

Agilent B1500A Semiconductor Device Analyzer

User's Guide



Agilent Technologies

Notices

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Agilent Technologies

DECLARATION OF CONFORMITY
According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014



Manufacturer's Name: Agilent Technologies International sarl
Manufacturer's Address: Rue de la Gare 29
Supplier's Address: CH - 1110 Morges
Switzerland

Declares under sole responsibility that the product as originally delivered

Product Name: Semiconductor Device Analyzer
High Power Source/Monitor Unit Module,
Medium Power Source/Monitor Unit Module,
High Resolution Source/Monitor Unit Module,
Multi Frequency Capacitance Measurement Unit Module,
High Voltage Semiconductor Pulse Generator Unit Module,
Waveform Generator/Fast Measurement Unit Module
Model Number: Agilent B1500A
Agilent B1510A, Agilent B1511A, Agilent B1517A,
Agilent B1520A, Agilent B1525A, Agilent B1530A
Product Options: This declaration covers all options of the above product(s)

complies with the essential requirements of the following applicable European Directives, and carries the CE marking accordingly:

Low Voltage Directive (73/23/EEC, amended by 93/68/EEC)

EMC Directive (89/336/EEC, amended by 93/68/EEC)

and conforms with the following product standards

| EMC | Standard | Limit |
|-----|---|---------------------------------------|
| | IEC 61326:2002 / EN 61326:1997 +A1:1998 +A2:2001 +A3:2003 | |
| | CISPR 11:1997 / EN 55011:1998 | Group 1 Class A |
| | IEC61000-4-2:1995 / EN61000-4-2:1995 | 4 kV CD, 8 kV AD |
| | IEC 61000-4-3:1995 / EN61000-4-3:1995 | 3 V/m, 80-1000 MHz |
| | IEC 61000-4-4:1995 / EN61000-4-4:1995 | 0.5 kV signal lines, 1 kV power lines |
| | IEC 61000-4-5:1995 / EN61000-4-5:1995 | 0.5 kV line-line, 1 kV line-ground |
| | IEC 61000-4-6:1996 / EN61000-4-6:1996 | 3 V, 0.15-80 MHz |
| | IEC 61000-4-11:1994 / EN61000-4-11:1994 | 1 cycle, 100% |

Canada: ICES-001:1998

Australia/New Zealand: AS/NZS 2064.1

The product was tested in a typical configuration with Agilent Technologies test systems.

Safety IEC 61010-1:2001 / EN 61010-1:2001
Canada: CSA C22.2 No. 1010.1:1992, NRTL/C

Supplementary Information:

This DoC applies to above-listed products placed on the EU market after:

October 01, 2008

Date

川路利行

Toshiyuki Kawaji

QA Manager
Agilent Technologies

- **Herstellerbescheinigung**

GEÄUSCHEMISSION

$L_{pa} < 70 \text{ dB}$

am Arbeitsplatz

normaler Betrieb

nach DIN 45635 T. 19

- **Manufacturer's Declaration**

ACOUSTIC NOISE EMISSION

$L_{pa} < 70 \text{ dB}$

operator position

normal operation

per ISO 7779

NOTE

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme ?Hla norme NMB-001 du Canada.



This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/ electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a "Monitoring and Control instrumentation" product.

Do not dispose in domestic household waste.

To return unwanted products, contact your local Agilent office, or see www.agilent.com/environment/product/ for more information.

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 B1500 complies with INSTALLATION CATEGORY II for mains input and INSTALLATION CATEGORY I for measurement input terminals, and POLLUTION DEGREE 2 defined in IEC 1010-1.

Agilent B1500 is an INDOOR USE product.

NOTE

LED in Agilent B1500 is Class 1 in accordance with IEC 825-1. CLASS 1 LED PRODUCT.

- *GROUND THE INSTRUMENT*

This is Safety Class I 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 example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

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



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



Indicates earth (ground) terminal.



Alternating current.



Direct current.



STANDBY (Supply).

CAT I

Means INSTALLATION CATEGORY I. Measurement terminals on the rear panel 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 personal.

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.

HIGH VOLTAGE SHOCK HAZARD

Agilent B1500 can force dangerous voltages (200 V for HPSMU, and 100 V for MPSMU/HRSMU) at the force, guard, and sense terminals. To prevent electric shock hazard, the following safety precautions must be observed during the use of Agilent B1500.

- Use a three-conductor AC power cable to connect cabinet (if used) and Agilent B1500 to an electric ground (safety ground).
- If you do not use Agilent 16442 Test Fixture, make sure to connect the Interlock terminal to a switch that turns off when the shielding box access door is opened.
- Confirm periodically that interlock function works normally.
- Before touching the connections of the force, guard, and sense terminals, turn Agilent B1500 off and discharge any capacitors whenever possible. If you do not turn Agilent B1500 off, complete “all” of the following items, regardless of any Agilent B1500 settings.
 - Terminate measurement by pressing Stop key, confirm that the Measurement status indicator is not lit.
 - Confirm that the High Voltage indicator is not lit.
 - Open the shielding box access door (open the Interlock terminal).
 - Discharge any capacitors if the capacitance is connected to an SMU.
- Warn workers in the vicinity of Agilent B1500 about dangerous conditions.

高電圧感電注意

Agilent B1500 のフォース、ガード、センス端子には、危険電圧が出力されることがあります (HPSMU の場合は最大± 200 Vdc、MPSMU/HRSMU の場合は最大± 100 Vdc)。感電事故防止のため、必ず以下の事柄を守ってください。

- 3 極電源ケーブルを使用して Agilent B1500 を設置すること。
- Agilent 16442 テスト・フィクスチャ以外のフィクスチャ、あるいはプローバを使用する場合には、シールド・ボックスにインターロック回路を接続すること。インターロック回路とは、シールド・ボックスの蓋を開けた時に Agilent B1500 の Interlock 端子を開放にすることができる回路のことをいいます。
- インターロック機能が正常であることを定期的に確認すること。
- フォース、ガード、センス端子に繋がる接続部に触れる前には、測定器の電源を切ること。また、測定系にキャパシタが接続されている場合は、キャパシタを放電すること。電源を切らない場合は、以下の事項を全て実施すること。
 - Stop キーを押して Measurement インジケータが消灯したことを確認すること。
 - 高電圧警告 (High Voltage) インジケータが消灯していることを確認すること。
 - シールド・ボックスの蓋を開ける (Interlock 端子を開放する) こと。
 - キャパシタが SMU に接続されているならば、キャパシタを放電すること。
- 周囲のほかの作業者に対しても、高電圧危険に対する注意を徹底すること。

PRECAUTIONS POUR COMMOTION A HAUTE TENSION

Une tension dangereuse (max. \pm pour HPSMU; 200 Vdc, max. \pm pour MPSMU/HRSMU; 100 Vdc) émanant du dispositif Agilent B1500 peut être sortie aux bornes de force, d'appareil de protection ou de détection. Les précautions suivantes doivent être observées contre commotion électrique accidentelle:

- Mettre à la terre le dispositif Agilent B1500 au moyen du câble d'alimentation tripolaire.
- En cas de hors service du dispositif d'essai, FIXTURE Agilent 16442, connecter les bornes de verrouillage (Interlock) de façon à ce que soit ouverte lorsque le couvercle de la boîte de blindage est ouvert.
- Essayer périodiquement le fonctionnement normal de verrouillage.
- Avant de toucher la partie connexion à partir des bornes de force, d'appareil de protection et de détection, mettre hors tension le dispositif Agilent B1500. Et, en cas de condensateurs connectés au circuit de mesure, décharger ces condensateurs. Lorsque l'alimentation n'est pas mise hors tension, les 4 instructions suivantes doivent être exécutées:
 - Finir la mesure en appuyant sur la touche "Stop"; vérifier que l'indicateur "Measurement" n'est pas allumé.
 - S'assurer que soit allumé l'indicateur d'alarme de la haute tension.
 - Ouvrir le couvercle de la boîte de blindage (Ouvrir les bornes de verrouillage).
 - En cas de condensateurs connectés à SMU, décharger les condensateurs.
- Alerter d'autres personnes autour de vous contre le danger de haute tension.

Achtung! Gefährliche Spannung

Von den Geräten Agilent B1500 können Spannungen an den Anschlüssen "Force, Guard und Sense" von bis zu 200 V ausgehen. Um elektrischem Schlag vorzubeugen, ist bei der Benützung der Geräte Agilent B1500 folgendes zu beachten:

- Erden Sie das Kabinett (falls verwendet) sowie die Geräte Agilent B1500 mittels dreiadriger Netzleitungen.
- Wenn die Meßfassung, Agilent 16442, zwar angeschlossen, jedoch nicht verwendet wird, schließen Sie die Verriegelungsklemme (Interlock) so an, daß bei geöffnetem Deckel die Stromzuführung zu Agilent 16442 auf jeden Fall unterbrochen wird.
- Vergewissern Sie sich regelmäßig daß die Verriegelungsfunktion korrekt arbeitet.
- Schalten Sie die Geräte Agilent B1500 aus, und entladen Sie alle Kapazitäten bevor Sie die Anschlüsse "Force, Guard und Sense" berühren. Falls Sie die Geräte Agilent B1500 nicht ausschalten, führen Sie unabhängig von den Geräteeinstellungen folgende Schritt durch:
 - Beenden Sie die gegenwärtige Messung durch Drücken der Stop Taste (die Measurement Leuchtdiode erlischt).
 - Vergewissern Sie sich daß die Hochspannungswarnlampe erloschen ist.
 - Öffnen Sie den Deckel der Meßfassung Agilent 16442 (die Verriegelungsklemme (Interlock) öffnen).
 - Entladen Sie alle an SMUs angeschlossenen Kondensatoren (falls vorhanden).
- Informieren Sie Personen in unmittelbarer Nähe der Geräte Agilent B1500 über die Gefährlichkeit der bestehenden Hochspannung, und sichern Sie den Zugang zum Prüfplatz zum Schutz Dritter.

Precautionary Statement

Agilent B1500 Semiconductor Device Analyzer operates in the Microsoft Windows XP Professional environment. Agilent B1500 requires Agilent EasyEXPERT software, a specially-designed Windows XP application program.

- About guarantee and support for Agilent B1500

Agilent Technologies guarantees and supports the performance of Agilent B1500 for the same condition as the preload condition when shipped from the factory.

- About updating Agilent EasyEXPERT and the Windows Update

Agilent Technologies confirms the operation of Agilent EasyEXPERT patch programs and important Windows security patches, and provides recommended update information. Visit Agilent B1500 support site, download the patches, and perform the software update.

- About Windows XP application programs and peripherals (including driver)

Using commercial products on Agilent B1500 is your responsibility. Agilent Technologies cannot provide compatibility information for commercial products. If problems arise, perform Agilent B1500 system recovery.

- About servicing

Bench repair service is available at your nearest Agilent Technologies service center. Be aware that the B1500 configuration might be updated to the latest one without notice because of support issues.

The internal hard disk drive (HDD) might be initialized during servicing. If peripherals are connected, they will be removed.

When Agilent B1500 is returned, the internal HDD might be initialized. Peripherals will be returned separately.

- Other notes

- Back up the internal HDD to prevent loss of data by accident or failure.
- Protect Agilent B1500 from computer viruses.
- If you connect Agilent B1500 to the network, take care to protect it from computer virus.

Working in Comfort

To optimize your comfort and productivity, it is important that you set up your work area correctly and use your instrument properly. With that in mind, we have developed some set-up and use recommendations for you to follow based on established ergonomic principles. Improper and prolonged use of keyboards and input devices are among those tasks that have been associated with repetitive strain injury (RSI) to soft tissues in the hands and arms. If you experience discomfort or pain while using the instrument, discontinue use immediately and consult your physician as soon as possible. For more information on RSI you may wish to consult the *About Repetitive Strain Injury* section. Please study the recommendations described below. Included there are references to relevant parts of international standards, regulations and guidelines, such as ISO 9241 and the European Community Display Screen Equipment directive. You may also wish to consult your employer's human resources department or other relevant departments for guidance specific to your company.

About Repetitive Strain Injury

Because your comfort and safety are our primary concern, we strongly recommend that you use the instrument in accordance with established ergonomic principles and recommendations. Scientific literature suggests that there may be a relationship between injury to soft tissues -especially in the hands and arms- and prolonged improper use of keyboards or other equipment requiring repeated motions of the hands and forearms. This literature also suggests that there are many other risk factors that may increase the chance of such injury, commonly called Repetitive Strain Injury.

What is RSI?

Repetitive Strain Injury (RSI -also known as cumulative trauma disorder or repetitive motion injury) is a type of injury where soft tissues in the body, such as muscles, nerves, or tendons, become irritated or inflamed. RSI has been a reported problem for those who perform repetitive tasks such as assembly line work, meatpacking, sewing, playing musical instruments, and computer work. RSI also has been observed in those who frequently engage in activities such as carpentry, knitting, housework, gardening, tennis, windsurfing and lifting children.

What causes RSI?

The specific causes of RSI have not been established. Nevertheless, the incidence of RSI has been associated with a variety of risk factors, including:

- Too many uninterrupted repetitions of an activity or motion.

- Performing an activity in an awkward or unnatural posture.
- Maintaining static posture for prolonged periods.
- Failing to take frequent short breaks.
- Other environmental and psychosocial factors.

In addition, there have been reports associating the occurrence of RSI with the use of keyboards, mice, and other input devices. Also, certain medical conditions, such as rheumatoid arthritis, obesity and diabetes, may predispose some people to this type of injury.

What if I experience discomfort?

If you are experiencing any discomfort, seek professional medical advice immediately. Typically, the earlier a problem is diagnosed and treated, the easier it is to resolve.

Mice and Other Input Devices

Various aspects of using mice and other input devices may increase your risk of discomfort or injury. Observing the following recommendations may reduce that risk.

- Try to keep your hand, wrist, and forearm in a neutral position while using your mouse or other input device.
- If you use your thumb to rotate the ball on a trackball or spaceball, keep it in a relaxed, natural shape, and maintain a neutral posture in your hand, wrist, and forearm.
- Hold the mouse gently by draping your fingers over it. Keep your hand relaxed and fingers loose. Do not grip the mouse tightly.
- It takes very little pressure or force from your fingers to activate the buttons or scroll wheel on your mouse, scrolling mouse, trackball, or other input device. Using too much force can place unnecessary stress on the tendons and muscles in your hands, wrists, and forearms.
- If you are using a scrolling mouse, be sure to keep your fingers and hand in a relaxed, neutral position when activating the scroll wheel. Also, this type of mouse features software that can minimize the number of mouse movements or button clicks.
- When using a mouse, trackball, or other input device, position it as close to the keyboard as possible, and keep it at the same level as you do not have to stretch while using it.
- Be sure to keep your mouse and trackball clean. Regular removal of accumulated dust and dirt helps ensure proper tracking and reduces unnecessary hand and wrist motions.

In This Manual

This manual describes the front panel operation, installation, and functions of Agilent Technologies B1500. This manual consists of the following chapters:

- Chapter 1, “Getting Started”
This chapter describes the basic operations of Agilent B1500.
- Chapter 2, “Introduction”
This chapter describes overview, specifications, accessories and options of Agilent B1500.
- Chapter 3, “Installation”
This chapter explains how to install Agilent B1500, and how to connect the device under test to a test fixture.
- Chapter 4, “Using EasyEXPERT”
This chapter provides the reference information of Agilent EasyEXPERT software.
- Chapter 5, “Classic Test Definition”
This chapter provides the reference information of the classic test definition.
- Chapter 6, “Application Test Definition”
This chapter provides the reference information of the application test definition.
- Chapter 7, “Function Details”
This chapter explains the several functions and initial settings of Agilent B1500.
- Chapter 8, “Built-in Programming Tool”
This chapter provides information about the built-in mathematical functions and read out functions.
- Chapter 9, “If You Have a Problem”
This chapter explains how to solve a problem if you encounter any problem, and describes error codes. This chapter also describes how to perform the system recovery and the data backup/recovery.
- Chapter 10, “Application Library and Utilities”

NOTE

To get the latest firmware/software/electronic manuals/support information, visit Agilent Technologies support site (<http://www.home.agilent.com>), and click Additional Test & Measurement Products > Parametric Test, click Semiconductor Parameter/Device Analyzer Series, and click B1500A Semiconductor Device Analyzer. You can reach Agilent B1500A support site.

Online Documents

The following electronic documentation files are stored in Agilent B1500's internal hard disk drive. The files provide the information of how to use Agilent B1500 and Agilent EasyEXPERT software.

Folder: C:\Program Files\Agilent\B1500\Documents

- B1500_help.chm

A part of Agilent B1500A User's Guide. This is the online help that can be opened from the Help menu on the EasyEXPERT main screen.

- B1500_Self_Trng.mht

Agilent B1500A Self-paced Training Manual that can be opened by a browser

Utilities

The following utility programs are stored in Agilent B1500's internal hard disk drive. For details, see "Application Library and Utilities" on page 10-1.

- License Management Tool

This is the GUI based program used to manage the license of the EasyEXPERT Plus edition and the Desktop EasyEXPERT Plus edition.

- Setup File Converter

This is the GUI based program used to convert Agilent 4155/4156 setup file (.MES file) and create the EasyEXPERT setup file (.XTS file).

- Prober Control Scripts

Execution files that can be used to control the chuck movement of a prober. For details, see the readme file.

- SetupFileConverter.exe

This is the script version of the Setup File Converter.

- sleep.exe

Execution file that can be used to put a wait time in the test execution flow of an application test.

- XSLT Filters

XSLT filters that can be used by the Export in My Format function. They are filter files for changing the format of the test result record.

NOTE

The utility programs are just sample. If the samples damage your devices, Agilent Technologies is NOT LIABLE for the damage. And the operation is not guaranteed.

Contents

1. Getting Started

| | |
|------------------------------------|------|
| To Turn On/Off B1500A | 1-3 |
| To Turn B1500A On..... | 1-4 |
| To Turn B1500A Off..... | 1-4 |
| To Launch EasyEXPERT | 1-6 |
| If Only One Workspace Exists | 1-7 |
| To Create Workspace | 1-8 |
| To Select Workspace | 1-9 |
| To Use Application Test Mode..... | 1-10 |
| To Use Classic Test Mode | 1-12 |
| To Perform Measurement | 1-14 |
| To Use Test Result Editor | 1-15 |
| To Use Analysis Tools..... | 1-16 |

2. Introduction

| | |
|---|------|
| Overview | 2-3 |
| Agilent EasyEXPERT Software..... | 2-5 |
| Front View..... | 2-7 |
| Rear View | 2-10 |
|  | 2-11 |
|  | 2-12 |
|  | 2-13 |
|  | 2-14 |
|  | 2-15 |
| Measurement Units | 2-16 |
| GNDU - Ground Unit..... | 2-16 |

Contents

| | |
|---|------|
| About SMU | 2-17 |
| B1510A High Power SMU | 2-18 |
| B1511A Medium Power SMU | 2-21 |
| B1517A High Resolution SMU | 2-24 |
| B1520A Multi Frequency CMU | 2-28 |
| B1525A High Voltage SPGU | 2-31 |
| B1530A WGFMU | 2-32 |
| Specifications | 2-33 |
| Hardware | 2-33 |
| Agilent EasyEXPERT Software | 2-65 |
| Agilent Desktop EasyEXPERT Software | 2-72 |
| General Specifications | 2-75 |
| Accessories and Options | 2-76 |

3. Installation

| | |
|---|------|
|  | 3-2 |
| Requirements | 3-3 |
| Power Requirements | 3-3 |
| Operating Environment | 3-3 |
| Storing/Shipping Environment | 3-3 |
| Ventilation Requirements | 3-4 |
| Power Cable | 3-4 |
| Inspection and Installation | 3-6 |
| To Inspect B1500 and Accessories | 3-6 |
| To Perform Initial Setup | 3-7 |
| To Change Windows Logon Setting | 3-9 |
| To Change GPIB Address | 3-9 |
| To Enable System Controller | 3-10 |
| Installing Accessories | 3-11 |

Contents

| | |
|---|------|
| To Connect 16442B Test Fixture | 3-12 |
| To Connect Connector Plate | 3-14 |
|  Connecting the interlock terminal | 3-16 |
| To Connect ASU | 3-17 |
| To Connect SCUU/GSWU. | 3-21 |
| To Connect GNDU Adapter. | 3-25 |
| To Interconnect SPGUs. | 3-26 |
| Mounting Connectors | 3-27 |
|  To Make an Interlock Circuit | 3-29 |
| To Connect GNDU Output | 3-32 |
| To Connect SMU Output | 3-33 |
| To Connect MFCMU Output | 3-39 |
| Connecting Measurement Devices | 3-40 |
| Using Test Fixture | 3-41 |
| Using Connector Plate | 3-43 |
| Capacitance Compensation When Using Switching Matrix | 3-47 |
| Required Conditions | 3-48 |
| To Create Compensation Data File. | 3-50 |
| Maintenance | 3-55 |
| Cleaning | 3-55 |
| Self-test and Diagnostics | 3-55 |
| Calibration | 3-55 |
| About Plug-in Modules | 3-56 |
| Module Type and Locations | 3-57 |
| 4. Using EasyEXPERT | |
| Start EasyEXPERT | 4-4 |
| Workspace Configurator | 4-5 |
| If there is no workspace. | 4-5 |

Contents

| | |
|--|------|
| If there is one workspace | 4-6 |
| If there are Workspace more than two | 4-8 |
| Main Screen | 4-10 |
| Main Screen GUI | 4-11 |
| Run Option | 4-18 |
| Data Display Manager | 4-19 |
| Data Display Properties | 4-20 |
| Test Result Editor | 4-21 |
| Test Results Data Filter | 4-22 |
| Export in My Format | 4-22 |
| Test Results Data Folder Export | 4-23 |
| Test Results Data Auto Export | 4-24 |
| Test Results Data Properties | 4-26 |
| Application Test | 4-27 |
| Quick Test | 4-29 |
| Repeat Measurement Setup | 4-31 |
| Organize Preset Group | 4-33 |
| Calibration | 4-35 |
| Module Self Calibration | 4-35 |
| SMU Zero Cancel | 4-36 |
| CMU Calibration | 4-37 |
| Configuration | 4-41 |
| Main Frame | 4-41 |
| Modules | 4-42 |
| ASU | 4-43 |
| Switching Matrix | 4-43 |
| SMU/PG Selector | 4-45 |
| Event Log | 4-45 |
| Extended Configuration | 4-46 |

Contents

| | |
|--|------|
| Switching Matrix Operation Panel | 4-48 |
| Standby Channel Definition | 4-50 |
| Data Display | 4-51 |
| Data Display GUI | 4-53 |
| Display Setup | 4-62 |
| Graph Properties | 4-63 |
| List Display Properties | 4-64 |
| Tool Bar | 4-64 |
| Data Status | 4-67 |
| Miscellaneous Operations | 4-68 |
| Preview | 4-74 |
| Preview Window GUI | 4-74 |
| Preview Settings | 4-76 |
| Text File Export settings | 4-77 |

5. Classic Test Definition

| | |
|-----------------------------------|------|
| I/V Sweep | 5-4 |
| Channel Setup | 5-5 |
| Measurement Setup | 5-6 |
| Multi Channel I/V Sweep | 5-9 |
| Channel Setup | 5-10 |
| Measurement Setup | 5-11 |
| I/V List Sweep | 5-13 |
| Channel Setup | 5-14 |
| Measurement Setup | 5-15 |
| Define vector data | 5-18 |
| I/V-t Sampling | 5-21 |
| Channel Setup | 5-22 |
| Measurement Setup | 5-23 |

