc voltage, capacitance and conductance, differential voltage

- dc measurements:
 - spot measurement, sweep measurement, pulse bias, and pulse sweep measurement

Measurement unit	HRSMU (high resolution source monitor unit) MPSMU (medium power source monitor unit) HPSMU (high power source monitor unit)
Measurement range (SMU1 or SMU2)	1 fA to 100 mA, 2 μ V to 100V ¹
Measurement range (SMU3 to SMU8)	100 fA to 1 A, 2 μ V to 200 V ²

1. Using optional HRSMU. Using MPSMU, 10 fA to 100 mA, 2 μ V to 100 V.
2. Using optional HPSMU. Using MPSMU, 100 fA to 100 mA, 2 μ V to 100 V.

- Capacitance/conductance measurement (with or without dc bias voltage)

Measurement unit	Agilent 4284A (CMU)
Measurement frequencies	1 kHz, 10 kHz, 100 kHz, 1 MHz
Measurement range	1 fF to 100 nF, 0.1 nS to 7.5 mS
dc bias voltage	\pm 40 V

Specifications

Agilent 4073A Specifications

- Two terminal differential voltage measurement:

Measurement unit	Agilent 3458A (DVM)
Measurement range	0.1 μ V to 100 V

- High-frequency pulse force:

Pulse generator unit	Agilent 8110A, 81110A, or 8114A
Maximum number of installable pulse generators ¹	5 \times 8110A or 5 \times 81110A (without 8114A) 4 \times 8110A or 4 \times 81110A (with 1 \times 8114A) 2 \times 8110A or 2 \times 81110A (with 2 \times 8114A)
Pulse level (at open load)	\pm 19 V (8110A and 81110A) –49.9 V to +50 V (8114A)
Pulse period	350 ns to 999 s (8110A and 81110A) 350 ns to 999 ms (8114A)
Pulse width	50 ns to 999 ms (8110A and 81110A) 150 ns to 150 ms (8114A)
Pulse delay	0 s to 998 ms
Transition time	20 ns to 220 ms (8110A and 81110A) 65 ns (8114A)

1. You cannot install both 8110A and 81110A in the system.

- Measurement pins

Minimum 12 pins, maximum 48 pins. (There is also an additional pin for connecting to wafer prober chuck)

- Switching matrix instrument ports:

- SMU ports (for up to 8 SMUs)
- One ground unit (GNDU) port
- AUX ports (for up to 8 external instruments)
- HF ports (for up to 6 PGUs)
- Extended path port (for up to 48 external connections)
- Pulse switch input/output ports

General Specifications

Accuracy is specified at:

- Temperature: 23°C ± 5°C
- Humidity: 5% to 70% RH
- Warm up: at least 40 minutes
- After self-calibration: N/A
- Integration time: medium or long (16 PLC or longer)

NOTE

Temperature Change

The temperature change, after calibration, must be less than 3°C.

Humidity

5% to 60% RH (no-condensing) for current measure accuracy of HRSMU in less than 1 nA range.

Integration Time

Long integration time for current measure accuracy of HRSMU in less than 1 nA range.

Isolation and Leakage

Isolation and Leakage current is specified separately.

- Power requirement:

Nominal Line Voltage ¹	Allowable Voltage Range	Required Maximum Current
200 Vac	180 - 220 Vac	20 A
208 Vac	188 - 228 Vac	24 A
220 Vac	198 - 242 Vac	20 A
240 Vac	216 - 252 Vac	20 A

1. Line frequency must be 48 to 63 Hz.

- Operating temperature range: 5°C to 35°C
- Operating humidity range: 5% to 70% (no-condensing)
- Storage temperature range: -20°C to 50°C
- Storage humidity range: ≤ 80% (no-condensing)
- Warm up time: at least 40 minutes
- Regulatory compliance:

EMC:	EMC Directive 89/336/EEC, 93/68/EEC
Safety:	Low Voltage Directive 73/23/EEC, 93/68/EEC CSA 1010, CSA Certified SEMI S2/93

Specifications

Agilent 4073A Specifications

- Dimensions:

System cabinet: 600 mm (W) by 900 mm (D) by 1600 mm (H)

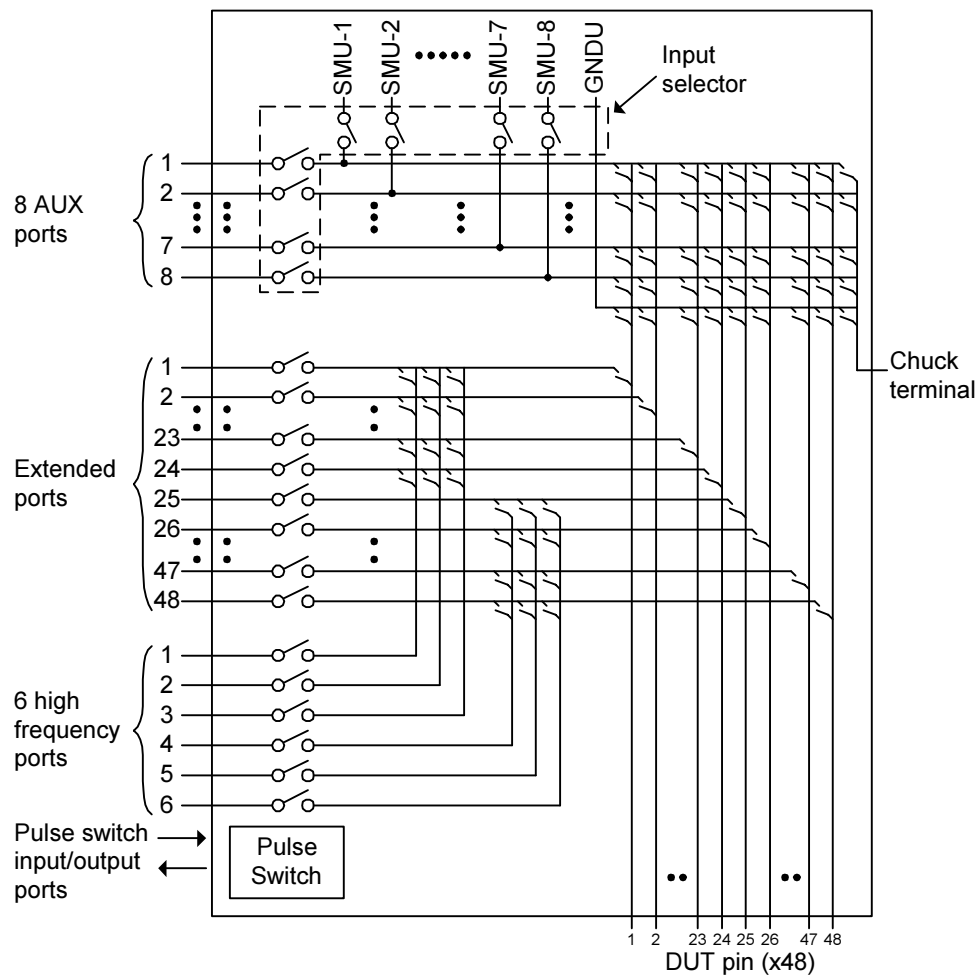
Testhead: 640 mm (W) by 642 mm (D) by 400 mm (H)

- Weight:

System cabinet: 250 kg (including 4284A, 3458A, 4 × 81110A and 8114A)

Testhead: 75 kg (including 4 SMUs and 48 pins)

Switching Matrix Subsystem



- Maximum measurement pins:

48 pins + 1 pin for prober chuck connection (triaxial connector)

Only Agilent E3122A (high resolution pin board) can be used for 4073A (cannot use Agilent E3121A).

- Maximum number of instrument ports:

- SMU ports: 8 SMU + GNDU

Ports	Connection	Max. Number of Ports
Low current measurement ports	non-Kelvin	2 ports
Standard ports	Kelvin	4 ports
	non-Kelvin	2 ports
GNDU	Kelvin	1 port

- Auxiliary (AUX) ports:

8 ports for external instruments (including CMU and DVM).

Inputs	Maximum Number of Ports
Triaxial (force/guard/common)	2 ports (AUX input ports 1 and 2)
2 BNCs (force/common, sense/common)	4 ports (AUX input ports 3 to 6)
BNC (force/common)	2 ports (AUX input ports 7 and 8)

- High frequency (HF) port:

6 for pulse generators (8110A, 81110A, and 8114A) or other external instruments.

HF ports 1 through 3 can access measurement pins 1 through 24, and HF ports 4 through 6 can access measurement pins 25 through 48 pins. The user has the option of connecting any of the following HF port pairs together via a 1 to 2 adapter in order to access all (1 through 48) measurement pins: ports 1 and 4, ports 2 and 5, and ports 3 and 6.

- Pulse switch input/output ports:

See “Pulse Switch”.

- Extended path:

48 paths to the measurement pins. Each path can be connected to one measurement pin by an on/off relay switch.

- Maximum voltage at each port:

Port	Maximum Voltage
SMU	±200 V
AUX 1, 2	±200 V
AUX 3 - 8	±100 V
High frequency ports	±100 V (between force and common of each HF port) ±100 V (between two of forces of all HF ports) ±100 V (between any force of HF ports and any force of extended path)
Extended path	±100 V (between force and common of each extended path) ±100 V (between any force of HF ports and any force of extended path)

Agilent 4073A Specifications

- Maximum current at each port:

Port	Maximum Current
SMU	±1.0 A
GNDU	±1.6 A
AUX	±1.0 A
High frequency port	±0.5 A
Extended path	±0.5 A

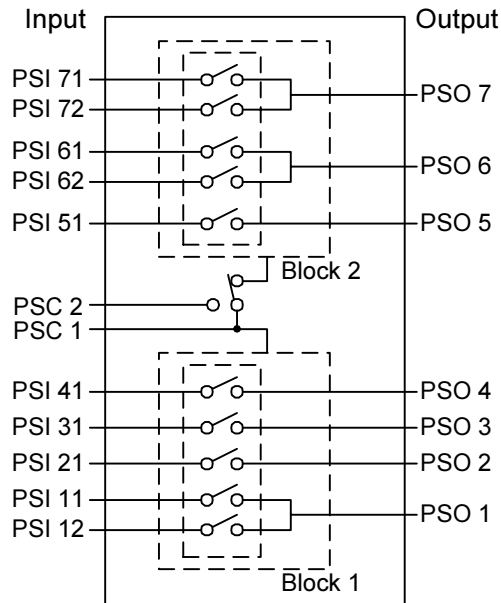
- Maximum residual resistance:

Port	Resistance
Low current port	1.0 Ω (Force)
Kelvin port	1.0 Ω (Force)
	2.5 Ω (Sense)
Non-Kelvin port	1.0 Ω (Force)
High frequency port	2.0 Ω^1

1. Supplemental Characteristics

- Maximum stray capacitance between measurement pins (supplemental characteristics):
3 pF (between C measurement ports)
- Isolation resistance (supplemental characteristics):
Low current port (with guard): $1 \times 10^{15} \Omega$
- HF port bandwidth (@-3dB) (supplemental characteristics):
60 MHz (50 Ω load impedance: from port to DUT pin, 3 \times 24 configuration)
- HF port crosstalk between pins (supplemental characteristics):
 $\pm 2\%$ (5 k Ω load impedance: from port to DUT pin, 20 ns pulse transition time)

Pulse Switch



The pulse switch includes seven semiconductor switching relays, for reliable and direct control of pulse shaping by the pulse generator or CPU. The pulse switch is integrated into the 4073A testhead.

- Number of blocks: 2
- Number of switches of each block:
 - Block 1: 3 relays (make or break, selectable type) and 1 relay (transfer type to create multi-level pulse)
 - Block 2: 1 relay (make or break, selectable type) and 2 relays (transfer type to create multi-level pulse)
- Control input port:
 - One input per each block (PSC1 and PSC2)
- Control method:
 - Both the PG and CPU can control all switches. PG or CPU control is independent for every block. In the case of PG control, block 1 can be controlled by the PSC1 input, and block 2 can be controlled by either PSC1 or PSC2 (selectable).
- Mode of relay control:
 - Make or break, selectable type relay: Normally open or normally closed modes are selectable.
 - Transfer relay: Normally open and normally closed modes are not selectable.
- Maximum voltage:
 - ±60 V (between force and common of each switch)
 - ±60 V (between PSI21 and PSO2, between PSI31 and PSO3, between PSI41 and PSO4, between PSI51 and PSO5)
 - ±60 V (between PSI11 (or PSI12) and PSO1, between PSI11 and PSI12, between PSI61 (or PSI62) and PSO6, between PSI61 and PSI62, between PSI71 (or PSI72) and PSO7, between PSI71 and PSI72)

Specifications

Agilent 4073A Specifications

- Maximum current:
±0.4 A (from input to output)
- Residual Resistance (supplemental characteristics):
Nominal 2 Ω (from IN to OUT)
- OFF capacitance (supplemental characteristics):
80 pF (between IN and OUT: $V_{in}-V_{out}=0$ V)
100 pF (force \leftrightarrow common @ output of make or break, selectable type relay: $V_{in}-V_{out}=0$ V)
- Operating time of switching (supplemental characteristics):
max. 2 ms

Source and Monitor Unit (SMU)

- Voltage source/monitor range, resolution, and accuracy (using HRSMU):

Full Scale Voltage Range	Resolution Force	Resolution Measure High Speed	Resolution Measure Precision	Force Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{volt})$	Measure Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{volt})$
$\pm 2 \text{ V}$	100 μV	100 μV	2 μV	0.03% + 0.035% + $(R_{\text{mat}}^1 \times I_o^2)$	0.02% + 0.025% + $(R_{\text{mat}}^1 \times I_o^2)$
$\pm 20 \text{ V}$	1 mV	1 mV	20 μV	0.03% + 0.02% + $(R_{\text{mat}}^1 \times I_o^2)$	0.02% + 0.015% + $(R_{\text{mat}}^1 \times I_o^2)$
$\pm 40 \text{ V}$	2 mV	2 mV	40 μV		
$\pm 100 \text{ V}$	5 mV	5 mV	100 μV		

- Residual resistance of matrix port force. See note below.
- Output current

- Voltage source/monitor range, resolution, and accuracy (using MPSMU and HRSMU):

Full Scale Voltage Range	Resolution Force	Resolution Measure High Speed	Resolution Measure Precision	Force Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{volt})$	Measure Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{volt})$
$\pm 2 \text{ V}$	100 μV	100 μV	2 μV	0.05% + 0.05% + $(R_{\text{mat}}^1 \times I_o^2)$	0.04% + 0.04% + $(R_{\text{mat}}^1 \times I_o^2)$
$\pm 20 \text{ V}$	1 mV	1 mV	20 μV		
$\pm 40 \text{ V}$	2 mV	2 mV	40 μV		
$\pm 100 \text{ V}$	5 mV	5 mV	100 μV		
$\pm 200 \text{ V}^3$	5 mV	10 mV	100 μV		0.045% + 0.04% + $(R_{\text{mat}}^1 \times I_o^2)$

- Residual resistance of matrix port force. See note below.
- Output current
- HPSMU only

NOTE

Rmat is different at each port.

Low Current Port (SMU1, SMU2): 1.0 Ω

Kelvin Port (SMU3 to SMU6): 3 m Ω

Non-Kelvin Port (SMU7, SMU8): 1.0 Ω

When using the prober chuck connection pin, add 0.1 Ω to Rmat.

Agilent 4073A Specifications

- Current source/monitor range, resolution, and accuracy (HRSMU):

Full Scale Current Range	Resolution Force	Resolution Measure High Speed	Resolution Measure Precision	Force Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{amp})$	Measure Accuracy $\pm(\% \text{reading} + \% \text{range} + \text{amp})$
$\pm 100 \text{ mA}$	$5 \text{ }\mu\text{A}$	$5 \text{ }\mu\text{A}$	100 nA	$0.12\% + [0.05 + (0.0001 \times V_o^1)]\%$	$0.1\% + [0.04 + (0.0001 \times V_o)]\%$
$\pm 10 \text{ mA}$	500 nA	500 nA	10 nA	$0.06\% + [0.04 + (0.0001 \times V_o)]\%$	$0.06\% + [0.03 + (0.0001 \times V_o)]\%$
$\pm 1 \text{ mA}$	50 nA	50 nA	1 nA	$0.06\% + [0.05 + (0.0001 \times V_o)]\%$	$0.06\% + [0.04 + (0.0001 \times V_o)]\%$
$\pm 100 \text{ }\mu\text{A}$	5 nA	5 nA	100 pA	$0.07\% + [0.04 + (0.0001 \times V_o)]\%$	$0.06\% + [0.035 + (0.0001 \times V_o)]\%$
$\pm 10 \text{ }\mu\text{A}$	500 pA	500 pA	10 pA	$0.07\% + [0.05 + (0.0001 \times V_o)]\%$	$0.06\% + [0.04 + (0.001 \times V_o)]\%$
$\pm 1 \text{ }\mu\text{A}$	50 pA	50 pA	1 pA	$0.12\% + [0.04 + (0.0001 \times V_o)]\%$	$0.12\% + [0.035 + (0.0001 \times V_o)]\%$
$\pm 100 \text{ nA}$	5 pA	5 pA	100 fA	$0.12\% + [0.05 + (0.0001 \times V_o)]\% + (1 \text{ fA/V} \times V_o)$	$0.12\% + [0.04 + (0.0001 \times V_o)]\% + (1 \text{ fA/V} \times V_o)$
$\pm 10 \text{ nA}$	500 fA	500 fA	10 fA	$1\% + [0.05 + (0.0001 \times V_o)]\% + 3 \text{ pA} + (1 \text{ fA/V} \times V_o)$	$1\% + [0.04 + (0.0001 \times V_o)]\% + 3 \text{ pA} + (1 \text{ fA/V} \times V_o)$
$\pm 1 \text{ nA}$	50 fA	50 fA	10 fA	$1\% + [0.07 + (0.0001 \times V_o)]\% + 3 \text{ pA} + (1 \text{ fA/V} \times V_o)$	$1\% + [0.04 + (0.0001 \times V_o)]\% + 3 \text{ pA} + (1 \text{ fA/V} \times V_o)$
$\pm 100 \text{ pA}$	5 fA	5 fA	2 fA	$4\% + [0.4 + (0.0001 \times V_o)]\% + 500 \text{ fA} + (1 \text{ fA/V} \times V_o)$	$4\% + [0.12 + (0.0001 \times V_o)]\% + 500 \text{ fA} + (1 \text{ fA/V} \times V_o)$
$\pm 10 \text{ pA}$	1 fA	2 fA	1 fA	$4\% + [4.0 + (0.0001 \times V_o)]\% + 500 \text{ fA} + (1 \text{ fA/V} \times V_o)$	$4\% + [1.0 + (0.0001 \times V_o)]\% + 500 \text{ fA} + (1 \text{ fA/V} \times V_o)$

1. Output voltage

- Current source/monitor range, resolution, and accuracy (MPSMU in SMU1, SMU2):

Full Scale Current Range	Resolution Force	Resolution Measure High Speed	Resolution Measure Precision	Force Accuracy ±(%reading + %range + amp)	Measure Accuracy ±(%reading + %range + amp)
±100 mA	5 µA	5 µA	100 nA	0.12% + [0.1 + (0.0005 × V _o ¹)]%	0.1% + [0.05 + (0.0005 × V _o ¹)]%
±10 mA	500 nA	500 nA	10 nA		
±1 mA	50 nA	50 nA	1 nA		
±100 µA	5 nA	5 nA	100 pA		
±10 µA	500 pA	500 pA	10 pA		
±1 µA	50 pA	50 pA	1 pA	0.2% + [0.1 + (0.0005 × V _o)]% + (2 pA/V × V _o)	0.2 % + [0.05 + (0.0005 × V _o)]% + (2 pA/V × V _o)
±100 nA	5 pA	5 pA	100 fA		
±10 nA	500 fA	500 fA	10 fA	1% + [0.1 + (0.0005 × V _o)]% + 3 pA + (2 pA/V × V _o)	1% + [0.1 + (0.0005 × V _o)]% + 3 pA + (2 pA/V × V _o)
±1 nA	50 fA	50 fA	10 fA		

1. Output voltage

- Current source/monitor range, resolution, and accuracy (SMU3 to SMU8):

Full Scale Current Range	Force Resolution	Resolution Measure High Speed	Resolution Measure Precision	Force Accuracy ±(%reading + %range + amp)	Measure Accuracy ±(%reading + %range + amp)
±1 A ¹	50 µA	50 µA	1 µA	0.5% + [0.1 + (0.0005 × V _o)]%	0.5% + [0.05 + (0.0005 × V _o)]%
±100 mA	5 µA	5 µA	100 nA	0.12% + [0.1 + (0.0005 × V _o ²)]%	0.1 % + [0.05 + (0.0005 × V _o ²)]%
±10 mA	500 nA	500 nA	10 nA		
±1 mA	50 nA	50 nA	1 nA		
±100 µA	5 nA	5 nA	100 pA		
±10 µA	500 pA	500 pA	10 pA	0.2% + [0.1 + (0.0005 × V _o)]% + (300 pA + 10 pA/V × V _o)	0.2% + [0.05 + (0.0005 × V _o)]% + (300 pA + 10 pA/V × V _o)
±1 µA	50 pA	50 pA	1 pA		
±100 nA	5 pA	5 pA	100 fA	1% + [0.1 + (0.0005 × V _o)]% + 3 pA + (300 pA + 1000 pA/100V × V _o)	1% + [0.1 + (0.0005 × V _o)]% + 3 pA + (300 pA + 1000 pA/100V × V _o)
±10 nA ³	500 fA	500 fA	10 fA		
±1 nA ³	50 fA	50 fA	10 fA		

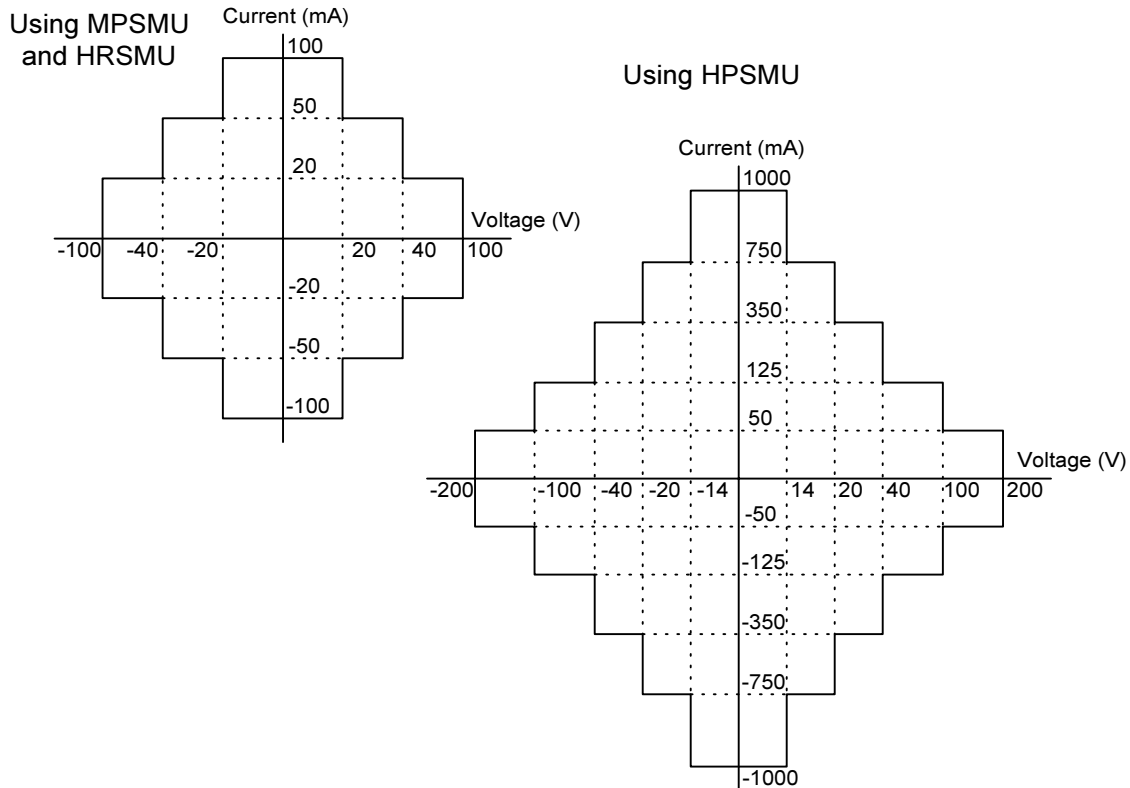
1. Using HPSMU.
2. V_o refers to output voltage.
3. Supplemental Characteristics when using Port 3 to Port 8

NOTE The HPSMU can be connected only to ports 3 or 4.