Contents

| | |
|--|------|
| C-V Sweep | 5-26 |
| Channel Setup | 5-27 |
| Measurement Setup | 5-28 |
| Direct Control | 5-30 |
| Channel Setup | 5-31 |
| Measurement Setup | 5-33 |
| Advanced Setup | 5-34 |
| Command Setup | 5-36 |
| compenReZ | 5-38 |
| compenImZ | 5-39 |
| compenReY | 5-40 |
| compenImY | 5-41 |
| Function Setup | 5-42 |
| Auto Analysis Setup | 5-43 |
| Display Setup | 5-46 |
| SMU Range Setup Window | 5-48 |
| ADC and Integration Time Setup Window | 5-50 |
| Advanced Setup Window | 5-51 |
| CMU Range Setup Window | 5-53 |
| Advanced Setup Window for C-V Sweep | 5-54 |
| Switching Matrix Control | 5-55 |
| SPGU Control | 5-57 |
| Advanced Setup Window for SPGU Control | 5-58 |
| SPGU Pulse Setup Window | 5-59 |
| Load Z Setup Window | 5-61 |
| Pulse Switch Setup Window | 5-62 |

Contents

| | |
|---------------------------------------|------|
| SPGU ALWG Setup Window | 5-63 |
| Define ALWG Waveform Window | 5-64 |
| Waveform Pattern Editor | 5-67 |

6. Application Test Definition

| | |
|--|------|
| Test Definition Window | 6-3 |
| Test Specification | 6-5 |
| Define Layout | 6-10 |
| Test Output | 6-14 |
| Analysis Parameter Definition | 6-15 |
| Test Contents | 6-16 |
| Defining/Editing Test Contents | 6-17 |
| Debugging Test Contents | 6-21 |
| Variable Inspector | 6-22 |
| External Variable Setup | 6-23 |
| Local Variable Definition | 6-24 |
| Program Component | 6-26 |
| Auto Analysis | 6-27 |
| Data Display Control | 6-30 |
| Display Data Setup | 6-31 |
| GPIB I/O | 6-33 |
| Message | 6-38 |
| Data Store Control | 6-39 |
| Command Execution | 6-40 |
| Using Command Execution | 6-42 |
| Command Parameters | 6-42 |

Contents

| | |
|--|------|
| Defining Numeric/Vector Input Parameter | 6-43 |
| Defining String/Numeric Input Parameters | 6-43 |
| Defining Numeric Output Parameter | 6-44 |
| Defining Vector Output Parameter | 6-44 |
| Defining String Output Parameter | 6-44 |
| Defining Format Field | 6-45 |
| Setup Example | 6-46 |

7. Function Details

| | |
|--|------|
| I/V Sweep Measurement | 7-3 |
| Available Modules | 7-3 |
| Output Range | 7-4 |
| Basic Sweep Measurement | 7-4 |
| Subordinate Sweep Measurement | 7-6 |
| Synchronous Sweep Measurement | 7-8 |
| Pulsed Sweep Measurement | 7-9 |
| Multi Channel I/V Sweep Measurement | 7-12 |
| I/V-t Sampling Measurement | 7-13 |
| Available Modules | 7-13 |
| Operation Summary | 7-13 |
| Setup Parameters | 7-15 |
| Time Data and Index | 7-17 |
| Source Output Sequence and Time Origin | 7-18 |
| Sampling Completion | 7-18 |
| C-V Sweep Measurement | 7-19 |
| Available Module | 7-19 |
| Setup Parameters | 7-19 |
| Measurement Parameters | 7-21 |
| Four-Terminal Pair Configuration | 7-23 |
| Error Correction | 7-24 |

Contents

| | |
|---|------|
| SPGU Module | 7-26 |
| PG Operation Mode | 7-27 |
| ALWG Operation Mode | 7-34 |
| Sweep Abort Function | 7-36 |
| When abort occurs | 7-36 |
| Standby Function | 7-37 |
| Standby Channels | 7-37 |
| Standby State | 7-37 |
| Output Sequence of Standby Channels | 7-38 |
| To Use Standby Function | 7-39 |
| Bias Hold Function | 7-40 |
| Current Offset Cancel | 7-42 |
| SMU CMU Unify Unit | 7-44 |
| Atto Sense and Switch Unit | 7-46 |
| SMU/PG Selector | 7-48 |
| SMU Ranging Mode | 7-49 |
| To Set Ranging Mode | 7-49 |
| Auto Ranging | 7-50 |
| Limited Auto Ranging | 7-51 |
| Fixed Range | 7-51 |
| Compliance Range | 7-51 |
| Enhanced Auto Ranging for Current Measurement | 7-52 |
| SMU Compliance | 7-53 |
| Polarity and Output Area | 7-53 |
| Power Compliance | 7-54 |
| To Set Compliance | 7-55 |
| SMU Pulse | 7-56 |
| To Set Pulse Output | 7-56 |

Contents

| | |
|--------------------------------------|------|
| SMU Measurement Time | 7-57 |
| Integration Time | 7-57 |
| Overhead Time | 7-59 |
| To Specify Source Output Time | 7-59 |
| Wait Time | 7-60 |
| Multiple Measurement Channels | 7-61 |
| SMU Filter | 7-62 |
| SMU Series Resistor | 7-63 |
| Interlock Function | 7-64 |
| Auto Power Off Function | 7-65 |
| Initial Settings | 7-66 |
| | |
| 8. Built-in Programming Tool | |
| Variables and Expressions | 8-3 |
| Expressions | 8-4 |
| Built-in Functions | 8-7 |
| Read Out Functions | 8-15 |
| Functions for Marker | 8-15 |
| Functions for Cursor | 8-15 |
| Functions for Line | 8-16 |
| Functions for Two Line Display | 8-17 |
| Script Program Statements | 8-19 |
| | |
| 9. If You Have a Problem | |
| When You Operate B1500A | 9-3 |
| Power On Trouble | 9-3 |
| SCUU is not Detected | 9-3 |
| ASU is not Detected | 9-4 |

Contents

| | |
|---|------|
| External GPIB Devices are not Detected | 9-4 |
| To Simplify the Connections | 9-5 |
| When You Perform Measurement | 9-6 |
| Measurement Takes More Time than Specified | 9-6 |
| Noise Affects the Measured Values | 9-7 |
| Voltage Measurement Error is Large | 9-8 |
| SMU Oscillates for High-Frequency Device Measurements | 9-8 |
| SMU Oscillates for Negative Resistance Measurements | 9-9 |
| Large Current Causes High Temperature (Thermal Drift) | 9-10 |
| Measurement Damages the Device under Test | 9-10 |
| Leaving Connections Damages Devices after Measurement | 9-10 |
| Unexpected Sampling Measurement Data is Returned | 9-11 |
| MFCMU Causes Unbalance Condition | 9-11 |
| Before Shipping to Service Center | 9-12 |
| To Make Backup | 9-12 |
| To Check Module Slots | 9-12 |
| To Check ASU/HRSMU Combination | 9-12 |
| To Collect Equipment and Accessories | 9-13 |
| Data Backup and Recovery | 9-14 |
| Folders to Backup | 9-15 |
| To Make Database Backup | 9-15 |
| To Restore Database Backup | 9-16 |
| To Make Backup of Other Data | 9-17 |
| To Restore Backup of Other Data | 9-18 |
| B1500A System Recovery | 9-19 |
| To Perform System Recovery | 9-19 |
| To Initialize Database | 9-20 |
| To Restore Database | 9-21 |
| Updating EasyEXPERT | 9-22 |

Contents

| | |
|---|------|
| Error Codes | 9-23 |
| Agilent EasyEXPERT Operation Error. | 9-23 |
| Agilent FLEX Execution Error | 9-48 |
| Agilent B1500A Self-test/Calibration Error. | 9-66 |
| Setup File Converter Execution Error. | 9-77 |

10. Application Library and Utilities

| | |
|--|-------|
| Application Test Definitions | 10-3 |
| QSCV Measurement Supplemental Data | 10-13 |
| Maximum Measurement Value | 10-13 |
| Considering Measurement Accuracy. | 10-17 |
| License Management Tool | 10-49 |
| License Management Tool GUI | 10-49 |
| Setup File Converter | 10-50 |
| Setup File Converter GUI | 10-51 |
| Utility Programs. | 10-52 |
| Prober Control | 10-52 |
| SetupFileConverter.exe | 10-53 |
| sleep.exe | 10-56 |
| XSLT | 10-57 |
| Desktop EasyEXPERT | 10-67 |
| About Desktop EasyEXPERT | 10-68 |
| System Requirements | 10-69 |
| To Install Desktop EasyEXPERT | 10-70 |
| Before Starting Desktop EasyEXPERT. | 10-70 |
| To Start Desktop EasyEXPERT | 10-71 |
| Execution Mode dialog box | 10-71 |
| Start EasyEXPERT window. | 10-72 |
| To Change Execution Mode and GPIB Settings | 10-73 |

Contents

| | |
|---|-------|
| To Move the EasyEXPERT Database | 10-73 |
| Using 4155B/4156B/4155C/4156C | 10-74 |

Contents

1

Getting Started

Getting Started

This chapter describes the basic operations of Agilent B1500A. Before learning the product details, let's try to use the B1500A briefly. The operations need the B1500A, power cable, and USB keyboard only (USB mouse and stylus pen are optional).

During the operations, you will not connect device under test. Open all measurement terminal.

This chapter consists of the following sections.

- “To Turn On/Off B1500A”
- “To Launch EasyEXPERT”
- “To Use Application Test Mode”
- “To Use Classic Test Mode”
- “To Perform Measurement”
- “To Use Analysis Tools”

To Turn On/Off B1500A

NOTE**When turning the B1500A on**

Open the measurement terminals at the device side when turning the B1500A on. Also disconnect the device from the measurement terminals and open the measurement terminals after the test. If you leave the connection with the device, the device may be damaged by unexpected operations or charge-up of measurement cables.

NOTE**If you use the B1500A at the first time**

If this is the first time to turn Agilent B1500 on after the delivery, you need to perform the initial setup of the B1500. See “Inspection and Installation” on page 3-6. After the initial setup and if no users are added, you can automatically logon as “Agilent B1500 User” account without password.

NOTE**If Start EasyEXPERT button is not displayed**

Select All Programs > Start EasyEXPERT from the Start menu. The Start EasyEXPERT button will be displayed.

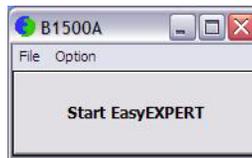
Getting Started

To Turn On/Off B1500A

To Turn B1500A On

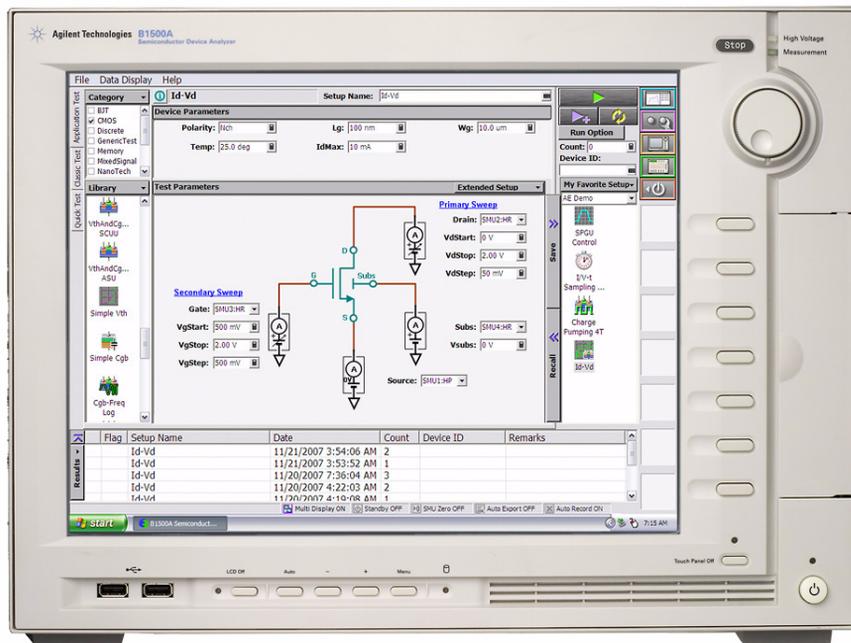
1. Connect the power cable from Agilent B1500A to an AC power outlet.
2. Connect the USB keyboard to the B1500A. Optionally, connect the USB mouse to the B1500A.
3. Press the Standby switch (lower right corner of the front panel). Windows, measurement module initialization, and self-calibration will start. For the Windows logon screen, log on Windows.

After logging on, the Start EasyEXPERT button will be displayed on the screen.



To Turn B1500A Off

Press the Standby switch (lower right corner of the front panel). Windows will be shutdown and the B1500A will become the standby state.



NOTE

Agilent B1500A has the following front panel user interface.

- **Stop**
Stops the present measurement or source output immediately.
- **Rotary knob**
Rotating the knob moves the marker on the graph window, or increases/decreases/changes the value in the active entry field.
Pressing the knob sets or enters the value.
- **Softkeys**
Seven softkeys are available. Used to select one for the entry field specified or the dialog box. They are also used to recall the test definitions (pre-defined test setups).
- **Touch Panel Off**
Enables or disables the touch screen operation.
- **Standby switch**
Turns the B1500A on. Pressing the button in the ON state makes the B1500A in the standby state.
- **LCD Off**
Enables or disables the LCD panel. LED lights when the LCD is disabled.
- **Auto, -, +, Menu**
Four keys are available for the display adjustment. Press Auto to perform adjustment automatically. Use -, +, and Menu to adjust manually.

Agilent B1500A also requires Agilent EasyEXPERT software as its graphical user interface. You can operate Agilent EasyEXPERT by using the touch panel. Use your fingers, stylus pen, and so on for the touch panel operation. The USB keyboard and the USB mouse are also available for operating the EasyEXPERT.

To Launch EasyEXPERT

1. Click the Start EasyEXPERT button, and wait until the EasyEXPERT main screen or workspace selection screen is displayed.



NOTE

Workspace is the space created in Agilent B1500A's internal hard disk drive, and is used to store the test setup, test result data, and so on. The workspace can be created and allocated for each user.

2. If this is the first time to start the EasyEXPERT, or if no workspace exists, a workspace will be created automatically.
Skip to "To Use Application Test Mode" on page 1-10 or "To Use Classic Test Mode" on page 1-12.
3. If only one workspace exists, the B1500A displays the screen as shown in Figure 1-1.
Skip to "If Only One Workspace Exists" on page 1-7.
4. If two or more workspaces exist, the B1500A displays the screen as shown in Figure 1-3.
Skip to "To Select Workspace" on page 1-9.

If Only One Workspace Exists

For the screen as shown in Figure 1-1, perform the following steps.

1. If you do not want to create a workspace, select the Yes radio button and click OK.

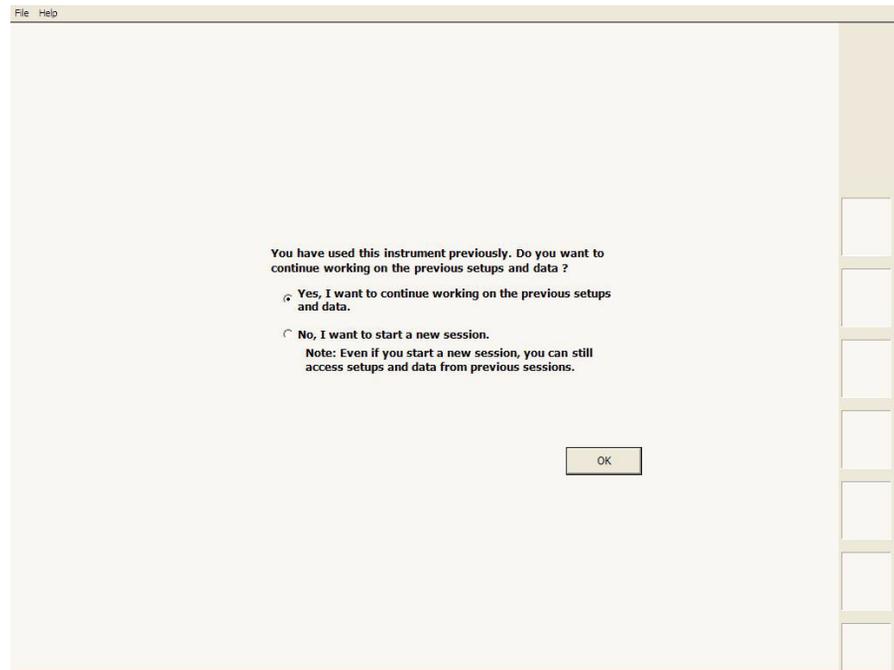
Skip to “To Use Application Test Mode” on page 1-10 or “To Use Classic Test Mode” on page 1-12.

2. If you want to create a workspace, select the No radio button and click Next. The B1500A displays the screen as shown in Figure 1-2.

Skip to “To Create Workspace” on page 1-8.

Figure 1-1

If Only One Workspace Exists



To Create Workspace

For the screen as shown in Figure 1-2, perform the following steps. To cancel creating workspace, click Prev.

1. Enter the name of the new workspace into the above-entry field.
Check *Allow other users to access this workspace* box if you want to create a public workspace that is opened for all users.
2. If you are the owner of the existing workspace, you can change the name of the existing workspace.
If you want to rename the existing workspace, enter the name into the below-entry field.
Check *Allow other users to access this workspace* box if you want to set it to a public workspace that is opened for all users.
3. Click OK.

Skip to “To Use Application Test Mode” on page 1-10 or “To Use Classic Test Mode” on page 1-12.

Figure 1-2

To Create Workspace

File Help

Agilent EasyEXPERT software manages setups and data in enclosures known as "Workspaces." Since you want to start a new session, you should create a new Workspace with a distinctive name. Please specify a name for the new Workspace:

Untitled

Allow other users to access this Workspace.

You can also rename a previously defined Workspace:

Demo Workspace

Allow other users to access this Workspace.

To Select Workspace

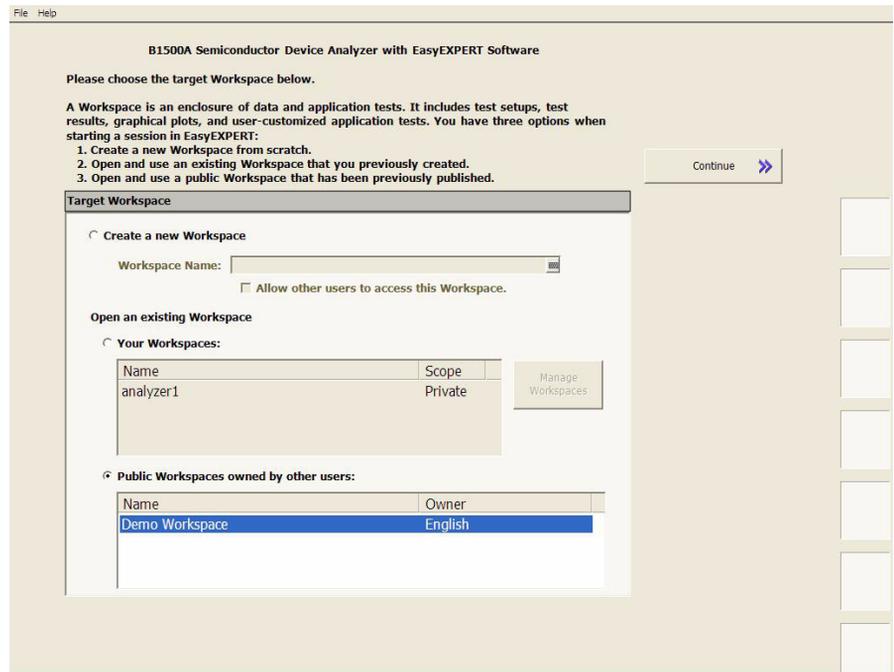
For the screen as shown in Figure 1-3, perform the following steps. This example selects the workspace named as *Demo Workspace* that is a public workspace that is opened for all users.

1. Select *Public Workspaces owned by other users* radio button.
2. Click *Demo Workspace* to select it.
3. Click Continue.

Skip to “To Use Application Test Mode” on page 1-10 or “To Use Classic Test Mode” on page 1-12.

Figure 1-3

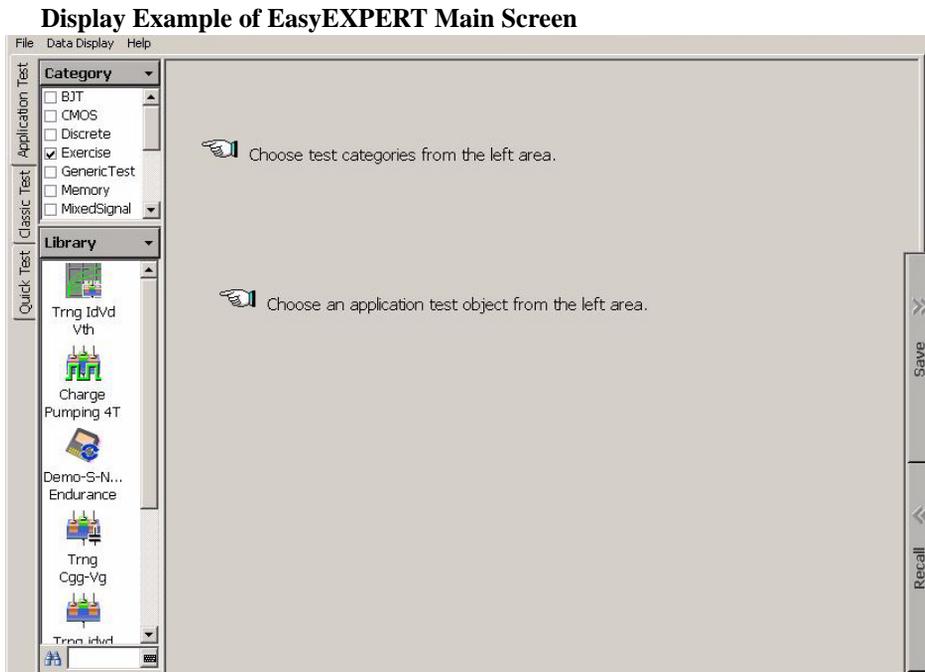
To Select Workspace



To Use Application Test Mode

For the screen as shown in Figure 1-4, perform the following procedure.

Figure 1-4



1. Select a test definition on the EasyEXPERT main screen while the Application Test tab has been selected. The tab is in the leftmost column on the screen.
 - a. Set the Category area to change the test definitions listed in the Library area. For example, check the CMOS only.
 - b. Select a test definition at the Library area. For example, click *Id-Vg* and Select button sequentially. The *Id-Vg* screen is displayed. See Figure 1-5.
2. Change the test conditions at the Test Parameters area on the main screen as shown in Figure 1-5.

For example, the following steps change the sweep range of voltage output.

- a. Set VgStart to 0 V and VgStep to 0.2 V.
- b. VsubsStep to -1.0 V.

To enter the value, use the USB keyboard or the screen/numeric keyboard opened by clicking the button to the right of the entry field.

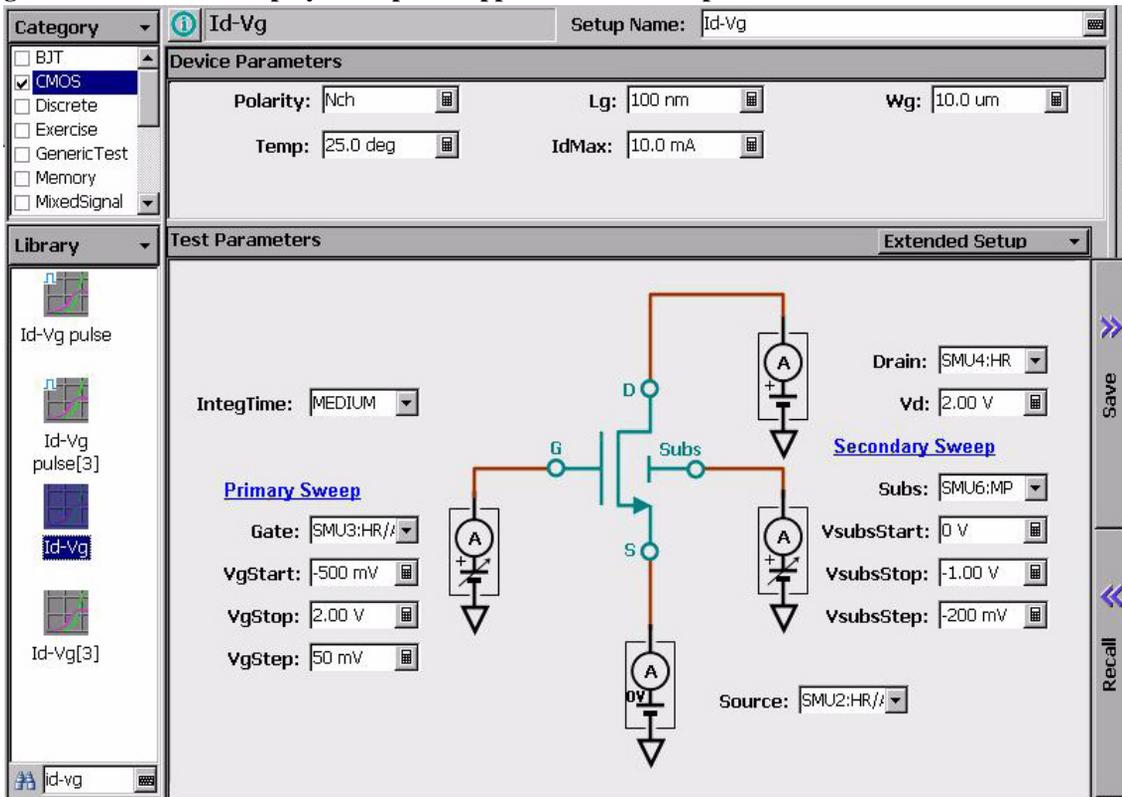
See “To Perform Measurement” on page 1-14 to start measurement.

NOTE

Test Definitions

Test definitions are the built-in test setups that have been defined and stored in the EasyEXPERT as the application library. The EasyEXPERT contains more than two hundred test definitions. You can execute the test without modifications. Also you can create your own test setup/definition by making any changes. All furnished test definitions are just sample. Agilent Technologies is NOT LIABLE for any damages caused by the samples.

Figure 1-5 Display Example of Application Test Setup Screen



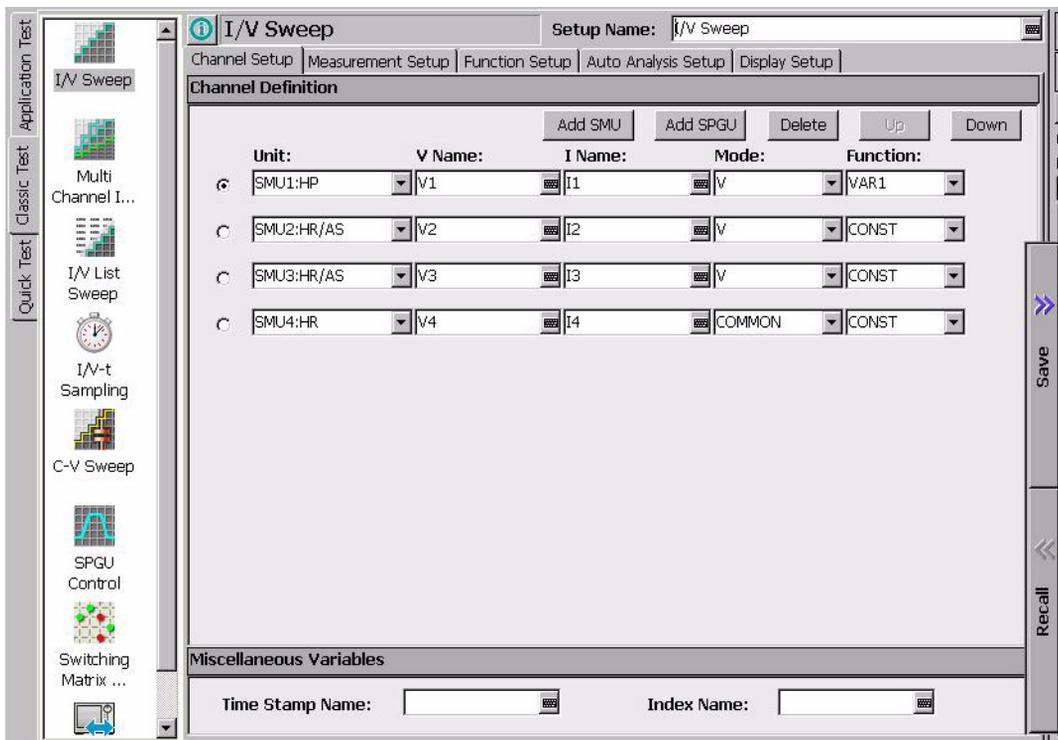
To Use Classic Test Mode

The following procedure performs the I/V Sweep classic test setup.

1. Click the Classic Test tab on the main screen. The tab is in the leftmost column on the screen.
2. Click I/V Sweep and Select button sequentially. The I/V Sweep Channel Setup screen is displayed. See Figure 1-6.
3. Set the Channel Setup parameters as shown in Table 1-1.
4. Click the Measurement Setup tab and set the parameters as shown in Table 1-2.
5. Click the Display Setup tab and set the parameters as shown in Table 1-3.

To enter the value, use the USB keyboard or the screen/numeric keyboard opened by clicking the button to the right of the entry field.

Figure 1-6 Display Example of I/V Sweep Channel Setup Screen



See “To Perform Measurement” on page 1-14 to start measurement.

Table 1-1 I/V Sweep Channel Setup

| Unit | V Name | I Name | Mode ^a | Function |
|------|--------|--------|-------------------|----------|
| SMU1 | V1 | I1 | V | VAR1 |
| SMU2 | V2 | I2 | V | CONST |

a. Channel output mode. Set I or IPULSE for the current output and voltage measurement. Set V, VPULSE, or COMMON for the voltage output and current measurement.

Table 1-2 I/V Sweep Measurement Setup

| VAR1 | | Timing | | Constants | |
|------------|--------|--------|-----|------------|-----------------|
| Unit | SMU1 | Hold | 0 s | Unit | SMU2 |
| Name | V1 | Delay | 0 s | V Name | V2 |
| Direction | Single | | | I Name | I2 |
| Linear/Log | LINEAR | | | Mode | V |
| Start | 0 V | | | Source | 0 V |
| Stop | 1 V | | | Compliance | 100 mA |
| Step | 10 mV | | | | |
| No of Step | 101 | | | | |
| Compliance | 100 mA | | | | |
| Pwr Comp | OFF | | | Sweep | CONTINUE AT ANY |

Table 1-3 I/V Sweep Display Setup

| | Name | Sharing | Scale | Min | Max |
|-----------|------|---------|--------|-------|------|
| X | V1 | (None) | Linear | 0 V | 1 V |
| Y1 | I1 | (None) | Linear | -1 pA | 1 pA |

To Perform Measurement

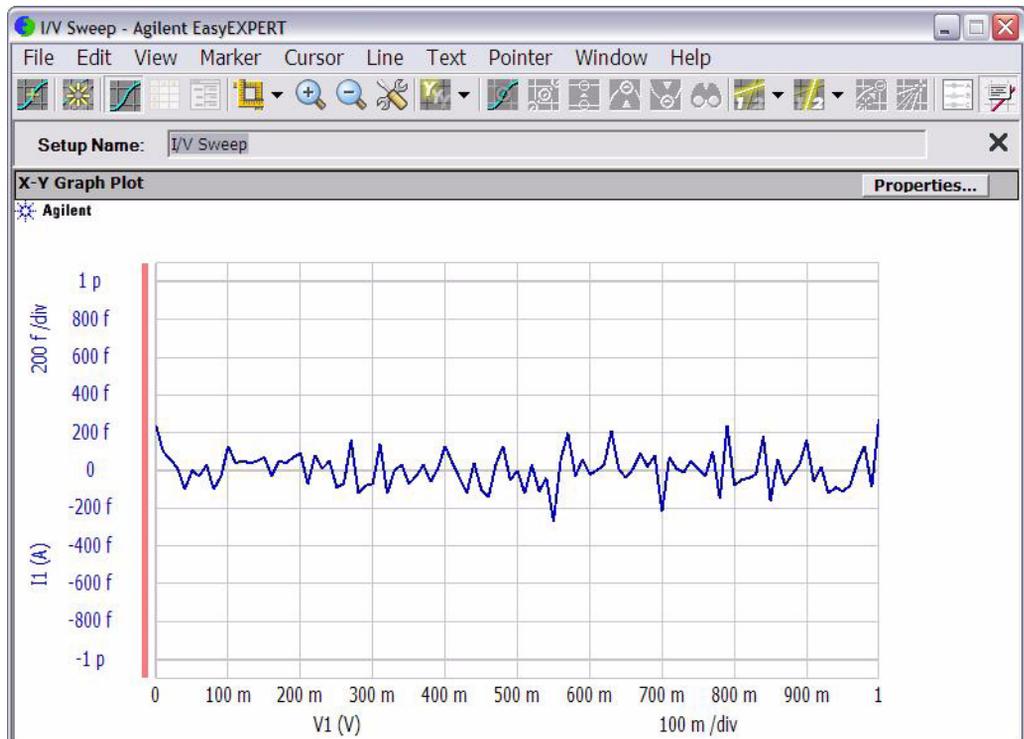
1. Click the Single button (upper right on the main screen) to start measurement. This opens the Data Display window and starts a single sweep measurement.



After the measurement, the measurement data is displayed on the Data Display window. For the measurement after performing “To Use Classic Test Mode” on page 1-12, you will have the test result as shown in Figure 1-7. This is the leakage current measurement result because all measurement terminal is opened for performing the procedures described in this chapter.

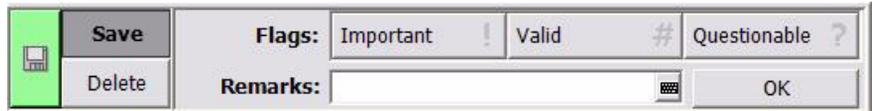
2. If the automatic data record function has been set to ON (Auto Record ON), Test Result Editor appears on the lower area of the screen when the measurement is completed. See “To Use Test Result Editor” on page 1-15.

Figure 1-7 Display Example of Data Display Window



To Use Test Result Editor

The Test Result Editor provides the following GUI to set a flag and remarks to the test result record.



- Save button and Delete button

Divides test records into groups, Save and Delete.

Test records in Save-group are always listed in the lower area of the EasyEXPERT main screen.

Test records in Delete-group can be listed when Results > Filter > Show Deleted Data is checked.

- Flags buttons

The following buttons are available. You can set one of the following flags.

- Important ! button

Sets the important flag (!) to the test result record.

- Valid # button

Sets the valid flag (#) to the test result record.

- Questionable ? button

Sets the questionable flag (?) to the test result record.

- Remarks field

You can enter characters into this field. The characters will be recorded as the Remarks value of the test result record.

- OK button

Applies the setup on the Test Result Editor, and closes this dialog box.

To Use Analysis Tools

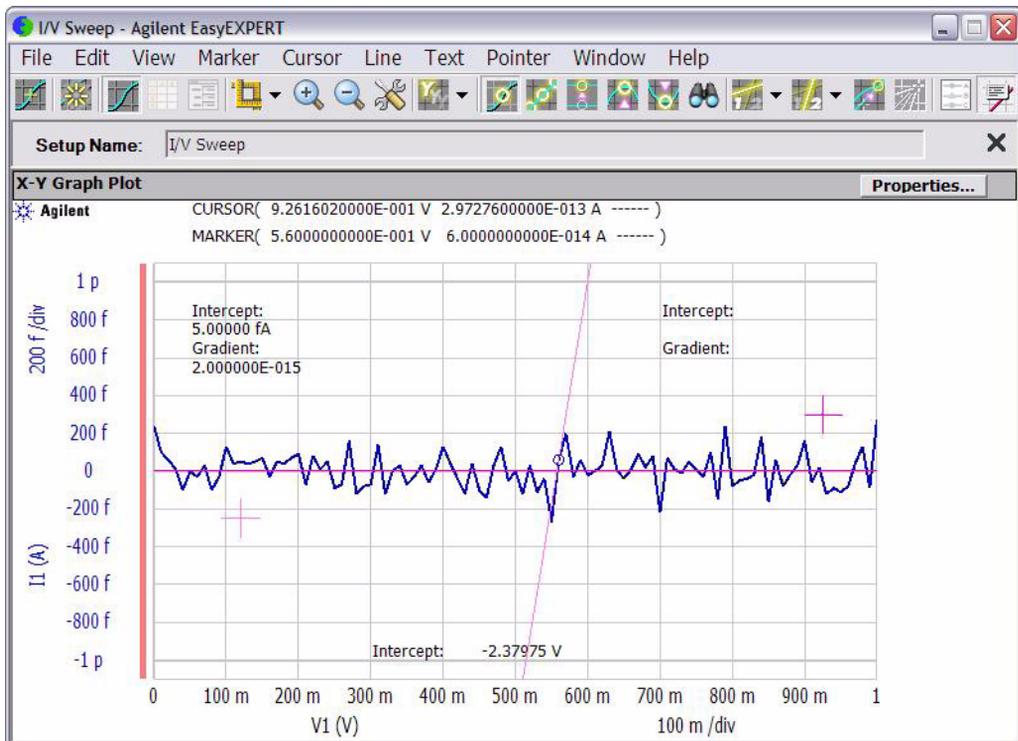
The Data Display window provides several analysis functions.

- View menu: used to adjust the graph scale.
- Marker menu: used to display and control the marker.
- Cursor menu: used to display and control the cursor.
- Line menu: used to display and control the lines.

When the marker, cursor, and lines are effective, their parameters are also displayed on the X-Y Graph Plot area.

Figure 1-8 is an example displaying marker, tangent line, and regression line on the test result graph shown in Figure 1-7. You can read position of the marker and the active cursor, and intercept and gradient of the active line.

Figure 1-8 Display Example of Analysis Tools



Introduction

This chapter describes the basic functions and features of Agilent B1500A Semiconductor Device Analyzer, and consists of the following sections:

- “Overview”
- “Front View”
- “Rear View”
- “Measurement Units”
- “Specifications”
- “Accessories and Options”

NOTE

Application Library

Agilent B1500A has installed Agilent EasyEXPERT software as the user interface. The EasyEXPERT contains an application library that is a set of test definitions. The application test can be performed by selecting a test definition and setting the test condition for the actual DUT (device under test).

All test definitions are just sample. If the samples damage your devices, Agilent Technologies is NOT LIABLE for the damage.

NOTE

Utility

The folder C:\Program Files\Agilent\B1500\EasyEXPERT\Utilities stores the following sample programs.

- Prober control programs
- 4155/4156 setup file converter
- sleep.exe program

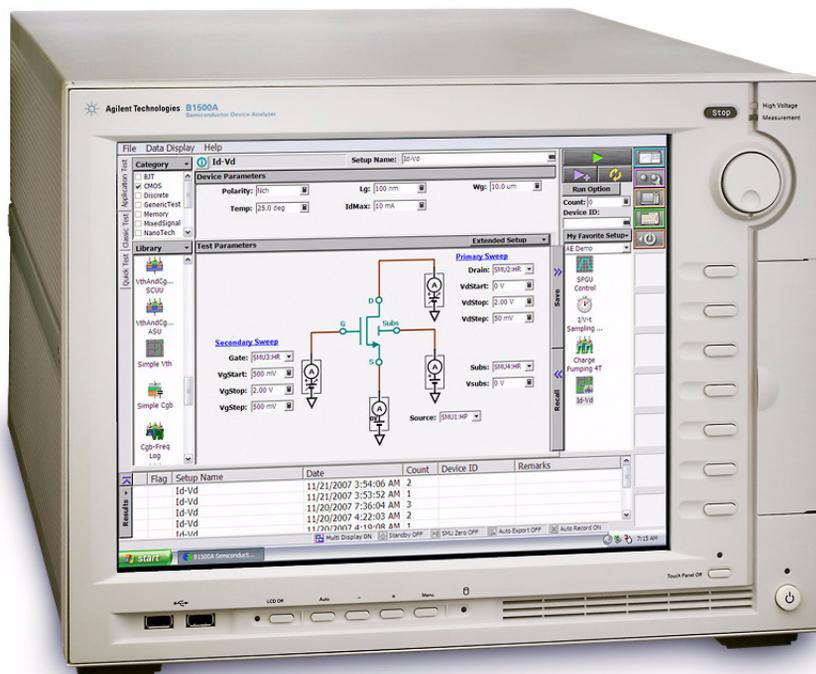
For more details, see Chapter 10, “Application Library and Utilities.”

Overview

Agilent B1500A Semiconductor Device Analyzer is the new generation one box solution for the semiconductor device DC/AC parametric measurement and analysis application. You can perform measurement and analysis easily and effectively on the Microsoft Windows environment with intuitive graphical user interface, touch screen LCD panel, keyboard, and mouse by using Agilent B1500A.

Agilent B1500A provides the DC voltage/current output capability, the DC voltage/current measurement capability, and the AC signal output and impedance measurement capability. So you can perform the current-voltage sweep measurement and the capacitance-voltage sweep measurement for example by one instrument. You can also analyze the measurement result characteristics graph by using several tools such as markers, cursors, and lines.

Also, in the GPIB remote control mode, you can control the B1500A from an external computer by using Agilent FLEX command set that is the common language for Agilent semiconductor DC measurement instruments. So you can reuse the measurement program created for Agilent 4155/4156/E5260/E5270.



Introduction

Overview

- Agilent B1500A Semiconductor Device Analyzer
Mainframe that provides the ground unit (GNDU) and ten empty slots for the measurement facilities, and Agilent EasyEXPERT software for the operating environment. The EasyEXPERT is the GUI based measurement control and analysis software runs on the Microsoft Windows XP Professional.
The B1500A is equipped with the 15 inch LCD with touch panel, hard disk drive, DVD-ROM/CD-ROM/CD-RW drive, and USB/LAN/GP-IB interfaces. The USB keyboard, the USB mouse, and the stylus pen are available as option.
- Agilent B1510A HPSMU module
High power source/monitor unit module. Occupies two slots.
- Agilent B1511A MPSMU module
Medium power source/monitor unit module. Occupies one slot.
- Agilent B1517A HRSMU module
High resolution source/monitor unit module. Occupies one slot. Needs Agilent E5288A ASU to perform atto level current measurement or automatic switching of the measurement resource connection.
- Agilent B1520A MFCMU module
Multi frequency capacitance measurement unit module. Occupies one slot. Needs Agilent N1301A-100 SCUU to perform automatic switching of the measurement resource connection.
- Agilent B1525A SPGU module
High voltage semiconductor pulse generator unit module. Occupies one slot. Up to five modules can be installed in one B1500A mainframe. One module provides two output channels. Needs Agilent 16440A and 16445A to perform automatic switching of the measurement resource connection.
- Agilent B1530A WGF MU module and Agilent B1531A RSU
Waveform generator/fast measurement unit module and the remote-sense and switch unit. Occupies one slot. Up to five modules can be installed in one B1500A mainframe. One module provides two channels. See Agilent B1530A *User's Guide* for using the WGF MU.
- Agilent 16440A SMU/Pulse Generator Selector
Used to switch the measurement resource connected to the DUT. The measurement resource can be SPGU or SMU. Needs the 16445A adapter to use the selector. One selector provides two switching channels.

- Agilent 16445A Selector Adapter
Used to connect the 16440A selector to the B1500A. Two selectors can be connected.
- Agilent E5288A ASU
Atto sense and switch unit (ASU). Used to enable the 1 pA range for the atto level current measurement, also switch the measurement resource connected to the DUT. The measurement resource can be HRSMU or the instrument connected to the AUX terminal.
- Agilent N1301A-100 SCUU
SMU CMU unify unit (SCUU). Used to switch the measurement resource connected to the DUT. The measurement resource can be CMU or one of two SMUs connected to the SCUU.
- Agilent N1301A-200 GSWU
Guard switch unit (GSWU). Needs the SCUU to use the GSWU. Effective for the accurate impedance measurements by connecting the guard lines between CMU high and low near the DUT.

Agilent EasyEXPERT Software

Agilent EasyEXPERT software is a specially-designed Windows XP application program for controlling Agilent B1500A. The EasyEXPERT provides the easy and effective measurement and analysis environment with intuitive graphical user interface (GUI), touch screen LCD panel, keyboard, and mouse. Some of the functions are listed below.

- Single measurement, repeat measurement, and append measurement
- Switching matrix control
Supported models:
 - Agilent B2200A/B2201A switching matrix
 - Agilent E5250A switching matrix with E5252A (EasyEXPERT Plus edition)
- Measurement/setup data management by workspace
- Graph display and analysis with markers, cursors, and lines; and auto analysis
- Data import/export capability, data output by CSV/XML format, and graph output by EMF/BMP/GIF/PNG format
- Maintenance; self-test and self-calibration

[Introduction](#)

[Overview](#)

The EasyEXPERT has the following measurement execution environments.

- Application test
- Classic test
- Quick test

Application Test

The EasyEXPERT contains an application library that supports typical measurements for CMOS devices, TFT, BJT, memory, nanotechnology devices such as CNT FET, and so on. The application library includes more than two hundred test definitions.

You can perform measurements by choosing the best one for your device under test (DUT) from the application libraries, and modifying and executing it. Modification is really simple. For example, it will be completed by changing the output voltage only to DUT terminals. And the setup with your modifications can be saved and recalled as your setup (*My Favorite Setup*).

Classic Test

You can perform measurements by using the user interface similar to the semiconductor parameter analyzers such as Agilent 4156C. The setup can be made by entering values into the setup tables used for the measurement module control. And it can be saved and recalled as your setup (*My Favorite Setup*). This measurement environment provides the following functions.

- I/V Sweep
- Multi Channel I/V Sweep
- I/V List Sweep
- I/V-t Sampling
- C-V Sweep
- SPGU Control
- Switching Matrix Control
- Direct Control

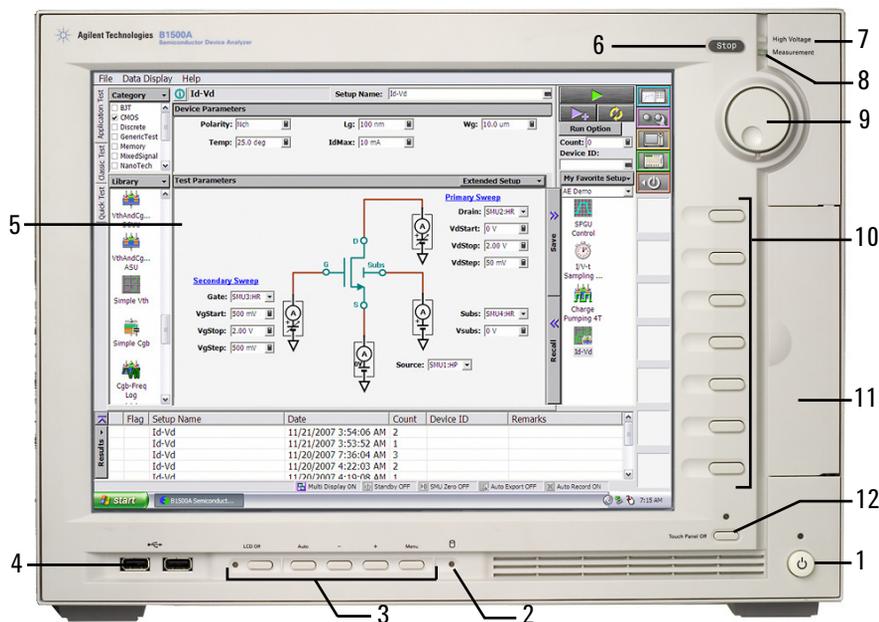
The Direct Control test mode is used to control the measurement modules directly by using the B1500A GPIB control commands and perform measurement. For the control commands, see “Agilent B1500A Programming Guide”.

Quick Test

You can execute the test setups saved in a preset group (*My Favorite Setup*) sequentially.

Front View

This section describes the front view of Agilent B1500A.