NOTE Electromagnetic Fields and SMU Current Measure Accuracy

Current measurement accuracy of SMUs may be affected by electromagnetic field strength over 3 V/m at a frequency range of 26 MHz to 1 GHz.

- Maximum output voltage/current:



- Over current range: 15% of range (0% for 100 mA range of MPSMU and HRSMU, 0% for 1 A range of HPSMU, 5% for 10 pA and 100 pA ranges of HRSMU)
- Over voltage range (V Force): 0% of range
- Over voltage range (V Measure): 10% of range (0% for 100 V range of MPSMU and HRSMU, 0% for 200 V range of HPSMU)
- Current compliance setting range: 1 pA to Maximum current
- Accuracy of converse polar current limit (supplemental characteristics):
 - ±2% of range (100 nA to 100 mA ranges)
 - ±10% of range (10 pA to 10 nA ranges)
- Maximum capacitive load: ≤1000 pF
- Maximum allowable guard capacitance: 250 pF (between signal and guard line outside the matrix)
- Maximum slew rate: 0.2 V/μs

SMU Configuration

Minimum configuration: 1 HRSMU and 2 MPSMUs (default configuration)

A maximum of 2 HRSMUs can be installed and can only be connected to port 1 and 2. And a maximum of 2 HPSMUs can be installed and only be connected to ports 3 and 4. The first HPSMU must be connected to port 3, and the second to port 4. The default configuration of the 4072A has 1 HRSMU (connected to port 2) and 2 MPSMUs (connected to ports 3 and 4). The following tables indicate the installation order for additional MPSMUs.

- 1 HRSMU and no HPSMU are installed:

Port Number	Installed SMU	Installation order for additional SMUs
1	MPSMU	2
2	HRSMU	Default
3	MPSMU	Default
4	MPSMU	Default
5	MPSMU	1
6	MPSMU	3
7	MPSMU	4
8	MPSMU	5

- 2 HRSMUs and no HPSMU are installed:

Port Number	Installed SMU	Installation order for additional SMUs
1	HRSMU	Optional HRSMU
2	HRSMU	Default
3	MPSMU	Default
4	MPSMU	Default
5	MPSMU	1
6	MPSMU	2
7	MPSMU	3
8	MPSMU	4

- 1 HRSMU and 1 HPSMU are installed:

Port Number	Installed SMU	Installation order for additional SMUs
1	MPSMU	1
2	HRSMU	Default
3	HPSMU	Optional HPSMU
4	MPSMU	Default
5	MPSMU	Default
6	MPSMU	2
7	MPSMU	3
8	MPSMU	4

Agilent 4073A Specifications

- 2 HRSMU and 1 HPSMU are installed:

Port Number	Installed SMU	Installation order for additional SMUs
1	HRSMU	Optional HRSMU
2	HRSMU	Default
3	HPSMU	Optional HPSMU
4	MPSMU	Default
5	MPSMU	Default
6	MPSMU	1
7	MPSMU	2
8	MPSMU	3

- 1 HRSMU and 2 HPSMUs are installed:

Port Number	Installed SMU	Installation order for additional SMUs
1	MPSMU	Default
2	HRSMU	Default
3	HPSMU	Optional HPSMU
4	HPSMU	Optional HPSMU
5	MPSMU	Default
6	MPSMU	1
7	MPSMU	2

- 2 HRSMUs and 2 HPSMUs are installed:

Port Number	Installed SMU	Installation order for additional SMUs
1	HRSMU	Optional HRSMU
2	HRSMU	Default
3	HPSMU	Optional HPSMU
4	HPSMU	Optional HPSMU
5	MPSMU	Default
6	MPSMU	Default

Ground Unit (GNDU)

This unit is used for ground when making measurements.

Output voltage:	0 V
Maximum current:	±1.6 A
Offset voltage:	±200 μ V
Maximum capacitance load:	1 μ F (supplemental characteristics)

Digital Volt Meter (Agilent 3458A)

Voltage measurement range, resolution, and accuracy (NPCL \geq 1)

Full Scale Voltage Range	Resolution	Accuracy (% of reading + volt)
0.1 V	0.1 μ V	0.01% + 100 μ V
1 V	1 μ V	0.01% + 100 μ V
10 V	10 μ V	0.01% + 200 μ V
100 V	100 μ V	0.02% + 1 mV

Capacitance Measurement Unit (Agilent 4284A)

Accuracy is specified between any two output pins, except the chuck connection pin.

Measurement range:	1 fF to 1.2 nF and 10 nS to 7.5 mS (1 MHz) 1 fF to 10 nF and 1 nS to 6.3 mS (100 kHz) 1 fF to 100 nF and 0.1 nS to 6.3 mS (10 kHz) 10 fF to 100 nF and 0.1 nS to 0.63 mS (1 kHz)
--------------------	---

Measurement frequency: 1 kHz, 10 kHz, 100 kHz, and 1 MHz

dc bias voltage: ±40 V

Measurement speed: medium or long

Note: Above specifications are valid after calibration data measurement and offset are cancelled.

dc bias range accuracy:

Full Scale Voltage Range	Force Accuracy \pm (% reading + %range + volt)
±40 V	0.1% + 10 mV

Accuracy is specified between CMH and CML pins.

Test signal level: 30 mV (rms)

Bias current isolation function: OFF

Agilent 4073A Specifications

C/G measurement range, resolution, and accuracy:

Frequency	C Range	C Accuracy % of reading + % of range	G Range	G Accuracy % of reading + % of range
1 MHz	10 pF ¹	$0.8\% + [1.0 + (0.6 \times Gm^2 / 63 \mu S)]\%$	63 μ S	$0.8\% + [1.0 + (0.6 \times Cm^3 / 10 \text{ pF})]\%$
	100 pF	$0.8\% + [0.3 + (0.6 \times Gm / 630 \mu S)]\%$	630 μ S	$0.8\% + [0.3 + (0.6 \times Cm / 100 \text{ pF})]\%$
	1 nF	$1.5\% + [0.2 + (1.7 \times Gm / 6.3 \text{ mS})]\%$	6.3 mS	$1.3\% + [0.2 + (2.2 \times Cm / 1 \text{ nF})]\%$
100 kHz	10 pF ¹	$0.4\% + [1.0 + (0.3 \times Gm / 6.3 \mu S)]\%$	6.3 μ S	$0.4\% + [1.0 + (0.4 \times Cm / 10 \text{ pF})]\%$
	100 pF	$0.3\% + [0.3 + (0.3 \times Gm / 63 \mu S)]\%$	63 μ S	$0.3\% + [0.3 + (0.3 \times Cm / 100 \text{ pF})]\%$
	1 nF	$0.3\% + [0.2 + (0.4 \times Gm / 630 \mu S)]\%$	630 μ S	$0.3\% + [0.2 + (0.4 \times Cm / 1 \text{ nF})]\%$
	10 nF	$0.5\% + [0.2 + (1.0 \times Gm / 6.3 \text{ mS})]\%$	6.3 mS	$0.7\% + [0.2 + (0.8 \times Cm / 10 \text{ nF})]\%$
10 kHz	100 pF	$0.3\% + [0.2 + (0.3 \times Gm / 6.3 \mu S)]\%$	6.3 μ S	$0.3\% + [0.2 + (0.3 \times Cm / 100 \text{ pF})]\%$
	1 nF	$0.3\% + [0.1 + (0.3 \times Gm / 63 \mu S)]\%$	63 μ S	$0.3\% + [0.1 + (0.3 \times Cm / 1 \text{ nF})]\%$
	10 nF	$0.3\% + [0.1 + (0.3 \times Gm / 630 \mu S)]\%$	630 μ S	$0.3\% + [0.1 + (0.3 \times Cm / 10 \text{ nF})]\%$
	100 nF	$0.3\% + [0.1 + (1.0 \times Gm / 6.3 \text{ mS})]\%$	6.3 mS	$0.7\% + [0.1 + (0.7 \times Cm / 100 \text{ nF})]\%$
1 kHz	100 pF ¹	$0.4\% + [0.5 + (0.4 \times Gm / 0.63 \mu S)]\%$	0.63 μ S	$0.4\% + [0.5 + (0.4 \times Cm / 100 \text{ pF})]\%$
	1 nF	$0.3\% + [0.1 + (0.3 \times Gm / 6.3 \mu S)]\%$	6.3 μ S	$0.3\% + [0.1 + (0.3 \times Cm / 1 \text{ nF})]\%$
	10 nF	$0.3\% + [0.1 + (0.3 \times Gm / 63 \mu S)]\%$	63 μ S	$0.3\% + [0.1 + (0.3 \times Cm / 10 \text{ nF})]\%$
	100 nF	$0.3\% + [0.1 + (0.3 \times Gm / 630 \mu S)]\%$	630 μ S	$0.3\% + [0.1 + (0.3 \times Cm / 100 \text{ nF})]\%$

1. Supplemental characteristics
2. Gm is measured conductance.
3. Cm is measured capacitance.

Accuracy is specified between any DUT pins.

Stray capacitance between force and guard must be under 5 pF.

Accuracy of frequency: $\pm 0.1\%$

Test signal level: 30 mVrms ± 5 mVrms

When measurement speed is set to SHORT, add 0.25% to the % of reading and 0.1% to the % of range.

When open/short calibration at DUT pins are carried out, accuracy is the same as in the above table. (Note: The length of cable from the output pins must be less than 1 meter and the capacitance to guard must be under 100 pF.)

Pulse Force Unit

Supported pulse generators: 8110A, 81110A, and 8114A

Maximum number of installable pulse generators: 5 × 8110A or 5 × 81110A (without 8114A)
 4 × 8110A or 4 × 81110A (with 1 × 8114A)
 2 × 8110A or 2 × 81110A (with 2 × 8114A)

Pulse Force Mode

Pulse signal: 2-level and 3-level output

Burst count: 10⁹ (max.) or infinite

Output mode: Normal mode or pattern mode

Normal mode: All pulse generators (up to 5) can force synchronously

Pattern mode: All pulse generator except a master pulse generator can force synchronously (more accurate pulse width and pulse delay than normal mode).

Note the 8114A does not support pattern mode.

Load impedance: 999 kΩ (default),
 selectable from 2.5 Ω to 999 kΩ (8110A and 81110A)
 selectable from 10 Ω to 999 kΩ (8114A)

Pulse Setting Range

- Pulse period:

Mode	PGU	Range
Normal mode	8110A, 81110A	350 ns to 999 s, Resolution: 4 digits (min. 100 ps)
	8114A	350 ns to 999 ms, Resolution: 3 digits (min. 1 ns)
Pattern mode	8110A or 81110A in a master unit	120 μs to 999 s, Resolution, 4 digits (min. 100 ns)
	8114A in a master unit	120 ns to 999 ms, Resolution, 3 digits (min. 1 μs)

Agilent 4073A Specifications

• Pulse width

Mode	PGU	Range
Normal mode	8110A	50 ns to 999 ms, Resolution: 3 digits (min. 100 ps)
	81110A	50 ns to 999 ms, Resolution: 3.5 digits (min. 50 ps)
	8114A	150 ns to 150 ms, Resolution: 3 digits (min. 1 ns)
Pattern mode	8110A or 81110A in a master unit	50 ns to 150 ms, Resolution: 3 digits (min. 100 ps)
	8114A in a master unit	150 ns to 150 ms, Resolution: 3 digits (min. 1 ns)
	8110A or 81110A in a slave unit	100 ns to 999 ms Resolution: 1×10^{-n} (at $1000 \times 10^{-n} < T \leq 4000 \times 10^{-n}$) 2×10^{-n} (at $4000 \times 10^{-n} < T \leq 8000 \times 10^{-n}$) 2.5×10^{-n} (at $8000 \times 10^{-n} < T \leq 10000 \times 10^{-n}$) T means the maximum value of (pulse width + delay time) among all the channels. For example, if T is 250 μ s, then according to above table, the resolution is 0.1 μ s (1×10^{-7}) because $T=250 \times 10^{-6}=2500 \times 10^{-7}$.

• Pulse delay

Mode	PGU	Range
Normal mode	8110A, 8114A	0 to 998 ms, Resolution: 3 digits (min. 10 ps)
	81110A	0 to 998 ms, Resolution: 3.5 digits (min. 5 ps)
Pattern mode	8110A, 81110A, or 8114A in a master unit	0 to 998 ms, Resolution: 3 digits (min. 10 ps)
	8110A or 81110A in a slave unit	100 ns to 999 ms Resolution: 1×10^{-n} (at $1000 \times 10^{-n} < T \leq 4000 \times 10^{-n}$) 2×10^{-n} (at $4000 \times 10^{-n} < T \leq 8000 \times 10^{-n}$) 2.5×10^{-n} (at $8000 \times 10^{-n} < T \leq 10000 \times 10^{-n}$) T means the maximum value of (pulse width + delay time) among all the channels. For example, if T is 250 μ s, then according to above table, the resolution is 0.1 μ s (1×10^{-7}) because $T=250 \times 10^{-6}=2500 \times 10^{-7}$.

• Transition time

8110A, 81110A	20 ns to 200 ms
8114A	65 ns (fixed)

- Pulse level (at open load)

8110A, 81110A	±19 V (at 2 level) ±19 V (at 3 level) ¹
8114A	–49.9 V to +50 V (at 2 level) –49.9 V to +50 V (at 3 level) ²
(8110A or 81110A) + 8114A	–49.9 V to +50 V (at 3 level)

1. Restriction for "3-level pulse with one PG" output mode: the sum of the absolute values of both amplitudes cannot exceed 20 V.
2. There is no "3-level pulse with one PG" output mode on the 8114A because it has only one output.

- Pulse level accuracy (at open load)

8110A and 81110A level	±((2% of amplitude) + 150 mV)
8114A baseline	±((2% of amplitude) + 200 mV)
8114A amplitude:	±((2% of baseline) + (1% of amplitude) + 200 mV)

- Pulse shape accuracy (at 50 ohm load impedance)

8110A width	±(5% of setting + 2 ns) (in normal mode, width ≥ 50 ns)
81110A width	±(3% of setting + 2 ns) ±(0.5% of setting + 2 ns) ¹ after timing calibration (in normal mode, width ≥ 50 ns)
8110A delay	±(5% of setting + 1 ns) (in normal mode)
81110A delay	±(3% of setting + 1 ns) ¹ after timing calibration (in normal mode, width ≥ 50 ns)
8110A and 81110A transition	(–10% of setting) to (+10% of setting + 20 ns) (transition time ≥ 20 ns)
8110A and 81110A overshoot	±(5% of amplitude + 20 mV) (transition time ≥ 20 ns)
8114A width	±(5% of setting + 3.5 ns) (width ≥ 200 ns) ±(5% of setting + 6.0 ns) (width ≥ 150 ns)
8114A delay	±(5% of setting + 1 ns)
8114A transition	65 ns ± 20 ns
8114A overshoot	±(5% of amplitude + 50 mV)

1. Supplemental characteristics

Specifications

Agilent 4073A Specifications

- Pulse shape accuracy (at 5 kohm load impedance: supplemental characteristics)

8110A and 81110A overshoot/ringing	$\pm(5\% \text{ of amplitude} + 20 \text{ mV})$
8114A overshoot/ringing	$(-8\% \text{ of amplitude}) \text{ to } (+4\% \text{ of amplitude})$
8110A and 81110A transition time	$\pm(10\% \text{ of setting} + 5 \text{ ns})$
8114A transition time	$56 \text{ ns} \pm 5 \text{ ns}$
Skew between pins	$\pm 10 \text{ ns}$

System Controller

- Supported computers:

HP 9000 series 700 model 745i/100
HP 9000 series 700 model 745/132L
HP Visualize workstation C3600

- Operating system:

HP-UX 10.20 (with Y2K patches) or HP-UX 11i
BASIC/UX with SICL, or C/ANSI C with SICL

- Required memory:

Minimum requirement is 64 MB (128 MB is recommended).

- Required disk:

2GB is required
4GB is recommended

- Required GPIB interface:

Agilent Technologies recommends two external GPIB interface cards for use with:

- Instruments controlled by the 4070 TIS commands (e.g. Agilent 4284A, Agilent 3458A)
- Automatic wafer prober

System Software

The standard 4070 system software provides the following capabilities:

- System management
- Control of subsystems (TIS Library)
- Parameter measurement utility (PARA Library)
- Off-line debugging
- Interactive debugging panel (IDP) (includes Agilent FASTCode Generating Function)
- Probing pattern generation and wafer maps display (PPG, MAP)
- Prober control libraries (sample program): Electroglas, TEL, and TSK
- Application program (sample program): flash memory cell evaluation, charge pumping method
- Automatic diagnostics

Agilent Semiconductor Process Evaluation Core Software (SPECS)

Agilent SPECS is a test shell environment for the 4070 series.

Input:	User interaction occurs via a windows-based graphical interface with spreadsheet-like operation. Test plans require only four simple specifications: wafer, die, test, and probe.
Customization:	Agilent supplies basic development, engineering, and operator test shell frameworks, which users can tailor or modify to create entirely new frameworks.
Analysis and output:	All data is output into a flat ASCII file, which users can manipulate to allow for input into database software. In addition, the data management structure supports x-y graphs, histograms, and wafer maps.
UNIX:	Users have full access to the UNIX environment from within the test shell.

B CMU Calibration

This appendix provides information about the CMU calibration.

There are three types of CMU calibrations in the Agilent 4072A/4073A tester as follows:

- Switching matrix compensation parameters
- DUT interface residual capacitance compensation
- Agilent 4284A CMU open/short compensation

No CMU calibration above is necessary when the periodic system calibration service is performed. The following shows when the CMU calibration is necessary:

- Switching matrix compensation parameters is necessary when:
 - Any pin board configurations are changed.
 - The CMU C-G test fails.
- DUT interface residual capacitance compensation is necessary when:
 - User needs to compensate the stray capacitance between the measurement pins and probing needles.
- The 4284A CMU open/short compensation is necessary when:
 - The CMU cable (Agilent 16048E test leads) is replaced.
 - The CMU C-G test fails.

Measurement for the CMU Error Compensation Data

You can measure the CMU error compensation data by executing the `cal4070` command.

NOTE *Only if the CMU capacitance and conductance test failed or you replaced the CMU cable (the 16048E test lead), measure the capacitance error compensation data by using following procedure.*

1. Execute the `cal4070` command in the `dterm` window.

```
$ cal4070 Return
```

The calibration window appears.

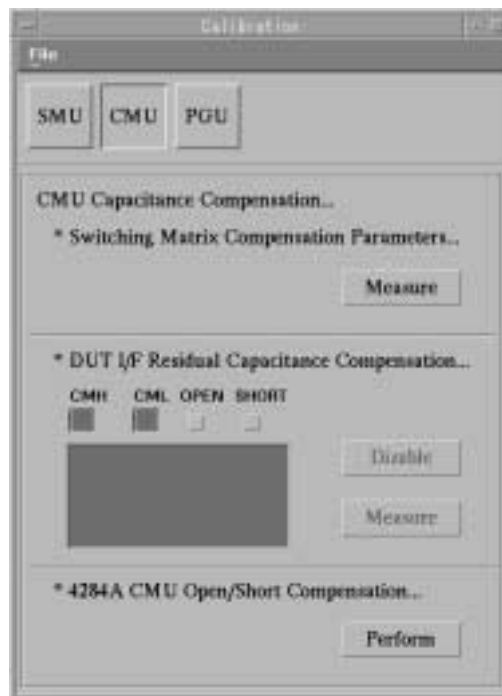
2. Click **CMU** in the calibration window. The Calibration window is changed to the CMU mode. You can now perform one of the following:

“Agilent 4284A CMU Open/Short Compensation”

“Switching Matrix Compensation Parameters”

“DUT I/F Residual Capacitance Compensation”

Figure B-1 Calibration Window for CMU Error Compensation



See the *User's Guide* for more information.

Measurement for the CMU Error Compensation Data

Agilent 4284A CMU Open/Short Compensation

The following describes the procedures for measuring and storing open and short error compensation data for the cables that connect the CMU to the testhead.

Required Equipment

- PV fixture adapter (E3190-60041)
- PV open fixture (E3190-60042)
- BNC-T (m-m-f) adapter (1250-2405)

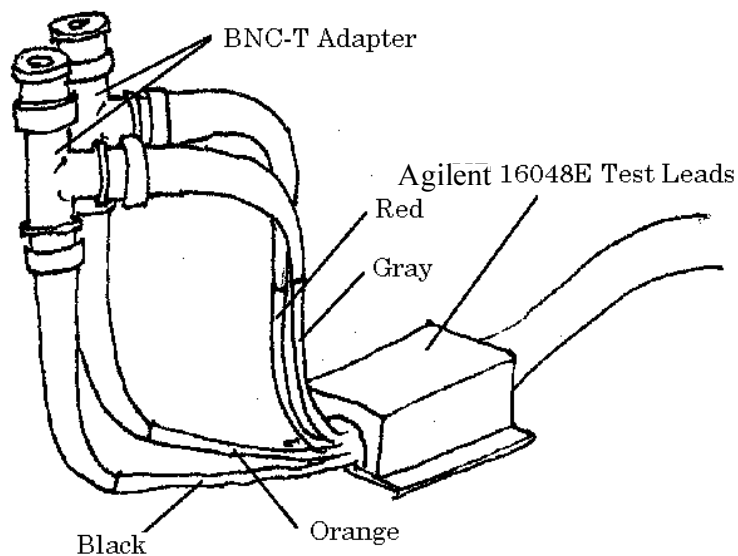
NOTE Testhead must be enable when you execute CMU open/short compensation. The PV fixture adapter and the PV open fixture are used to enable the testhead.

Execution Procedure

1. Click **Perform** in the 4284A CMU open/short compensation area.
2. To perform open compensation, disconnect the CMH and CML cable from the testhead, then click **Continue**.

NOTE When open compensation is performed, the outside of the BNC-T Adapter must be contacting each other.

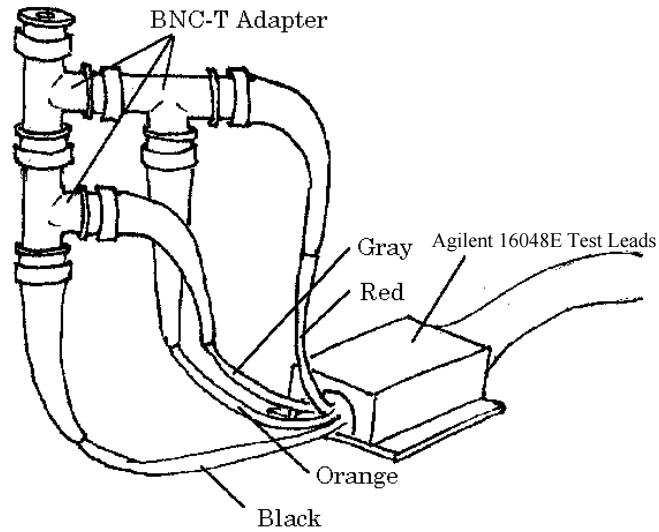
Figure B-2 Test Lead Connections for Open Compensation



Measurement for the CMU Error Compensation Data

3. Connect CMH and CML by using the BNC-T adapter (1250-2405) to perform the short compensation, then click **Continue**.

Figure B-3 Test Lead Connections for Short Compensation



4. Connect CMH and CML to the testhead.

The error compensation data is stored in the 4284A, which is used to automatically compensate measurement data.