1. Standby switch

Turns the B1500A on. Pressing the button in the ON state makes the B1500A in the standby state. The green LED lights when the B1500A is in the ON state.

NOTE

When turning the B1500A on

Open the measurement terminals at the device side when turning the B1500A on. Also disconnect the device from the measurement terminals and open the measurement terminals after the measurement. If you leave the connection with the device, the device may be damaged by unexpected operations or charge-up of measurement cables.

2. HDD access indicator

This green LED lights in the access status of HDD or DVD-ROM/CD-ROM/CD-RW drive. Do not turn the B1500A off during this LED lights.

Introduction

Front View

3. OSD buttons

LCD Off enables or disables the LCD panel. The green LED lights when the LCD is disabled.

Four keys are available for the display adjustment. Press Auto to perform adjustment automatically. Use -, +, and Menu to adjust manually.

4. USB interfaces

USB, 2 ports. For keyboard, mouse, and so on. USB keyboard and USB mouse are available as option.

5. LCD panel

15 inch TFT XGA display, 1024 × 768 resolution. Displays the Windows screen, Agilent EasyEXPERT software window, and so on. Touch screen operation is available when the Touch Panel Off indicator does not light.

NOTE

About screen adjustment

If you find swinging or flickering in screen while you use this instrument, perform the screen adjustment. In most cases, the symptoms can be resolved by pressing the Auto button below the LCD panel. The Auto button is used to start the automatic screen adjustment. Also the manual screen adjustment is available by using the adjustment menu displayed by pressing the Menu button.

6. Stop key

Stops the present measurement or source output immediately.

7. High voltage status indicator

This red LED lights when a source channel applies more than ± 42 V.

8. Measurement status indicator

This green LED lights when a measurement channel performs measurement.

9. Rotary knob

Works on Agilent EasyEXPERT environment. Rotating the knob moves the marker on the graph window, or increases/decreases/changes the value in the active entry field. Pressing the knob sets or enters the value.

10. Softkeys

Seven softkeys are available for Agilent EasyEXPERT environment. Used to select an alternative for the entry field specified or the dialog box.

11. DVD-ROM/CD-ROM/CD-RW drive

For data backup, B1500A update, or data transfer.

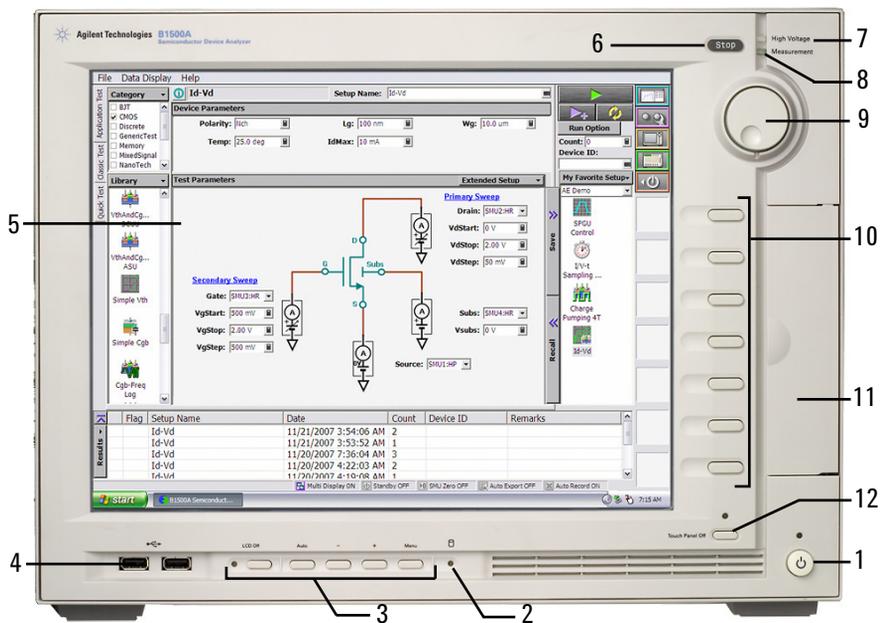
12. Touch Panel Off key

Works on Agilent EasyEXPERT environment. Enables or disables the touch screen operation. The green LED lights when the touch screen is disabled.

NOTE

To disable the touch panel

Use Touch Panel Device Properties, and remove the check from the Enabled box on the Advanced tab screen. The Touch Panel Device Properties dialog box can be opened by selecting Gunze TPDD > Adjust Settings from Windows program menu.



Rear View

This section describes the rear view of Agilent B1500A.



1. Serial number

You need this *serial number* when using Agilent Technologies telephone assistance program.

2. LED status indicator

For troubleshooting. Followings are some examples.

- Both LEDs turn off:
B1500A is in the standby state and Standby switch is OFF position.
- One LED turns green:
Power supply works normally.
- Both LEDs turn orange:
B1500A is in the standby state and Standby switch is ON position.

3. LINE input receptacle

AC power cable is connected to this receptacle.

4. GPIB interface

Use an Agilent 82357A USB/GPIB interface or Agilent 10833A/B/C/D GPIB cable to connect to an external computer or equipment.

5. Module slot

Ten slots are available for installing the modules. Several kinds of module can be installed in the B1500A. However, the allowable number to install is different by the module type. See “Measurement Units” on page 2-16. Also, there is a rule for the installation order by the module type. See Chapter 3, “Installation.”

If the WGFMU is installed, the following condition must be satisfied by the modules installed in the B1500A.

Total rating (sum of ratings set to modules) < 60

Rating of module: HPSMU 14, MPSMU 2, HRSMU 2, CMU 7, SPGU 12, WGFMU 10

For example, if the B1500A installs two HPSMU, one CMU, and two WGFMU, the total rating is $2 \times 14 + 7 + 2 \times 10 = 55$.

 6. Circuit Common () and Frame ground () terminals

Normally, connect the terminals together by using the shorting bar (Agilent part number 5000-4206). For floating measurement, remove the shorting bar.

CAUTION

For floating measurement, do not apply voltage more than ± 42 V to the Circuit Common terminal. Failure to heed this caution may result in damage to the B1500A.

WARNING

If the Circuit Common terminal is *not* connected to the frame ground terminal (for floating measurement), a potential shock hazard may present. Do not touch any of measurement circuit at any time while a floating measurement is in progress.

7. Zero Check terminal

Ground reference point of the B1500A.

CAUTION

The Zero Check terminal can be used for the service purpose only. For the B1500A normal operation, leave this terminal open and do not connect anything to this terminal. Connecting anything can damage the B1500A.

Introduction

Rear View

8. GNDU terminal

0 V constant voltage source. Used for the reference of measurement ground. Triaxial connector.

9. LAN interface

RJ45 connector.

10. USB interfaces

USB, 2 ports. For keyboard, mouse, or peripherals. USB keyboard and USB mouse are available as option.

11. Ext Trig terminals

Two BNC connectors, one for trigger input, and one for trigger output. For details about the trigger function, see *Programming Guide*.

12. Digital I/O terminal

DSUB 25 pin connector. Can be used for the trigger input/output terminals or an interface to control an external relay circuit and so on. For details, see *Programming Guide*. This connector is also used to connect Agilent 16445A selector adapter.



13. Interlock terminal

Used in conjunction with the interlock function of the B1500A. If the Interlock terminal is open, maximum SMU output is limited to ± 42 V. Be sure to connect this terminal to the 16442B test fixture or connector plate before performing measurement. If you use a connector plate, you must install an interlock circuit. For details on how to install the interlock circuit, see “To Make an Interlock Circuit” on page 3-29.

WARNING

Dangerous voltage of up to the maximum voltage of SMUs may be present at force, guard, and sense terminals if the Interlock terminal is closed.



A. GNDU/ADC

Ground unit and A/D converter module. Always installed in the B1500A.

B. SPGU module

The semiconductor pulse generator unit (SPGU) has the Output 1 and Output 2 terminals and the following terminals to synchronize the operation between SPGUs or with an external equipment.

Ref Out/Sync Out: Connect to the Ref In/Sync In of the slave SPGU.

Ref In/Sync In: Connect to the Ref Out/Sync Out of the master SPGU.

Trig Out: Connect to the trigger input terminal of the equipment synchronized with the SPGU output.

CAUTION

Connect the Ref Out/In, Sync Out/In, and Trig Out terminals to the specified terminal properly. Connecting to the other terminal may result in damage to the SPGU.

In the EasyEXPERT operation mode, the SPGU outputs can be specified by the PG number. PG1 and PG2 are assigned to the Output 1 and Output 2 terminals of the SPGU at the lowest position. And the following PG numbers are assigned to the outputs of the upper SPGUs in sequence. Use the PG number label furnished with the B1500A or equivalent to identify the SPGU channel number.

 C. WGFMU module

The waveform generator/fast measurement unit (WGFMU) has the Ch 1 and Ch 2 terminals and the following terminals to synchronize the operation between WGFMUs or with an external equipment.

Sync Out: Connect to the Sync In of the slave WGFMU.

Sync In: Connect to the Sync Out of the master WGFMU.

Trig Out: Connect to the trigger input terminal of the equipment synchronized with the WGFMU output.

CAUTION

Connect the Sync Out/In, and Trig Out terminals to the specified terminal properly. Connecting to the other terminal may result in damage to the WGFMU.

Connect the connection cable between the WGFMU and the RSU (remote-sense and switch unit) before turning the B1500A on. Changing the cable connection in the power on state may damage the WGFMU and RSU. See Agilent B1530A *User's Guide* for cable connection and usage.

 D. SMU module

The source/monitor unit (SMU) has two triaxial connectors, force and sense, for the Kelvin connections. The HRSMU (high resolution SMU) also provides a D-sub connector (To ASU terminal) which is used to connect the dedicated ASU (atto sense and switch unit). The HPSMU (high power SMU) occupies two slots.

In the EasyEXPERT operation mode, the SMUs can be specified by the SMU number. SMU1 is assigned to the SMU at the lowest position. And the following SMU numbers are assigned to the upper SMUs in sequence. Use the SMU number label furnished with the B1500A or equivalent to identify the SMU number.

NOTE

To use the ASU, connect the connection cables between the HRSMU and the dedicated ASU before turning the B1500A on.

WARNING

There are potentially hazardous voltages (200 V for HPSMU, and 100 V for MPSMU/HRSMU/ASU) present at the Force, Sense, and Guard terminals of Agilent B1500A. To prevent electrical shock, the following safety precautions must be observed during the use of the B1500A.

- a. Use a three-conductor AC power cable to connect the cabinet (if used) and the B1500A to an electrical ground (safety ground).
- b. If you do *not* use the 16442B test fixture, you must install and connect an interlock circuit that opens the Interlock terminal when the shielding box access door is opened.
- c. Confirm periodically that the interlock function works normally.
- d. Before touching the connections on the Force, Guard, and Sense terminals, turn the B1500A off and discharge any capacitors. If you do *not* turn the B1500A off, complete *all* of the following items, regardless of the B1500A settings.
 - Press the Stop key to set the module output off.
 - Confirm that the High Voltage indicator is not lit.
 - Open the shielding box access door (open the Interlock terminal).
 - Discharge any capacitors connected to an SMU.
- e. Warn persons working around the B1500A about dangerous conditions.

 E. CMU module

The multi frequency capacitance measurement unit (MFCMU) has four coaxial connectors, Lcur, Lpot, Hpot, and Hcur, for the four-terminal pair connection. The Hcur and Hpot have to be connected together at a terminal of the device under test (DUT). Also the Lcur and Lpot have to be connected together at the other terminal of the DUT. Then, the guard lines of four-terminal pair must be connected together.

CAUTION

Do not apply voltage more than ± 25 V to the MFCMU input terminals. Failure to heed this caution may result in damage to the module.

Measurement Units

Agilent B1500A can be equipped with the following measurement modules.

- “GNDU - Ground Unit”
- “B1510A High Power SMU”
- “B1511A Medium Power SMU”
- “B1517A High Resolution SMU”
- “B1520A Multi Frequency CMU”
- “B1525A High Voltage SPGU”
- “B1530A WGFMU”

See “Using EasyEXPERT” on page 4-1 for the functions available for Agilent EasyEXPERT software. See *Programming Guide* for the functions available for the GPIB remote mode. See Agilent B1530A *User’s Guide* for using the WGFMU.

GNDU - Ground Unit

Agilent B1500A is equipped with the ground unit (GNDU). The GNDU is a 0 V constant voltage source, and used for the reference of measurement ground. Also the GNDU can sink up to ± 4.2 A, so it is effective for using the HPSMU (high power SMU). Figure 2-1 is a simplified circuit diagram of GNDU.

Figure 2-1

Simplified GNDU Circuit Diagram



About SMU

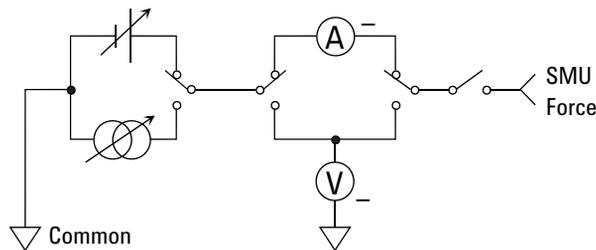
Source/monitor unit (SMU) can apply DC voltage or current, and can measure DC current or voltage. Figure 2-2 is a simplified SMU circuit diagram. The SMU can perform the following operations:

- Apply voltage and measures current
- Apply current and measures voltage
- Apply voltage and measures voltage
- Apply current and measures current

NOTE

To select the SMU operation mode in the GPIB remote condition, enter the CMM command.

Figure 2-2 Simplified SMU Circuit Diagram



Compliance

The SMU has a compliance feature that limits output voltage or current to prevent damage to the device under test. When the SMU applies voltage, you can specify current compliance. When the SMU applies current, you can specify voltage compliance. For details about the compliance, refer to “SMU Compliance” on page 7-53.

B1510A High Power SMU

This section describes typical specification of the high power source/monitor unit (HPSMU) for Agilent B1500A. Maximum four modules can be installed in one mainframe.

- Maximum voltage, current, output power: ± 200 V, ± 1 A, 20 W
- Minimum range: 2 V, 1 nA
- Output/measurement value and resolution: see Table 2-1 to Table 2-4.

Figure 2-3

HPSMU Output and Measurement Ranges

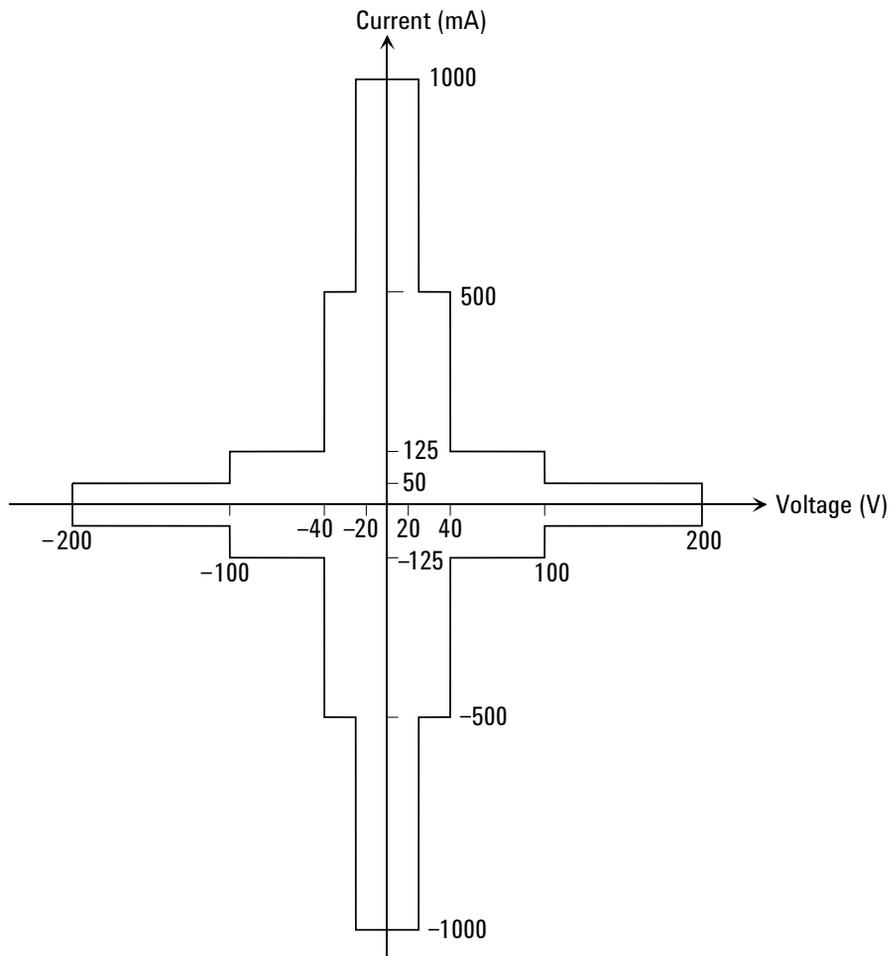


Table 2-1 HPSMU Output Voltage Ranges and Resolutions

| Range | Output Value | Setting Resolution | Maximum Current |
|-------|---------------------------------|--------------------|-----------------------|
| 2 V | $0 \leq V \leq 2 \text{ V}$ | 100 μV | $\pm 1000 \text{ mA}$ |
| 20 V | $0 \leq V \leq 20 \text{ V}$ | 1 mV | $\pm 1000 \text{ mA}$ |
| 40 V | $0 \leq V \leq 40 \text{ V}$ | 2 mV | $\pm 500 \text{ mA}$ |
| 100 V | $0 \leq V \leq 100 \text{ V}$ | 5 mV | $\pm 125 \text{ mA}$ |
| 200 V | $0 \leq V \leq 200 \text{ V}$ | 10 mV | $\pm 50 \text{ mA}$ |

Table 2-2 HPSMU Output Current Ranges and Resolutions

| Range | Output Value | Setting Resolution | Maximum Voltage |
|-------------------|--|--------------------|---------------------|
| 1 nA | $0 \leq I \leq 1.15 \text{ nA}$ | 50 fA | $\pm 200 \text{ V}$ |
| 10 nA | $0 \leq I \leq 11.5 \text{ nA}$ | 500 fA | $\pm 200 \text{ V}$ |
| 100 nA | $0 \leq I \leq 115 \text{ nA}$ | 5 pA | $\pm 200 \text{ V}$ |
| 1 μA | $0 \leq I \leq 1.15 \mu\text{A}$ | 50 pA | $\pm 200 \text{ V}$ |
| 10 μA | $0 \leq I \leq 11.5 \mu\text{A}$ | 500 pA | $\pm 200 \text{ V}$ |
| 100 μA | $0 \leq I \leq 115 \mu\text{A}$ | 5 nA | $\pm 200 \text{ V}$ |
| 1 mA | $0 \leq I \leq 1.15 \text{ mA}$ | 50 nA | $\pm 200 \text{ V}$ |
| 10 mA | $0 \leq I \leq 11.5 \text{ mA}$ | 500 nA | $\pm 200 \text{ V}$ |
| 100 mA | $0 \leq I \leq 50 \text{ mA}$ | 5 μA | $\pm 200 \text{ V}$ |
| | $50 \text{ mA} < I \leq 115 \text{ mA}$ | 5 μA | $\pm 100 \text{ V}$ |
| 1 A | $0 \leq I \leq 50 \text{ mA}$ | 50 μA | $\pm 200 \text{ V}$ |
| | $50 \text{ mA} < I \leq 125 \text{ mA}$ | 50 μA | $\pm 100 \text{ V}$ |
| | $125 \text{ mA} < I \leq 500 \text{ mA}$ | 50 μA | $\pm 40 \text{ V}$ |
| | $500 \text{ mA} < I \leq 1 \text{ A}$ | 50 μA | $\pm 20 \text{ V}$ |

Table 2-3 HPSMU Measurement Voltage Values and Resolutions

| Range | Measurement Value ^a | Measurement Resolutions | |
|-------|---------------------------------|-------------------------|---------------------|
| | | High Speed ADC | High Resolution ADC |
| 2 V | $0 \leq V \leq 2.2 \text{ V}$ | 100 μV | 2 μV |
| 20 V | $0 \leq V \leq 22 \text{ V}$ | 1 mV | 20 μV |
| 40 V | $0 \leq V \leq 44 \text{ V}$ | 2 mV | 40 μV |
| 100 V | $0 \leq V \leq 110 \text{ V}$ | 5 mV | 100 μV |
| 200 V | $0 \leq V \leq 200 \text{ V}$ | 10 mV | 200 μV |

Table 2-4 HPSMU Measurement Current Values and Resolutions

| Range | Measurement Value ^a | Measurement Resolutions | |
|-------------------|--|-------------------------|---------------------|
| | | High Speed ADC | High Resolution ADC |
| 1 nA | $0 \leq I \leq 1.15 \text{ nA}$ | 50 fA | 10 fA |
| 10 nA | $0 \leq I \leq 11.5 \text{ nA}$ | 500 fA | 10 fA |
| 100 nA | $0 \leq I \leq 115 \text{ nA}$ | 5 pA | 100 fA |
| 1 μA | $0 \leq I \leq 1.15 \text{ }\mu\text{A}$ | 50 pA | 1 pA |
| 10 μA | $0 \leq I \leq 11.5 \text{ }\mu\text{A}$ | 500 pA | 10 pA |
| 100 μA | $0 \leq I \leq 115 \text{ }\mu\text{A}$ | 5 nA | 100 pA |
| 1 mA | $0 \leq I \leq 1.15 \text{ mA}$ | 50 nA | 1 nA |
| 10 mA | $0 \leq I \leq 11.5 \text{ mA}$ | 500 nA | 10 nA |
| 100 mA | $0 \leq I \leq 115 \text{ mA}$ | 5 μA | 100 nA |
| 1 A | $0 \leq I \leq 1 \text{ A}$ | 50 μA | 1 μA |

a. This column is applied to the auto ranging or the limited auto ranging. For fixed ranging, maximum measurement value is **Range** column value.

B1511A Medium Power SMU

This section describes typical specification of the medium power source/monitor unit (MPSMU) for Agilent B1500A.

- Maximum voltage, current, output power: ± 100 V, ± 100 mA, 2 W
- Minimum range: 0.5 V, 1 nA
- Output/measurement value and resolution: see Table 2-5 to Table 2-8.