Switching Matrix Compensation Parameters

To execute switching matrix compensation parameters, click **Measure** in the Switching Matrix Compensation Parameters area.

The error compensation data is stored in the `/etc/opt/hp4070/ccdata` file, which is used to automatically compensate measurement data.

Measurement for the CMU Error Compensation Data

DUT I/F Residual Capacitance Compensation

The following describes the procedures for measuring and storing open and/or short error compensation data, for the measurement path beyond any two measurement pins of the testhead (for example, probing needles).

Execution Procedure

1. In the DUT I/F Residual Capacitance Compensation area, enter the pin number of CMH in the CMH field and pin number of CML in the CML field, respectively.
2. Make the probe needles open (nothing connected to the needles).
3. Click **OPEN** and **SHORT**.
4. Click **Measure**.
5. Make the corresponding probe pins open (nothing connected) and click **Continue**.
The open compensation data is measured.
6. Make the corresponding probe pins shortened and click **Continue**.
The short compensation data is measured.
7. Repeat step 1. through step 6. for all combinations of measurement pins that you use for capacitance measurement.
8. All measured pins are displayed in the lower left area of the DUT I/F Residual Capacitance Compensation area.
You can save measured compensation data in a file and restore the data from a file later.

To Store Compensation Data

1. Choose the **File: Save C Compensation Table...** menu in the Calibration window.
The Compensation Table File window appears.
2. Enter the file name in the Selection field.
3. Click **OK**.
All measured compensation data is stored in the file.

To Load Compensation Data

1. Choose the **File: Load C Compensation Table...** menu in the Calibration window.
The Compensation Table File window appears.
2. Enter the file name in the Selection field.
3. Click **OK**.
The compensation data is loaded from the file.

C PG Skew Calibration

This appendix provides information about PG skew calibration.

PG skew calibration is for measuring the skew compensation data for all the PGUs in order to synchronize the pulse outputs from all the PGUs. The maximum time difference of pulse outputs is about $\times\times$ nano-seconds, even though the same pulse waves are forced from two PGUs at a time. This difference depends on the characteristics of the trigger circuit of each PGU. The Agilent 4072A/4073A makes the pulse outputs synchronize by using the skew compensation data, which can be retrieved by PG skew calibration.

PG skew calibration is necessary when:

- The pulse generator is replaced with another unit.
- The pulse generator is added in the 4072A/4073A.
- The pulse generator is repaired.

PG skew calibration is not necessary when the periodic system calibration service is performed, because an error of nano-seconds order does not affect the actual measurements.

This appendix includes the following sections:

- “Procedures of PG Skew Calibration”
- “Operating Theory of PG Skew Calibration”

Procedures of PG Skew Calibration

This section describes the procedures and required test equipment for PG skew calibration. Perform PG skew calibration according to the instructions in this section.

PG skew calibration is executed from the Standard Value Input window, which is opened by clicking the **PG Skew Calibration...** button in the Performance Verification window.

Figure C-1 Standard Value Input Window for PG Skew Calibration



Procedures of PG Skew Calibration

Required Equipment

Agilent 54750A/54751A or Agilent 86100A/86112A oscilloscope

Agilent 8493C option 020 attenuator (20dB)

PV fixture adapter (E3190-60041)

PV pulse fixture (E3190-60021)

BNC-to-SMA cable assembly (E3190-61611)

Trigger cable assembly (E3190-61612)

Calibration Procedure

1. Click the **Calibrate** button.
2. Click the **Measure** button.
3. Install the PV pulse fixture on the testhead.
4. Connect the BNC terminal of the trigger cable assembly to the PV TRIGGER terminal on the trigger distributor. The trigger distributor is located inside the system cabinet.
5. Connect the SMA terminal (tagged "TO TRIGGER") of the trigger cable assembly to the Trigger terminal on the 54751A or 86100A.
6. Install the 20 dB attenuator on the channel A terminal of the 54751A or channel 1 terminal of 86100A.
7. Connect the SMA terminal of the BNC-to-SMA cable assembly to the 20 dB attenuator.
8. Connect the BNC cable tagged "PGxx", which is from the pulse generators, to the HF n terminal on the testhead according to the displayed instructions.
9. Connect the BNC terminal of the BNC-to-SMA cable assembly to the specified terminal on the PV Pulse Fixture according to the displayed instruction. First, it is P8 terminal.
10. Click **Continue**. The skew data is measured.
11. Repeat steps 8. through 10. according to the displayed instructions on the pop-up window, if non-evaluated pulse sources are present.

After calibration, the PG skew data is shown in the column "Measured Skew".

Figure C-2 Connection of PG Skew Calibration (with Agilent 54750A/54751A)

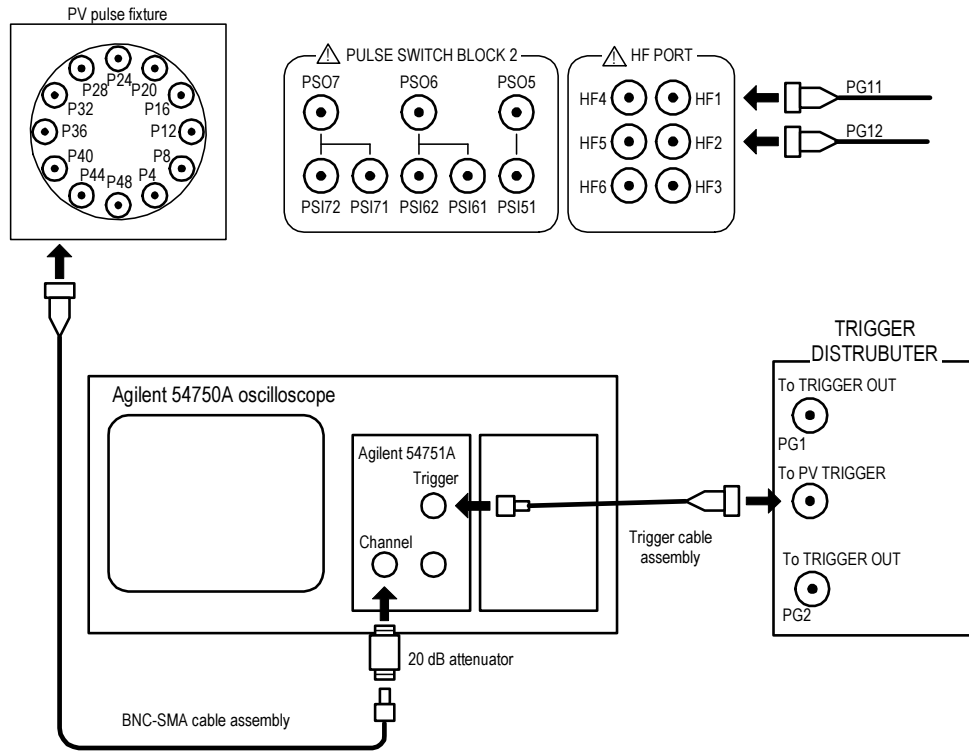
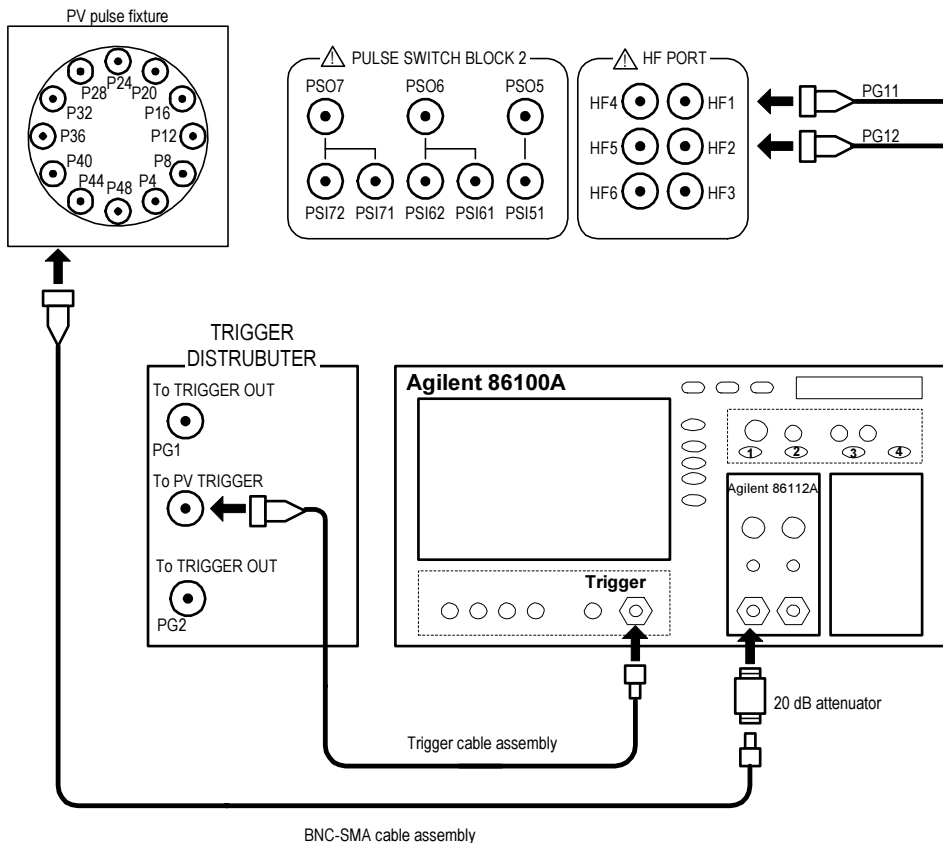


Figure C-3 Connection of PG Skew Calibration (with Agilent 86100A/86112A)



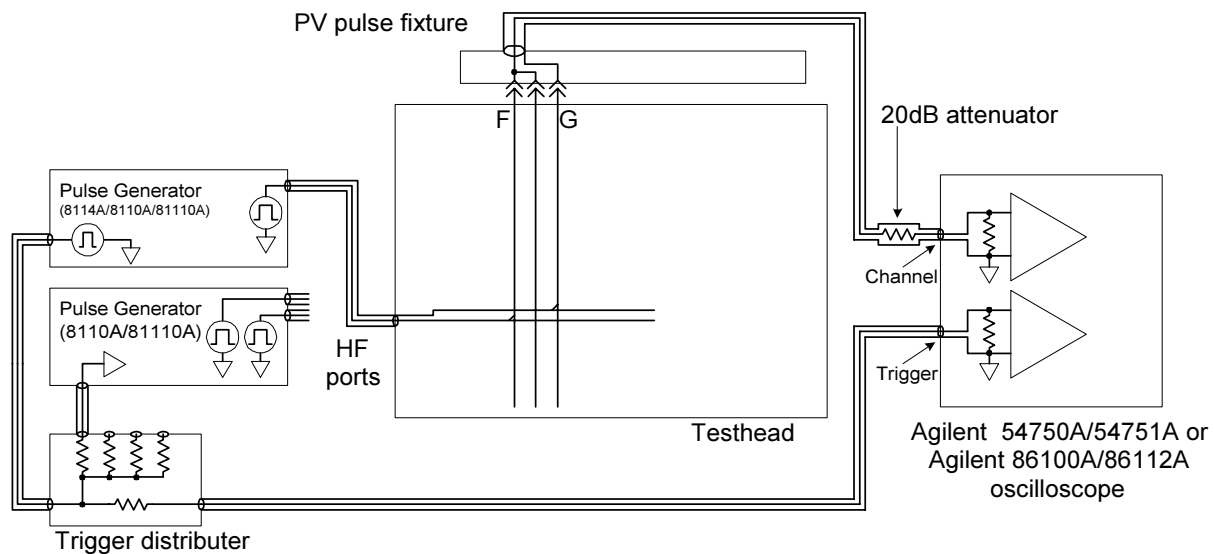
Operating Theory of PG Skew Calibration

This section provides the theory of PG skew calibration.

The 4072A/4073A can be equipped with up to 10 pulse sources (PGUs). The pulse trigger timing for each PGU, however, depends on the particular hardware's traits in nano-second order. To compensate the trigger timing for all the PGUs, the PG skew calibration measures the actual timing parameters and calculates compensation data. The compensation data is stored in the `/etc/opt/hp4070/config/skewdata` file.

Figure C-4 shows a simplified test circuit.

Figure C-4 PG Skew Calibration Circuit



Theory of Operation

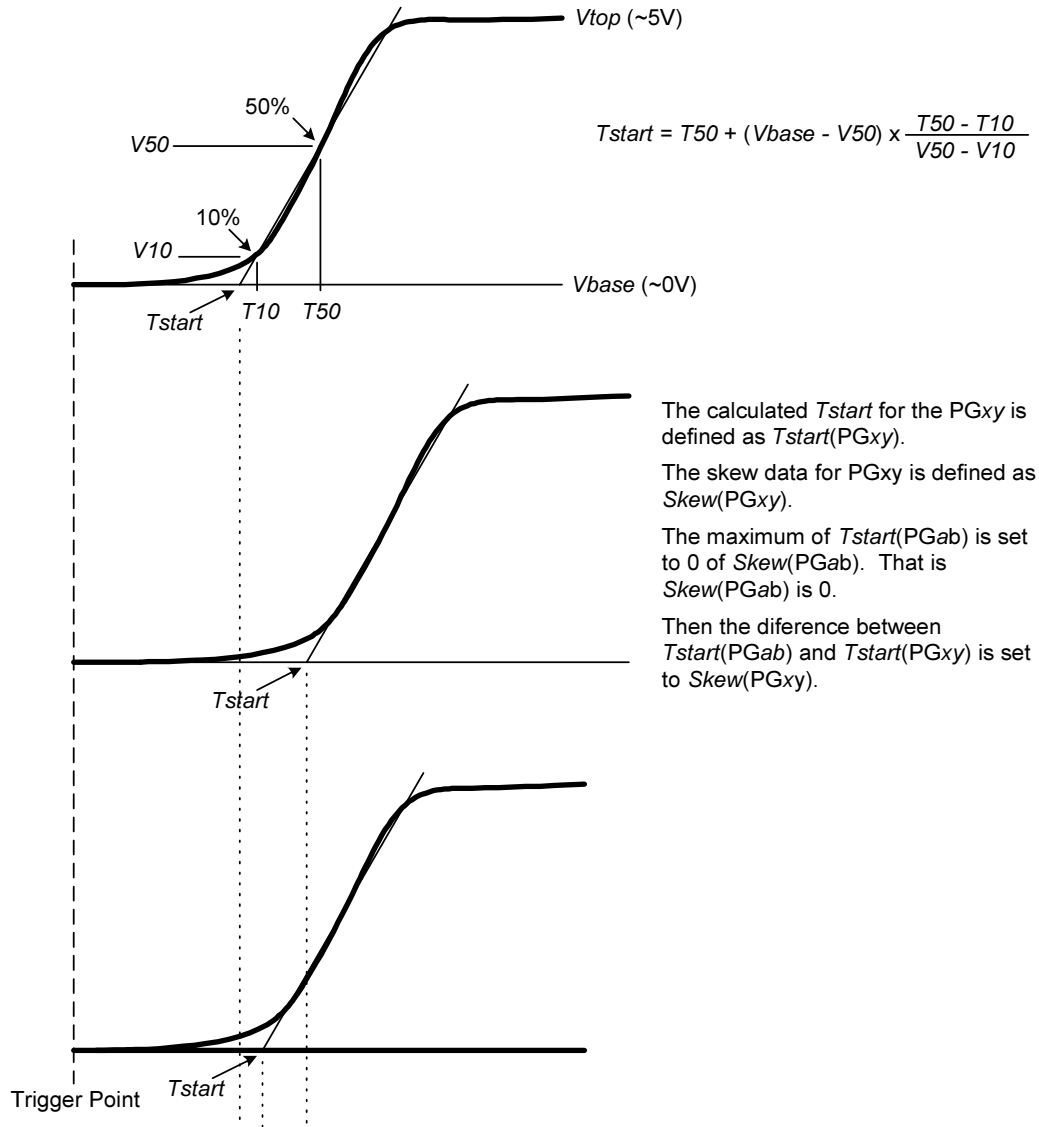
1. Set the PG (Agilent 8114A/81110A/8110A) as follows:

Pulse period:	1 ms
Pulse width:	500 μ s
Delay time:	0 s
Transition time:	20 ns
Load impedance:	50 Ω to 50 Ω
Pulse high:	5 V
Pulse low:	0 V
Polarity:	POSITIVE (only for the 8114A)
Pulse base:	0 V (only for the 8114A)
Amplitude:	5 V (only for the 8114A)

2. Force a pulse from PG_{xx} and measure V_{top} and V_{base} with the oscilloscope.
3. Force a pulse again and measure T_{10} , V_{10} , T_{50} , and V_{50} .

4. Calculate the T_{start} of PG_{xx}.
 5. Repeat steps 2 to 4 for all the PG_{xx}.
 6. Calculate the skew compensation data and store the `/etc/opt/hp4070/config/skewdata` file.
- Figure C-5 shows the definitions of pulse wave.

Figure C-5 Theory of PG Skew Calibration



T_{start} is calculated as the start time of the pulse's leading edge. The T_{start} of one PGU is different from that of other PGUs. The PGU having the maximum T_{start} value is recognized as datum of skew. That is, the skew value is 0 (zero). The skew data for each PGU is calculated by subtracting T_{start} from the maximum of T_{start} .

PG Skew Calibration

Operating Theory of PG Skew Calibration

The following are typical contents of a PG skew data file (/etc/opt/hp4070/config/skewdata):

```
# Agilent 4070 PGU Skew Calibration Data file
# Format Revision 1.0
# lines beginning with '#' are comment lines
PG11    PG8114A DE33700974 +6.359000E-08 +1.343250E-08
PG21    PG8110A ExchG00015 +7.702250E-08 +0.000000E+00
PG22    PG8110A ExchG00015 +7.695250E-08 +7.000000E-11
PG31    PG8110A DE38704634 +7.522250E-08 +1.800000E-09
PG32    PG8110A DE38704634 +7.310250E-08 +3.920000E-09
```

The first column is the PGU identifier. The second column shows the model number of the PG. The third column shows the serial number of the PG. The fourth column shows the measured and calculated T_{start} data. The fifth column shows the skew data. In other words, it is PG skew compensation data.

D Error Messages

1-xxxxx

- **1-10001 System software inconsistency discovered.**
- **1-10002 System software inconsistency discovered in session login mechanism.**
- **1-10003 System software inconsistency discovered in session logout mechanism.**

Unknown error occurred during the 4070 system software execution, or login/logout session. Cannot continue the session. Execute hp4070 -logout, then execute hp4070 -login again.

- **1-10004 Cannot allocate memory.**

Could not allocate enough memory. Execute hp4070 -logout, then execute hp4070 -login again.

- **1-10006 Cannot set socket buffer size.**
- **1-10007 Failed to call socket().**
- **1-10008 Failed to call bind().**
- **1-10009 Failed to call listen().**
- **1-10010 Failed to call symlink().**
- **1-10011 Failed to call accept().**
- **1-10012 Failed to call connect().**
- **1-10013 Failed to call shmget().**
- **1-10014 Failed to call shmat().**

Unknown error occurred in the 4070 system software. Execute hp4070 -logout, then execute hp4070 -login again. Or reboot HP-UX.

- **1-10015 Cannot open hardware configuration file(in /etc/opt/hp4070/config/).**
- **1-10016 Cannot fstat() hardware configuration file(in /etc/opt/hp4070/config/).**
- **1-10017 Cannot mmap() hardware configuration file(in /etc/opt/hp4070/config/).**
- **1-10018 Cannot read() hardware configuration file(in /etc/opt/hp4070/config/).**
- **1-10019 Cannot unmap() hardware configuration file(in /etc/opt/hp4070/config/).**

Could not open the configuration file (/etc/opt/hp4070/config/1). Check the configuration file. If problem is not found in the data, permission and so on, re-install the 4070 system software.

- **1-10020 Cannot allocate event handler table.**

Too many test programs are running. Or too many events are registered by the `Wait_event` command. Stop unnecessary test programs.

- **1-10021 Cannot read Optical Interface Special Data Register 0.**
- **1-10022 Cannot ioctl() Optical Interface Card.**
- **1-10023 Cannot ioctl() Optical Interface Card.**
- **1-10024 Cannot ioctl() Optical Interface Card.**
- **1-10025 Cannot read Optical Interface Special Data Register N.**
- **1-10029 Cannot ioctl() Optical Interface Card N.**

Error occurred when accessing the optical interface card. Execute hp4070 -logout, then execute hp4070 -login again. Or the optical interface card may be defective.

- **1-10026 Power Fail occurred. TIS Daemon process is going to die.**

Testhead was turned off. Turn the testhead on. And execute hp4070 -login.

- **1-10027 Another online TIS Daemon is running.**

Another online TIS daemon is already running. Only one online TIS daemon can be running.

- **1-10028 Cannot open optical interface device file.**

Could not open the optical interface device file. Check the following device files. If problem is not found in the data, permission and so on, execute the configure command after removing the /dev/hp4070 directory. The permission of the file must be `crw-rw-rw-`.

- ❑ /dev/hp4070/opt_sN
- ❑ /dev/hp4070/opt_sNF0
- ❑ /dev/hp4070/opt_sNF1
- ❑ /dev/hp4070/opt_sNF2
- ❑ /dev/hp4070/opt_sNs0
- ❑ /dev/hp4070/opt_sNs1
- ❑ /dev/hp4070/opt_sNs2

where, *N* is the ISA slot number (1, 2, 3, or 4) where the optical interface card is installed.

- **1-10031 Cannot fork expmon4070 (errno=*N*).**

Could not execute expmon4070. Check /opt/hp4070/sbin/expmon4070. The permission must be `-r-xr-xr-x`. If too many processes are running, kill unnecessary processes.

where, *N* is the error number returned by the HP-UX kernel or system call.

- **1-10032 OptCard selftest(register r/w test) error.**
- **1-10033 OptCard selftest(FIFO memory r/w test) error.**
- **1-10034 OptCard selftest(communication test) error.**

Failed on the self-test of the optical interface card installed in the system controller. Replace the optical interface card.

- **1-10035 Test Head is not in normal mode. Cannot continue TIS Daemon.**

Unknown problem occurred in the testhead. Turn off the power of the testhead and on again. Then restart the TIS server again.

- **1-20001 Client Table full. Please quit some applications that use TIS library.**

Too many test programs or test algorithms are running. Stop unnecessary programs or algorithms.

- **1-20003 Error in iclear() on accessing GPIB device.**
- **1-20004 Error in itimeout() on accessing GPIB device.**
- **1-20005 Error in igpibllo() on accessing GPIB device.**
- **1-20006 Error in iprintf() on accessing GPIB device.**
- **1-20007 Error in iopen() on accessing GPIB device.**
- **1-20008 Error in iwrite() on accessing GPIB device.**
- **1-20009 Error in iread() on accessing GPIB device.**
- **1-20022 Error in igpibusstatus().**

Error occurred in accessing GPIB interface. Check the GPIB interface card or the system instruments.

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- **1-20010 Error in ioctl() on accessing optical interface.**
- **1-20011 Error in write() on accessing optical interface.**
- **1-20012 Error in read() on accessing optical interface.**
- **1-20014 Error in select() on accessing optical interface (errno=*N*).**
- **1-20015 Error in select() on accessing optical interface.**

Error occurred in accessing the optical interface. Check the optical interface card or direction of optical interface cables.

where, *N* is the error number returned by the HP-UX kernel or system call.

- **1-20013 Optical Interface Timeout.**

Time out occurred when accessing the testhead. Check the test program. Or turn off the testhead.

- **1-20016 Error in read() on accessing socket.**
- **1-20018 Error in close() of socket.**
- **1-20019 Error in write() on accessing socket.**

Error occurred in accessing the testhead CPU.

- **1-20020 Cannot load C compensation data file.**

Could not read the capacitance compensation data. Check the data and permission of the `/etc/opt/hp4070/ccdata` file and `/etc/opt/hp4070/ccdata0` file.

- **1-20021 C compensation data is not loaded.**

TIS command needs the capacitance compensation data. Related to error No. 1-20020. Solve error No. 1-20020.