Figure 2-4

MPSMU Output and Measurement Ranges

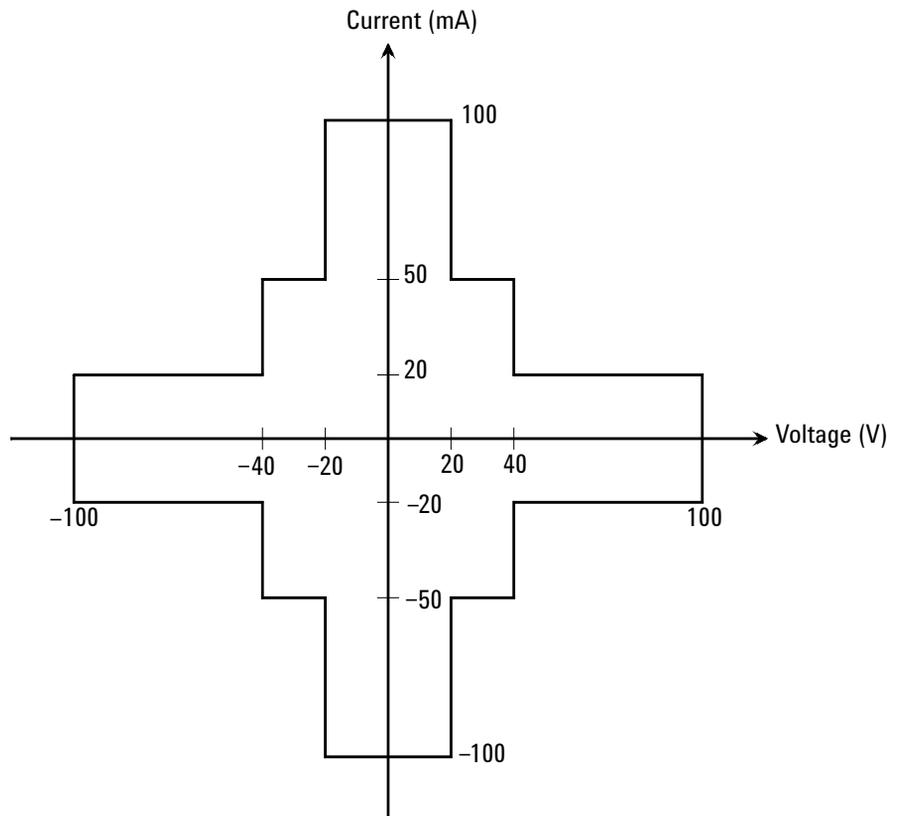


Table 2-5 **MPSMU Output Voltage Ranges and Resolutions**

| Range | Output Value | Setting Resolution | Maximum Current |
|-------|---|--------------------|----------------------|
| 0.5 V | $0 \leq V \leq 0.5 \text{ V}$ | 25 μV | $\pm 100 \text{ mA}$ |
| 2 V | $0 \leq V \leq 2 \text{ V}$ | 100 μV | $\pm 100 \text{ mA}$ |
| 5 V | $0 \leq V \leq 5 \text{ V}$ | 250 μV | $\pm 100 \text{ mA}$ |
| 20 V | $0 \leq V \leq 20 \text{ V}$ | 1 mV | $\pm 100 \text{ mA}$ |
| 40 V | $0 \leq V \leq 20 \text{ V}$ | 2 mV | $\pm 100 \text{ mA}$ |
| | $20 \text{ V} < V \leq 40 \text{ V}$ | 2 mV | $\pm 50 \text{ mA}$ |
| 100 V | $0 \leq V \leq 20 \text{ V}$ | 5 mV | $\pm 100 \text{ mA}$ |
| | $20 \text{ V} < V \leq 40 \text{ V}$ | 5 mV | $\pm 50 \text{ mA}$ |
| | $40 \text{ V} < V \leq 100 \text{ V}$ | 5 mV | $\pm 20 \text{ mA}$ |

Table 2-6 **MPSMU Output Current Ranges and Resolutions**

| Range | Output Value | Setting Resolution | Maximum Voltage |
|-------------------|---|--------------------|---------------------|
| 1 nA | $0 \leq I \leq 1.15 \text{ nA}$ | 50 fA | $\pm 100 \text{ V}$ |
| 10 nA | $0 \leq I \leq 11.5 \text{ nA}$ | 500 fA | $\pm 100 \text{ V}$ |
| 100 nA | $0 \leq I \leq 115 \text{ nA}$ | 5 pA | $\pm 100 \text{ V}$ |
| 1 μA | $0 \leq I \leq 1.15 \mu\text{A}$ | 50 pA | $\pm 100 \text{ V}$ |
| 10 μA | $0 \leq I \leq 11.5 \mu\text{A}$ | 500 pA | $\pm 100 \text{ V}$ |
| 100 μA | $0 \leq I \leq 115 \mu\text{A}$ | 5 nA | $\pm 100 \text{ V}$ |
| 1 mA | $0 \leq I \leq 1.15 \text{ mA}$ | 50 nA | $\pm 100 \text{ V}$ |
| 10 mA | $0 \leq I \leq 11.5 \text{ mA}$ | 500 nA | $\pm 100 \text{ V}$ |
| 100 mA | $0 \leq I \leq 20 \text{ mA}$ | 5 μA | $\pm 100 \text{ V}$ |
| | $20 \text{ mA} < I \leq 50 \text{ mA}$ | 5 μA | $\pm 40 \text{ V}$ |
| | $50 \text{ mA} < I \leq 100 \text{ mA}$ | 5 μA | $\pm 20 \text{ V}$ |

Table 2-7 MPSMU Measurement Voltage Values and Resolutions

| Range | Measurement Value ^a | Measurement Resolutions | |
|-------|----------------------------------|-------------------------|---------------------|
| | | High Speed ADC | High Resolution ADC |
| 0.5 V | $0 \leq V \leq 0.55 \text{ V}$ | 25 μV | 0.5 μV |
| 2 V | $0 \leq V \leq 2.2 \text{ V}$ | 100 μV | 2 μV |
| 5 V | $0 \leq V \leq 5.5 \text{ V}$ | 250 μV | 5 μV |
| 20 V | $0 \leq V \leq 22 \text{ V}$ | 1 mV | 20 μV |
| 40 V | $0 \leq V \leq 44 \text{ V}$ | 2 mV | 40 μV |
| 100 V | $0 \leq V \leq 100 \text{ V}$ | 5 mV | 100 μV |

Table 2-8 MPSMU Measurement Current Values and Resolutions

| Range | Measurement Value ^a | Measurement Resolutions | |
|-------------------|---|-------------------------|---------------------|
| | | High Speed ADC | High Resolution ADC |
| 1 nA | $0 \leq I \leq 1.15 \text{ nA}$ | 50 fA | 10 fA |
| 10 nA | $0 \leq I \leq 11.5 \text{ nA}$ | 500 fA | 10 fA |
| 100 nA | $0 \leq I \leq 115 \text{ nA}$ | 5 pA | 100 fA |
| 1 μA | $0 \leq I \leq 1.15 \text{ } \mu\text{A}$ | 50 pA | 1 pA |
| 10 μA | $0 \leq I \leq 11.5 \text{ } \mu\text{A}$ | 500 pA | 10 pA |
| 100 μA | $0 \leq I \leq 115 \text{ } \mu\text{A}$ | 5 nA | 100 pA |
| 1 mA | $0 \leq I \leq 1.15 \text{ mA}$ | 50 nA | 1 nA |
| 10 mA | $0 \leq I \leq 11.5 \text{ mA}$ | 500 nA | 10 nA |
| 100 mA | $0 \leq I \leq 100 \text{ mA}$ | 5 μA | 100 nA |

a. This column is applied to the auto ranging or the limited auto ranging.
For fixed ranging, maximum measurement value is **Range** column value.

B1517A High Resolution SMU

This section describes typical specification of the high resolution source/monitor unit (HRSMU) for Agilent B1500A.

- Maximum voltage, current, output power: ± 100 V, ± 100 mA, 2 W
- Minimum range: 0.5 V, 10 pA (1 pA when the E5288A ASU is used)
- Output/measurement value and resolution: see Table 2-9 to Table 2-12.

Figure 2-5

HRSMU Output and Measurement Ranges

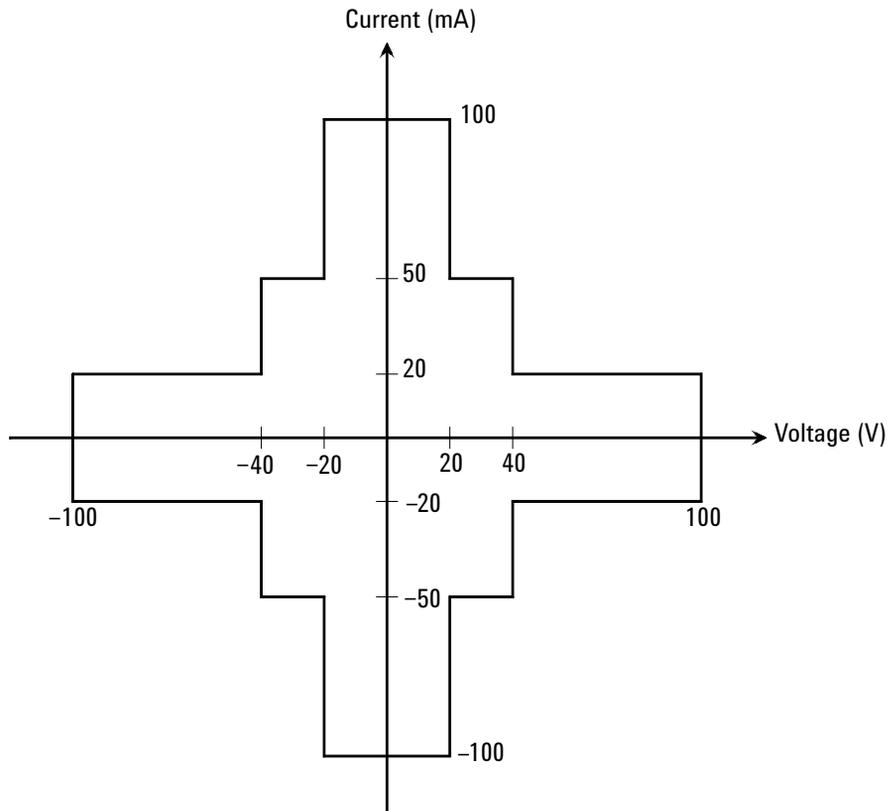


Table 2-9 HRSMU Output Voltage Ranges and Resolutions

| Range | Output Value | Setting Resolution | Maximum Current |
|-------|---|--------------------|----------------------|
| 0.5 V | $0 \leq V \leq 0.5 \text{ V}$ | 25 μV | $\pm 100 \text{ mA}$ |
| 2 V | $0 \leq V \leq 2 \text{ V}$ | 100 μV | $\pm 100 \text{ mA}$ |
| 5 V | $0 \leq V \leq 5 \text{ V}$ | 250 μV | $\pm 100 \text{ mA}$ |
| 20 V | $0 \leq V \leq 20 \text{ V}$ | 1 mV | $\pm 100 \text{ mA}$ |
| 40 V | $0 \leq V \leq 20 \text{ V}$ | 2 mV | $\pm 100 \text{ mA}$ |
| | $20 \text{ V} < V \leq 40 \text{ V}$ | 2 mV | $\pm 50 \text{ mA}$ |
| 100 V | $0 \leq V \leq 20 \text{ V}$ | 5 mV | $\pm 100 \text{ mA}$ |
| | $20 \text{ V} < V \leq 40 \text{ V}$ | 5 mV | $\pm 50 \text{ mA}$ |
| | $40 \text{ V} < V \leq 100 \text{ V}$ | 5 mV | $\pm 20 \text{ mA}$ |

Table 2-10 HRSMU Output Current Ranges and Resolutions

| Range | Output Value | Setting Resolution | Maximum Voltage |
|-------------------|---|--------------------|---------------------|
| 1 pA ^a | $0 \leq I \leq 1.15 \text{ pA}$ | 1 fA | $\pm 100 \text{ V}$ |
| 10 pA | $0 \leq I \leq 11.5 \text{ pA}$ | 5 fA | $\pm 100 \text{ V}$ |
| 100 pA | $0 \leq I \leq 115 \text{ pA}$ | 5 fA | $\pm 100 \text{ V}$ |
| 1 nA | $0 \leq I \leq 1.15 \text{ nA}$ | 50 fA | $\pm 100 \text{ V}$ |
| 10 nA | $0 \leq I \leq 11.5 \text{ nA}$ | 500 fA | $\pm 100 \text{ V}$ |
| 100 nA | $0 \leq I \leq 115 \text{ nA}$ | 5 pA | $\pm 100 \text{ V}$ |
| 1 μA | $0 \leq I \leq 1.15 \mu\text{A}$ | 50 pA | $\pm 100 \text{ V}$ |
| 10 μA | $0 \leq I \leq 11.5 \mu\text{A}$ | 500 pA | $\pm 100 \text{ V}$ |
| 100 μA | $0 \leq I \leq 115 \mu\text{A}$ | 5 nA | $\pm 100 \text{ V}$ |
| 1 mA | $0 \leq I \leq 1.15 \text{ mA}$ | 50 nA | $\pm 100 \text{ V}$ |
| 10 mA | $0 \leq I \leq 11.5 \text{ mA}$ | 500 nA | $\pm 100 \text{ V}$ |
| 100 mA | $0 \leq I \leq 20 \text{ mA}$ | 5 μA | $\pm 100 \text{ V}$ |
| | $20 \text{ mA} < I \leq 50 \text{ mA}$ | 5 μA | $\pm 40 \text{ V}$ |
| | $50 \text{ mA} < I \leq 100 \text{ mA}$ | 5 μA | $\pm 20 \text{ V}$ |

a. Available when the E5288A Atto Sense and Switch Unit (ASU) is used.

Table 2-11 HRSMU Measurement Voltage Values and Resolutions

| Range | Measurement Value ^a | Measurement Resolutions | |
|-------|----------------------------------|-------------------------|---------------------|
| | | High Speed ADC | High Resolution ADC |
| 0.5 V | $0 \leq V \leq 0.55 \text{ V}$ | 25 μV | 0.5 μV |
| 2 V | $0 \leq V \leq 2.2 \text{ V}$ | 100 μV | 2 μV |
| 5 V | $0 \leq V \leq 5.5 \text{ V}$ | 250 μV | 5 μV |
| 20 V | $0 \leq V \leq 22 \text{ V}$ | 1 mV | 20 μV |
| 40 V | $0 \leq V \leq 44 \text{ V}$ | 2 mV | 40 μV |
| 100 V | $0 \leq V \leq 100 \text{ V}$ | 5 mV | 100 μV |

Table 2-12 HRSMU Measurement Current Values and Resolutions

| Range | Measurement Value ^a | Measurement Resolutions | |
|-------------------|---|-------------------------|----------------------------|
| | | High Speed ADC | High Resolution ADC |
| 1 pA ^b | $0 \leq I \leq 1.15 \text{ pA}$ | 100 aA | 100 aA |
| 10 pA | $0 \leq I \leq 11.5 \text{ pA}$ | 1 fA | 1 fA / 400 aA ^b |
| 100 pA | $0 \leq I \leq 115 \text{ pA}$ | 5 fA | 2 fA / 500 aA ^b |
| 1 nA | $0 \leq I \leq 1.15 \text{ nA}$ | 50 fA | 10 fA |
| 10 nA | $0 \leq I \leq 11.5 \text{ nA}$ | 500 fA | 10 fA |
| 100 nA | $0 \leq I \leq 115 \text{ nA}$ | 5 pA | 100 fA |
| 1 μA | $0 \leq I \leq 1.15 \text{ } \mu\text{A}$ | 50 pA | 1 pA |
| 10 μA | $0 \leq I \leq 11.5 \text{ } \mu\text{A}$ | 500 pA | 10 pA |
| 100 μA | $0 \leq I \leq 115 \text{ } \mu\text{A}$ | 5 nA | 100 pA |
| 1 mA | $0 \leq I \leq 1.15 \text{ mA}$ | 50 nA | 1 nA |
| 10 mA | $0 \leq I \leq 11.5 \text{ mA}$ | 500 nA | 10 nA |
| 100 mA | $0 \leq I \leq 100 \text{ mA}$ | 5 μA | 100 nA |

- a. This column is applied to the auto ranging or the limited auto ranging.
For fixed ranging, maximum measurement value is **Range** column value.
- b. Available when the E5288A Atto Sense and Switch Unit (ASU) is used.

NOTE

To connect ASU

The specifications are satisfied and guaranteed for the exclusive combination of the ASU and the HRSMU. So confirm the serial number of the ASU and connect it to the dedicated HRSMU properly.

To connect the ASU, see “To Connect ASU” on page 3-17.

To confirm the serial number, see “ASU” on page 4-43.

NOTE

Before using 1 pA range

The measurement channel connected to the ASU supports the 1 pA range. To use the 1 pA range, set the 1 pA fixed range or the 1 pA limited auto ranging.

The B1500A automatically performs the compensation of the data measured by the 1 pA range and returns the compensated data. You can use either the pre-stored offset data or the pre-measured offset data.

To measure the offset data, perform the self-calibration before starting the measurement for a DUT. This offset data is temporarily memorized until the B1500A is turned off. See “Module Self Calibration” on page 4-35.

B1520A Multi Frequency CMU

This section describes typical specification of the multi frequency capacitance measurement unit (CMU) for Agilent B1500A. The CMU performs the impedance measurement and returns the specified measurement data such as Cp-G. Only one module can be installed in one mainframe.

- Measurement parameters: See Table 2-13.
All measurement parameters are supported by Agilent B1500A in the GPIB remote mode. However, Agilent EasyEXPERT software supports the Cp-G, Cp-D, Cs-Rs, and Z-θ measurements only.
- AC signal, output frequency:
1 kHz to 5 MHz
Setting resolution: 1 mHz (1 kHz to), 10 mHz (10 kHz to), 0.1 Hz (100 kHz to), or 1 Hz (1 MHz to 5 MHz)
- AC signal, output level:
10 mVrms to 250 mVrms, 1 mV resolution
- DC bias:
0 to ± 100 V
Setting resolution: 1 mV (0 to ± 25 V) or 5 mV (to ± 100 V)
DC bias > ± 25 V is available when using the SMU CMU unify unit (SCUU).
- Measurement range:
For the fixed ranging mode, measurement range (impedance range) must be specified to perform measurement. Table 2-14 shows the available measurement ranges and the corresponding impedance value. And Figure 2-6 shows the calculation example of the impedance vs frequency characteristics of a capacitive load. Use these information to decide the measurement range.

Impedance Z is calculated by the following formula.

$$Z = 1 / (2\pi f C)$$

where f is frequency (Hz) and C is capacitance (F).

Table 2-13

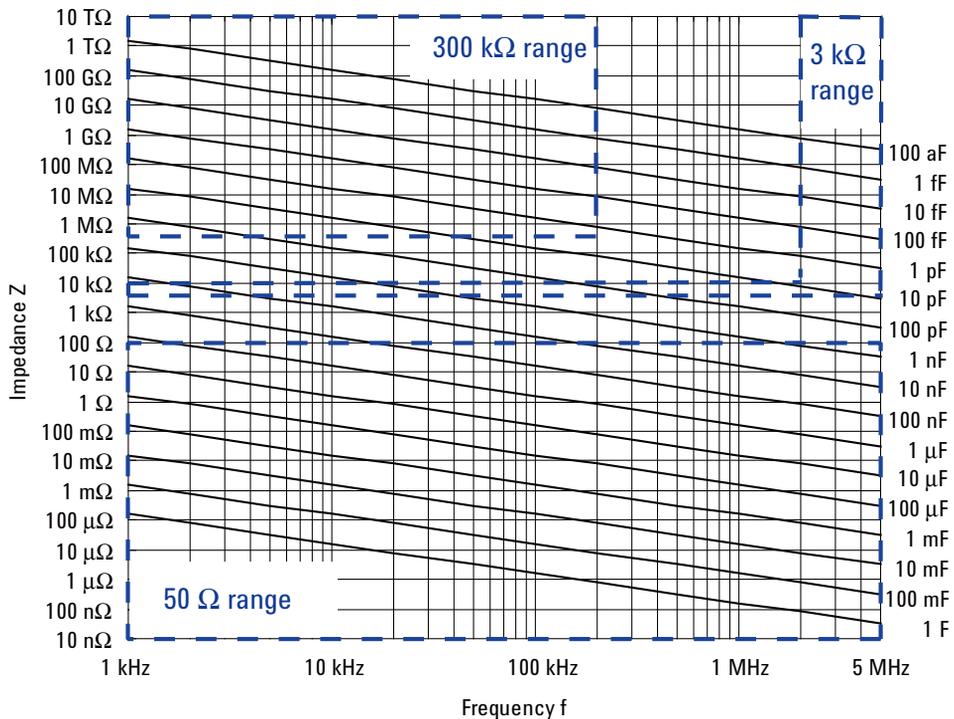
Measurement Parameters

| Primary Parameter | Secondary Parameter |
|------------------------------|-------------------------------------|
| R (resistance, Ω) | X (reactance, Ω) |
| G (conductance, S) | B (susceptance, S) |
| Z (impedance, Ω) | θ (phase, radian) |
| Z (impedance, Ω) | θ (phase, degree) |
| Y (admittance, S) | θ (phase, radian) |
| Y (admittance, S) | θ (phase, degree) |
| Cp (parallel capacitance, F) | G (conductance, S) |
| Cp (parallel capacitance, F) | D (dissipation factor) |
| Cp (parallel capacitance, F) | Q (quality factor) |
| Cp (parallel capacitance, F) | Rp (parallel resistance, Ω) |
| Cs (series capacitance, F) | Rs (series resistance, Ω) |
| Cs (series capacitance, F) | D (dissipation factor) |
| Cs (series capacitance, F) | Q (quality factor) |
| Lp (parallel inductance, H) | G (conductance, S) |
| Lp (parallel inductance, H) | D (dissipation factor) |
| Lp (parallel inductance, H) | Q (quality factor) |
| Lp (parallel inductance, H) | Rp (parallel resistance, Ω) |
| Ls (series inductance, H) | Rs (series resistance, Ω) |
| Ls (series inductance, H) | D (dissipation factor) |
| Ls (series inductance, H) | Q (quality factor) |

Table 2-14 Measurement Range for Fixed Ranging Mode

| Impedance Z | Measurement range (impedance range) | | |
|--|---|--|--|
| | $1 \text{ kHz} \leq f \leq 200 \text{ kHz}$ | $200 \text{ kHz} < f \leq 2 \text{ MHz}$ | $2 \text{ MHz} < f \leq 5 \text{ MHz}$ |
| $0 \leq Z < 100 \Omega$ | 50 Ω | 50 Ω | 50 Ω |
| $100 \Omega \leq Z < 300 \Omega$ | 100 Ω | 100 Ω | 100 Ω |
| $300 \Omega \leq Z < 1 \text{ k}\Omega$ | 300 Ω | 300 Ω | 300 Ω |
| $1 \text{ k}\Omega \leq Z < 3 \text{ k}\Omega$ | 1 $\text{k}\Omega$ | 1 $\text{k}\Omega$ | 1 $\text{k}\Omega$ |
| $3 \text{ k}\Omega \leq Z < 10 \text{ k}\Omega$ | 3 $\text{k}\Omega$ | 3 $\text{k}\Omega$ | 3 $\text{k}\Omega$ |
| $10 \text{ k}\Omega \leq Z < 30 \text{ k}\Omega$ | 10 $\text{k}\Omega$ | 10 $\text{k}\Omega$ | |
| $30 \text{ k}\Omega \leq Z < 100 \text{ k}\Omega$ | 30 $\text{k}\Omega$ | 30 $\text{k}\Omega$ | |
| $100 \text{ k}\Omega \leq Z < 300 \text{ k}\Omega$ | 100 $\text{k}\Omega$ | | |
| $300 \text{ k}\Omega \leq Z$ | 300 $\text{k}\Omega$ | | |

Figure 2-6 Impedance vs Frequency Characteristics of Capacitive Load, Calculation Example



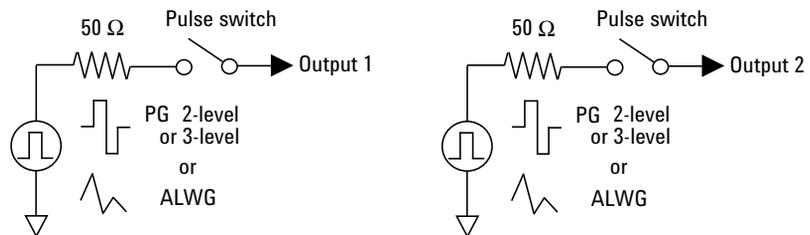
B1525A High Voltage SPGU

This section describes key specification of the high voltage semiconductor pulse generator unit (SPGU) for Agilent B1500A. Maximum five modules can be installed in one mainframe.

- Number of output channels: 2 channels per module
- Output impedance: $50\ \Omega$
- Output level: 0 to $\pm 40\ \text{V}$ (open load), $\pm 20\ \text{V}$ ($50\ \Omega$ load), 1 mV resolution
- SPGU operation mode:
PG (pulse generator) or ALWG (arbitrary linear waveform generator)
- Channel output operation mode:
Free run, duration, or pulse count (PG mode)/sequence count (ALWG mode)
- PG output mode:
2-level pulse or 3-level pulse, for each channel
- Pulse timing parameters:
Period: 20 ns to 10 s, 10 ns resolution
Width: 10 ns to period-10 ns, resolution 2.5 ns or 10 ns (transition time $> 8\ \mu\text{s}$)
Delay: 0 to period-20 ns, resolution 2.5 ns or 10 ns (transition time $> 8\ \mu\text{s}$)
Transition time (leading time or trailing time): 8 ns to 400 ms, resolution 2 ns or 8 ns (transition time $> 8\ \mu\text{s}$)
- Pulse switch, which is more durable than mechanical relays, and better suited for frequent switching applications.
- Automatic voltage level adjustment by specifying load impedance of DUT

Figure 2-7

SPGU Simplified Circuit Diagram



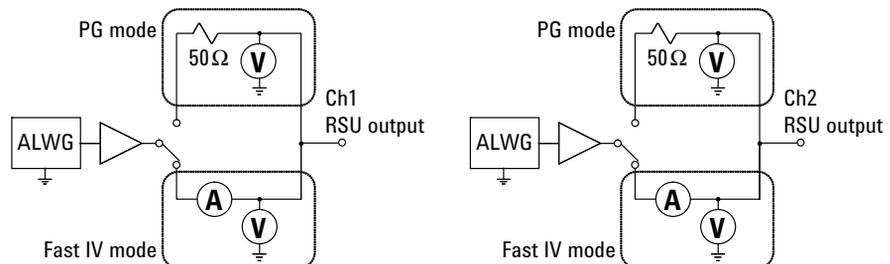
B1530A WGFMU

This section describes typical specification of the waveform generator/fast measurement unit (WGFMU) for Agilent B1500A. Maximum five modules can be installed in one mainframe.

- Number of channels: 2 channels per module
- Function:
Voltage output and current or voltage sampling measurement with minimum sampling interval of 5 ns
- Current measurement range: 1 μA , 10 μA , 100 μA , 1 mA, 10 mA
- Operation mode: PG mode, Fast IV mode, DC mode
- PG mode:
ALWG (arbitrary linear waveform generator) voltage output and voltage measurement (VFVM). The output voltage will be divided by the internal 50 Ω resistor and the load impedance.
Output level: -5 V to 5 V
Minimum pulse width: 100 ns
- Fast IV mode:
ALWG voltage output and current or voltage measurement (VFIM or VFVM).
Output level: 0 to -10 V, 0 to 10 V, -5 V to 5 V
Minimum pulse width: 300 ns
- DC mode:
DC voltage output and current or voltage measurement (VFIM or VFVM).
Output level: 0 to -10 V, 0 to 10 V, -5 V to 5 V

Figure 2-8

WGFMU Simplified Circuit Diagram



Specifications

This section lists specifications and supplemental information for the B1500A and its associated modules. The specifications are the standards against which the B1500A and its associated modules are tested. When the B1500A and any of its associated modules are shipped from the factory, they meet the specifications. The “supplemental” information and “typical” entries in the following specifications are not warranted, but provide useful information about the functions and performance of the instrument.

Hardware

- “Specification Conditions”
- “Mainframe”
- “MPSMU/HRSMU”
- “ASU”
- “HPSMU”
- “SMU Common Specifications”
- “SMU Supplemental Information”
- “MFCMU”
- “SCUU/GSWU”
- “HV-SPGU”
- “Selector”
- “Selector Adapter”
- “WGFMU/RSU”

Specification Conditions

The measurement and output accuracy are specified at the rear panel connector terminals when referenced to the Zero Check terminal. The B1530A WGF MU measurement and output accuracy are specified at the output terminal of the RSU. Accuracy is specified under the following conditions:

1. Temperature: $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$
2. Humidity: 20 % to 60 %
3. After 40 minutes warm-up followed by self-calibration
4. Ambient temperature change less than $\pm 1\text{ }^{\circ}\text{C}$ after self-calibration execution, not applicable for MFCMU
5. Measurement made within one hour after self-calibration execution, not applicable for MFCMU and WGF MU
6. Calibration period: 1 year
7. SMU integration time setting:
 - 1 PLC (1 nA to 1 A range, voltage range)
 - 20 PLC (100 pA range)
 - 50 PLC (1 pA to 10 pA range)
 - Averaging of high speed ADC: 128 samples per 1 PLC
8. SMU filter: ON
9. SMU measurement terminal connection: Kelvin connection
10. WGF MU load capacitance: 25 pF or less

NOTE

Agilent Technologies is responsible for removing, installing, and replacing the B1500A modules. Contact your nearest Agilent Technologies to install and calibrate the B1500A modules.

Mainframe

The B1500A supports ten slots for plug-in modules.

| Module | Slots occupied | Range of operation | Measurement resolution |
|-------------------------|----------------|--|-----------------------------------|
| B1510A HPSMU | 2 | -200 V to 200 V, -1A to 1 A | 2 μ V, 10 fA |
| B1511A MPSMU | 1 | -100 V to 100 V, -100 mA to 100 mA | 0.5 μ V, 10 fA |
| B1517A HRSMU | 1 | -100 V to 100 V, -100 mA to 100 mA | 0.5 μ V, 1 fA |
| E5288A ASU ^a | - | -100 V to 100 V, -100 mA to 100 mA | 0.5 μ V, 0.1 fA |
| B1520A MFCMU | 1 | 1 kHz to 5 MHz | 0.035 fFrms ^b |
| B1525A HV-SPGU | 1 | \pm 40 V (80 Vp-p) | 50 μ V |
| B1530A WGFMU | 1 | PG Mode: -3 V to 3 V, -5 V to 5 V Fast IV Mode: -3 V to 3 V, -5 V to 5 V, 0 V to 10 V, -10 V to 0 V | 0.014 % of the range ^c |

- The E5288A Atto Sense and Switch Unit (ASU) is connected with the B1517A High Resolution SMU (HRSMU).
- Dispersion of measurement values when connecting a DUT 10 pF to the measurement terminals under the measurement condition of frequency 1 MHz, signal level 250 mVac, and measurement time 1 PLC. The display resolution is 0.000001 fF at 1 fF order by 6 digits display.
- Display resolution

- Maximum module configuration

The B1500A can contain up to 4 dual-slot SMUs (HPSMUs) and 2 single-slot SMUs (MPSMUs and/or HRSMUs); it can contain up to 10 single-slot SMUs (MPSMUs and/or HRSMUs); and it can contain any combination of dual-slot and single-slot SMUs between these two extremes. Only one single-slot MFCMU can be installed per B1500A mainframe. Up to five single-slot HV-SPGUs can be installed per mainframe. Up to five single-slot WGFMs can be installed per mainframe.

Introduction
Specifications

When one or more WGFMU modules are installed in the B1500A mainframe, the following table applies. Multiply the values given below by the number of installed modules of that type and add the products together. The sum of the products must be less than or equal to 59 for the configuration to be permissible.

| | |
|---------|----|
| MPSMU | 2 |
| HRSMU | 2 |
| HPSMU | 14 |
| MFCMU | 7 |
| HV-SPGU | 12 |
| WGFMU | 10 |

- Maximum voltage between common and ground
 $\leq \pm 42 \text{ V}$

- Ground unit (GNDU)

The GNDU is furnished standard with the mainframe.

- Output voltage: $0 \text{ V} \pm 100 \mu\text{V}$
- Maximum sink current: $\pm 4.2 \text{ A}$
- Output terminal/connection: Triaxial connector, Kelvin (remote sensing)
- Load capacitance: $1 \mu\text{F}$, supplemental information
- Cable resistance: supplemental information

| Terminal | Cable resistance |
|----------|--|
| Sense | $\leq 10 \Omega$ |
| Force | $< 1 \Omega$ ($I_s \leq 1.6 \text{ A}$) $< 0.7 \Omega$ ($1.6 \text{ A} < I_s \leq 2.0 \text{ A}$) $< 0.35 \Omega$ ($2.0 \text{ A} < I_s \leq 4.2 \text{ A}$) where I_s is the current being sunk by the GNDU. |

MPSMU/HRSMU

MPSMU: Medium Power Source/Monitor Unit

HRSMU: High Resolution Source/Monitor Unit

- Voltage range, resolution, and accuracy

See Table 2-15 for high resolution ADC and Table 2-17 for high speed ADC.

- Current range, resolution, and accuracy

See Table 2-16 for high resolution ADC and Table 2-18 for high speed ADC.

Specified measurement resolution is limited by fundamental noise limits. Minimum displayed resolution is 1 aA at 1 pA range by 6 digits. Measurements made in the lower ranges can be greatly impacted by vibrations and shocks. These specifications assume an environment free of these factors.

- Power consumption

Voltage source mode:

| Voltage range (V) | Power consumption ^a (W) |
|-------------------|------------------------------------|
| 0.5 | $I_c \times 20$ |
| 2 | $I_c \times 20$ |
| 5 | $I_c \times 20$ |
| 20 | $I_c \times 20$ |
| 40 | $I_c \times 40$ |
| 100 | $I_c \times 100$ |

a. I_c is the current compliance setting.

Current source mode:

| Voltage compliance ^a (V) | Power consumption ^b (W) |
|-------------------------------------|------------------------------------|
| $V_c \leq 20$ | $I_o \times 20$ |
| $20 < V_c \leq 40$ | $I_o \times 40$ |
| $40 < V_c \leq 100$ | $I_o \times 100$ |

a. V_c is the voltage compliance setting.

b. I_o is the output current.

Table 2-15 Voltage range, resolution, and accuracy (high resolution ADC)

| Range | Force resolution | Measurement resolution | Force accuracy $\pm(\%+mV)^a$ | Measurement accuracy $\pm(\%+mV)^a$ | Maximum current |
|-------------|------------------|------------------------|-------------------------------|-------------------------------------|-----------------|
| ± 0.5 V | 25 μ V | 0.5 μ V | $\pm(0.018 + 0.15)$ | $\pm(0.01 + 0.12)$ | 100 mA |
| ± 2 V | 100 μ V | 2 μ V | $\pm(0.018 + 0.4)$ | $\pm(0.01 + 0.14)$ | 100 mA |
| ± 5 V | 250 μ V | 5 μ V | $\pm(0.018 + 0.75)$ | $\pm(0.009 + 0.25)$ | 100 mA |
| ± 20 V | 1 mV | 20 μ V | $\pm(0.018 + 3)$ | $\pm(0.009 + 0.9)$ | 100 mA |
| ± 40 V | 2 mV | 40 μ V | $\pm(0.018 + 6)$ | $\pm(0.01 + 1)$ | b |
| ± 100 V | 5 mV | 100 μ V | $\pm(0.018 + 15)$ | $\pm(0.012 + 2.5)$ | |

a. $\pm(\%$ of output/measured value + offset value in mV)

b. 100 mA ($V_o \leq 20$ V), 50 mA (20 V $< V_o \leq 40$ V), 20 mA (40 V $< V_o$), V_o is the output voltage.

Table 2-16 Current range, resolution, and accuracy (high resolution ADC)

| Range | Force resolution | Measurement resolution | Force accuracy $\pm(\%+A+A)^a$ | Measurement accuracy $\pm(\%+A+A)^a$ | Maximum voltage |
|---------------------------|------------------|----------------------------|---|---|-----------------|
| ± 1 pA ^b | 1 fA | 0.1 fA | $\pm(0.9+15E^{-15})$ | $\pm(0.9+12E^{-15})$ | 100 V |
| ± 10 pA ^c | 5 fA | 0.4 fA ^b / 1 fA | $\pm(0.46+3E^{-14}+V_o \times 1E^{-17})$ | $\pm(0.46+15E^{-15}+V_o \times 1E^{-17})$ | 100 V |
| ± 100 pA ^c | 5 fA | 0.5 fA ^b / 2 fA | $\pm(0.3+1E^{-13}+V_o \times 1E^{-16})$ | $\pm(0.3+3E^{-14}+V_o \times 1E^{-16})$ | 100 V |
| ± 1 nA | 50 fA | 10 fA | $\pm(0.1+3E^{-13}+V_o \times 1E^{-15})$ | $\pm(0.1+2E^{-13}+V_o \times 1E^{-15})$ | 100 V |
| ± 10 nA | 500 fA | 10 fA | $\pm(0.1+3E^{-12}+V_o \times 1E^{-14})$ | $\pm(0.1+1E^{-12}+V_o \times 1E^{-14})$ | 100 V |
| ± 100 nA | 5 pA | 100 fA | $\pm(0.05+3E^{-11}+V_o \times 1E^{-13})$ | $\pm(0.05+2E^{-11}+V_o \times 1E^{-13})$ | 100 V |
| ± 1 μ A | 50 pA | 1 pA | $\pm(0.05+3E^{-10}+V_o \times 1E^{-12})$ | $\pm(0.05+1E^{-10}+V_o \times 1E^{-12})$ | 100 V |
| ± 10 μ A | 500 pA | 10 pA | $\pm(0.05+3E^{-9}+V_o \times 1E^{-11})$ | $\pm(0.04+2E^{-9}+V_o \times 1E^{-11})$ | 100 V |
| ± 100 μ A | 5 nA | 100 pA | $\pm(0.035+15E^{-9}+V_o \times 1E^{-10})$ | $\pm(0.03+3E^{-9}+V_o \times 1E^{-10})$ | 100 V |
| ± 1 mA | 50 nA | 1 nA | $\pm(0.04+15E^{-8}+V_o \times 1E^{-9})$ | $\pm(0.03+6E^{-8}+V_o \times 1E^{-9})$ | 100 V |
| ± 10 mA | 500 nA | 10 nA | $\pm(0.04+15E^{-7}+V_o \times 1E^{-8})$ | $\pm(0.03+2E^{-7}+V_o \times 1E^{-8})$ | 100 V |
| ± 100 mA | 5 μ A | 100 nA | $\pm(0.045+15E^{-6}+V_o \times 1E^{-7})$ | $\pm(0.04+6E^{-6}+V_o \times 1E^{-7})$ | d |

a. $\pm(\%$ of output/measured value + fixed offset in A + proportional offset in A), V_o is the output voltage in V.

b. Available when Agilent E5288A Atto Sense and Switch Unit (ASU) is used.

c. Available for HRSMU.

d. 100 V ($I_o \leq 20$ mA), 40 V (20 mA $< I_o \leq 50$ mA), 20 V (50 mA $< I_o$), I_o is the output current.

Table 2-17 Voltage range, resolution, and accuracy (high speed ADC)

| Range | Force resolution | Measurement resolution | Force accuracy $\pm(\%+mV)^a$ | Measurement accuracy $\pm(\%+mV)^a$ | Maximum current |
|-------------|------------------|------------------------|-------------------------------|-------------------------------------|-----------------|
| ± 0.5 V | 25 μ V | 0.5 μ V | $\pm(0.018 + 0.15)$ | $\pm(0.01 + 0.25)$ | 100 mA |
| ± 2 V | 100 μ V | 2 μ V | $\pm(0.018 + 0.4)$ | $\pm(0.01 + 0.7)$ | 100 mA |
| ± 5 V | 250 μ V | 5 μ V | $\pm(0.018 + 0.75)$ | $\pm(0.01 + 2)$ | 100 mA |
| ± 20 V | 1 mV | 20 μ V | $\pm(0.018 + 3)$ | $\pm(0.01 + 4)$ | 100 mA |
| ± 40 V | 2 mV | 40 μ V | $\pm(0.018 + 6)$ | $\pm(0.015 + 8)$ | b |
| ± 100 V | 5 mV | 100 μ V | $\pm(0.018 + 15)$ | $\pm(0.02 + 20)$ | |

a. $\pm(\%$ of output/measured value + offset value in mV)

b. 100 mA ($V_o \leq 20$ V), 50 mA (20 V < $V_o \leq 40$ V), 20 mA (40 V < V_o), V_o is the output voltage.

Table 2-18 Current range, resolution, and accuracy (high speed ADC)

| Range | Force resolution | Measurement resolution | Force accuracy $\pm(\%+A+A)^a$ | Measurement accuracy $\pm(\%+A+A)^a$ | Maximum voltage |
|---------------------------|------------------|----------------------------|---|--|-----------------|
| ± 1 pA ^b | 1 fA | 0.1 fA | $\pm(0.9+15E^{-15})$ | $\pm(1.8+12E^{-15})$ | 100 V |
| ± 10 pA ^c | 5 fA | 0.4 fA ^b / 1 fA | $\pm(0.46+3E^{-14}+V_o \times 1E^{-17})$ | $\pm(0.5+15E^{-15}+V_o \times 1E^{-17})$ | 100 V |
| ± 100 pA ^c | 5 fA | 0.5 fA ^b / 2 fA | $\pm(0.3+1E^{-13}+V_o \times 1E^{-16})$ | $\pm(0.5+4E^{-14}+V_o \times 1E^{-16})$ | 100 V |
| ± 1 nA | 50 fA | 10 fA | $\pm(0.1+3E^{-13}+V_o \times 1E^{-15})$ | $\pm(0.25+3E^{-13}+V_o \times 1E^{-15})$ | 100 V |
| ± 10 nA | 500 fA | 10 fA | $\pm(0.1+3E^{-12}+V_o \times 1E^{-14})$ | $\pm(0.25+2E^{-12}+V_o \times 1E^{-14})$ | 100 V |
| ± 100 nA | 5 pA | 100 fA | $\pm(0.05+3E^{-11}+V_o \times 1E^{-13})$ | $\pm(0.1+2E^{-11}+V_o \times 1E^{-13})$ | 100 V |
| ± 1 μ A | 50 pA | 1 pA | $\pm(0.05+3E^{-10}+V_o \times 1E^{-12})$ | $\pm(0.1+2E^{-10}+V_o \times 1E^{-12})$ | 100 V |
| ± 10 μ A | 500 pA | 10 pA | $\pm(0.05+3E^{-9}+V_o \times 1E^{-11})$ | $\pm(0.05+2E^{-9}+V_o \times 1E^{-11})$ | 100 V |
| ± 100 μ A | 5 nA | 100 pA | $\pm(0.035+15E^{-9}+V_o \times 1E^{-10})$ | $\pm(0.05+2E^{-8}+V_o \times 1E^{-10})$ | 100 V |
| ± 1 mA | 50 nA | 1 nA | $\pm(0.04+15E^{-8}+V_o \times 1E^{-9})$ | $\pm(0.04+2E^{-7}+V_o \times 1E^{-9})$ | 100 V |
| ± 10 mA | 500 nA | 10 nA | $\pm(0.04+15E^{-7}+V_o \times 1E^{-8})$ | $\pm(0.04+2E^{-6}+V_o \times 1E^{-8})$ | 100 V |
| ± 100 mA | 5 μ A | 100 nA | $\pm(0.045+15E^{-6}+V_o \times 1E^{-7})$ | $\pm(0.1+2E^{-5}+V_o \times 1E^{-7})$ | d |

a. $\pm(\%$ of output/measured value + fixed offset in A + proportional offset in A), V_o is the output voltage in V.

b. Available when Agilent E5288A Atto Sense and Switch Unit (ASU) is used.

c. Available for HRSMU.

d. 100 V ($I_o \leq 20$ mA), 40 V (20 mA < $I_o \leq 50$ mA), 20 V (50 mA < I_o), I_o is the output current.

ASU

ASU: Atto Sense and Switch Unit

- Maximum voltage, AUX path
 - 100 V (AUX input to AUX common)
 - 100 V (AUX input to circuit common)
 - 42 V (AUX common to circuit common)
- Maximum current, AUX path
 - 0.5 A (AUX input to Force output)
- Band width (at -3 dB), AUX port
 - 30 MHz, supplemental information

NOTE**Connect ASU to dedicated HRSMU**

The specifications are satisfied and guaranteed for the exclusive combination of the ASU and the HRSMU. So confirm the serial number of the ASU and connect it to the dedicated HRSMU properly.

NOTE**Connection path control**

Disable source output of the SMU and other instrument connected to the ASU inputs before controlling the ASU connection path.

HPSMU

HPSMU: High Power Source/Monitor Unit

- Voltage range, resolution, and accuracy
See Table 2-19 for high resolution ADC and Table 2-21 for high speed ADC.
- Current range, resolution, and accuracy
See Table 2-20 for high resolution ADC and Table 2-22 for high speed ADC.
Specified measurement resolution is limited by fundamental noise limits.
- Power consumption

Voltage source mode:

| Voltage range (V) | Power consumption ^a (W) |
|-------------------|------------------------------------|
| 2 | $I_c \times 20$ |
| 20 | $I_c \times 20$ |
| 40 | $I_c \times 40$ |
| 100 | $I_c \times 100$ |
| 200 | $I_c \times 200$ |

a. I_c is the current compliance setting.

Current source mode:

| Voltage compliance ^a (V) | Power consumption ^b (W) |
|-------------------------------------|------------------------------------|
| $V_c \leq 20$ | $I_o \times 20$ |
| $20 < V_c \leq 40$ | $I_o \times 40$ |
| $40 < V_c \leq 100$ | $I_o \times 100$ |
| $100 < V_c \leq 200$ | $I_o \times 200$ |

a. V_c is the voltage compliance setting.

b. I_o is the output current.

Table 2-19 Voltage range, resolution, and accuracy (high resolution ADC)

| Range | Force resolution | Measurement resolution | Force accuracy $\pm(\%+mV)^a$ | Measurement accuracy $\pm(\%+mV)^a$ | Maximum current |
|-------------|------------------|------------------------|-------------------------------|-------------------------------------|-----------------|
| ± 2 V | 100 μ V | 2 μ V | $\pm(0.018 + 0.4)$ | $\pm(0.01 + 0.14)$ | 1 A |
| ± 20 V | 1 mV | 20 μ V | $\pm(0.018 + 3)$ | $\pm(0.01 + 0.14)$ | 1 A |
| ± 40 V | 2 mV | 40 μ V | $\pm(0.018 + 6)$ | $\pm(0.01 + 1)$ | 500 mA |
| ± 100 V | 5 mV | 100 μ V | $\pm(0.018 + 15)$ | $\pm(0.012 + 2.5)$ | 125 mA |
| ± 200 V | 10 mV | 200 μ V | $\pm(0.018 + 30)$ | $\pm(0.014 + 2.8)$ | 50 mA |

a. $\pm(\%$ of output/measured value + offset value in mV)

Table 2-20 Current range, resolution, and accuracy (high resolution ADC)

| Range | Force resolution | Measurement resolution | Force accuracy $\pm(\%+A+A)^a$ | Measurement accuracy $\pm(\%+A+A)^a$ | Maximum voltage |
|-------------------|------------------|------------------------|--|--|-----------------|
| ± 1 nA | 50 fA | 10 fA | $\pm(0.1+3E^{-13}+Vo \times 1E^{-15})$ | $\pm(0.1+3E^{-13}+Vo \times 1E^{-15})$ | 200 V |
| ± 10 nA | 500 fA | 10 fA | $\pm(0.1+3E^{-12}+Vo \times 1E^{-14})$ | $\pm(0.1+25E^{-13}+Vo \times 1E^{-14})$ | 200 V |
| ± 100 nA | 5 pA | 100 fA | $\pm(0.05+3E^{-11}+Vo \times 1E^{-13})$ | $\pm(0.05+25E^{-12}+Vo \times 1E^{-13})$ | 200 V |
| ± 1 μ A | 50 pA | 1 pA | $\pm(0.05+3E^{-10}+Vo \times 1E^{-12})$ | $\pm(0.05+1E^{-10}+Vo \times 1E^{-12})$ | 200 V |
| ± 10 μ A | 500 pA | 10 pA | $\pm(0.05+3E^{-9}+Vo \times 1E^{-11})$ | $\pm(0.04+2E^{-9}+Vo \times 1E^{-11})$ | 200 V |
| ± 100 μ A | 5 nA | 100 pA | $\pm(0.035+15E^{-9}+Vo \times 1E^{-10})$ | $\pm(0.03+3E^{-9}+Vo \times 1E^{-10})$ | 200 V |
| ± 1 mA | 50 nA | 1 nA | $\pm(0.04+15E^{-8}+Vo \times 1E^{-9})$ | $\pm(0.03+6E^{-8}+Vo \times 1E^{-9})$ | 200 V |
| ± 10 mA | 500 nA | 10 nA | $\pm(0.04+15E^{-7}+Vo \times 1E^{-8})$ | $\pm(0.03+2E^{-7}+Vo \times 1E^{-8})$ | 200 V |
| ± 100 mA | 5 μ A | 100 nA | $\pm(0.045+15E^{-6}+Vo \times 1E^{-7})$ | $\pm(0.04+6E^{-6}+Vo \times 1E^{-7})$ | b |
| ± 1 A | 50 μ A | 1 μ A | $\pm(0.4+3E^{-4}+Vo \times 1E^{-6})$ | $\pm(0.4+15E^{-5}+Vo \times 1E^{-6})$ | |

a. $\pm(\%$ of output/measured value + fixed offset in A + proportional offset in A), V_o is the output voltage in V.

b. 200 V ($I_o \leq 50$ mA), 100 V (50 mA $< I_o \leq 125$ mA), 40 V (125 mA $< I_o \leq 500$ mA), 20 V (500 mA $< I_o \leq 1$ A), I_o is the output current.