- **1-20085 CMU GPIB error occurred.**

GPIB error occurred during communication with the 4284A. Check the GPIB interface card, GPIB cable, and 4284A.

- **1-20086 DVM GPIB error occurred.**

GPIB error occurred during communication with the 3458A. Check the GPIB interface card, GPIB cable, and 3458A.

- **1-30001 Cannot make connection because no session is logged in now.**

No session is logged in now. Execute `hp4070 -login`.

- **1-30002 Cannot make connection because of wrong session id.**

Wrong session ID was specified. Use correct session ID, or log out of unnecessary session.

- **1-30003 Request was refused because the TIS Daemon is not in the normal state. Current state is *N*.**

where, *N*(=1 to 6) means the following status.

- 1: Testhead power fail occurred.
- 2: Testhead emergency (Over Current or Over voltage) occurred.
- 3: Test fixture is open.
- 4: Interlock is open.
- 5: Testhead firmware is abnormal. Replace Testhead CPU board.
- 6: Another client program (test algorithm, etc.) is in abort process.

This error message appears because of the above status. Solve the problem corresponding to the status.

- **1-30004 Optical Interface timeout.**

Time out occurred during communication with the testhead. Check the optical interface card and the optical fiber cables.
- **1-30005 GPIB timeout.**

Time out occurred during communication with the system instruments. Check the GPIB interface card, GPIB cable, and the system instruments.
- **1-30006 Hardware Exception occurred and cannot accept any request.**

Sub-message for error No. 1-30003.
- **1-30007 A client is in aborting sequence.**

Sub-message for error No. 1-30003.
- **1-30008 SICL error occurred: *N***

Error occurred during communication with the system instruments. Check the GPIB interface card, GPIB cable, and the system instruments.
- **1-30009 Cannot make connection. Only one Debugging Panel may run at a time.**

Tried to open a second Interactive Debugging Panel in same session. You can open only one debugging panel at a time in same session.
- **1-30010 Cannot make connection. Another Diagnostics is running.**

Only one Diagnostics program can run at a time. Use the Diagnostics program that is already running. Or stop the program that is already running to newly run the Diagnostics program.
- **1-30011 Cannot make connection. Another Performance Verification is running.**

Only one performance verification (PV) program can run at a time. Use the program that is already running. Or stop the program that is already running to newly run the PV program.
- **1-30012 Request was refused because Diagnostics or PV is running.**

Test program using TIS cannot be executed when the Diagnostics program or the performance verification (PV) program is running. Stop the Diagnostics program or the PV program to run the test program using TIS.
- **1-30013 TIS command cannot be executed because the testhead is in power failure.**

TIS command cannot be executed because a power failure was detected in the testhead. Turn on the power to the testhead again, then restart the TIS server.
- **1-30014 TIS command cannot be executed because over voltage or current is forced to SMUs.**

The TIS command cannot be executed because over voltage or over current is being forced to the SMUs from external instruments or SMUs.
- **1-30015 TIS command cannot be executed because the fixture is open.**

The TIS command cannot be executed because the test fixture lid is open. Close the lid of test fixture.
- **1-30016 TIS command cannot be executed because the interlock is open.**

The TIS command cannot be executed because the interlock circuit is open. Close the interlock circuit.
- **1-30017 TIS command cannot be executed because the testhead cannot work properly.**

The TIS command cannot be executed because the testhead cannot work properly. There is something wrong with the optical interface communication, or something wrong with the testhead. Contact the nearest Agilent Technologies Sales and Service office if the system cannot be restarted.

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- **1-30018 TIS command cannot be executed because the system is running an internal process.**
The TIS command cannot be executed because the system is running an internal process.
- **1-30019 TIS command cannot be executed because an abnormal condition exists.**
The TIS command cannot be executed because an abnormal condition in the system. Remove the abnormal condition before executing the TIS command again.
- **1-30021 Detected wrong (*Type1*) pin board(s). Exchange pin(s) marked with “*” for the *Type2* pin board(s).**
1-30022 Detected wrong (*Type1*) chuck connection pin board. Exchange for the *Type2* chuck connection pin board.
1-30023 Detected wrong (*Type1*) low current input board(s). Exchange for the *Type2* low current input board(s).
1-30024 Detected wrong (*Type1*) kelvin input board(s). Exchange for the *Type2* kelvin input board(s).
1-30025 Detected wrong type of kelvin input board or low current input board(s). Exchange for the correct type of kelvin or low current input board(s).
 - ❑ If *Type1* is HR type and *Type2* is standard type: The high-resolution type board is installed in the 4072A. Exchange the high-resolution type board for the standard type board.
 - ❑ If *Type1* is standard type and *Type2* is HR type: The standard type board is installed in the 4073A. Exchange the standard type board for the high-resolution type board.

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- **2-10002 Cannot open file. filename: *File***
Could not open the file specified by *File*. Confirm the file name and permission of the file.
- **2-10004 An illegal format data exists. filename: *File*, data: *Data***
Tried to open file with invalid data format. Change the data format of the data *Data* in the file *File*.
- **2-10008 An improper option is specified. option: *Option***
Improper value (*Option*) was specified for the option. Specify the option properly.
- **2-10009 An improper argument is specified. option: *Option*, argument: *Argument***
Argument value (*Argument*) invalid for the option (*Option*) was specified. Specify the argument properly.
- **2-10014 Cannot execute command. command path: *Path***
Could not execute the command path *Path*. Re-install the 4070 system software.
- **2-10019 Cannot get character input.**
Could not read the character input. Maximum 1024 characters.
- **2-11001 Failed to write the test selection file. Check permission.**
Un-specifiable error occurred in write operation of the test selection file. Check the permission of the file.
- **2-13002 An error occurred in TIS.**
Error occurred in TIS. Refer to the additional messages.
- **2-14001 Cannot open Optical Interface Card device file.**
Could not open the device file for the optical interface card. Check the configuration file (*/etc/opt/hp4070/config/1*) and specify the proper slot number for the optical interface card. Or kill the unnecessary process that opened the optical interface card device file.
- **2-14003 An error occurred in Optical Interface Card Loopback test.**
Optical interface card failed the loopback test. Check the optical fiber cables or the optical interface card.
- **2-21001 No test is selected. Please select at least one test.**
No test is selected in the "Test Selection" field. Select at least one test.
- **2-21002 No SMU is selected. Please select at least one SMU.**
No SMU is selected in the "Test Selection" field. Select at least one SMU.
- **2-21003 No Pin is selected. Please select at least one pin, chuck or input board.**
No pin is selected in the "Test Selection" field. Select at least one pin, chuck pin, or input board.
- **2-21004 Only a numeric value is allowed here.**
Invalid character (non-numeric) is entered in the input field for numeric character. Enter a numeric value.
- **2-21005 Only an integer value is allowed here.**
Invalid character (non-integer) is entered in the input field for integer. Enter an integer value.

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- **2-21006 Invalid repeat count. Must be 1 to 999999 (integer).**

Wrong value is specified for how many times to repeat the test. The value must be 1 to 999999.
- **2-21007 Invalid margin ratio. Must be 0.0 to 1.0 (float).**

Wrong value is specified for the marginal ratio used to define the marginal test limit. The value must be 0.0 to 1.0.
- **2-21008 Can't read the file. The file does not exist or no read permission.**

The file could not be read. The file does not exist or does not have read permission. Check if the file exists or check the permission of the file.
- **2-21009 Can't write the file. The file or directory has no write permission, or the directory does not exist.**

The file could not be written. The file or directory for the file does not have write permission. Or the directory does not exist. Check that the directory exists, and check the permission of the directory and the file.
- **2-21012 Failed to start diagnostics (errno = N).**

HP-UX kernel error No. *N* occurred in starting diagnostics. Check if the `/opt/hp4070/sbin/diagBody4070` program exists and check the permission of the program. If the program does not exist, re-install the 4070 system software. Or check the number of processes in progress, and kill unnecessary process.
- **2-21013 Can't preserve the result data file (errno = N). Check permission or maybe diagnostics was not executed yet.**

HP-UX kernel error No. *N* occurred in preserving the result data file by File: Preserve data... menu on the Diagnostics window. Execute diagnostics once at least. Or check the permission of the file and `/var/opt/hp4070/diag` directory.
- **2-21014 Failed to write the result data (errno = N). Check permission.**

HP-UX kernel error No. *N* occurred in writing the result data. Check the permission of the file and `/var/opt/hp4070/diag` directory.
- **2-21015 Failed to read result data file (errno = N). Check permission.**

HP-UX kernel error No. *N* occurred in reading the result data. Check the permission of the file and `/var/opt/hp4070/diag` directory.
- **2-21016 Failed to write to result data file (errno = N). Check permission or free disk space.**

HP-UX kernel error No. *N* occurred in writing the result data file. Check the permission of the file and `/var/opt/hp4070/diag` directory. Or check the free disk space. File system full may cause this error.
- **2-23001 ADC Board is defective or not installed.**

The high-resolution ADC board is not installed or may be defective. Install or replace the board.
- **2-23002 GNDU is defective or not installed.**

The GNDU board is not installed or may be defective. Install or replace the board.
- **2-23003 Chuck Connection Board is defective or not installed.**

The chuck connection pin board is not installed or may be defective. Install or replace the board.
- **2-23004 LC Input Board (Port *Port_No.*) is defective or not installed.**

The low current input board is not installed or may be defective. Install or replace the board.

- **2-23005 Kelvin Input Board is defective or not installed.**
The kelvin input board is not installed or may be defective. Install or replace the board.
- **2-23006 CMU Input Board is defective or not installed.**
The CMU input board is not installed or may be defective. Install or replace the board.
- **2-23007 Relay Test Board (Block *Block_No.*) is defective or not installed.**
The relay test board is not installed or may be defective. Install or replace the board.
- **2-23011 ADC Board attenuation factor measurement failed. port: *Port*, expected: *Data1*, measured: *Data2***
High-resolution ADC board failed the attenuation factor measurement test. If all ports failed this test, replace the high-resolution ADC board, otherwise follow the diagnostics execution results.
- **2-23012 ADC Board guard amp offset measurement failed. port: *Port*, measured: *Data***
High-resolution ADC board failed the guard amplifier offset measurement test. Follow the diagnostics execution results. If all ports failed this test, replace the high-resolution ADC board.
- **2-23021 Status error occurred in SMU. port: *Port*, status: *Status***
Status error occurred in the SMU specified by *Port*. Check the SMU if the 4070 failed the diagnostics.
- **2-23022 Status error occurred in CMU. status: *Status***
Status error occurred in the CMU. Check the CMU if the 4070 failed the diagnostics.
- **2-23023 Status error occurred in DVM. status: *Status***
Status error occurred in the DVM. Check the DVM if the 4070 failed the diagnostics.
- **2-23031 HF Matrix Board N is defective or not installed.**
Reference configuration file (*/etc/opt/hp4070/config/refconfig1*) shows the existence of HF matrix board N, but it is not detected by the testhead firmware. HF matrix board may not be installed or may be defective. Install or replace the board.
- **2-23032 HF Matrix Addressing Board is defective or not installed.**
Reference configuration file (*/etc/opt/hp4070/config/refconfig1*) shows the existence of HF matrix addressing board, but it is not detected by the testhead firmware. HF matrix addressing board is not installed or may be defective. Install or replace the board.
- **2-23033 Pulse Switch N Board is defective or not installed.**
Reference configuration file (*/etc/opt/hp4070/config/refconfig1*) shows the existence of pulse switch board N, but it is not detected by the testhead firmware. Pulse switch board N is not installed or may be defective. Install or replace the board.
- **2-23041 SMU (port: *N*) is defective or not installed.**
The SMU board is not installed in port *N* or may be defective. Confirm that the SMU configuration. *hp4070 -login* command displays the 4070 system configuration.
- **2-44343 Low Current Input Board *N* inner port test was skipped.**
The low current input board relay test was skipped because of an SMU error. Repair the SMU connected to the low current input board *N*.
- **2-31001 File already exists. Do you want to replace it?**
If you want to replace the data, select **OK** button. Or else, select **Cancel** button.

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- **2-31002 The test(s) requested on non-existent resources will be ignored.**
Invalid test item, SMU, or pin number is selected. The selection is ignored.
- **2-33001 Cannot identify Pin Board. pin: *Pin***
Actual pin board configuration did not match the configuration file (/etc/opt/hp4070/config/refconfig1). Check the configuration file and define the actual configuration.
- **2-33002 Cannot identify SMU Board. port: *Port***
Actual SMU configuration did not match the configuration file (/etc/opt/hp4070/config/refconfig1). Check the configuration file and define the actual configuration.
- **2-33003 Cannot identify CMU.**
Actual CMU configuration did not match the configuration file (/etc/opt/hp4070/config/refconfig1). Check the configuration file and define the actual configuration.
- **2-33004 Cannot identify DVM.**
Actual DVM configuration did not match the configuration file (/etc/opt/hp4070/config/refconfig1). Check the configuration file and define the actual configuration.
- **2-33005 Testhead Power Line Cycle is mismatching. reference: *Ref* [Hz], actual: *Act* [Hz]**
Actual line frequency did not match the configuration file (/etc/opt/hp4070/config/refconfig1). Check the configuration file and define the actual frequency.
- **2-33006 Cannot identify HF Matrix.**
The command attempts to control the HF matrix, even though the reference configuration file (/etc/opt/hp4070/config/refconfig1) has the information of no MF matrix installed. Check the following items:
 - If the command that you execute is correct.
 - If the reference configuration file includes the correct system configuration information.
- **2-33007 Cannot identify Pulse Switch.**
The command attempts to control the pulse switch, even though the reference configuration file (/etc/opt/hp4070/config/refconfig1) has the information of no pulse switch installed. Check the following items:
 - If the command that you execute is correct.
 - If the reference configuration file includes the correct system configuration information.
- **2-33008 Cannot identify *PGn*.**
The command attempts to control the *PGn*, even though the reference configuration file (/etc/opt/hp4070/config/refconfig1) has the information of no *PGn* installed. Check the following items:
 - If the command that you execute is correct.
 - If the reference configuration file includes the correct system configuration information.

- **2-33009 *PGn* type or GPIB address mismatch.**
The *PGn* definition in the reference configuration file (/etc/opt/hp4070/config/refconfig1) is not correct. Check if the reference configuration file includes the correct system configuration information.
- **2-33011 Cannot find pin for connection test. Port: *Port*.**
Cannot execute the connection test. At least one pin board must be installed in:
 - ❑ Slot 1 to 24 for the HF ports 1, 2, and 3.
 - ❑ Slot 25 to 48 for the HF ports 4, 5, and 6.
 - ❑ Slot 1 to 48 for the AUX ports 1 to 8.
- **2-41001 Margin detection disabled.**
Detection mode for the marginal limit was disabled.
- **2-45001 Relay contact check failed.**
description: *Testcase*
measured: *Data1*, **offset:** *Offset*, **Rmeas:** *Data2*
Rlimit: *Limit*
Failed in the contact check of the HF Matrix Relay Test. Check the connection of the short adapter. Or do troubleshooting and replace defective part.
- **2-45002 Relay stuck check failed.**
description: *Testcase*
board: *board*, **relay:** *relay*, **measured:** *Data1*, **expected:** *Data2*
Failed in the open check of the HF matrix relay test. Do troubleshooting and replace defective part.
- **2.45101 PG selftest failed.**
description: *PGn Status code: Code*
Message: *PG_Error_Message*
Failed in the selftest of the PG. Do troubleshooting and replace defective part.
- **2-45201 PG connection test failed.**
description: *PGn*
port: *Port*, **expected:** *Data1*, **measured:** *Data2*
Failed in the PG connection test. Check the cable connection and connect properly. Or do troubleshooting and replace defective part.
- **2-45202 PG connection test marginally passed.**
description: *PGn*
port: *Port*, **expected:** *Data1*, **measured:** *Data2*
Passed in the PG connection test but the result is nearly test limit. Check the cable connection and connect properly. Or do troubleshooting and replace defective part.
- **2-45301 Pulse switch test failed.**
description: *PGn*
port: *Port*, **control:** *TH*, **expected:** *Data1*, **measured:** *Data2*
Failed in the testhead controlled pulse switch test. Check the cable connection and connect properly. Or do troubleshooting and replace defective part.

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- **2-45302 Pulse switch test marginally passed.**

description: *PGn*

port: *Port*, **control:** *TH*, **expected:** *Data1*, **measured:** *Data2*

Passed in the testhead controlled pulse switch test but the result is nearly test limit. Check the cable connection and connect properly. Or do troubleshooting and replace defective part.

- **2-45303 Pulse switch test failed.**

description: *PGn*

port: *Port*, **control:** *N*, **switch:** *Switch*, **expected:** *Data1*, **measured:** *Data2*

Failed in the PG controlled pulse switch test (multiplexer switch). Check the cable connection and connect properly. Or do troubleshooting and replace defective part.

- **2-45304 Pulse switch test marginally passed.**

description: *PGn*

port: *Port*, **control:** *N*, **switch:** *Switch*, **expected:** *Data1*, **measured:** *Data2*

Passed in the PG controlled pulse switch test (multiplexer switch) but the result is nearly test limit. Check the cable connection and connect properly. Or do troubleshooting and replace defective part.

- **2-45305 Pulse switch test failed.**

description: *PGn*

port: *Port*, **control:** *N*, **switch:** *Switch*, **expected:** *Data1*, **measured:** *Data2*

Failed in the PG controlled pulse switch test (open/close switch). Check the cable connection and connect properly. Or do troubleshooting and replace defective part.

- **2-45306 Pulse switch test marginally passed.**

description: *PGn*

port: *Port*, **control:** *N*, **switch:** *Switch*, **expected:** *Data1*, **measured:** *Data2*

Passed in the PG controlled pulse switch test (open/close switch) but the result is nearly test limit. Check the cable connection and connect properly. Or do troubleshooting and replace defective part.

- **2-45401 PG output level test failed.**

description: *PGn*

port: *Port*, **expected:** *Data1*, **measured:** *Data2*

Failed in the PG output level test. Check the cable connection and connect properly. Or do troubleshooting and replace defective part.

- **2-45402 PG output level test marginally passed.**

description: *PGn*

port: *Port*, **expected:** *Data1*, **measured:** *Data2*

Passed in the PG output level test but the result is nearly test limit. Check the cable connection and connect properly. Or do troubleshooting and replace defective part.

- **2-45501 PG trigger test failed.**

description: *PGn*

port: *Port*, **expected:** *Data1*, **measured:** *Data2*

Failed in the PG trigger test. Check the cable connection and connect properly. Or do troubleshooting and replace defective part.

- **2-45502 PG trigger test marginally passed.**

description: *PGn*

port: *Port*, **expected:** *Data1*, **measured:** *Data2*

Passed in the PG trigger test but the result is nearly test limit. Check the cable connection and connect properly. Or do troubleshooting and replace defective part.

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- **3-10001 System software inconsistency discovered.**
Unknown error occurred during the Agilent 4070 system software execution. Cannot continue the session.
- **3-10002 Cannot open file. filename: *File***
Could not open the file specified by *File*. Check the file name and permission of the file.
- **3-10004 An illegal format data exists. filename: *File*, data: *Data***
Tried to open file with invalid data format. Change the data format of the data *Data* in the file *File* or remake dataflow.
- **3-10006 Cannot write data to file. filename: *Filename***
Could not write data to *Filename*. Check the permission of file or directory. Or check the free disk space. File system full may cause this error.
- **3-10015 Cannot execute command. command path: *Path***
Check the *Path* command. The command may not have execute permission. If problem is not found, re-install Agilent 4070 system software.
- **3-10023 Failed to open Standard Set calibration data directory.**
Could not open `/etc/opt/hp4070/diag/caldata` directory. Check the data directory. If problem is not found in the directory, permission and so on, re-install the Agilent 4070 system software.
- **3-10024 Cannot rename file. filename: *Filename***
Could not rename the file. Check the permission of file or directory. If problem is not found, re-install the Agilent 4070 system software.
- **3-11001 Failed to write the test selection file.**
Un-specifiable error occurred during write operation of the test selection file. Check the permission of file.
- **3-11002 Failed to open temporary PVheader file.**
Could not open `/var/opt/hp4070/diag/PVheader` file. Check the free disk space. File system full may cause this error. If problem is not found, re-install the Agilent 4070 system software.
- **3-11003 pvBody4070 process is already running. Something is wrong.**
The pvBody4070 process has been started. Check the pvBody process.
- **3-11004 Failed to open pipe (errno = *N*).**
HP-UX kernel error No. *N* occurred during communication with diagnostics program. Exit from the Agilent 4070 system software environment, then log into it again. Then execute diagnostics program.
- **3-11005 Failed to invoke diagBody4070 program (errno = *N*).**
HP-UX kernel error No. *N* occurred when starting diagnostics. Check if the diagBody4070 program exists and check the permission of the program. If the program does not exist, re-install the Agilent 4070 system software. Or check the number of processes in progress, and kill unnecessary process.
- **3-13002 An error occurred in TIS.**
Error occurred in TIS. Refer to the additional messages.

- **3-16001 Memory exhausted.**

The measurement data could not be loaded because of small free memory space. Stop unnecessary applications and close windows to increase free memory.
- **3-16010 Failed to open the file. Check permission or diskette.**

The file was not loaded/saved because error occurred during load/save of file. Check the permission of the file. Or check the diskette.
- **3-16011 Failed to read the file. Check permission or diskette.**

The file was not loaded because error occurred during load of file. Check the permission of the file. Or check the diskette.
- **3-16012 Failed to write the file. Check permission or diskette.**

The file was not saved because error occurred during save of file. Check the permission of the file. Or check the diskette.
- **3-16013 Failed to end printing (errno = N).**

Error No. *N* occurred at end of printing. Cannot close the pipe for LP command.
- **3-20001 Failed to read Standard Set calibration data.**

Could not read the data file in `/etc/opt/hp4070/diag/caldata` directory. Check the permission of the data file and directory.
- **3-20002 Failed to write Standard Set calibration data.**

Could not write the data file in `/etc/opt/hp4070/diag/caldata` directory. Check the permission of the data file and directory.
- **3-20003 Failed to remove Standard Set calibration data.**

Could not remove the data file in `/etc/opt/hp4070/diag/caldata` directory. Check the permission of the data file and directory.
- **3-21001 No test is selected. Please select at least one test.**

No test is selected in the "Test Selection" field. Select at least one test.
- **3-21002 No SMU is selected. Please select at least one SMU.**

No SMU is selected in the "SMU Selection" field. Select at least one SMU.
- **3-21003 No Pin is selected. Please select at least one pin, chuck or input board.**

No pin is selected in the "Pin Selection" field. Select at least one pin or chuck pin.
- **3-21004 Failed to open the profile data file.**

Could not open the profile data file. Check if the file exists and permission of file or directory. If this message is displayed when you open the system default file, check the `/etc/opt/hp4070/diag/PVprofile` file.
- **3-21005 Failed to read the profile data file.**

Could not read the profile data file. Check if the file exists and permission of file or directory.
- **3-21006 Failed to write to the profile data file.**

Could not write the profile data file. Check if the file exists and permission of file or directory. If this message is displayed when you write the system default file, check the `/etc/opt/hp4070/diag/PVprofile` file.

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- **3-21008 Can't read the file. The file does not exist or no read permission, or the directory does not exist.**

The file could not be read. The file or directory for the file does not have read permission. Or the directory does not exist. Check that the directory exists, and check the permission of the directory and the file.
- **3-21009 Can't write the file. The file or directory does not have write permission, or the directory does not exist.**

The file could not be written. The file or directory for the file does not have write permission. Or the directory does not exist. Check that the directory exists, and check the permission of the directory and the file.
- **3-21010 The DMM address for PV is not specified. Specify GPIB address in Configuration Window.**
- **3-21011 Standard C/R set to be used is not specified. Specify their serial numbers in Configuration Window.**
- **3-21012 Specified value for *Equipment_Name* exceeds the $\pm 5\%$ range limit against the nominal value. Set the correct value.**
- **3-21013 GPIB address must be integer value. Specify an integer value for DMM address.**

A non-integer value is specified for GPIB address. Specify an integer value.
- **3-21022 The Oscilloscope address for PV is not specified. Specify GPIB address in Configuration Window.**

No GPIB address for the 54750A or 86100A oscilloscope is specified in the Standard Selection window. Specify the GPIB address of the oscilloscope.
- **3-21023 Specified Oscilloscope GPIB address is an integer. Specify an integer value.**

Specified GPIB address value for the 54750A or 86100A oscilloscope is not integer. Specify a proper integer value for the GPIB address of the oscilloscope.
- **3-23001 ADC Board is defective or not installed.**

The high-resolution ADC board is not installed or may be defective. Install or replace the board.
- **3-23002 GNDU Board is defective or not installed.**

The GNDU board is not installed or may be defective. Install or replace the board.
- **3-23003 Chuck Connection Pin Board is defective or not installed.**

The chuck connection pin board is not installed or may be defective. Install or replace the board.
- **3-23004 LC Input Board (Port *Port_No.*) is defective or not installed.**

The low current input board is not installed or may be defective. Install or replace the board.
- **3-23005 Kelvin Input Board is defective or not installed.**

The Kelvin input board is not installed or may be defective. Install or replace the board.
- **3-23006 CMU Input Board is defective or not installed.**

The CMU input board is not installed or may be defective. Install or replace the board.
- **3-23007 Relay Test Board (Block *Block_No.*) is defective or not installed.**

The relay test board is not installed or may be defective. Install or replace the board.

- **3-23011 ADC Board attenuation factor measurement failed.**
port: *Port*, **expected:** *Data1*, **measured:** *Data2*

The high-resolution ADC board failed the attenuation factor measurement test. Follow the performance verification execution results. If all ports failed this test, replace the high-resolution ADC board.
- **3-23012 ADC Board guard amp offset measurement failed.**
port: *port*, **measured:** *Data*

The high-resolution ADC board failed the guard amplifier offset measurement test. Follow the diagnostics execution results. If all ports failed this test, replace the high-resolution ADC board.
- **3-23021 Status error occurred in SMU. port:** *port*, **status:** *Data*

Status error occurred in the SMU specified by *Port*. Check the SMU if the Agilent 4071A/4072A failed the performance verification.
- **3-23022 Status error occurred in CMU. status:** *Status*

Status error occurred in the CMU. Check the CMU if the Agilent 4071A/4072A failed the performance verification.
- **3-23023 Status error occurred in DVM. status:** *Status*

Status error occurred in the DVM. Check the DVM if the Agilent 4071A/4072A failed the performance verification.
- **3-23030 Error in iopen() on GPIB device (DMM for PV).**

An error in `iopen()` occurred when the PV4070 program tries to communicate the DMM (3458A). Confirm if the specified logical unit of the DMM is correct or if the SICL configuration has the specified logical unit entry.
- **3-23031 DMM for PV is not found.**

The DMM (3458A) for PV is not responded by the serial polling on the specified logical unit+GPIB address. Check the following items:

 - If the GPIB address setting of the DMM is correct.
 - If another GPIB device other than the DMM is on the specified GPIB address.
 - If the GPIB cable is not broken.
- **3-23032 The DMM address must specify both logical unit and GPIB address.**

Logical unit or GPIB address of the DMM is not specified in the Standard Selection window. Specify both the logical unit and GPIB address of the DMM.
- **3-23034 Error in iread()/iwrite() on GPIB device (DMM for PV).**

An error occurred during the HP-UX communication between the computer and the DMM (3458A). Check the following items:

 - If the GPIB cable is not broken.
 - If the GPIB interface of the computer is not broken.
 - If the GPIB interface of the DMM (3458A) is not broken.
- **3-23036 Each test pin must be connected to different connector pin.**

Multiple test pins are connected to the same connector. Change the pin assignment.

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- **3-23051 HF Matrix Board *N* is defective or not installed.**

Reference configuration file (/etc/opt/hp4070/config/refconfig1) shows the existence of HF matrix board *N*, but it is not detected by the testhead firmware. HF matrix board may not be installed or may be defective. Install or replace the board.

- **3-23052 HF Matrix Addressing Board is defective or not installed.**

Reference configuration file (/etc/opt/hp4070/config/refconfig1) shows the existence of HF matrix addressing board, but it is not detected by the testhead firmware. HF matrix addressing board is not installed or may be defective. Install or replace the board.

- **3-23053 Pulse Switch *N* Board is defective or not installed.**

Reference configuration file (/etc/opt/hp4070/config/refconfig1) shows the existence of pulse switch board *N*, but it is not detected by the testhead firmware. Pulse switch board *N* is not installed or may be defective. Install or replace the board.

- **3-23054 Error in iopen() on GPIB device (Oscilloscope for PV).**

An error in iopen() occurred when the PV4070 program tried to communicate the 54750A or 86100A oscilloscope. Confirm if the specified logical unit of the 54750A or 86100A is correct or if the SICL configuration has the specified logical unit entry.

- **3-23055 Oscilloscope for PV is not found.**

The oscilloscope (54750A or 86100A) for PV is not responded by the serial polling on the specified logical unit+GPIB address. Check the following items:

- If the GPIB address setting of the oscilloscope is correct.
- If another GPIB device other than the oscilloscope is on the specified GPIB address.
- If the GPIB cable is not broken.

- **3-23056 The Oscilloscope address must specify both logical unit and GPIB address.**

Logical unit or GPIB address of the oscilloscope is not specified in the Standard Selection window. Specify both the logical unit and GPIB address of the oscilloscope.

- **3-23057 Error in iread()/iwrite() on GPIB device (Oscilloscope for PV).**

An error occurred during the HP-UX communication between the computer and the oscilloscope (54750A or 86100A). Check the following items:

- If the GPIB cable is not broken.
- If the GPIB interface of the computer is not broken.
- If the GPIB interface of the oscilloscope is not broken.

- **3-23070 Error in itimeout() on GPIB device (DMM for PV).**

- **3-23071 Error in iclear() on GPIB device (DMM for PV).**

- **3-23072 Error in itermchr() on GPIB device (DMM for PV).**

An error occurred when the computer tried to initialize the DMM (3458A). Check the following items:

- If the GPIB cable is not broken.
- If the GPIB interface of the computer is not broken.
- If the GPIB interface of the DMM is not broken.
- If the DMM is working correctly.

- **3-23080 Error in itimeout() on GPIB device (Oscilloscope for PV).**
3-23081 Error in iclear() on GPIB device (Oscilloscope for PV).
3-23082 Error in itermchr() on GPIB device (Oscilloscope for PV).

An error occurred when the computer tried to initialize the oscilloscope (54750A or 86100A). Check the following items:

- If the GPIB cable is not broken.
 - If the GPIB interface of the computer is not broken.
 - If the oscilloscope is working correctly.
 - If the GPIB interface of the oscilloscope is not broken.
- **3-24302 Cannot find available SMU. Please check using DIAG4070.**
Could not find available SMU for calibrating the relay test board. Check the testhead configuration by using DIAG4070.
 - **3-24303 Failed to calibrate a relay test board. Please check using DIAG4070.**
Could not calibrate a relay test board and could not check of measurement pin position is correct. Check the relay test board by using DIAG4070.
 - **3-24501 Each test pin must be connected to different connector pin.**
Multiple test pins are connected to the same connector. Change the pin assignment.
 - **3-24801 Cannot specify chuck connection pin for test pin.**
Chuck connection pin was specified to be CMU bias test pin. Set CMU bias test pin to other pin.
 - **3-24901 One of 1/2/3/4/48 pin should be available for SMU Output Resistance Test.**
Check the pin board 1, 2, 3, 4 and 48 by using DIAG4070.
 - **3-24902 Pin *N* is defective or not installed. SMU Output Resistance Test needs this pin board.**
The pin *N* is not installed or may be defective. Check the pin *N* by using DIAG4070.
 - **3-24903 The SMU Output Resistance Test requires at least two SMUs.**
SMU is defective or at least two SMUs are not installed. Check the SMU function and configuration by using DIAG4070.
 - **3-24951 Each test pin must be in different block.**
Pulse level test and pulse parameter test require that at least one pin board is installed in each matrix block of the testhead. One pin board must be installed in the slot numbers 1 to 24, and another pin board must be in the numbers 25 to 48.
 - **3-24952 Each test pin must be a multiple of 4.**
Test pins specified for the pulse parameter test must be multiples of 4. That is, they are 4, 8, 12, 16, ..., 48. Check the pin configuration.
 - **3-25001 Calibration Bus(block: *N*) does not have enough performance. Please check using DIAG4070.**
The calibration is discontinued because calibration bus does not have enough performance. Check the calibration bus by using DIAG4070 and calibrate again.

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- **3-25002 SMU *N* does not have enough performance. Please check using DIAG4070. (V[V]: I [A], V[V]: I [A])**
The calibration is discontinued because SMU *N* does not have enough performance. Check the SMU *N* by using DIAG4070 and calibrate again.
- **3-25003 Failed to measure Reference Resistor. (measured: *Measured_R* [ohm], expected: *Expected_R* [ohm])**
3-25004 Failed to measure Reference Resistor. (expected: *R1* [ohm], min: *R2* [ohm], max: *R3* [ohm])
Could not measure the reference resistor. Check the cable connections, DMM for PV, and high-resolution ADC board.
- **3-25011 ADC Reference Volt measurement failed. (measured: *Measured_V* [V], expected: *Expected_V* [V]).**
3-25012 ADC B-COM Volt measurement failed.(B-COM: *V* [V])
Check the high-resolution ADC board by using DIAG4070. Or check the cable connections.
- **3-25021 ADC R Ref Calibration must be executed before SMU R Calibration.**
The R Ref Calibration was not executed before SMU Ref Calibration. Re-calibrate SMU reference by using **Cal SMU**.
- **3-25031 Vtop/Vbase measurement for skew calibration was failed. Check *PGn-HFm* connection.**
Failed to measure Vtop or Vbase value for the skew calibration. Check the cable connections between the *PGn* and *HFm*. If the skew calibration still fails with this error, check the cable connections between the PV pulse fixture and signal input connector of the oscilloscope.
- **3-25032 *PGn* delay time measurement for skew calibration was failed.**
Failed to measure delay times for the skew calibration. Check the cable connections between the *PGn* and *HFm*. If the skew calibration still fails with this error, check the cable connections between the PV pulse fixture and signal input connector of the oscilloscope.
- **3-26001 Can't read the file. The file does not exist or no read permission or illegal path name is specified. Check the path name.**
- **3-26002 Can't write the file. The file or directory has no write permission, or an illegal path name is specified. Check the path name.**
- **3-26003 Failed to initiate spooler command. Check the specified command.**
- **3-26004 Failed to print (errno = *Error*).**
Could not send the data to spooler command. Check the spooler setting.
- **3-26006 Failed to open diskette directory. Check the following:
DOS format diskette is inserted into the disk drive.
The specified disk drive path name is correct.
The scsifloppy device driver is present in the HP-UX kernel.
The DOS-UTIL fileset is installed.**
- **3-26010 File format error. Specified field delimiter is not found. Check the file format and delimiter specification.**
- **3-26011 File format error. Specified string quotation mark is not found. Check the file format and quotation specification.**
- **3-26012 File format error. Numerical value is not found in a numeric field.**

- **3-26013 File format error. No valid data.**
- **3-27001 An error occurred in Testhead. status: *Status***

Testhead timeout occurred when ADC board was calibrated. Check the ADC board, testhead CPU board and so on.
- **3-31001 File already exists. Do you want to overwrite it?**

If you want to overwrite the data, select **OK** button. If not, select **Cancel** button.
- **3-31002 The test(s) requested on non-existent resources will be ignored.**

Invalid test item, SMU, or pin number is selected. The selection is ignored.
- **3-33001 Cannot identify Pin Board. pin: *Pin***

Actual pin board configuration did not match the configuration file (/etc/opt/hp4070/config/refconfig1). Check the configuration file and define the actual configuration.
- **3-33002 Cannot identify SMU Board. port: *Port***

Actual SMU configuration did not match the configuration file (/etc/opt/hp4070/config/refconfig1). Check the configuration file and define the actual configuration.
- **3-33003 Cannot identify CMU.**

Actual CMU configuration did not match the configuration file (/etc/opt/hp4070/config/refconfig1). Check the configuration file and define the actual configuration.
- **3-33004 Cannot identify DVM.**

Actual DVM configuration did not match the configuration file (/etc/opt/hp4070/config/refconfig1). Check the configuration file and define the actual configuration.
- **3-33005 Testhead Power Line Cycle in config file does not match actual line frequency. reference: *Ref* [Hz], actual: *Act* [Hz]**

Actual line frequency did not match the configuration file (/etc/opt/hp4070/config/refconfig1). Check the configuration file and define the actual frequency.
- **3-33006 Cannot identify HF Matrix.**

The command attempts to control the HF matrix, even though the reference configuration file (/etc/opt/hp4070/config/refconfig1) has the information of no MF matrix installed. Check the following items:

 - If the command that you execute is correct.
 - If the reference configuration file includes the correct system configuration information.
- **3-33007 Cannot identify Pulse Switch.**

The command attempts to control the pulse switch, even though the reference configuration file (/etc/opt/hp4070/config/refconfig1) has the information of no pulse switch installed. Check the following items:

 - If the command that you execute is correct.
 - If the reference configuration file includes the correct system configuration information.

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- **3-33088 Cannot identify *PGn*.**
The command attempts to control the *PGn*, even though the reference configuration file (*/etc/opt/hp4070/config/refconfig1*) has the information of no *PGn* installed. Check the following items:
 - If the command that you execute is correct.
 - If the reference configuration file includes the correct system configuration information.
- **3-36001 File already exists. Do you want to overwrite it?**
If you want to overwrite the data, click **OK** button. If not, click **Cancel** button.
- **3-41001 Is it ok to remove the Standard Set calibration data? Note that this operation is not recoverable.**
If you want to remove the data, select **OK** button. If not, select **Cancel** button.
- **3-41002 Do you want to discard all unsaved changes? Note that this operation is not recoverable.**
If you want to discard all unsaved changes, select **OK** button. If not, select **Cancel** button.
- **3-41003 The currently modified data will be lost. Do you want to save them before loading the new Standard Set data?**
If you want to save the data, select **OK** button. If not, select **Cancel** button.
- **3-45701 Relay contact check failed.**
description: *Testcase*
measured: *Data1*, **offset:** *Offset*, **Rmeas:** *Data1*, **Rlimit:** *Limit*
Failed in the contact check of the HF Matrix Relay Test. Check the connection of the short adapter. Or do troubleshooting and replace defective part.
- **3-45702 Relay stuck check failed.**
description: *Testcase*
measured: *Data1*, **offset:** *Offset*, **Rmeas:** *Data1*, **Rlimit:** *Limit*
Failed in the open check of the HF Matrix Relay Test. Do troubleshooting and replace defective part.
- **3-45801 Pulse switch test failed.**
description: *Testcase*
measured: *Data*
Failed in the pulse switch test (on/off test). Check the test lead connections and connect properly. Or do troubleshooting and replace defective part.
- **3-45901 Pulse level test failed.**
description: *Testcase*
measured: *Data*
Failed in the pulse level test. Check the connection from PGU and HF port to the signal input port of the oscilloscope. And connect properly. Or do troubleshooting and replace defective part.
- **3-45921 Pulse parameter test failed.**
description: *Testcase*
measured: *Data*
Failed in the pulse parameter test (except for overshooting). Check the connection from PGU and HF port to the signal input port of the oscilloscope. And connect properly. Or do troubleshooting and replace defective part.

- **3-45922 Pulse parameter test failed due to overshoot.**

description: *Testcase*

measured: *Data*

Failed in the pulse parameter test due to overshoot. Check the connection from PGU, HF port to 54751A. And connect properly. Or do troubleshooting and replace defective part.

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- **4-110001 Cannot make connection because no session is logged in now.**
Before starting up the IDP, you need to log in to the 4070 operating environment. Execute hp4070 -login command before executing idp4070 command.
- **4-110004 Break connection because TIS Daemon process was down.**
TIS daemon was down during IDP operation. Log in to the 4070 again, and execute idp4070 command.
- **4-110005 Cannot send event data to idp4070.**
IDP was down abnormally. Exit IDP by choosing File: Exit menu on the IDP window.
- **4-120001 Cannot allocate memory for reading last measurement data.**
The measurement data could not be loaded when choosing File: Open Last Test menu on the Graph window of IDP because of small free memory space. Stop unnecessary applications and close windows to increase free memory size.
- **4-202004 Allocation size is too large. Ignored.**
Tried to load data file that was edited or broken. Internal error. Number of vector data is larger than the allocated size. Excess data is not set.
- **4-202005 Data size is larger than allocated size. The data is ignored.**
Tried to load data file that was edited or broken. Internal error. Tried to set number of vector data that was negative number. No action.
- **4-202006 Invalid block number is selected. Ignored.**
Internal error. Block number of the data block to be cleared is a negative number or over the maximum number. No action.
- **4-202007 Selected block size is too large. Last selected block is ignored.**
Tried to load data file that was edited or broken. Internal error. Too large block size was specified for block selection. The block is not selected.
- **4-202009 Measurement vector number is invalid. The vector is ignored.**
Tried to load data file that was edited or broken. Internal error. Tried to set number of the vector data that is negative number, zero, or over the number of registered data. The vector data is not set.
- **4-205011 Warning: Illegal data format in data file. Ignored. Too long line. Line = *Line_No*..**
Data file to be loaded was edited or broken. Number of characters in line *Line_No*. of data file to be loaded was over 128 characters. The line is ignored. Delete the line or edit the line so that it is 128 or less characters.
- **4-205012 Warning: Too many data in one data block: <= 2002 data per data block. Used only the first 2002 data.**
Data file to be loaded was edited or broken. Number of data in a vector data is over 2002. Only the first 2002 data are loaded. Delete the excess data so that number of data is 2002 or less.
- **4-205013 Warning: Bad data Tag found in data file. Ignored. Line = *Line_No*..**
Data file to be loaded was edited or broken. Invalid specifier was used in line *Line_No*. of the data file. The line is ignored. Delete the line. Or edit the data file. Use ": (colon)", for example, "BX:", "BY:" and so on, to indicate the specifiers.

- **4-205014 Warning: Cannot use Attributes Tag in data block portion. Ignored. Use this Tag in header portion of data file. Line = *Line_No.***

Data file to be loaded was edited or broken. Attribute tag is inserted in line *Line_No.* of the data file to be loaded. The line is ignored. Delete the line.
- **4-205015 Warning: Illegal data format in data file. Ignored. Line = *Line_No.***

Data file to be loaded was edited or broken. Non-numeric data is included in line *Line_No.* The line is ignored. Delete the non-numeric data, or exchange it with the numeric data.
- **4-205016 Warning: Illegal range format in data file for *Data*. Ignored. Line = *Line_No.***

Data file to be loaded was edited or broken. Could not get the data from the lines #XI, #X and #Y for graph in the data file. The line *Line_No.* is ignored. Delete the line. Or edit the file and insert the proper value.
- **4-205018 Warning: Illegal Character in data file for *Data*. Used NULL String. Line = *Line_No.***

Data file to be loaded was edited or broken. Invalid character was used in line *Line_No.* The line is ignored. Edit the file. Numeric characters, and '-' (minus), '+' (plus), '_' (underscore), ' ' (space), '.' (period) and ',' (comma) are allowed for the data.
- **4-205019 Warning: Illegal string description in data file. Ignored. Line = *Line_No.***

Data file to be loaded was edited or broken. Strings are not enclosed by double quotations ("). The line *Line_No.* is ignored. Edit the file and properly enclose the strings by double quotations.
- **4-205101 Warning: Bad data range for Log scale;*Axis*. Turned off log scale mode.**

Tried to set minimum value or maximum value of X axis or Y axis in log scale to 0 or negative value. Graph scale is set to linear scale automatically. The data must be positive value for log scale.
- **4-205102 Warning: Bad data for Log scale. Turned off log scale mode.**

Tried to set X-axis data or Y-axis data in log scale to negative value. Graph scale is set to linear scale automatically. The data must be positive value for log scale.
- **4-205103 Warning: Bad range for scale. Set previous value.**

Difference between maximum value and minimum value of the graph is almost 0. Minimum value and maximum value are set to the previous values automatically. Specify a bigger difference.
- **4-205112 Warning: No Y data. Cannot plot any data.**

Data file to be loaded was edited or broken. Internal error. Y vector data does not exist although X vector data exists. Graph does not plot any data. Create one Y vector data at least.
- **4-211000 Can't open file.**

Error occurred during loading/saving the IDP data file. The data file is not loaded/saved. Confirm that the directory for the data file exists, and the permission of the directory and the data file.
- **4-211001 Can't write file.**

Error occurred while saving the IDP data file. The data file is not saved. Confirm that there is sufficient free disk space. Prepare approximately 10 KByte for one IDP data file.
- **4-211002 Can't read file.**

Size of the data file is less than the size of IDP data file. The data file is not loaded. Specify the IDP data file name properly. If the file was edited, the file cannot be loaded.

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- **4-211003 Saving to a file is not allowed when some resource fields are modified.**

Tried to save the IDP data file before setup was completed (clicking **Set** button) on the IDP window. The data file is not saved. Close the Save Dialog and click **Set** button. Then save the data file.

- **4-211004 File format revision mismatch. Can't read the file.**

Tried to load data file, but did not match the IDP data format. The data file is not loaded. Specify the file name of the IDP data. If the IDP data file was edited and changes made, the data file cannot be loaded.

- **4-211005 Can't close the resource display when some resource fields are modified.**

Tried to delete a resource from the Resource Selection dialog before setup for the resource was completed (clicking **Set** button) on the IDP window. The resource is not deleted from the Resource Selection dialog. Close the Resource Selection dialog, click **Set** button. Then delete the resource from the Resource Selection dialog.

- **4-211006 Can't open last measurement data. *Test_name* doesn't create array data.**

4-211007 Can't open last measurement data. No measurement has been performed.

4-211008 Can't open last measurement data. There is no measurement data. The measurement might have been executed on offline system.

Data on the Graph window does not change. Before choosing File: Open Last Test menu, you must execute measurement that makes array data.

File: Open Last Test menu on the Graph window is used to display array data that was measured in the On-line mode.

- **4-212001 Cannot create measurement blocks.**

Number of measurement data exceeds the maximum number. Measurement block is not created. Clear the data loaded on the Graph.

- **4-212002 Cannot create vector data blocks.**

Tried to load data file that was edited or broken. Internal error. Number of data for vector data is zero, negative number, or exceeds the maximum number. No action.

- **4-212003 Cannot allocate data.**

Tried to load data file that was edited or broken. Internal error. Tried to create data with negative number or over the maximum number.

- **4-215100 Error: Data block index value must be 1 to 7.**

Tried to load data file that was edited or broken. Internal error. Data block index value must be 1 to 7.

- **4-215150 Error: Bad file name: May be too long file name or no suffix; *File_name*.**

Name of file to load is too long or no suffix. The file is not loaded. Enter the proper name for the file on the Load dialog, and try to load the file again.

- **4-215151 Error: Bad file suffix.**

Suffix of the file name entered is not '.dpg' or '.dps'. The file is not loaded. Enter the proper name for the file in the Load Dialog, and try to load the file again.

- **4-215152 Error: Bad file type; not an ordinary file.**

File is not ASCII file. The file is not loaded. Enter the proper name for the file in the Load Dialog, and try to load the file again.

- **4-215155 Error: Too long file path name. Maximum 1018 characters.**

File name over 1018 characters was entered. The file is not saved. Use file name with 1018 or less characters and try to save the file again.

- **4-215156 Error: Specified path name is too long. Only the leading 1023 characters are used.**
Path name over 1023 characters was entered. The file is not saved. Use path name with 1023 or less characters and try to save the file again.
- **4-215301 Error: Syntax error in dump command; *Command*.**
Syntax error occurred in dump command. Enter the proper command for dump/print.
- **4-215303 Error: Cannot generate PostScript code.**
Temporary PostScript file could not be created. Secure enough free disk space for temporary file.
- **4-225001 System Error: Cannot open data file; *File_name*.**
Specified data file does not exist, improper directory is specified, or temporary file for dump cannot be created. Check the name of data file, or permission of the file and directory. Or secure enough free disk space for temporary file.