Table 2-21 Voltage range, resolution, and accuracy (high speed ADC)

| Range | Force resolution | Measurement resolution | Force accuracy $\pm(\%+mV)^a$ | Measurement accuracy $\pm(\%+mV)^a$ | Maximum current |
|-------------|------------------|------------------------|-------------------------------|-------------------------------------|-----------------|
| ± 2 V | 100 μ V | 2 μ V | $\pm(0.018 + 0.4)$ | $\pm(0.01 + 0.7)$ | 1 A |
| ± 20 V | 1 mV | 20 μ V | $\pm(0.018 + 3)$ | $\pm(0.01 + 4)$ | 1 A |
| ± 40 V | 2 mV | 40 μ V | $\pm(0.018 + 6)$ | $\pm(0.015 + 8)$ | 500 mA |
| ± 100 V | 5 mV | 100 μ V | $\pm(0.018 + 15)$ | $\pm(0.02 + 20)$ | 125 mA |
| ± 200 V | 10 mV | 200 μ V | $\pm(0.018 + 30)$ | $\pm(0.035 + 40)$ | 50 mA |

a. $\pm(\%$ of output/measured value + offset value in mV)

Table 2-22 Current range, resolution, and accuracy (high speed ADC)

| Range | Force resolution | Measurement resolution | Force accuracy $\pm(\%+A+A)^a$ | Measurement accuracy $\pm(\%+A+A)^a$ | Maximum voltage |
|-------------------|------------------|------------------------|--|---|-----------------|
| ± 1 nA | 50 fA | 10 fA | $\pm(0.1+3E^{-13}+Vo \times 1E^{-15})$ | $\pm(0.25+3E^{-13}+Vo \times 1E^{-15})$ | 200 V |
| ± 10 nA | 500 fA | 10 fA | $\pm(0.1+3E^{-12}+Vo \times 1E^{-14})$ | $\pm(0.25+2E^{-12}+Vo \times 1E^{-14})$ | 200 V |
| ± 100 nA | 5 pA | 100 fA | $\pm(0.05+3E^{-11}+Vo \times 1E^{-13})$ | $\pm(0.1+2E^{-11}+Vo \times 1E^{-13})$ | 200 V |
| ± 1 μ A | 50 pA | 1 pA | $\pm(0.05+3E^{-10}+Vo \times 1E^{-12})$ | $\pm(0.1+2E^{-10}+Vo \times 1E^{-12})$ | 200 V |
| ± 10 μ A | 500 pA | 10 pA | $\pm(0.05+3E^{-9}+Vo \times 1E^{-11})$ | $\pm(0.05+2E^{-9}+Vo \times 1E^{-11})$ | 200 V |
| ± 100 μ A | 5 nA | 100 pA | $\pm(0.035+15E^{-9}+Vo \times 1E^{-10})$ | $\pm(0.05+2E^{-8}+Vo \times 1E^{-10})$ | 200 V |
| ± 1 mA | 50 nA | 1 nA | $\pm(0.04+15E^{-8}+Vo \times 1E^{-9})$ | $\pm(0.04+2E^{-7}+Vo \times 1E^{-9})$ | 200 V |
| ± 10 mA | 500 nA | 10 nA | $\pm(0.04+15E^{-7}+Vo \times 1E^{-8})$ | $\pm(0.04+2E^{-6}+Vo \times 1E^{-8})$ | 200 V |
| ± 100 mA | 5 μ A | 100 nA | $\pm(0.045+15E^{-6}+Vo \times 1E^{-7})$ | $\pm(0.1+2E^{-5}+Vo \times 1E^{-7})$ | b |
| ± 1 A | 50 μ A | 1 μ A | $\pm(0.4+3E^{-4}+Vo \times 1E^{-6})$ | $\pm(0.5+3E^{-4}+Vo \times 1E^{-6})$ | |

a. $\pm(\%$ of output/measured value + fixed offset in A + proportional offset in A), V_o is the output voltage in V.

b. 200 V ($I_o \leq 50$ mA), 100 V (50 mA $< I_o \leq 125$ mA), 40 V (125 mA $< I_o \leq 500$ mA), 20 V (500 mA $< I_o \leq 1$ A), I_o is the output current.

SMU Common Specifications

- Output terminal/connection
 - Dual triaxial connector, Kelvin (remote sensing)
- Voltage/current compliance (limiting)
 - The SMU can limit output voltage or current to prevent damaging the device under test.
 - Voltage compliance:
 - 0 V to ± 100 V (MPSMU, HRSMU)
 - 0 V to ± 200 V (HPSMU)
 - Current compliance:
 - ± 10 fA to ± 100 mA (HRSMU with ASU)
 - ± 100 fA to ± 100 mA (HRSMU)
 - ± 1 pA to ± 100 mA (MPSMU)
 - ± 1 pA to ± 1 A (HPSMU)
 - Compliance accuracy:
 - Same as the current or voltage set accuracy.
- About measurement accuracy
 - RF electromagnetic field and SMU measurement accuracy
 - Voltage and current measurement accuracy can be affected by RF electromagnetic field strengths greater than 3 V/m in the frequency range of 80 MHz to 1 GHz. The extent of this effect depends upon how the instrument is positioned and shielded.
 - Induced RF field noise and SMU measurement accuracy
 - Voltage and current measurement accuracy can be affected by induced RF field noise strengths greater than 3Vrms in the frequency range of 150 kHz to 80 MHz. The extent of this effect depends upon how the instrument is positioned and shielded.
- Pulsed measurement
 - Width: 500 μ s to 2 s
 - Period: 5 ms to 5 s

Period \geq Width+2 ms (when Width \leq 100 ms)

Period \geq Width+10 ms (when Width $>$ 100 ms)

- Resolution: 100 μ s
- Pulse setting accuracy (fixed measurement range), supplemental information
 - Width: 0.5 % + 50 μ s
 - Period: 0.5 % + 100 μ s

SMU Supplemental Information

- Maximum allowable cable resistance (Kelvin connection)
Sense: 10 Ω
Force: 10 Ω (\leq 100 mA), 1.5 Ω ($>$ 100 mA)
- Voltage source output resistance (Force line, Non-Kelvin connection)
0.2 Ω (HPSMU)
0.3 Ω (MPSMU, HRSMU)
- Voltage measurement input resistance: $\geq 10^{13}$ Ω
- Current source output resistance: $\geq 10^{13}$ Ω (at 1 nA range)
- Current compliance setting accuracy (for opposite polarity)
For 1 pA to 10 nA ranges: Setting accuracy ± 12 % of range
For 100 nA to 1 A ranges: Setting accuracy ± 2.5 % of range
- Maximum capacitive load
For 1 pA to 10 nA ranges: 1000 pF
For 100 nA to 10 mA ranges: 10 nF
For 100 mA and 1 A ranges: 100 μ F
- Maximum guard capacitance
900 pF (HPSMU, MPSMU, HRSMU)
660 pF (HRSMU with ASU)
- Maximum shield capacitance
5000 pF (HPSMU, MPSMU, HRSMU)
3500 pF (HRSMU with ASU)

Introduction

Specifications

- Maximum guard offset voltage
 - ± 1 mV (HPSMU)
 - ± 3 mV (MPSMU, HRSMU)
 - ± 4.2 mV (HRSMU with ASU, $I_{out} \leq 100 \mu\text{A}$)
- Noise characteristics (filter ON)
 - Voltage source: 0.01 % of V range (rms.)
 - Current source: 0.1 % of I range (rms.)
- Overshoot (filter ON), typical
 - Voltage source: 0.03 % of V range
 - Current source: 1 % of I range
- Range switching transient noise (filter ON)
 - Voltage ranging: 250 mV
 - Current ranging: 70 mV
- Slew rate: 0.2 V/ μs (maximum)
- Voltage range, resolution, and accuracy (high speed ADC)
 - See Table 2-23.
- Current range, resolution, and accuracy (high speed ADC)
 - See Table 2-24.

Specified measurement resolution is limited by fundamental noise limits. Minimum displayed resolution is 1 aA at 1 pA range by 6 digits.

Measurements made in the lower ranges can be greatly impacted by vibrations and shocks. These specifications assume an environment free of these factors.

Table 2-23 Voltage range, resolution, and accuracy (high speed ADC), supplemental information

| Range | Measurement resolution | Measurement accuracy $\pm(\%+mV)^a$ | Range | Measurement resolution | Measurement accuracy $\pm(\%+mV)^a$ |
|--------------------------|------------------------|-------------------------------------|--------------------------|------------------------|-------------------------------------|
| ± 0.5 V ^b | 25 μ V | $\pm(0.01 + 0.25)$ | ± 40 V | 2 mV | $\pm(0.015 + 8)$ |
| ± 2 V | 100 μ V | $\pm(0.01 + 0.7)$ | ± 100 V | 5 mV | $\pm(0.02 + 20)$ |
| ± 5 V ^b | 250 μ V | $\pm(0.01 + 2)$ | ± 200 V ^c | 10 mV | $\pm(0.035 + 40)$ |
| ± 20 V | 1 mV | $\pm(0.01 + 4)$ | | | |

a. \pm (% of reading + offset value in mV). Averaging is 128 samples in 1 PLC.

b. Available for MPSMU/HRSMU.

c. Available for HPSMU.

Table 2-24 Current range, resolution, and accuracy (high speed ADC), supplemental information

| Range | Measurement resolution | Measurement accuracy $\pm(\%+A+A)^a$ | Range | Measurement resolution | Measurement accuracy $\pm(\%+A+A)^a$ |
|---------------------------|------------------------|--|------------------------|------------------------|---|
| ± 1 pA ^b | 0.1 fA | $\pm(1.8+12E^{-15})$ | ± 10 μ A | 500 pA | $\pm(0.04+2E^{-9}+V_o \times 1E^{-11})$ |
| ± 10 pA ^c | 1 fA | $\pm(0.5+15E^{-15}+V_o \times 1E^{-17})$ | ± 100 μ A | 5 nA | $\pm(0.03+2E^{-8}+V_o \times 1E^{-10})$ |
| ± 100 pA ^c | 5 fA | $\pm(0.3+3E^{-14}+V_o \times 1E^{-16})$ | ± 1 mA | 50 nA | $\pm(0.03+2E^{-7}+V_o \times 1E^{-9})$ |
| ± 1 nA | 50 fA | $\pm(0.1+3E^{-13}+V_o \times 1E^{-15})$ | ± 10 mA | 500 nA | $\pm(0.03+2E^{-6}+V_o \times 1E^{-8})$ |
| ± 10 nA | 500 fA | $\pm(0.1+2E^{-12}+V_o \times 1E^{-14})$ | ± 100 mA | 5 μ A | $\pm(0.04+2E^{-5}+V_o \times 1E^{-7})$ |
| ± 100 nA | 5 pA | $\pm(0.05+2E^{-11}+V_o \times 1E^{-13})$ | ± 1 A ^d | 50 μ A | $\pm(0.4+3E^{-4}+V_o \times 1E^{-6})$ |
| ± 1 μ A | 50 pA | $\pm(0.05+2E^{-10}+V_o \times 1E^{-12})$ | | | |

a. \pm (% of reading + fixed offset in A + proportional offset in A), V_o is the output voltage in V.

b. Available when Agilent E5288A Atto Sense and Switch Unit (ASU) is used.

c. 10 pA and 100 pA ranges are available for HRSMU with or without ASU.

d. Available for HPSMU.

MFCMU

MFCMU: Multi Frequency Capacitance Measurement Unit

- Measurement functions
 - Measurement parameters: Cp-G, Cp-D, Cp-Q, Cp-Rp, Cs-Rs, Cs-D, Cs-Q, Lp-G, Lp-D, Lp-Q, Lp-Rp, Ls-Rs, Ls-D, Ls-Q, R-X, G-B, Z- θ , Y- θ
 - Ranging: Auto or fixed
 - Measurement terminal: Four-terminal pair configuration, four BNC (female) connectors
 - Cable length: 1.5 m or 3 m, automatic identification of accessories
- Test signal
 - Frequency
Range: 1 kHz to 5 MHz
Resolution: 1 mHz (minimum)
Accuracy: $\pm 0.008\%$
 - Output signal level
Range: 10 mVrms to 250 mVrms
Resolution: 1 mVrms
Accuracy:
 $\pm (10.0\% + 1 \text{ mVrms})$ at the measurement port of the MFCMU
 $\pm (15.0\% + 1 \text{ mVrms})$ at the measurement port of the MFCMU cable (1.5 m or 3.0 m)
 - Output impedance: 50 Ω , typical
 - Signal level monitor
Range: 10 mVrms to 250 mVrms
Accuracy (open load):
 $\pm (10.0\% \text{ of reading} + 1 \text{ mVrms})$ at the measurement port of the MFCMU
 $\pm (15.0\% \text{ of reading} + 1 \text{ mVrms})$ at the measurement port of the MFCMU cable (1.5 m or 3.0 m)

- DC bias function

- DC bias

Range: 0 to ± 25 V

Resolution: 1 mV

Accuracy: $\pm (0.5 \% + 5.0 \text{ mV})$ at the measurement port of the MFCMU or the MFCMU cable (1.5 m or 3.0 m)

- Maximum DC bias current, supplemental information:

| Impedance range (Ω) | Maximum DC bias current (A) |
|------------------------------|-----------------------------|
| 50 | 10×10^{-3} |
| 100 | 10×10^{-3} |
| 300 | 10×10^{-3} |
| 1×10^3 | 1×10^{-3} |
| 3×10^3 | 1×10^{-3} |
| 10×10^3 | 100×10^{-6} |
| 30×10^3 | 100×10^{-6} |
| 100×10^3 | 10×10^{-6} |
| 300×10^3 | 10×10^{-6} |

- Output impedance: 50 Ω , typical

- DC bias monitor

Range: 0 to ± 25 V

Accuracy (open load): $\pm (0.2 \% \text{ of reading} + 10 \text{ mV})$ at the measurement port of the MFCMU or the MFCMU cable (1.5 m or 3.0 m)

- Sweep characteristics

- Available sweep parameters: DC bias voltage, oscillator level, frequency

- Sweep type: linear, log

- Sweep mode: single, double

- Sweep direction: up, down

- Number of measurement points: maximum 1001

Introduction

Specifications

- Measurement accuracy

Measurement accuracy at the measurement port of the MFCMU or the MFCMU cable (1.5 m or 3.0 m)

- $|Z|$ accuracy: $\pm E$ (%)
- θ accuracy: $\pm E/100$ (radian)
- C accuracy:
 - $\pm E$ (%) at $Dx \leq 0.1$
 - $\pm E \times (1 + Dx^2)^{1/2}$ (%) at $Dx > 0.1$
- D accuracy:
 - $\pm E/100$ at $Dx \leq 0.1$
 - $\pm E \times (1 + Dx)/100$ at $Dx > 0.1$
- G accuracy:
 - $\pm E/Dx$ (%) at $Dx \leq 0.1$
 - $\pm E \times ((1 + Dx^2)/Dx)^{1/2}$ (%) at $Dx > 0.1$

where,

Zx : Impedance measurement value (Ω)

Dx : Measurement value of D

$$E = E_P' + (Z_S' / |Zx| + Y_O' \times |Zx|) \times 100 \text{ (%)}$$

$$E_P' = E_{PL} + E_{POSC} + E_P \text{ (%)}$$

$$Y_O' = Y_{OL} + Y_{OSC} + Y_O \text{ (S)}$$

$$Z_S' = Z_{SL} + Z_{OSC} + Z_S \text{ (\Omega)}$$

For the parameter value, see Table 2-25 to Table 2-27. Calculation example of the measurement accuracy is also shown in Table 2-28.

Specification conditions:

- Temperature: $23 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$
- Integration time: 1 PLC or 16 PLC

Table 2-25 Parameters E_{POSC} , Z_{OSC}

| Oscillator level V_{osc} mV | E_{POSC} % | Z_{OSC} m Ω |
|----------------------------------|---------------------------------|------------------------------|
| $125 < V_{osc} \leq 250$ | $0.03 \times (250/V_{osc} - 1)$ | $5 \times (250/V_{osc} - 1)$ |
| $64 < V_{osc} \leq 125$ | $0.03 \times (125/V_{osc} - 1)$ | $5 \times (125/V_{osc} - 1)$ |
| $32 < V_{osc} \leq 64$ | $0.03 \times (64/V_{osc} - 1)$ | $5 \times (64/V_{osc} - 1)$ |
| $V_{osc} \leq 32$ | $0.03 \times (32/V_{osc} - 1)$ | $5 \times (64/V_{osc} - 1)$ |

V_{osc} is oscillator level in mV.

Table 2-26 Parameters E_{PL} , Y_{OL} , Z_{SL}

| Cable length | E_{PL} % | Y_{OL} nS | Z_{SL} m Ω |
|--------------|---------------------------|-----------------------|---------------------|
| 1.5 m | $0.02 + 3 \times f / 100$ | $750 \times f / 100$ | 5.0 |
| 3 m | $0.02 + 5 \times f / 100$ | $1500 \times f / 100$ | 5.0 |

f is frequency in MHz. If measurement cable is extended, open compensation, short compensation, and load compensation must be performed.

Table 2-27 Parameters Y_{OSC} , Y_O , E_P , Z_S

| Frequency f Hz | Y_{OSC} nS | Y_O nS | E_P % | Z_S m Ω |
|-----------------------|---------------------------------|----------|---------|------------------|
| $1k \leq f \leq 200k$ | $1 \times (125/V_{osc} - 0.5)$ | 1.5 | 0.095 | 5.0 |
| $200k < f \leq 1M$ | $2 \times (125/V_{osc} - 0.5)$ | 3.0 | 0.095 | 5.0 |
| $1M < f \leq 2M$ | $2 \times (125/V_{osc} - 0.5)$ | 3.0 | 0.28 | 5.0 |
| $2M < f$ | $20 \times (125/V_{osc} - 0.5)$ | 30.0 | 0.28 | 5.0 |

V_{osc} is oscillator level in mV.

Table 2-28 Example of calculated C/G measurement accuracy

| Frequency | Measured Capacitance | C Accuracy ^a | Measured Conductance | G Accuracy ^a |
|-----------|----------------------|-------------------------|----------------------|-------------------------|
| 5 MHz | 1 pF | ± 0.61 % | 3 µS | ± 192 nS |
| | 10 pF | ± 0.32 % | 31 µS | ± 990 nS |
| | 100 pF | ± 0.29 % | 314 µS | ± 9 µS |
| | 1 nF | ± 0.32 % | 3 mS | ± 99 µS |
| 1 MHz | 1 pF | ± 0.26 % | 628 nS | ± 16 nS |
| | 10 pF | ± 0.11 % | 6 µS | ± 71 nS |
| | 100 pF | ± 0.10 % | 63 µS | ± 624 nS |
| | 1 nF | ± 0.10 % | 628 µS | ± 7 µS |
| 100 kHz | 10 pF | ± 0.18 % | 628 nS | ± 11 nS |
| | 100 pF | ± 0.11 % | 6 µS | ± 66 nS |
| | 1 nF | ± 0.10 % | 63 µS | ± 619 nS |
| | 10 nF | ± 0.10 % | 628 µS | ± 7 µS |
| 10 kHz | 100 pF | ± 0.18 % | 628 nS | ± 11 nS |
| | 1 nF | ± 0.11 % | 6 µS | ± 66 nS |
| | 10 nF | ± 0.10 % | 63 µS | ± 619 nS |
| | 100 nF | ± 0.10 % | 628 µS | ± 7 µS |
| 1 kHz | 100 pF | ± 0.92 % | 63 nS | ± 6 nS |
| | 1 nF | ± 0.18 % | 628 nS | ± 11 nS |
| | 10 nF | ± 0.11 % | 6 µS | ± 66 nS |
| | 100 nF | ± 0.10 % | 63 µS | ± 619 nS |

a. The calculation examples are specified under the conditions $D_x = 0.1$, 1 PLC integration time, 30 mVrms test signal level, and at four-terminal pair port of MFCMU.

SCUU/GSWU

SCUU: SMU CMU Unify Unit

GSWU: Guard Switch Unit

The SCUU multiplexes the outputs from two SMUs (MPSMUs and/or HRSMUs) and the CMU. The SCUU outputs are two sets of Kelvin triaxial ports (Force and Sense). The SCUU also allows the SMUs to act as DC bias sources in conjunction with the CMU. Special cables are available to connect the SMUs and CMU with the SCUU, and an auto-detect feature automatically compensates for the cable length going to the SCUU.

The GSWU contains a relay that automatically opens for IV measurements and closes for CV measurements, forming a guard return path to improve CV measurement accuracy.

- Supported SMU: MPSMU and HRSMU
- SCUU
 - Inputs
 - Triaxial port: Force1, Sense1, Force2, and Sense2
 - BNC port: for MFCMU
 - Control port: for MFCMU
 - Outputs
 - Triaxial port: Force1/CMUH, Sense1, Force2/CMUL, and Sense2
 - Control port: for GSWU
 - LED: SMU/CMU output status indicator
 - Docking mode
 - Direct and indirect mode
- GSWU
 - Input
 - Control port: for SCUU
 - Mini pin plug port: Guard1 and Guard2
 - Output
 - LED: Connection status indicator

Introduction

Specifications

- SCUU supplemental information
 - SMU path
 - Offset current: < 20 fA
 - Offset voltage: < 100 μ V at 300 sec
 - Closed channel residual resistance: < 200 m Ω
 - Channel isolation resistance: > 10^{15} Ω
 - CMU path
 - Test signal
 - Signal output level additional errors (CMU bias, open load):
 - ± 2 % (direct docking)
 - ± 7 % (indirect docking)
 - Signal output level additional errors (SMU bias, open load):
 - ± 5 % (direct docking, ≥ 10 kHz)
 - ± 10 % (indirect docking, ≥ 10 kHz)
 - Output impedance: 50 Ω , typical
 - Signal level monitor additional errors (open load):
 - ± 2 % (CMU bias), direct docking
 - ± 5 % (SMU bias), direct docking
 - ± 7 % (CMU bias), indirect docking
 - ± 10 % (SMU bias), indirect docking
 - DC bias function
 - DC voltage bias (CMU bias)
 - Range: 0 to ± 25 V
 - Resolution: 1 mV
 - Additional errors (for CMU bias): ± 100 μ V (open load)
 - DC voltage bias (SMU bias)
 - Range: 0 to ± 100 V
 - Resolution: 5 mV

Additional errors (for SMU voltage output accuracy): $\pm 100 \mu\text{V}$
(open load)

- DC bias monitor additional errors (open load):
 - $\pm 20 \text{ mV}$, direct docking
 - $\pm 30 \text{ mV}$, indirect docking
- Output impedance: 50Ω , typical
- DC output resistance: 50Ω (CMU bias), 130Ω (SMU bias)
- Measurement accuracy

Impedance measurement error is given by adding the following additional error E_e to the MFCMU measurement error.

$$E_e = \pm (A + Z_s / |Z_x| + Y_o \times |Z_x|) \times 100 (\%)$$

Z_x : Impedance measurement value (Ω)

A: 0.05 % (direct docking) or 0.1 % (indirect docking)

Z_s : $500 \times (1 + f)$ m Ω (f: frequency in MHz)

Y_o : $1 + f \times 10$ nS (direct docking, $\times 2$ for indirect docking)

When the measurement terminals are extended by using the measurement cable, the measurement accuracy is applied to the data measured after performing the open/short/load correction at the DUT side cable end.