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- **5-10001 Cannot make connection with TIS Daemon. No session or environment variable PCS_SESSION_ID is not properly set.**

Execute hp4070 -login command. Or confirm the setting of the environmental variable PCS_SESSION_ID.

- **5-10002 Cannot allocate memory. Please quit and try again.**

To allocate memory, stop the action and try it again.

- **5-10003 Environmental variable: PCS_SESSION_ID is not set.**

Quit from the 4070 operating environment, set PCS_SESSION_ID, and then log in again.

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- **6-20001 Cannot translate 4062 port address into 4070 port address.**

Specified port address for the 4062 could not be translated to the 4070 port address. Check the port address, and specify the correct port address.
- **6-20002 Invalid port is assigned.**

Specified port address is not correct. Confirm the port address.
- **6-20003 Invalid pin is assigned.**

Specified pin number is not correct. Confirm the pin number.
- **6-20004 [F_ROM] Pin number must be 0 to 48.**

Pin number must be 0 to 48. Enter a valid value.
- **6-20005 Specified pin board is defective or not installed.**

Pin board for the specified pin number is not installed or defective. Confirm the pin board configuration. hp4070 -login command displays the 4070 system configuration.
- **6-20006 From_pin is out of range.**

Pin number assigned for the *first pin* parameter of the *Connect_th* command is not correct. Confirm the pin number.
- **6-20007 To_pin is out of range.**

Pin number assigned for the *last pin* parameter of the *Connect_th* command is not correct. Confirm the pin number.
- **6-20008 1st parameter must be 1 (connect) or 0 (disconnect).**

Wrong value was specified for the first parameter of *Tap_port* command. The value must be 0 (disconnect) or 1 (connect). Check the value and specify the proper value.
- **6-20009 2nd parameter must be port address of SMU/AUX port 1 or 2.**

Wrong value was specified for the second parameter of *Tap_port* command. The value must be the port address of SMU port 1 or 2, or AUX port 1 or 2. Check the value and specify the proper value.
- **6-20010 3rd parameter must be port address of SMU/AUX port 1 or 2.**

Wrong value was specified for the third parameter of *Tap_port* command. The value must be the port address of SMU port 1 or 2, or AUX port 1 or 2. Check the value and specify the proper value.
- **6-20011 Improper SMU voltage range specified.**

Voltage range setting for SMU is not correct. Check the value of the output voltage and the voltage range, and specify the proper value.
- **6-20012 Improper SMU voltage source, voltage output range, or compliance specified.**

Output voltage value, voltage output range, or current compliance value are not correct. Verify the values of output voltage, voltage output range, and current compliance and then specify the correct value.
- **6-20013 Improper SMU current range specified.**

Current range setting of SMU is not correct. Check the value of the output current and the current range, and specify the proper value.

- **6-20014 Improper SMU current source or compliance specified.**

Value of output current or voltage compliance is not correct. Check the value of output current and voltage compliance, and specify the proper value.
- **6-20015 Specified SMU is defective or not installed.**

Specified SMU board is not installed or defective. Confirm the SMU configuration. `hp4070 -login` command displays the 4070 system configuration.
- **6-20016 Source pin must be connected to an SMU.**

Specified pin board is not connected to SMU. Check the measurement program. The program must have a program line that connects the SMU to the pin board *before* the program line that forces the output of the SMU specified by the pin number.
- **6-20017 Source port must be an SMU or a pin connected to an SMU.**

Source port address used in the `Force_meas` command is not correct. Source port address must be SMU port address or the pin number of the pin board connected to the SMU. Check the port address and specify the proper value.
- **6-20018 Measure pin must be connected to an SMU.**

Specified pin board is not connected to SMU. Check the measurement program. The program must have a program line that connects the SMU to the pin board *before* the program line that performs measurement using the SMU specified by the pin number.
- **6-20019 Measure port must be an SMU or a pin connected to an SMU.**

Measurement port address is not correct. Measurement port address must be SMU port address or the pin number of the pin board connected to the SMU. Check the port address and specify the proper value.
- **6-20020 3rd parameter must be 1 (voltage source) or 2 (current source).**

Wrong value was specified for the third parameter of `Force_meas` command. The value must be 1 (voltage source) or 2 (current source). Check the value and specify the proper value.
- **6-20021 Wait time must be 0 to 655.35 sec.**

Specified value for the wait time is out of range. The value must be 0 to 655.35 seconds. Check the value and specify the proper value.
- **6-20022 Hold time must be 0 to 655.35 sec.**

Specified value for the hold time is out of range. Available value for the hold time is 0 to 655.35 sec. Check the value and specify the proper value.
- **6-20023 Port must be CMH when forcing voltage on CMU.**

Invalid port was specified for the `Force_v` command. When setting the dc bias of CMU, the CMH port address must be specified. Check the port address and specify the correct port.
- **6-20024 Wait time must be 0 to 655.35 sec.**

Wait time value is not correct. Available value for the wait time is 0 to 655.35 sec. Check the value and specify the proper value.
- **6-20025 Size of port array must be greater than or equal to 1.**

No port is defined for the array used to specify the multiple ports. Check the value and size of the array, and define the array properly.

- **6-20026 1st parameter must be an SMU port address or a pin connected to an SMU.**

Wrong value was specified for the first parameter of the `Stand_by_port` command. The value must be the SMU port address or the pin number of the pin board connected to the SMU. Check the value and specify the value properly.
- **6-20027 2nd parameter must be an SMU port address or a pin connected to an SMU.**

Wrong value was specified for the second parameter of the `Stand_by_port` command. The value must be the SMU port address or the pin number of the pin board connected to the SMU. Check the value and specify the value properly.
- **6-20028 3rd parameter must be an SMU port address or a pin connected to an SMU.**

Wrong value was specified for the third parameter of the `Stand_by_port` command. The value must be the SMU port address or the pin number of the pin board connected to the SMU. Check the value and specify the value properly.
- **6-20029 Nth parameter must be an SMU port address or a pin connected to an SMU.**

Wrong value was specified for the `Nth` parameter of the `Stand_by_port` command. The value must be the SMU port address or the pin number of the pin board connected to the SMU. Check the value and specify the value properly.
- **6-20030 Cannot connect Extended I/O port to the Chuck terminal.**

Cannot specify Extended Path port for the `Connect_chuck` command. Specify an SMU, GNDU, or AUX port address for the `Connect_chuck` command.
- **6-20031 Ports must be SMU or CMU.**

Invalid port was specified for the `Disable_port` command. Must specify an SMU or CMU port address, or the pin number of a pin board connected to the SMU or CMU. Check the port value and specify the port properly.
- **6-20032 Adc must be 0 (ADC_PERCH) or 1 (ADC_REF).**

Wrong value was specified for the parameter to select ADC. The value must be 0 (high-speed ADC) or 1 (high-resolution ADC). Check the value and specify the value properly.
- **6-20033 Filter must be 0 (FILTER_OFF) or 1 (FILTER_ON).**

Wrong value was specified for the parameter to select SMU filter status. The value must be 0 (filter off) or 1 (filter on). Check the value and specify the value properly.
- **6-20034 Wait time ratio must be 0.0 to 10.0.**

Wrong value was defined for the wait time factor. The value must be 0 to 10. Check the value and specify the value properly.
- **6-20035 Integration time mode setting must be 0, 1, 2, or 3.**

Wrong value was specified for the mode parameter of the `Set_smu` or the `Set_adc` command. The value must be 0 (manual), 1 (short), 2 (medium) or 3 (long). Check the value and specify the proper value.
- **6-20036 Averaging or integration time is out of range.**

Wrong value was specified for the integration time or averaging parameter of the `Set_adc` or the `Set_smu` command, or the integration time parameter of the `Set_adc3458` command. Check the value and specify the proper value.

- **6-20037 Autozero must be 0 (AUTOZERO_OFF) or 1 (AUTOZERO_ON).**

Wrong value was specified for the auto zero parameter of the `Set_adc` or the `Set_adc3458` command. The value must be 0 (auto zero off) or 1 (auto zero on). Check the value and specify the proper value.
- **6-20038 Port must be an SMU or a pin connected to an SMU.**

Port address setting is not correct. The port address must be the SMU port address or the pin number of the pin board connected to the SMU. Check the value and specify the proper value.
- **6-20039 Port must be an SMU or a pin connected to an SMU.**

Port address setting is not correct. The port address must be the SMU port address or the pin number of the pin board connected to the SMU. Check the value and specify the proper value.
- **6-20040 Search mode must be 0 to 15 for `Set_bsearch`, 0 to 11 for `Set_lsearch`.**

Wrong value was specified for the search mode parameter of the `Set_lsearch` or the `Set_bsearch` command. The search mode value for the `Set_lsearch` must be 0 to 11, and the value for the `Set_bsearch` must be 0 to 15.
- **6-20041 Upper search boundary is equal to lower search boundary.**

Same value was set for the start/stop parameters of the `Set_lsearch` command or the min/max parameters of the `Set_bsearch` command. Start (or min) value must be different from the stop (or max) value.
- **6-20042 Step value must be greater than 0 for `Set_lsearch` or `Set_bdv_search`.**

Wrong value was specified for the step parameter for the `Set_lsearch` or the `Set_bdv_search` command. The value must be greater than 0.
- **6-20043 Target value must be less than measurement compliance.**

Too large value was specified for the target parameter of the `Set_lsearch` or the `Set_bsearch` command. The value must be less than the value of the compliance parameter.
- **6-20044 Convergence condition in Accuracy mode must be 0 to 100.**

Value of the convergence condition parameter of the `Set_bsearch` command in the Accuracy mode is out of range. The value must be 0 to 100.
- **6-20045 Convergence condition in Times mode must be 0 to 16.**

Value of the convergence condition parameter of the `Set_bsearch` command in the Times mode is out of range. The value must be 1 to 16.
- **6-20046 Delay time must be 0 to 65.535 sec.**

Setting value of the delay time is out of range. The value must be 0 to 65.535 sec. Check the value and specify the proper value.
- **6-20047 Skip_back value must be 0 to 100.**

Wrong value was specified for the skip back parameter of the `Set_lsearch` command. The value must be 0 to 100.
- **6-20048 `Set_skip` may not be used with `Set_bsearch` or `Set_bdv_search`.**

Cannot use the `set_skip` command with the `set_bsearch` or the `Set_bdv_search` function in C language programming environment. Use the `set_skip` command with the `set_lsearch`.

- **6-20049 Set_bsearch or Set_lsearch is not called before Search is called.**

Before executing Search command, the Set_lsearch or the Set_bsearch command must be executed to define the search measurement setup. The setup defined by the Set_lsearch or the Set_bsearch command is canceled by the Init_system command.
- **6-20050 Compliance mode is not available for voltage measurement of Set_lsearch.**

For the search mode 8 to 11 (compliance mode) of the Set_lsearch command, the output mode of sense port SMU must be set to VF (voltage force) mode. Before executing the Set_lsearch command, enter statement (for example, Force_v) to set the SMU output mode to VF mode.
- **6-20051 Sweep mode setting must be -4 to 4 (integer).**

Improper sweep mode was specified for the Set_iv or the Set_piv command. The value must be -4 (Current, log, double), -3 (Voltage, log, double), -2 (Current, log, single), -1 (Voltage, log, single), 1 (Voltage, linear, single), 2 (Current, linear, single), 3 (Voltage, linear, double), or 4 (Current, linear, double). Check the sweep mode setting and set the proper mode.
- **6-20052 Number of steps must be 2 to 1001.**

Improper number of steps was specified for the Set_iv or the Set_piv command. Value must be 2 to 1001. Check the value and set the proper value.
- **6-20053 Improper power compliance is specified.**

Setting of the power compliance is out of range. Check the value and set the proper value.
- **6-20054 Sweep stop mode must be 1 (continue on error) or 2 (stop on error).**

Improper stop mode was specified for the sweep measurement command. The value must be 1 (continue on error) or 2 (stop on error). Check the setting and set the proper value.
- **6-20056 Measurement mode must be 1 (voltage) or 2 (current).**

Improper measurement mode was specified for the Sweep_iv or the Rsweep_iv command. The value must be 1 (voltage measurement mode) or 2 (current measurement mode).
- **6-20057 Start and stop values have different polarity.**

In the logarithmic sweep measurement mode, polarity of the start and stop value must be the same.
- **6-20058 Hold time must be 0 to 655.35 sec.**

Setting of hold time is wrong. The value must be 0 to 655.35.
- **6-20059 Difference of start and stop must be greater than Voltage**

For the Set_bdv command, the difference between the *start* value and the *stop* value must be 10 V or more.

For the Set_ileak command, the difference between the *output voltage* value and the *start* value must be 10 V or more.
- **6-20060 Detection interval mode must be 0 (short) or 1 (long).**

Improper *detection interval* was specified for the Measure_bdv or the Measure_ileak command. The value must be 0 (short mode) or 1 (long mode).
- **6-20061 Skip value must be 1 to 20000.**

Improper *skip* value was specified for the Set_lsearch command. The value must be 1 to 20000.

- **6-20062 Target value must be less than the sense port compliance.**

Improper target value was specified for the `Set_lsearch` command. The value must be less than compliance of sense port.
- **6-20063 Sync port must have the same V/I output mode as the control variable.**

SMU output mode of the sync SMU defined for the `Set_sync` command must be the same output mode of the search SMU defined for the `Set_bsearch` or the `Set_lsearch` command. Set the SMU output mode of the sync SMU by entering the `Force_v` or the `Force_i` command before entering the `Set_sync` command.

The `Force_v` command is used to set the voltage output mode, and the `Force_i` command is used to set the current output mode.
- **6-20064 Improper synchronous search offset value is specified.**

Offset value of the `Set_sync` command is out of range. Or the offset value is not correct for the settings of the start/stop values of the `Set_lsearch` command or the min/max values of the `Set_bsearch` command. Set the proper value.
- **6-20066 Offset value of synchronous search port or compliance is improper.**

Sync port SMU output did not match to the compliance value. Check the offset and compliance values of the `Set_sync` command, and the start/stop values of the `Set_lsearch` command or the min/max values of the `Set_bsearch` command, and set the proper value.
- **6-20067 Synchronization polarity mode must be 0 (positive) or 1 (negative).**

Improper synchronization polarity mode was specified for the `Set_sync` command. The value must be 0 (positive sync) or 1 (negative sync).
- **6-20068 Synchronous sweep ratio must be 0.01 to 10.0.**

Improper synchronous sweep ratio value was specified for the `Set_sync` command. The value must be 0.01 to 10.0.
- **6-20069 Improper synchronous sweep offset value specified.**

Improper synchronous sweep offset value was specified for the `Set_sync` command. Check the value and set the proper value.
- **6-20070 Calculated start, stop or compliance of synchronous sweep is improper.**

Sync port SMU output is out of range, or does not match to the compliance value. Check the offset, ratio and compliance values of the `Set_sync` command, or the start/stop values of the command for sweep measurement.
- **6-20071 Measurement mode must be 0 (linear) or 1 (saturation).**

Invalid mode was specified for the `Measure_vth` command. The mode must be 0 (linear region) or 1 (saturation region).
- **6-20072 Number of points must be 2 to 20.**

Invalid number of points was specified for the `Measure_vth` command. The number of points must be 2 to 20.
- **6-20073 Compliance must be specified when SMU V/I output mode is changed.**

In the optimization level is 2 or 3, compliance value cannot be omitted for a command (`Force_v`, `Force_i`, etc.) that changes the SMU output mode. Confirm the optimization level and set the compliance value properly.

- **6-20074 Invalid pin number specified for Hpin.**

Invalid pin number was specified for the CMU high port of the `Corr_cmu` command. Check the pin number and set the correct number.
- **6-20075 Invalid pin number specified for Lpin.**

Invalid pin number was specified for the CMU low port of `Corr_cmu` command. Check the pin number and set the correct number.
- **6-20076 C Compensation file is not loaded.**

TIS command requires that capacitance compensation was executed before loading the capacitance compensation data file. Check `/etc/opt/hp4070/ccdata` file and `/etc/opt/hp4070/ccdata0` file, and the permission of the files.
- **6-20077 Cp should not be 0.**

Cp value of the `Conv_mode` command was set to zero. Cp value must not be zero.
- **6-20078 Proper sweep measurement is not done.**

`Status_miv` command could not read the measurement status of the last sweep measurement. Sweep measurement was not done properly. Check the measurement program. Or sweep measurement may be now in progress.
- **6-20079 Current is too large.**

Too large current value was set for the `Set_bdv` command. Set the proper value.
- **6-20080 Vg_start and Vg_stop should not be same.**

Same value was set for gate start and stop voltages of the `Set_vth` command. The same value cannot be set for these parameters. Set the values properly.
- **6-20081 Gate step voltage value must be greater than 0 V.**

Gate step voltage must be greater than 0 V for the `Set_vth` command. Set the value correctly.
- **6-20082 Id_start must be less than measurement port compliance.**

`Drain_search_start` current of the `Set_vth` command must be less than the compliance value of the measurement port. Set the value properly.
- **6-20083 Delay time must be 0 to 65.535 sec.**

Delay time value of the `Set_vth` command is out of range. Value must be 0 to 65.535 seconds. Set the value properly.
- **6-20084 Vg Skip_back value must be 0 to 100.**

Vg Skip_back value of the `Set_vth` command is out of range. Value must be 0 to 100. Set the value properly.
- **6-20085 Vg Skip value must be 1 to 20000.**

Vg Skip value of the `Set_vth` command is out of range. Value must be 1 to 20000. Set the value properly.
- **6-20086 Id_start value must be -0.1 to 0.1 A.**

Drain start current value of the `Set_vth` command is out of range. Value must be -0.1 to 0.1 A. Set the value properly.

- **6-20090 Sweep_miv or Rsweep_miv can be used with Set_iv, not Set_piv.**
Sweep_miv and Rsweep_miv commands for the multi-channel sweep measurement can only be used for sweep that was set up by the Set_iv command. The commands cannot be used with pulsed sweep, which is set up by the Set_piv command. Check and change the program.
- **6-20100 Measurement port is not connected to any pins.**
Measurement SMU port is not connected to any pin board. Connect the SMU to the measurement pin.
- **6-20101 Sweep port is not connected to any pins.**
Sweep measurement SMU port is not connected to any pin board. Connect the SMU to the measurement pin.
- **6-20102 The synchronous sweep port is not set up.**
An array was specified in the Sweep_miv command for returning source values of synchronous sweep port, but synchronous port was not set up. Either delete the array name from the Sweep_miv or set up synchronous sweep port by using the Set_sync.
- **6-20103 The synchronous sweep port is not connected to any pins.**
Synchronous sweep port is not connected to any pin board. Connect the SMU to the measurement pin.
- **6-20120 Force mode must be 1 (voltage force) or 2 (current force).**
Improper mode was specified for the force mode of the Set_pbias command. The value must be 1 (voltage force) or 2 (current force).
- **6-20121 Pulse sweep mode setting must be -4 to 4 (integer).**
Improper pulse sweep mode was specified for the Set_piv command. The value must be 1 (linear voltage), 2 (linear current), 3 (linear voltage double), 4 (linear current double), -1 (logarithmic voltage), -2 (logarithmic current), -3 (logarithmic voltage double), or -4 (logarithmic current double).
- **6-20122 Measurement mode must be 1 (voltage) or 2 (current).**
Improper measurement mode was specified for the Measure_p command. The value must be 1 (voltage measurement) or 2 (current measurement).
- **6-20123 Peak and base current must have the same polarity.**
For current, the pulse base and pulse peak values must be the same polarity for the Set_pbias command. Check the values and set the proper values.
- **6-20124 Peak, start and stop current must have the same polarity.**
For current, pulse base, start value, and stop value must be the same polarity for the Set_piv command. Check the values and set the proper values.
- **6-20125 Width value must be 0.0005 to 2 sec.**
Pulse width value is out of range. Value must be 0.0005 to 2 sec with 0.0001 sec resolution. Set the correct value.
- **6-20126 Period value must be 0.005 to 5 sec.**
Pulse period value is out of range. Value must be 0.005 to 5 sec with 0.0001 sec resolution. Set the correct value.
- **6-20128 Period value must be greater than width + 2ms.**
Pulse period value must be greater than pulse width + 2 ms. Set the pulse period or pulse width value correctly.

- **6-20200 Set_pbias must be executed before Measure_p.**
No setup for the Measure_p command. Execute the Set_pbias command before executing the Measure_P command.
- **6-20201 Set_iv or Set_piv must be executed before Sweep_iv.**
No setup for the Sweep_iv command. Execute the Set_iv or the Set_piv command before executing the Sweep_iv command.
- **6-20202 No measurement to stop by Rsweep_stop.**
No real time sweep measurement to stop. Rsweep_stop is used for stopping *real-time* sweep measurements only.
- **6-20203 Set_iv or Set_piv must be executed before Rsweep_iv.**
No setup for the Rsweep_iv command. Execute the Set_iv or the Set_piv command before executing the Rsweep_iv command.
- **6-20204 Set_iv must be executed before Rsweep_miv.**
No setup for the Rsweep_miv command. Execute the Set_iv command before executing the Rsweep_miv command.
- **6-20205 Set_iv must be executed before Sweep_miv.**
No setup for the Sweep_miv command. Execute the Set_iv command before executing the Sweep_miv command.
- **6-20206 Set_lsearch, Set_bsearch, or Set_bdv_search must be executed before Search or Search_iv.**
No setup for the Search or the Search_iv command. Execute the Set_lsearch, Set_bsearch, or Set_bdv_search command before executing the Search or the Search_iv.
- **6-20207 Synchronous port must be different from the primary sweep port.**
Must use different SMU ports for the primary sweep port and synchronous port.
- **6-20208 Synchronous port must be different from the primary search port.**
Must use different SMU ports for the primary search port and synchronous port.
- **6-20209 No sweep or search setup was set before Set_sync.**
No setup for the Set_sync command. Execute the Set_iv, the Set_piv, the Set_bsearch, or the Set_lsearch command before executing the Set_sync command.
- **6-20210 Set_bdv must be executed before Measure_bdv.**
No setup for the Measure_bdv command. Execute the Set_bdv command before executing the Measure_bdv command.
- **6-20211 Set_ileak must be executed before Measure_ileak.**
No setup for the Measure_ileak command. Execute the Set_ileak command before executing the Measure_ileak command.
- **6-20212 Set_lsearch, Set_bsearch, or Set_bdv_search must be executed before Rsearch or Rsearch_iv.**
No setup for the Rsearch or the Rsearch_iv command. Execute the Set_lsearch, the Set_bsearch, or the Set_bdv_search command before executing the Rsearch or the Rsearch_iv.

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- **6-20213 No measurement to stop by Rsearch_stop.**

No real time search measurement to stop. `Rsearch_stop` is used for stopping *real-time* search measurements only.
- **6-20214 Set_vth must be executed before Measure_vth.**

No setup for the `Measure_vth` command. Execute the `Set_vth` command before executing the `Measure_vth` command.
- **6-20215 Synchronous port must be different from the pulse bias port.**

Must use different SMU ports for the pulse bias port and synchronous port.
- **6-20216 Pulse bias port must be different from the Synchronous port.**

Must use different SMU ports for the synchronous port and the pulse bias port.
- **6-20220 Cannot call Status_miv during a sweep measurement.**

Cannot execute the `Status_miv` command while *real-time* sweep measurement is executing.
- **6-20221 Fine search start current value must be smaller than breakdown current value.**

The current value for fine search start must be smaller than the breakdown current value which sets compliance of an SMU in the `Set_bdv_search` command.
- **6-20222 Fine search start current and breakdown current must have the same polarity.**

The setup current values for fine search start and breakdown current must be the same polarity for the `Set_bdv_search` command. Check the polarity and set the correct values.
- **6-20223 Cannot omit fine search start parameter.**

Fine search start value must be specified when the skip parameter value is greater than 1 for the `Set_bdv_search` command.
- **6-20224 Compliance check delay time must be 0 to 65.535 sec.**

Setting value for compliance check delay is out of range. The value must be 0 to 65.535 sec. Check the value and specify it correctly.
- **6-20301 Invalid mode number specified.**

Mode number specified in the `Set_rangemode` is incorrect. The mode number must be 0 or 1.
- **6-20402 Integration time mode setting must be 0, 1, 2, 3, or 4.**

Integration time mode setting must be 0, 1, 2, 3, or 4. Enter a valid value.
- **6-20403 Must specify integration time mode setting for higher current range (0, 1, 2, 3, or 4).**

The integration time mode is not set for the higher current range. You must specify the integration time.
- **6-21001 Specified pin is not connected to any ports.**

Pins specified by the `Disable_port` command are not connected to any port. Specify the pin number of a pin board that is connected to a port.
- **6-21002 SMU output voltage incompatible with set voltage range.**

Wrong value was set for the SMU output voltage and voltage range. Set the values properly.
- **6-21003 SMU output current incompatible with set current range.**

Wrong value was set for the SMU output current and current range. Set the values properly.

- **6-22001 CMU bias voltage must be -40 to 40 Vdc.**
Wrong value was specified for the bias voltage of CMU. The value must be 0 to ± 40 Vdc for 4284A equipped with option 001.
- **6-22002 CMU bias voltage must be -2, -1.5, 0, 1.5, or 2 Vdc.**
Wrong value was specified for the bias voltage of CMU. The value must be 0, ± 1.5 , or ± 2 Vdc for 4284A without option 001.
- **6-22003 CMU integration time mode setting must be 1, 2, or 3.**
Invalid parameter was set for the integration time of the `Set_cm84` command. The value must be 1 (short), 2 (medium) or 3 (long).
- **6-22004 CMU signal level must be 0.005 V or more.**
Too small value was set for the signal level by the `Set_cm84` command. The value must be greater than 0.005 V.
- **6-22005 CMU signal level must be 20.0 V or less.**
Too large value was set for the signal level by the `Set_cm84` command. The value must be 20 V or less for 4284A equipped with option 001.
- **6-22006 CMU signal level must be 2.0 V or less.**
Too large value was set for the signal level by the `Set_cm84` command. The value must be 2 V or less for 4284A without option 001.
- **6-22007 CMU frequency must be 19.8 Hz or more.**
Too small value was set for the measurement frequency of CMU. The value must be 19.8 Hz or more.
- **6-22008 CMU frequency must be 1 MHz or less.**
Too large value was set for the measurement frequency of CMU. The value must be 1 MHz or less.
- **6-22009 CMU is defective or not installed.**
CMU (4284A) is not installed in the 4070, or may be defective. Execute `hp4070 -login` command and check the configuration of the 4070. If necessary, do the diagnostics.
- **6-22010 There is no capacitance and conductance data in buffer.**
Capacitance/conductance measurement was not executed properly. CMU (4284A) may be defective. Do the diagnostics.
- **6-22011 Set_cv84 must be executed before Sweep_cv84.**
No setup for the `Sweep_cv84` command. Execute the `Set_cv84` command before executing the `Sweep_cv84` command.
- **6-22012 Number of C-V sweep steps must be 2 to 1001.**
Number of steps for the `Set_cv84` command is out of range. The value must be 2 to 1001.
- **6-22013 Hold time and delay time must be 0.0 to 650.0 sec.**
Hold time or delay time value of the `Set_cv84` command is out of range. The value must be 0.0 to 650.0.
- **6-22014 4284A option 001 is not present.**
C-V sweep measurement needs 4284A equipped with the option 001. Execute `hp4070 -login` command and check the configuration of the 4070.

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- **6-23001 DVM is defective or not installed.**

DVM (3458A) is not installed in the 4070, or may be defective. Execute `hp4070 -login` command and check the configuration of the 4070. If necessary, do the diagnostics.

- **6-23002 DVM is not set to DC voltage measurement mode.**

DVM (3458A) is not in the dc voltage measurement mode. Set the mode correctly using front panel or GPIB command. Or DVM may be defective. If necessary, do the diagnostics.

- **6-23003 DVM GPIB address is not set or invalid.**

`Address3458` command was executed even though the DVM (3458A) is not installed in the 4070. Confirm the measurement program.

- **6-23100 Failed to call `igpibusstatus()`.**

GPIB interface card may be defective.

- **6-24001 Testhead Power Fail state.**

Testhead is turned off. Turn on the testhead. If testhead cannot turn on, check the testhead power supply.

- **6-24002 Testhead Emergency state.**

Testhead is in the emergency status. Do the diagnostics.

- **6-25000 *Command* is UNSUPPORTED.**

The 4070 system software does not support the command specified by *Command*. Do not use *Command*.

- **6-25001 Improper PGU unit address Address. Enter correct value.**

The available value depends on the configuration of the PGUs. To get the unit address from the port number, use `FNPort` or `PORT`.

- **6-25002 No PGU on the unit address. Enter correct value or check PGU.**

There is no PGU on the unit address you specified, or the PGU is defective. Confirm the unit address and enter a valid value. Verify the PGU is operating correctly.

- **6-25003 Must specify unit address of PGU disconnected from testhead.**

You must specify the unit address of the PGU disconnected from the testhead. Execute `pgconn4070` and verify that the value in the PG connection file matches the actual PGU connection, then specify the unit address of the PGU disconnected from the testhead.

- **6-25004 Pin number must be 1 to 24 for the HF port. Enter correct value.**

An invalid pin number was entered. Pin numbers 1 to 24 are available for the HF port you specified.

- **6-25005 Pin number must be 25 to 48 for the HF port. Enter correct value.**

An invalid pin number was entered. Pin numbers 25 to 48 are available for the HF port you specified.

- **6-25006 Pin number must be 1 to 48 for the THF port. Enter correct value.**

An invalid pin number was entered. Pin numbers 1 to 48 are available for the THF port you specified.

- **6-25007 Port address must be 20201 to 20206, or 20211 to 20213.**

An invalid port address was entered. Addresses 20201 to 20206 are available for the HF port, and addresses 20211 to 20213 are available for the THF port. Enter a valid port address.

- **6-25008 Must specify the port connected to the PGU.**

You must specify the port connected to the PGU. Execute `pgconn4070` and verify that the value in the PG connection file matches the actual PGU connection, then specify the port connected to the PGU.
- **6-25009 Only CH1 is available for the PGU in 3-level pulse output mode.**

The PGU specified is in the 3-level pulse output mode. Only CH1 is available for the PGU. Use CH1.
- **6-25010 Only CH1 is available for the PGU in 3-level pulse output mode.**

The PGU specified is in the 3-level pulse output mode. Only CH1 is available for the PGU. Use CH1.
- **6-25011 Improper port address. Enter correct value.**

Improper port address value is specified. You must specify the correct value for port connected to the PGU.
- **6-25012 Mode value must be 0 or 1. Enter correct value.**

`Set_sr_control` TIS error. The mode parameter value must be 0 (independent) or 1 (synchronous).
- **6-25013 Port number must be PSC1, 2, or PSO1 to 5.**

`Set_sr_mode` TIS error. The port address parameter must be PSC1, 2, or PSO2 to 5.
- **6-25014 Mode value must be 0 or 1. Enter correct value.**

`Set_sr_mode` TIS error. The mode parameter value must be 0 (Normally Closed) or 1 (Normally Open).
- **6-25015 Port number must be PGU address, PSC1, 2, or PSO1 to 7.**

`Connect_sr` TIS error. The port address parameter must be PGU address, PSC1, 2, or PSO1 to 7.
- **6-25016 PGU must be connected to the pulse switch control port 1 or 2.**

`Connect_sr` TIS error. When a PGU unit address is specified for the port parameter the PGU must be connected to pulse switch control port 1 or 2. Specify a valid unit address and verify the PGU is connected correctly.
- **6-25017 To use `Connect_sr/Switch_sr`, independent mode must be set by `Set_type_pg`.**

`Set_sr_pg` TIS error. To control switching by using the `Connect_sr` or the `Switch_sr` the mode parameter value must be 1 (independent mode).
- **6-25018 Port address must be HF, THF, AUX, PSI, or PGU address.**

An illegal port address was specified. Port address must be HF, THF, AUX, PSI, or PGU address.
- **6-25019 Must specify the port connected to the PGU.**

You must specify the port connected to the PGU. Execute `pgconn4070` and verify that the value in the PG connection file matches the actual PGU connection, then specify the port connected to the PGU.
- **6-25020 Only CH1 is available for the PGU in 3-level pulse output mode.**

`Set_type_pg` TIS error. The PGU you specified is in the 3-level pulse output mode. Only CH1 is available for the PGU. Use CH1.
- **6-25021 Mode value must be 1 to 3. Enter correct value.**

`Set_type_pg` TIS error. The mode parameter value must be 1 (2-level pulse), 2 (3-level pulse by one PGU), or 3 (3-level pulse by multiplexer). Enter a valid mode value.
- **6-25022 Only CH1 is available for the PGU in 3-level pulse output mode.**

`Set_type_pg` TIS error. Mode=2 is available only for CH1 of the PGU. Use CH1.

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- **6-25023 Mode value must be 1 or 3 for this port.**

Set_type_pg TIS error. For the 8114A pulse generator. Mode 1 (2-level pulse) and 3 (3-level pulse by multiplexer) are available for this port. Enter a valid mode value.

- **6-25024 PGU must have two channels for 3-level pulse output.**

The PGU you specified has only one channel. For 3-level pulse output use a PGU with two output channels.

- **6-25025 Must specify the port connected to the PGU.**

You must specify the port connected to the PGU. Execute pgconn4070 and verify the value in the PG connection file matches the actual PGU connection, then specify the port connected to the PGU.

- **6-25026 Only CH1 is available for the PGU in 3-level pulse output mode.**

Set_level_pg TIS error. The PGU specified is in the 3-level pulse output mode. Only CH1 is available for the PGU. Use CH1.

- **6-25027 Invalid port for using pulse switch.**

Set_level_pg TIS error. The PGU specified is in the 3-level pulse output mode. Pulse switch is available for the port set to the 2-level pulse or 3-level pulse by the multiplexer. Enter a valid port value.

- **6-25028 Port address must be HF, THF, AUX, PSI, or PGU address.**

An improper port address was specified. Port address must be HF, THF, AUX, PSI, or PGU address.

- **6-25029 Must specify the port connected to the PGU.**

You must specify the port connected to the PGU. Execute pgconn4070, and verify the value in the PG connection file matches the actual PGU connection, then specify the port connected to the PGU.

- **6-25030 Only CH1 is available for the PGU in 3-level pulse output mode.**

The PGU specified is in the 3-level pulse output mode. Only CH1 is available for the PGU. Use CH1.

- **6-25031 PGU must have two channels for 3-level pulse output.**

The PGU specified has only one channel. Use a PGU with two output channels for 3-level pulse output.

- **6-25032 Invalid port for using pulse switch.**

Set_time_pg TIS error. The PGU specified is in the 3-level pulse output mode. Pulse switch is available for the port which is set to the 2-level pulse or 3-level pulse by the multiplexer. Enter a a valid port value.

- **6-25033 Specify width2 parameter value.**

Set_time_pg TIS error. A Width2 parameter must be specified. Values from 3.3 nsec to 999 msec, or 10.0 nsec to 900 msec (for the 8114A) are available. See the Set_time_pg command reference for the required parameters.

- **6-25034 Delay2 parameter value must equal width1 plus delay1 or more.**

Set_time_pg TIS error. A Delay2 parameter value must equal width1 plus delay1 or more. Values from 0 to 999 msec, or 0 to 900 msec (for the 8114A) are available.

- **6-25035 Mode value must be 0, 1, or 2. Enter correct value.**

Set_sr_pg TIS error. The mode parameter value must be 0 (reset), 1 (independent), or 2 (synchronous with pulse). Enter a a valid mode value.

- **6-25036 Specify width parameter value, if mode is set to 2.**

Set_sr_pg TIS error. A width parameter must be specified. Values from 2 msec to 999 msec, or 2 msec to 900 msec (for the 8114A) are available. The width parameter is optional if the Set_sr_pg mode parameter is not 2.

- **6-25037 Must specify the PGU connected to the pulse switch control port.**

`Set_sr_pg` TIS error. Connect the PGU to the pulse switch control port correctly and execute `pgconn4070`. Verify the value in the PG connection file matches the actual PGU connection, then specify the PGU connected to the pulse switch control port. See the `Set_sr_pg` command reference for restrictions on the PGU.

- **6-25038 period value too short.**

`Force_pg` and `Prep_pg` TIS error. The period parameter must be more than or equal to the sum of the timing parameters defined by the `Set_time_pg` command. Enter a valid value.

- **6-25039 Cannot execute the TIS during pulse output.**

During pulse output the 4072A reports this error by the TIS which controls the PGU setup or the switching matrix PGU path. The TIS stops the program with this error, and also stops pulse output.

- **6-25040 Count value must be 0 to 10000000.**

`Force_pg` or `Start_pg` TIS error. The count parameter value must be from 0 to 10000000. If the count value is 1 to 10000000, `Force_pg` or `Start_pg` starts the pulse output, and waits for the last count of the pulse. For a count value of 0, the `Force_pg` or `Start_pg` triggers a continuous pulse output and finishes immediately. The pulse output continues until a `Stop_pg` TIS is received. During continuous pulse output the 4072A can receive TIS, but causes error 6-25039. See 6-25039.

- **6-25041 Install or turn on master PG.**

Cannot detect the master PG. Install or turn on the master PG. The master PG is the pulse generator unit which has the PG logical number 1. See the configuration file (`/etc/opt/hp4070/config/1`) to specify the master PG. This file contains the PG name, PG logical number, bus address, and GPIB address.

- **6-25042 Time accuracy mode must be 0 or 1.**

`Set_mode_pg` TIS error. The mode parameter value must be 0 (normal) or 1 (pattern). Mode=1 is not available for the 8114A.

- **6-25043 Define slave #1 PG.**

Pattern mode (`Set_mode_pg, mode=1`) needs slave #1 PG. The slave #1 PG is the pulse generator unit which has the PG logical number 2. Edit the configuration file (`/etc/opt/hp4070/config/1`) and define the slave #1 PG. See 6-25044.

- **6-25044 Install or turn on slave #1 PG.**

Pattern mode (`Set_mode_pg, mode=1`) needs slave #1 PG. Install and turn on the slave #1 PG. See 6-25043.

- **6-25045 For pattern mode, period value must be 120 μ sec or more.**

In the pattern mode (`Set_mode_pg, mode=1`), the period parameter value must be 120 μ sec or more. Enter a valid period value.

- **6-25046 Do not enter `Set_level_pg` for the pulse switch control port.**

You cannot set the pulse output level of the PGU connected to the pulse switch control port. Do not enter `Set_level_pg`.

- **6-25047 Do not enter `Set_type_pg` for the pulse switch control port.**

You cannot set the pulse mode of the PGU connected to the pulse switch control port. Do not enter `Set_type_pg`.

- **6-25048 Must specify the pulse switch control port connected to the PGU.**

You must specify the pulse switch control port connected to the PGU. Execute `pgconn4070` and verify the value in the PG connection file matches the actual PGU connection, then specify the pulse switch control port connected to the PGU.

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- **6-25049 Do not use 8114A as the slave #1 PG.**

When the time accuracy is set to pattern mode (`Set_mode_pg, mode=1`) the 8114A pulse generator cannot be used as slave #1. Use normal mode (`Set_mode_pg, mode=0`), or change the configuration by editing the configuration file `/etc/opt/hp4070/config/1`. See 6-25042 and 6-25043.

- **6-25050 Period value for 8114A must be Max msec or less.**

The period value of the 8114A pulse generator must be Max msec or less. Enter a valid period value.

- **6-25051 Specify period value. The value for 8114A must be Max msec or less.**

The 4072A automatically calculates the period parameter setting for the 8114A pulse generator in the `Force_pg` or the `Prep_pg` command. If this automatically calculated value exceeds Max msec, then you must manually or explicitly specify the period value.

- **6-25052 PGU (N) is defective or not connected. Check PGU and enter correct port.**

You must specify the port connected to the PGU. Specify the correct port, and verify the PGU is installed and working correctly.

- **6-25053 Cannot execute Command Name during pulse output.**

During pulse output, the 4072A causes this error by the TIS which controls the PGU setup or the switching matrix PGU path. The TIS stops the program with this error, and also stops pulse output.

- **6-25054 Output voltage of PGUs connected to PSO N must be same polarity or the difference must be 45 V or less.**

When an 8110A and an 8114A are connected to PSO1, 6, or 7 using a multiplexer switch, the absolute value of the amplitude of the pulses must be 45 V or less. If the amplitude of the pulses must be 45 V the polarity of the pulses must be the same.

- **6-25055 PG Voltage exceeds the limit. Check the PG voltage connected to PSO N.**

When using the 8110A and 8114A with a multiplexer, the signal was not output correctly. Verify that the 8110A and the 8114A are connected to PSO N and that amplitude of the pulse is set correctly. If this does not correct the error, reduce the amplitude of each pulse.

- **6-25056 PGU output voltage exceeds the limit. Check PGXX output amplitude.**

Check the amplitude of the PGXX output. The limit is -19 V. If necessary, reduce the amplitude of the signal. If this does not correct the error, contact the nearest Agilent Technologies Sales and Service office.

- **6-25057 Mode value must be 0 to 2. Enter correct value.**

`Switch_sr` TIS error. Mode must be 0, 1, or 2. Enter a valid mode number.

- **6-25058 Mode value must be 0 to 2. Enter correct value.**

`Connect_sr` TIS error. Mode must be 0, 1, or 2. Enter a valid mode number.

- **6-25059 Port number must be PSC1, 2, or PSO1 to 7.**

`Switch_sr` TIS error. The port address parameter must be PSC1, 2, or PSO1 to 7.

- **6-25501 PG Error.**

An error occurred in the pulse generator unit. The pulse generator will provide detailed error messages.

- **6-25502 PGN pulse level is out of range.**

The pulse level value is out of range. See the `Set_level_pg` command reference for the available range, and then enter a valid range.

- **6-25503 Load impedance value must be 2.5 ohm to 999 kohm.**
The load impedance value must be 2.5 ohm to 999 kohm. Enter a valid impedance value.
- **6-25504 Load impedance value must be 10 ohm to 999 kohm.**
The load impedance value of the 8114A must be 10 ohm to 999 kohm. Enter a valid impedance value.
- **6-25505 *AmpN* value is out of range.**
Set_level_pg TIS error. The *AmpN* parameter value is out of range. See the Set_level_pg command reference for the available range, and then enter a valid value.
- **6-25506 3-level pulse output value (*AmpN*) is out of range.**
Set_level_pg TIS error. The *AmpN* parameter value is out of range for the 3-level pulse output port (Set_type_pg, mode=2). See the Set_level_pg command reference for the available range, and then enter a valid value.
- **6-25507 Sum of 3-level pulse output value is out of range.**
Set_level_pg TIS error. The sum of Amp1 and Amp2 is out of range for the 3-level pulse output port (Set_type_pg, mode=2). See the Set_level_pg command reference for the available range, and enter a valid value.
- **6-25508 Invalid setup combination of Amp and Base.**
Set_level_pg TIS error. Cannot set the pulse level due to an invalid combination of the Amp value and Base value. See the Set_level_pg command reference for the available range, and then enter a valid combination.
- **6-25509 Pulse width (Value) is out of range.**
Set_time_pg TIS error. The width parameter value must be 3.3 nsec to 999 msec, or 10 nsec to 900 msec for the 8114A. Enter a valid range value.
- **6-25510 Delay time (Value) plus skew is out of range.**
Set_time_pg TIS error. The delay parameter value must be 0 to 999 msec, or 0 to 900 msec for 8114A. Enter a valid delay value. The skew between the PG outputs can cause this error.
- **6-25511 Invalid pulse leading time (Value). The value must be 2.0 nsec to 200 msec.**
Set_time_pg TIS error. The leading edge transition time must be 2.0 nsec to 200 msec. Enter a valid transition value.
- **6-25512 Invalid pulse trailing time (Value). The value must be 2.0 nsec to 200 msec.**
Set_time_pg TIS error. The trailing edge transition time must be 2.0 nsec to 200 msec. Enter a valid transition value.
- **6-25513 Leading time and trailing time must be in the same range.**
Set_time_pg TIS error. Both the leading and trailing time must be in the same range. See the Set_time_pg command reference for available ranges and then enter a valid value.
- **6-25514 PG Error. Cannot change arming source.**
Cannot change the arming source. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25515 PG Error. Cannot change pattern mode.**
Cannot change the pattern mode. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.

- **6-25516 PG Error. Cannot measure trigger period.**

The pulse generator cannot measure the trigger period. The trigger cable may be disconnected or defective. Or the PGU may be defective. Verify the trigger cable connection and the operation of the PGU.
- **6-25517 Cannot open file (errno = Error No.): *File_name***

Cannot open the specified file. Check the file name, permission, and so on.
- **6-25518 Cannot write file (errno = Error No.)**

Cannot write the file. Check the file name, permission, and so on.
- **6-25519 Cannot read file (errno = Error No.)**

Cannot read the specified file. Check the file name, permission, and so on.
- **6-25520 PG setup file revision mismatch.**

The PG setup file does not match the present revision.
- **6-25521 Configuration mismatch.**

The current configuration does not match the configuration written in the PG setup file. The PG setup file is the file saved by Save_pg TIS.
- **6-25522 PG (N) Error. No response to combined channel query.**

No response from the PGU for the combined channel query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25523 PG (N) Error. No response to arming source query.**

No response from the PGU for the arming source query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25524 PG (N) Error. No response to period source query.**

No response from the PGU for the period source query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25525 PG (N) Error. No response to trigger count query.**

No response from the PGU for the trigger count query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25526 PG (N) Error. No response to pattern mode query.**

No response from the PGU for the pattern mode query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25527 PG (N) Error. No response to period query.**

No response from the PGU for the period query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25528 PG (N) Error. No response to switch query.**

No response from the PGU for the switch query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25529 PG (N) Error. No response to rload query.**

No response from the PGU for the rload query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.

- **6-25530 PG (N) Error. No response to delay query.**
No response from the PGU for the delay query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25531 PG (N) Error. No response to width query.**
No response from the PGU for the width query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25532 PG (N) Error. No response to leading edge query.**
No response from the PGU for the leading edge query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25533 PG (N) Error. No response to trailing edge query.**
No response from the PGU for the trailing edge query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25534 PG (N) Error. No response to complement query.**
No response from the PGU for the complement query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25535 PG (N) Error. No response to voltage level query.**
No response from the PGU for the voltage level query. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25536 PG Error. Cannot change period source.**
Cannot change period source. The PGU may be defective or it may be a TIS fatal error. Verify the PGU is operating correctly.
- **6-25537 Set_level_pg Amp value is out of range.**
Set_level_pg TIS error. For 8114A pulse generator. The Amp parameter value is out of range. See the Set_level_pg command reference for the available range, and then enter a valid value.
- **6-25538 Can't open file. filename: *File***
Could not open the file specified by *File*. Confirm the file name and permissions of the file.
- **6-25539 Can't load the offline configuration file. File format incorrect.**
Could not read the offline configuration file because the file format is incorrect. Check the format of the file you loaded.
- **6-25540 Can't save the offline configuration file.**
Could not save the offline configuration file. Check the permissions of the file and directory.
- **6-25901 [F_ROM] Port address (Terminal Name) must be unique.**
Each terminal must be set to a unique port address. Set each terminal to a unique port address.
- **6-25902 [F_ROM] Relay mode must be enabled.**
Relay mode must be enabled to use pulse switch. Execute F_set_relay_md(1) to enable the relay mode.
- **6-25903 [F_ROM] Port (Terminal Name) must be connected to pulse switch output.**
A port must be connected to the pulse switch output. Connect the port and specify the correct port.
- **6-25904 [F_ROM] Port (Terminal Name) must be connected to pulse switch output 1, 6, or 7.**

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A port must be connected to the pulse switch output 1, 6, or 7. Connect the port and specify the correct port.

- **6-25905 [F_ROM] Port (Terminal Name) must be connected to pulse switch output 2, 3, 4, or 5.**

A port must be connected to the pulse switch output 2, 3, 4, or 5. Connect the port and specify the correct port.

- **6-25906 Invalid count (Value). The value must be 1 to 1000000000.**

The count parameter value must be 1 to 1000000000. Enter a valid value.

- **6-25907 [F_ROM] PGU (Terminal Name) must be unique.**

Each terminal must be connected to a unique PGU. Connect each terminal to a unique PGU.

- **6-25908 [F_ROM] Invalid port address for Terminal Name.**

`F_set_fport` PARA error. The port address must be 20201 to 20206 for HF port, and 20211 to 20213 for THF port, and 20101 to 20108. Enter a valid port address.

- **6-25909 [F_ROM] Invalid PGU connection for Terminal Name.**

The PGU must be connected to the specified port through the pulse switch. Connect the PGU to the pulse switch input and specify a valid port.

- **6-30002 SMU Calibration Fail.**

SMU failed the calibration. Do the diagnostics, and do troubleshooting.

- **6-30003 Automatic SMU Calibration Fail.**

SMU failed the automatic calibration. Do the diagnostics, and do troubleshooting.

- **6-30004 Automatic SMU Calibration Pass.**

SMU passed the automatic calibration.

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- **7-10001 Power Fail occurred.**
Testhead power fail occurred. Troubleshoot the testhead power supply and the testhead.
- **7-10002 Over Current or Voltage occurred.**
Over current or over voltage occurred in the testhead. Troubleshoot the testhead.
- **7-10003 Fixture is opened.**
Prober/Fixture Sense switch of the testhead is open. Close the sense switch of the testhead.
- **7-10004 Interlock is opened.**
Interlock of the testhead is open. Close the interlock switch of the testhead.
- **7-10005 Illigal Run Mode in Testhead.**
This error occurs if the testhead CPU receives any command when the testhead CPU is rebooting. You do not need to care this error.
- **7-10006 Hardware Status returned to the normal state.**
The 4070 hardware status returned to the normal state. The 4070 can be used normally.

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- **8-10001 Failed to fork TIS Server (errno = *Error_No.*).**

hp4070 command or START program failed to start up the TIS server in fork().

 - ❑ If *Error_No.* is 11: Too many processes are running. Kill unnecessary processes or reconfigure kernel to extend maximum number of processes.
 - ❑ If *Error_No.* is 12: Too small swap space or memory to execute TIS server. Increase the swap space or memory.
- **8-10002 Failed to exec TIS Server (errno = *Error_No.*).**

hp4070 command or START program failed to start up the TIS server in execv().

 - ❑ If *Error_No.* is 13: Check the permission and directory path of tis_online or tis_offline file.
 - ❑ If *Error_No.* is 249: Too many symbolic links are made for directory path of tis_online or tis_offline file.
 - ❑ If *Error_No.* is 8: tis_online or tis_offline file is not set as an executable file. Set the file as an executable file.
 - ❑ If *Error_No.* is 12: Too small memory to execute TIS server.
 - ❑ If *Error_No.* is 26: tis_online or tis_offline file is opened without write protection.
- **8-11001 TIS server died.**

hp4070 -shutdown command was executed, or testhead was turned off. Or fatal error occurred in testhead.
- **8-11002 Inconsistent exception (*Error_No.*).**

TIS server detected illegal error that is not defined as 4070 error condition.
- **8-20001 Invalid parameter.**

Improper command parameter was specified for hp4070 command. Check the parameter.
- **8-20002 Inconsistent parameters.**

Invalid multiple command parameters were specified for hp4070 command. Check the parameter.
- **8-20003 Incomplete parameter specification.**

Command parameter defined for hp4070 command is insufficient. Check the parameters.
- **8-20004 Already logged in.**

You have already logged into the 4070 operating environment.
- **8-20005 No such session (*Error_No.*).**

You have not logged into the 4070 operating environment yet. No session to log out.
- **8-20006 System busy (Used by session: *Session_ID*).**

The 4070 has already been logged into as the on-line mode by another user specified by *Session_ID*. On-line mode allows one user to use the 4070.
- **8-20007 Session ID must be 1 to 999999.**

Improper session ID was specified for the environmental parameter PCS_SESSION_ID. The value must be 1 to 999999.

- **8-20008 Optimization level setting must be 0, 1, 2 or 3.**
Improper value was specified for hp4070 -optimize command. Value must be 0, 1, 2, or 3.
- **8-20009 Too many OFF LINE sessions.**
Too many users logged into the 4070 off-line mode. Maximum 5 users can log into the 4070 off-line mode.
- **8-20010 Invalid unit on port *Port_No.***
Invalid measurement unit is assigned for the 4062 port number *Port_No.* on the port map file. Maybe the port map file was edited incorrectly. Define the port number mapping properly.
- **8-20011 Invalid 4070 port selection on 4062 port *Port_No.***
Improper 4070 port number is assigned for the 4062 port number *Port_No.* on the port map file. Maybe the port map file was edited incorrectly. Define the port number mapping properly.
- **8-20012 Duplicate 4142B slot specification on 4062 port *Port_No.***
Multiple measurement units are assigned for the 4062 *Port_No.* on the port map file. Only one unit must be defined for one port. Define the port number mapping properly.
- **8-20013 41420A SMU is in slot 1 on 4062 port *Port_No.***
Cannot assign the 41420A SMU for 4062 port *Port_No.* on the port map file because the 41420A uses two module slots of the 4142B. Define the port number mapping properly.
- **8-20014 Can't read the port map file. *Reason.***
Port map file could not be read because of the reason shown in *Reason.* Check the file name and the permission of the file and directory.
- **8-20015 Can't load the portmap file. File format incorrect.**
Port map file could not be loaded because the file format is incorrect.
- **8-20016 Can't load the DUMCONFIG file. File format incorrect.**
The 4062UX DUMCONFIG file used for port mapping could not be loaded because the file format is incorrect.
- **8-20017 Can't read the DUMCONFIG file *Reason.***
The 4062UX DUMCONFIG file could not be read because of the reason shown in *Reason.* Check the file name, and the permission of the file and directory.
- **8-20018 Can't save the portmap file. *Reason.***
Port map file could not be saved because of the reason shown in *Reason.* Check the directory name, and the permission of the file and directory.
- **8-21001 Testhead Over Voltage.**
SMU in testhead is over voltage. Testhead is automatically shut down.
- **8-22001 Insufficient args (Something's wrong).**
8-22002 Invalid auto cal interval specified (Something's wrong).
Error occurred in cal4070 command. Internal error.
- **8-22003 Failed at Matrix Mother Board C/G measurement (status: *Status*).**
8-22004 Failed at Matrix Mother Board offset measurement (status: *Status*).
8-22005 Failed at Matrix Mother Board R/L measurement (status: *Status*).
8-22006 Failed at Testhead offset measurement (status: *Status*).
Improper capacitance compensation data was returned by CMU (4284A). Check the measurement cable, or execute the relay test of testhead.

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- **8-22008 Invalid configuration; Pin Board *Pin_No.* is not present.**
8-22009 Invalid configuration; Chuck Connection Pin Board is not present.
 Cannot execute the capacitance compensation measurement, because the pin board specified by *Pin_No.* or the chuck connection pin board is not installed in the testhead, or defective. Check the configuration and install the pin board properly.
- **8-22010 Cannot read the file. The file does not exist or does not have read permission.**
 The specified file cannot be read because the file does not exist or does not have read permission.
- **8-22011 Cannot write the file. The file does not exist. Or the file or the directory does not have write permission.**
 The specified file cannot be written. Because the file does not exist, or the file or specified directory does not have write permission.
- **8-22021 Unable to use the same matrix *Pin_No.* for CMH and CML. Specify different pin number.**
 Unable to measure compensation data for level 2 capacitance measurement because the same matrix pin number shown as *Pin_No.* for CMH and CML is specified. Use a different pin number for each port.
- **8-22022 The specified matrix *Pin_No.* does not exist. Use a valid pin.**
 When executing compensation data measurement for level 2 capacitance measurement, a non-existing matrix pin was specified as *Pin_No.* Check available pins and use a valid pin number.
- **8-22030 Cannot find available SMU.**
 The system cannot find any SMUs to measure the PGU compensation data. To execute the PGU calibration, at least one SMU must be installed. Check the actual SMU configuration.
- **8-22031 Cannot find available Matrix Pin.**
 The system cannot find any pin boards for the PGU calibration. To execute the PGU calibration, at least one pin board must be installed for each matrix block. Check the actual pin board configuration.
- **8-22032 Can't save pg calibration data into "/etc/opt/hp4070/pgcaldata" file.**
 The compensation data cannot be saved in the /etc/opt/hp4070/pgcaldata file. Check the following items:
 - The /etc/opt/hp4070/pgcaldata must exist.
 - The permission, owner, and group of this file must be -rw-r--r--, "root", and "sys", respectively.
- **8-22033 Can't load pg calibration data file "/etc/opt/hp4070/pgcaldata".**
 The cal4070 program cannot load the PGU compensation data correctly because of the wrong data format. Copy the /etc/opt/hp4070/pgcaldata file from the /opt/hp4070/newconfig directory, then execute the cal4070 again.
- **8-22050 Failed at timing calibration *PGnn*. Error: *Error_message***
 The timing calibration for *PGnn* (81110A) from cal4070 program is failed.
- **8-23001 Can't open C compensation data file *File_name* for loading (errno = *Error_No.*).**
 Capacitance compensation data file could not be open because of the reason specified by *Error_No.*
- **8-23002 Can't open C compensation data file *File_name* for saving (errno = *Error_No.*).**
 Capacitance compensation data file could not be saved because of the reason specified by *Error_No.*

- **8-23003 Can't read C compensation data file *File_name* (errno = *Error_No.*).**
Capacitance compensation data file could not be read because of the reason specified by *Error_No.*
- **8-23004 Invalid C compensation data file format.**
Capacitance compensation data file could not be read because of invalid file format. Check the file name.
- **8-23005 C compensation data file does not match the present Pin Board configuration.**
Pin board configuration might be changed. Cannot execute the capacitance compensation properly for the present pin board configuration.
- **8-23501 Cannot find HF Matrix board. Check Port value in PG connection file.**
The HF matrix board is not installed or it is defective. Edit the PG connection file and delete the PG address set to the specified port (Port).
- **8-23502 One PG must be defined for the relative HF and THF ports. Check Port value in PG connection file.**
Different PG addresses are defined for the relative HF and THF ports. A single PG address must be defined for the ports. Edit the PG connection file and set a single PG or PSO address, or delete the address set to the specified port (Port).
- **8-23503 Invalid PG connection data on Port. Specified PG or PSO does not exist.**
An invalid PG or PSO address is defined in the PG connection file. Set the available PG or PSO address to the specified port (Port).
- **8-23504 Cannot find Pulse Switch Block N. Check Port value in PG connection file.**
Pulse switch block 1 or 2 is not installed or is defective. Edit the PG connection file and delete the PG address set to the specified port (Port) and to port PS11/2/3/4 or PS15/6/7.
- **8-23505 Invalid parameter for pgconn4070.**
An invalid parameter was set for the pgconn4070 command execution. Set the parameter properly or execute pgconn4070 with no parameter.
- **8-23506 Syntax error in dump command.**
An improper command is entered in the print dialog box. Enter the proper command.
- **8-23507 Cannot search connection for OFF LINE session.**
Actual PG connection cannot be searched for offline session.
- **8-32002 File already exists. OK to overwrite the file?**
The file name you specified already exists. Click OK to overwrite the file. Click No to cancel.
- **8-24001 Usage: *Parameter***
Improper command parameter was specified for the `setlf` command. Specify the command parameter properly.
- **8-24002 Can't open Optical Interface device file (*Reason*).**
Failed to open the optical interface device file by `setlf` command because of the reason shown in *Reason*.
- **8-24003 Can't open Optical Interface device file (*Reason*). Perhaps shutting down the system by `hp4070 -shutdown` is required.**
Failed to open the optical interface device file by `setlf` command because the 4070 is used by another user (process ID).

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Execute `hp4070 -shutdown` before executing `setlf` command.

- **8-24004 Can't write to the Optical Interface device file (*Reason*).**
Failed to write the optical interface device file by `setlf` command because of the reason shown in *Reason*.
- **8-24005 Can't read from the Optical Interface device file (*Reason*).**
Failed to read the optical interface device file by `setlf` command because of the reason shown in *Reason*.
- **8-25020 Can't load the offline configuration file. File format incorrect.**
Could not read the offline configuration file because the file format is incorrect. Check the format of the file you loaded.
- **8-25021 Can't save the offline configuration file.**
Could not save the offline configuration file. Check the permission of the file and directory.
- **8-27001 Failed to monitor the log file (`/var/opt/hp4070/syslog4070`). The log file might not exist.**
The System Management Panel failed to monitor the log file (`/var/opt/hp4070/syslog4070`). Verify the file exists. Check the permissions of the file or directory.
- **8-27002 Online TIS daemon is not running.**
The online TIS daemon is not running. Execute the `hp4070 -start` command.
- **8-27003 Online TIS daemon is already running.**
Another online TIS daemon is already running. Only one online TIS daemon can run at a time.
- **8-27004 The selected file is not writable. Select another file.**
The selected file is not writable. Select another file or check the permissions of the file.
- **8-40004 The port map table has been modified. Is it OK to discard the changes?**
The port map table was modified. Click **OK** to close the dialog box without saving the changes. Click **No** to cancel.
- **8-40005 File already exists. Do you want to overwrite it?**
The file name you specified already exists. Click **OK** to overwrite the file Click **No** to cancel.
- **8-40006 Is it OK to overwrite the default port map file?**
You are going to overwrite the default port map file. Click **OK** to overwrite the file. Click **No** to cancel.
- **8-40007 HF port map table has been modified. Is it OK to discard the changes?**
The HF port map table was modified. Click **OK** to close the dialog box without saving the changes. Click **No** to cancel.
- **8-40008 Is it OK to overwrite the default HF port map file?**
You are going to overwrite the default HF port map file. Click **OK** to overwrite the file. Click **No** to cancel.
- **8-40009 Pulse switch table has been modified. Is it OK to discard the changes?**
The pulse switch table was modified. Click **OK** to close the dialog box without saving the changes. Click **No** to cancel.
- **8-40010 Is it OK to overwrite the default pulse switch file?**
You are going to overwrite the default pulse switch file. Click **OK** to overwrite the file. Click **No** to cancel.

- **8-42016 Failed to measure calibration data of following PGU.**
PGnn, PGnn, PGnn
Please check using diag4070.
PG level calibration data will not be updated.

Abnormal data is measured for the *PGnn*. The level calibration data for the *PGnn* is not updated. Confirm the PG functions by using the diag4070.
- **8-43001 PG connection table was modified. OK to exit the program without saving?**

The PG connection table was modified. Click **OK** to exit the program without saving the changes. Click **No** to cancel.
- **8-43002 OK to overwrite the default PG connection file?**

You are going to overwrite the default PG connection file. Click **OK** to overwrite the file. Click **No** to cancel.
- **8-43003 PG connection table was modified. OK to open new file without saving?**

The PG connection table was modified. Click **OK** to open the new file without saving the changes. Click **No** to cancel.
- **8-43004 OK to exit the program?**

You are going to exit the program. Click **OK** to exit the program. Click **No** to cancel.
- **8-43005 Searching PGU connections.**

This message is displayed while searching the PG connection.
- **8-46001 Offline configuration was modified. Is it OK to exit the offline configuration tool without saving?**

To exit the offline configuration tool without saving, click the **OK** button. If you do *not* want to exit, click the **Cancel** button.
- **8-46002 Is it OK to overwrite the default Offline configuration file?**

To overwrite the default offline configuration file, click the **OK** button. If you do *not* want to overwrite the file, click the **Cancel** button.
- **8-46003 Offline configuration was modified. Is it OK to open a new file without saving?**

To open a new file without saving the existing file, click the **OK** button. If you *want* to save the existing file, click the **Cancel** button.
- **8-46004 Is it OK to exit the offline configuration tool?**

To exit the program, click the **OK** button. If you do *not* want to exit, click the **Cancel** button.
- **8-46005 Is it OK to select 12 pins (pins in multiples of 4)?**

To select 12 pins (pins in multiples of 4), click the **OK** button. If you do *not* want 12 pins, click the **Cancel** button.
- **8-46006 Is it OK to select 24 pins (even number of pins)?**

To select 24 pins (even number of pins), click the **OK** button. If you do *not* want 24, click the **Cancel** button.
- **8-46007 Is it OK to select 48 pins?**

To select 48 pins, click the **OK** button. If you do *not* want 48, click the **Cancel** button.
- **8-46008 Is it OK to clear all pins?**

To clear all pins, click the **OK** button. If you do *not* want to clear all pins, click the **Cancel** button.

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- **8-47001 Is it OK to exit the System Management Panel?**

To exit the System Management Panel, click the **OK** button. If you do *not* want to exit, click the **Cancel** button.

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- **42-11020 Parameter name can consist of alphanumeric, space, underscore and period characters only.**
42-11022 Parameter name must be 15 characters or less.
Maximum number of characters for parameter name in the IDP setup window is 15.
- **42-11023 Failed to start idpccgen program (*Reason*).**
Number of processes may be more than the limitation specified in kernel parameter, or available swap space or memory is not sufficient. The error message reported by the HP-UX kernel is shown in Reason.
- **42-11024 A directory name must be specified.**
A directory name must be specified in the Code Directory field of the Generate Code window.
- **42-11025 A file name must be specified.**
A file name must be specified in the Source Code Name field of the Generate Code window.
- **42-11026 BASIC line number and its incremental number must be positive.**
The line number and the incremental number in the BASIC Program Line Numbering field of the Generate Code window must be positive.
- **42-11028 Must specify Algorithm Function Name.**
An algorithm function name must be specified in the Code Generation Setup window.
- **42-11029 Algorithm function name must begin with an alpha character.**
- **42-23000 Syntax error.**
Usage: idpccgen {-b|-c} [-mhpfvSP] [-t directory] [-i file] [-o name] [-l 0(TIS)|1(algorithm)|2(program)] [-L [begin_num[,increment_num]]]

-b	Generates BASIC program
-c	Generates C program
-m	Generates Makefile for C language compile
-h	Generates C language header (.h file extension) file
-p	Generates program code for IDP running in the same session idpccgen executed
-f	Forces the specified output file to be overwritten
-v	Displays warning messages
-S	Generates or overwrites SPECS algorithm library spec file
-P	Generates program code using template file for pules
-t directory	Specifies that directory template file exists
-i file	Specifies IDP setup file (.dps file extension) from which program code is generated
-o name	Specifies file name (without file extension) program is saved to
-l 0 1 2	Specifies code generation level
-L begin num, increment_num	Specifies BASIC line numbering

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- **42-23001 Must specify one option: -b (BASIC) or -c (C)**

Idpcgen command must be used with -b (BASIC) or -c (C) option to specify generated programming language.
- **42-23002 Unable to specify -b (BASIC) and -c (C) language options together.**

Idpcgen command cannot specify both -b (BASIC) and -c (C) language options at the same time.
- **42-23003 Unable to specify -i and -p options together.**

Idpcgen command cannot specify both -i (specifies .dps IDP setup file) and -p (specifies IDP setup window currently open) options at the same time.
- **42-23004 Failed to open input file *File_name* (*Reason*).**

Idpcgen command failed to open specified *File_name*.dps IDP setup file. Cause of the error is shown in *Reason*.
- **42-23005 Must specify IDP setup file name with -i option.**

Idpcgen command must specify IDP setup file name from which the command generates the measurement program file.
- **42-23006 Failed to open output file *File_name* (*Reason*).**

Idpcgen command failed to open output file specified as *File_name*. The cause of the error is shown in *Reason*.
- **42-23007 The specified file name already exists. Use -f option to overwrite it.**

The output file name for measurement program generated by the idpcgen command already exists. To overwrite the file, specify the -f option with the idpcgen command, or if you do not want to overwrite the file, change the output filename.
- **42-23008 Must specify file name with -o option.**

When -o option is specified, the idpcgen command must specify a file name without a file extension.
- **42-23009 Failed to open template directory *Directory_name* (*Reason*).**

The idpcten command, used with the -t option, failed to open the specified directory *Directory_name*. The cause of the error is shown in *Reason*.
- **42-23010 Must specify directory name with -t option.**

When -t option is specified, the idpcgen command must specify a directory name.
- **42-23011 Improper generation level *Level_number*. Specify 0, 1, or 2 with -l option.**

Idpcgen command has the wrong *Level_number* setup for -l option (code generation level option). With -l option, specify 0, 1, or 2.
- **42-23012 Must specify 0, 1 or 2 with -l option.**

When -l option is specified, the idpcgen command must specify a code generation level number.
- **42-23013 Failed to open IPC connection to IDP (*Reason*).**

Idpcgen command with -p option failed to open IPC connection to IDP. The cause of the error is shown in *Reason*.
- **42-23014 Failed to connect IPC to IDP (*Reason*).**

Idpcgen command with -p option failed to connect IPC to IDP. The cause of the error is shown in *Reason*.

- **42-23015 idpcgen failed to communicate with IDP process (*Reason*).**

Idpcgen command with -p option failed to communicate with the process IDP generated because of the error shown in *Reason*.
- **42-23016 Possible incorrect IDP setup file. Record format mismatched.**

The file specified by the idpcgen command includes an unrecognized record. May be using an incorrect or incorrectly modified IDP setup file.
- **42-23017 Unable to generate program coding for IDP file created by Rev. B.01.20 or earlier.**

Idpcgen cannot generate program code for IDP setup file created by 4070 system rev. B.01.20 or earlier. Load the IDP setup file in the 4070 rev. B.01.20 IDP setup window, then save the setup and execute the idpcgen command again. Or, after loading the IDP setup file in the rev. B.01.20 environment, generate program code in the IDP environment.
- **42-23018 Possible incorrect IDP setup file. Record format mismatched.**

The file specified by the idpcgen command includes an unrecognized record. May be using an incorrect or incorrectly modified IDP setup file.
- **42-23100 Identical name (*Parameter_name*) cannot be used for different data types.**

The IDP setup file, specified by the idpcgen command, has the identical parameter name setup shown in *Parameter_name* for a different data type. Change the parameter name in the IDP setup window.
- **42-23101 Failed to open template file *File_name* (*Reason*).**

Idpcgen command failed to open the template file shown as *File_name*. The cause of the error is shown in *Reason*.
- **42-23102 Failed to read template file (*Reason*).**

Idpcgen command failed to read the template file. The cause of the error is shown in *Reason*.
- **42-23200 Unknown Token. Replace '@' with '@@'.**

There is an unknown token starting with '@' in the template file specified by the idpcgen command. Replace '@' with '@@'.
- **42-23301 Unknown variable type found: *Variable_type* (*Variable_name*); assumed REAL.**

In the Algorithm Spec Editor, the setup for *Variable_type* shown in *Variable_name* is incorrect. The setup variable type is ignored and the code is generated as type real.
- **42-33000 Unrecognizable input record: Record**

The IDP setup file specified by the idpcgen command, has an incorrect record that is not recognized by the code generation function. The IDP setup file may be modified incorrectly. The incorrect record is ignored.
- **42-33001 Duplicate *Parameter_name* exists. Change th *Parameter_name*.**

The IDP setup file, specified by the idpcgen command, has a duplicate *Parameter_name*. Change the *Parameter_name* in the IDP setup window.
- **42-33002 Template file *File_name* is not in directory shown in *Directory_name*.**

Template file *File_name* does not exist in the directory specified by *Directory_name*, when using idpcgen with the -t option.

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- **42-33003 Unable to access the specified template directory. Default template *File_name* is loaded.**
Unable to find the template file. The idpcgen command cannot access the specified template directory.

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