Specification conditions:

- Temperature: $23 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$
- Integration time: 1 PLC or 16 PLC

HV-SPGU

HV-SPGU: High Voltage Semiconductor Pulse Generator Unit

- Number of output channels: 2 channels per module
- Modes: pulse, constant, and free run
- Standard pulse mode
 - Two level pulse
 - Three level pulse per one channel
 - Pulse period: 30 ns to 10 s
- Delay range: 0 s to 9.99 s
- Delay resolution: minimum 2.5 ns
- Output count: 1 to 1,000,000
- Voltage monitor minimum sampling period: 5 μ s
- Trigger output

Level: TTL

Timing: Synchronized with pulse period

Trigger width: Pulse period \times 1/2 (pulse period \leq 10 μ s), maximum 5 μ s (pulse period $>$ 10 μ s)

- Pulse range and pulse parameter: See Table 2-29.
- Pulse/DC output voltage and accuracy: See Table 2-30.

Figure 2-9

SPGU pulse setup parameters

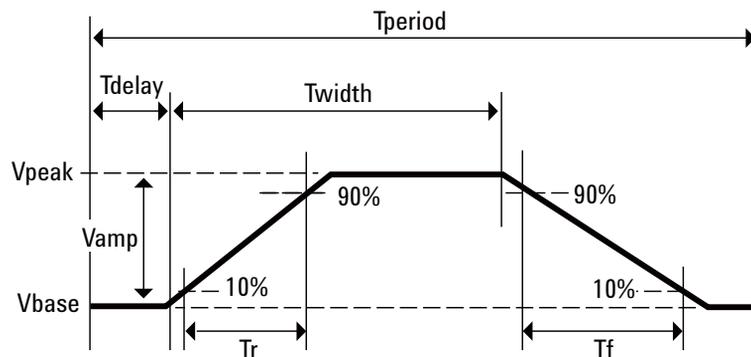


Table 2-29 Pulse range and pulse parameter

| Item | | Value ^a |
|--|--------------------|---|
| Frequency range | | 0.1 Hz to 33 MHz |
| Pulse period | Programmable range | 30 ns to 10 s |
| | Resolution | 10 ns |
| | Minimum | 100 ns ($V_{amp} \leq 10$ V) |
| | Accuracy | $\pm 1\%$ ($\pm 0.01\%$ ^b) |
| Pulse width | Programmable range | 10 ns to (period - 10 ns) |
| | Resolution | 2.5 ns (T_r and $T_f \leq 8$ μ s) |
| | | 10 ns (T_r or $T_f > 8$ μ s) |
| | Minimum | 50 ns (25 ns, typical) at $V_{amp} \leq 10$ V |
| | Accuracy | $\pm (3\% + 2$ ns) |
| Transition time (leading time T_r and trailing time T_f) ^c | Programmable range | 8 ns to 400 ms |
| | Resolution | 2 ns (T_r and $T_f \leq 8$ μ s) |
| | | 8 ns (T_r or $T_f > 8$ μ s) |
| | Minimum (typical) | < 15 ns ($V_{amp} \leq 10$ V) |
| | Minimum | 20 ns ($V_{amp} \leq 10$ V) |
| | | 30 ns ($V_{amp} \leq 20$ V) |
| | | 60 ns ($V_{amp} > 20$ V) |
| | Accuracy | -5 % to 5 % + 10 ns ($V_{amp} \leq 10$ V) |
| -5 % to 5 % + 20 ns ($V_{amp} \leq 20$ V) | | |
| Output relay switching time ^d | Open/close | < 100 μ s |

- a. Unless otherwise stated, all specifications assume a 50 Ω termination.
- b. Typical minimum. This is the supplemental information.
- c. The time from 10 % to 90 % of V_{amp} which is the amplitude of output pulse.
- d. The time it takes the open state relay to open or close.

Table 2-30 Pulse/DC output voltage and accuracy

| Item | Value | Condition |
|--|--|-----------|
| Output voltage (Vout) | -20 V to +20 V | 50 Ω load |
| | -40 V to +40 V | open load |
| Accuracy ^a | ± (0.5 % + 50 mV) | open load |
| Amplitude resolution | 0.2 mV (± 10 V range) | 50 Ω load |
| | 0.8 mV (± 40 V range) | |
| | 0.4 mV (± 10 V range) | open load |
| | 1.6 mV (± 40 V range) | |
| Output connectors | SMA | |
| Source impedance | 50 Ω ^b | |
| Short circuit current | 800 mA peak (400 mA average ^c) | |
| Overshoot/pre-shoot/ringing ^d | ± (5 % + 20 mV) | 50 Ω load |
| Output limit | Monitoring over current limit | |

a. At 1 μs after completing transition.

b. Typical (± 1 %)

c. Specification condition: $N \times 0.2 + I_{total} < 3.0$ A where, *N* is the number of installed HV-SPGUs, and *I_{total}* is DC current output by all modules (including HV-SPGUs)

d. Following the specified condition with transition time.

- ALWG (arbitrary linear waveform generator) function

Arbitrary linear waveform generator (ALWG) mode

- Output complex waveform per one channel of HV-SPGU
- Define multi-level pulse and multi-pulse waveform including open state pulse with ALWG GUI editor
- Sequential pulse waveform from user-defined pulse waveform
- 1024 points per one channel

- Programmable timing range: 10 ns to 10 s, 10 ns resolution
- SPGU supplemental information
 - Pulse width jitter: 0.001 % + 150 ps
 - Pulse period jitter: 0.001 % + 150 ps
 - Maximum slew rate: 1000 V/ μ s (50 Ω load)
 - Noise: 10 mVrms (at DC output)
 - Advanced feature:

Voltage monitor: The HV-SPGU has a voltage monitor function to measure the voltage at the DUT terminal.

Measurement accuracy (open load): \pm (0.1 % of reading + 25 mV)

Measurement resolution: 50 μ V

Note: Specified at 1 PLC (20 ms = (5 μ s sample + 5 μ s interval) \times 2000 samples)

Voltage compensation: The HV-SPGU can measure the impedance of DUT and adjust the output voltage according to the DUT impedance.

Figure 2-10

ALWG setup table and pattern example

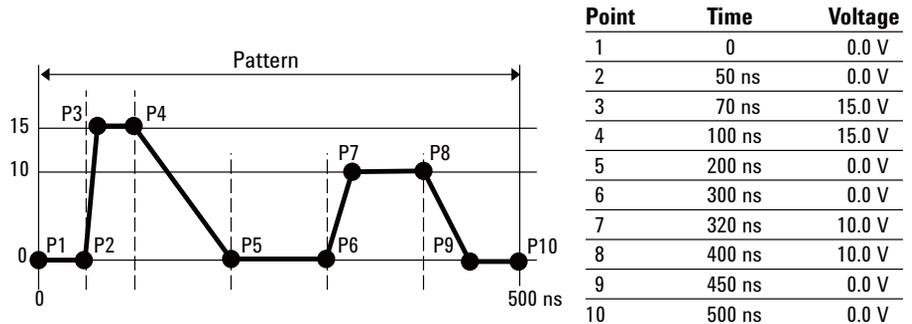
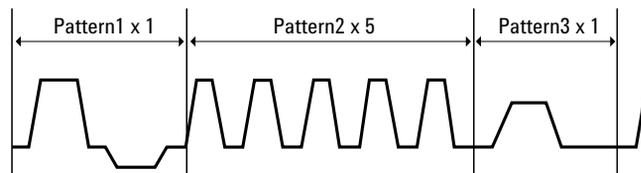


Figure 2-11

ALWG complex waveform example



Selector

Agilent 16440A SMU/pulse generator selector switches either a SMU or PGU to the associated output port. You can expand to four channels by adding an additional 16440A. The PGU port on channel 1 provides a “PGU OPEN” function, which can disconnect the PGU by opening a semiconductor relay. Agilent B1500A and 16445A are required to use the 16440A.

The following specifications data is specified at 23 °C ± 5 °C (73 °F ± 9 °F) and 50 % relative humidity.

- Channel configuration: 2 channels (CH 1 and CH 2). Can add the additional 2 channels (CH 3 and CH 4) by adding another 16440A (selector expander).

| | Input | Output |
|-------------------------------|-------------------------------|--------|
| Channel 1 (CH 1) | 2 (SMU and PGU ^a) | 1 |
| Channel 2 (CH 2) | 2 (SMU and PGU) | 1 |
| Channel 3 (CH 3) ^b | 2 (SMU and PGU ^a) | 1 |
| Channel 4 (CH 4) ^b | 2 (SMU and PGU) | 1 |

- a. PGU channels 1 and 3 have a built-in series semiconductor relay.
- b. Available when a selector expander is installed.

- Voltage and current range

| Input port | Maximum voltage (V) | Maximum current (A) |
|------------|---------------------|---------------------|
| SMU | 200 | 1.0 |
| PGU | 40 | 0.2 ^a |

- a. This is peak-to-peak ac current.

Selector Adapter

Agilent 16445A selector adapter is required to control and to supply DC power to the 16440A selector.

- Power requirement: 100 to 240 V, 50/60 Hz
- Maximum volt-amps (VA): 20 VA

WGFMU/RSU

WGFMU: Waveform Generator/Fast Measurement Unit

RSU: Remote-sense and Switch Unit

The WGFMU is a self-contained module offering the combination of arbitrary linear waveform generation (ALWG) with synchronized fast current or voltage (IV) measurement. The ALWG function allows you to generate not only DC, but also various types of AC waveforms. In addition to this versatile sourcing capability, the WGFMU can also perform measurement in synchronization with the applied waveform, which enables accurate high-speed IV characterization.

- Number of output channels: 2 channels per module
- Modes: Fast IV, PG (pulse generator), DC, and SMU pass-through
- Measurement functions, voltage forcing, voltage measurement, and current measurement: See Table 2-31.
- Voltage measurement accuracy, resolution and noise: See Table 2-32.
- Current measurement accuracy and resolution: See Table 2-33.
- Voltage force accuracy, resolution, and timing: See Table 2-34.
- RF electromagnetic field and WGFMU measurement accuracy

Voltage and current measurement accuracy may be affected by RF electromagnetic field of strength over 3 V/m at frequencies 80 MHz to 1 GHz and 1.4 GHz to 2.0 GHz, and 1 V/m at frequencies 2.0 GHz to 2.7 GHz. The extent of this effect depends upon how the instrument is positioned and shielded.

- RSU
 - Output terminal
 - Connector: SMA
 - Source impedance: 50 Ω (nominal), at DC output in PG mode
 - SMU path
 - Maximum voltage: ± 25 V
 - Maximum current: ± 100 mA
 - V Monitor terminal
 - Connector: BNC
 - Source impedance: 50 Ω (nominal), at DC output

Introduction

Specifications

The V Monitor terminal outputs a buffered signal equal to 1/10 of the Output terminal voltage (into a 50 Ω load).

- WGFMU to RSU cable length

The WGFMU and RSU are connected by a special composite cable. The following configurations are available.

- 3 m
- 5 m
- 1.5 m
- 2.4 m + connector adapter + 0.6 m
- 4.4 m + connector adapter + 0.6 m

Note: The connector adapter is used when routing the cable through the prober's connector panel.

- ALWG function: See Table 2-35.

- Trigger output

Level: TTL

Trigger width: 10 ns

Generated synchronously with ALWG waveform.

- Software

- Instrument library for WGFMU control (supported operating systems: Microsoft Windows XP Professional SP2 and Vista Business SP1)
- NBTI and general-purpose EasyEXPERT Application Tests
- Sample programs (NBTI and general-purpose measurement using WGFMU and RTS data analysis)

- WGFMU supported prober vendors

Cascade Microtech

Suss MicroTec

Vector Semicon

Note: The maximum number of installable RSUs for a given prober depends upon the available space. Please contact your local sales representative for details on connecting and mounting the WGFMU and RSU.

Table 2-31 Measurement functions, voltage forcing, voltage measurement, and current measurement

| Mode | Function | V force ranges | V measure ranges | I measure ranges |
|------------------|--------------------------------------|--|------------------------------|---|
| Fast IV | V force/I measure, V force/V measure | -3 V to +3 V, -5 V to +5 V, -10 V to 0 V, 0 V to +10 V | -5 V to +5 V, -10 V to +10 V | 1 μ A, 10 μ A, 100 μ A, 1 mA, 10 mA |
| PG | V force/V measure | -3 V to +3 V, -5 V to +5 V | -5 V to +5 V | - |
| DC | V force/I measure, V force/V measure | -3 V to +3 V, -5 V to +5 V, -10 V to 0 V, 0 V to +10 V | -5 V to +5 V, -10 V to +10 V | 1 μ A, 10 μ A, 100 μ A, 1 mA, 10 mA |
| SMU pass through | Measurement using SMU | Maximum \pm 25 V | - | Maximum \pm 100 mA |

Table 2-32 Voltage measurement accuracy, resolution, and noise

| | |
|-------------------------|--|
| Accuracy | \pm 0.1 % of reading \pm 0.1 % of range (independent of the range or mode) |
| Resolution ^a | 680 μ V (-5 V to +5 V range), 1.4 mV (-10 V to +10 V) |
| Noise | 4 mV _{rms} (-5 V to +5 V range) ^b |

a. Can vary at most 5 % based on the result of calibration

b. Into an open load. Without averaging.

Table 2-33 Current measurement accuracy and resolution

| | |
|-------------------------|--|
| Accuracy | \pm 0.1 % of reading \pm 0.1 % of range (independent of the range or mode) |
| Resolution ^a | 0.014 % of range |

a. Display resolution. Can vary at most 5% based on the results of calibration.

Table 2-34 Voltage force accuracy, resolution, and timing

| | |
|------------------------------|---|
| V force (Fast IV mode) | -5 V to +5 V, -10 V to 0 V, 0 V to +10 V |
| V force (PG mode) | -5 V to +5 V (open load), -2.5 V to +2.5 V (50 Ω load) |
| Accuracy | ± 0.1 % of setting ± 0.1 % of range ^{a b} |
| Resolution ^c | 96 μV (-3 V to +3 V), 160 μV (all ranges except for -3 V to +3 V) |
| Overshoot/undershoot | ± (5 % + 20 mV) ^d |
| Rise/fall time | -5 % to (+5 % + 10 ns) of setting ^e |
| Pulse period timing accuracy | ± 0.1 % of setting ^f |
| Pulse width timing accuracy | ± (3 % + 2 ns) ^g |

- a. Independent of the range or the mode. The load impedance must be ≥ 1 MΩ (1 μA range) or ≥ 200 kΩ (all other current ranges) for Fast IV mode, or ≥ 1 MΩ for PG mode.
- b. Excludes noise (by averaging over 10,000-time sampling) or transient behavior (by waiting for a sufficient time)
- c. Can vary at most 5 % based on the result of calibration
- d. Trise (10-90 %) and Tfall (90-10%) >16 ns with the 1.5 m cable, >32 ns with 3 m cable, or >56 ns with 5 m cable (PG mode, 50 Ω load)
- e. Trise (10-90 %) and Tfall (90-10 %) >24 ns (PG mode, 50 Ω load)
- f. For the minimum 100 ns period (PG mode, 50 Ω load)
- g. For the minimum 50 ns width (PG mode, 50 Ω load)

Table 2-35 ALWG function

| | |
|-------------------------------|---|
| Maximum number of vectors | 2048 |
| Maximum number of sequences | 512 |
| Maximum number of loop counts | 1 to 10 ¹² |
| Length of a vector | 10 ns to 10,000 s with 10 ns resolution |
| Sampling rate | 5 ns, or 10 ns to 1 s with 10 ns resolution |
| Hardware averaging | 10 ns to 20 ms with 10 ns resolution |
| Hardware memory | About 4 M data points/channel (typical) |

Agilent EasyEXPERT Software

Functions

- Operation mode
 - Application test mode
 - Classic test mode
 - Quick test mode
- Key functions
 - Categorized and predefined application test library
 - GUI-based application test editor
 - Save/recall My Favorite setups
 - Define/customize application library
 - Execute measurement (single/repeat/append)
 - Quick test execution
 - Direct control (GPIB FLEX)
 - Save/recall measurement data and settings
 - Test result data management
 - Import/export device definition, measurement settings, my favorite setup, measurement data, and application library
 - Graph plot display/analysis/printing
 - Switching matrix control
 - Workspace management
 - Self-test, self-calibration, diagnostics

Application library

Sample application tests are supplied for the following categories. They are subject to change without notice.

Structure, CMOS, Bipolar (BJT), Memory, Mixed Signal Device, TFT, Discrete, Reliability, Power Device, Nanotechnology, Utility

Measurement mode details

Agilent B1500A supports the following measurement modes:

- Staircase sweep
- Multi-channel sweep (EasyEXPERT does not support VAR1')
- Pulsed sweep
- Staircase sweep with pulsed bias
- IV sampling
- High speed IV sampling
- CV sweep
- C-t sampling
- C-f sweep
- List sweep
- Linear search (supported by FLEX command)
- Binary search (supported by FLEX command)

Each SMU can be set to VAR1 (primary sweep), VAR2 (secondary sweep), VAR1' (synchronous sweep), or CONST (constant voltage/current source).

- VAR1
Primary sweep controls the staircase (DC or pulsed) voltage or current sweep.
Maximum number of VAR1 steps: $N_1 = 1001$
- VAR2
Subordinate linear staircase or linear pulsed sweep. After primary sweep is completed, the VAR2 unit output value is changed.
Maximum number of VAR2 steps: $N_2 = 1001$ (condition: $1 \leq N_1 \times N_2 \leq 128128$)
- VAR1'
Staircase or pulse sweep synchronized with the VAR1 sweep. Sweep is made with a user specified ratio and offset values.
$$\text{VAR1}' = a \times \text{VAR1} + b$$

“a” is the user specified ratio, and “b” is the user specified offset value.

- **CONST**
A source unit can be set as a constant voltage or current source depending on the unit.
- **Staircase sweep measurement mode**
Forces swept voltage or current, and measures DC voltage or current. One channel can sweep current or voltage while up to ten channels can measure current or voltage. A second channel can be synchronized with the primary sweep channel as an additional voltage or current sweep source.
Number of steps: 1 to 1001
Sweep mode: linear or logarithmic (log)
Sweep direction: single or double sweep
Hold time: 0 to 655.35 s, 10 ms resolution
Delay time: 0 to 65.5350 s, 100 μ s resolution
- **Pulsed sweep measurement mode**
Forces pulsed swept voltage or current, and measures DC voltage or current. A second channel can be programmed to output a staircase sweep voltage or current synchronized with the pulsed sweep output.
- **Staircase sweep with pulsed bias measurement mode**
Forces swept voltage or current, and measures DC voltage or current. A second channel can be programmed to output a pulsed bias voltage or current. A third channel can be synchronized with the primary sweep channel as an additional voltage or current sweep source.
- **Sampling (time domain) measurement mode**
Displays the time sampled voltage/current data (by SMU) versus time.
Sampling channels: up to 10
Sampling mode: linear or logarithmic (log)
Sampling points: 1 to 100,001/(number of channels) for linear sampling, 1 to 1 + (number of data for 11 decades) for log sampling
Sampling interval range: $100 \mu\text{s} + 20 \mu\text{s} \times (\text{number of channels} - 1)$ to 2 ms in 10 μ s resolution, or 2 ms to 65.535 s in 1 ms resolution
Hold time, bias hold time: -90 ms to -100 μ s in 100 μ s resolution, 0 to 655.35 s in 10 ms resolution

Introduction

Specifications

Measurement time resolution: 100 μ s

- Standby mode

SMUs in “Standby” remain programmed to their specified output value even as other units are reset for the next measurement.

- Current offset cancel

This function subtracts the offset current from the current measurement raw data, and returns the result as the measurement data. This function is used to compensate the error factor (offset current) caused by the measurement path such as the measurement cables, manipulators, or probe card.

- Timestamp

The B1500A supports a time stamp function utilizing an internal quartz clock.

Resolution: 100 μ s

- Other measurement characteristics

- Measurement control:

Single, repeat, append, and stop

- SMU setting capabilities:

Limited auto ranging, voltage/current compliance, power compliance, automatic sweep abort functions, self-test, and self-calibration

Arithmetic and analysis functions

- User functions

Up to 20 user-defined functions can be defined using arithmetic expressions.

Measured data and pre-defined variables can be used in the computation. The results can be displayed on the LCD.

- Arithmetic operators

+, -, *, /, ^, abs (absolute value), at (arc tangent), avg (averaging), cond (conditional evaluation), delta, diff (differential), exp (exponent), integ (integration), lgt (logarithm, base 10), log (logarithm, base e), mavg (moving average), max, min, sqrt, trigonometric function, inverse trigonometric function, and so on

- Physical constants

Keyboard constants are stored in memory as follows:

- q: Electron charge, 1.602177E-19 C
- k: Boltzman's constant, 1.380658E-23
- ϵ (e): Dielectric constant of vacuum, 8.854188E-12
- Engineering units

The following unit symbols are also available on the keyboard.

a (10^{-18}), f (10^{-15}), p (10^{-12}), n (10^{-9}), u or μ (10^{-6}), m (10^{-3}), k (10^3), M (10^6), G (10^9), T (10^{12}), P (10^{15})

Analysis capabilities

- Overlay graph comparison

Graphical plots can be stored and overlaid.

- Scale

Auto scale and zoom

- Marker

Marker to min/max, interpolation, direct marker, and marker skip

- Cursor

Direct cursor

- Line

Two lines, normal mode, grad mode, tangent mode, and regression mode

Auto analysis function

On a graphics plot, the markers and lines can be automatically located using the auto analysis setup. Parameters can be automatically determined using automatic analysis, user function, and read out functions.

- Data variable display

Up to 20 user-defined parameters can be displayed on the graphics screen.

- Analysis functions

Up to 20 user-defined analysis functions can be defined using arithmetic expressions.

Measured data, pre-defined variables, and read out functions can be used in the computation. The results can be displayed on the LCD.

[Introduction](#)
[Specifications](#)

- Read out functions

The read out functions are built-in functions for reading various values related to the marker, cursor, or line.

Graph plot

- Display mode

Data display window can be printed. Only X-Y graph can be printed.

- Graph plot file

Graph plot can be stored as image data to clip board or mass storage device.

File type: bmp, gif, png, emf

Output

- Display mode

X-Y graph, list, and parameter

- X-Y graph display

X-axis and up to eight Y-axis. Linear and log scale. Real time graph plotting.

- List display

Measurement data and calculated user function data are listed in conjunction with VAR1 step number or time domain sampling step number. Up to 20 data sets can be displayed.

Other functions

- Import/export files

File type: Agilent EasyEXPERT format, XML-SS format, CSV format

- Data storage

Hard disk drive, DVD-ROM/CD-R/CD-RW drive

- Interfaces

GPIB, interlock, USB (USB 2.0, 2 ea. on front, 2 ea. on rear),
 LAN (100BASE-TX/10BASE-T), trigger in/out, digital I/O

- Trigger I/O
Only available using GPIB FLEX commands.
Trigger in/out synchronization pulses before and after setting and measuring DC voltage and current. Arbitrary trigger events can be masked or activated independently.
- External instruments supported by EasyEXPERT Standard edition:
Supported by switching matrix GUI: B2200A, B2201A
Supported by application tests: E5250A (E5252A cards), 4284A/E4980A, 81110A, 3458A
- External instruments supported by EasyEXPERT Plus edition:
All external instruments supported by EasyEXPERT Standard edition
Also supported by switching matrix GUI: E5250A (E5252A cards)

Furnished Software

- Prober control execution files
- Desktop EasyEXPERT software with license-to-use for Standard edition
- 4155/56 setup file converter tool (supported operating systems: Microsoft Windows 2000 Professional, XP Home, XP Professional, and Vista Business)
- *VXIplug&play* driver (supported operating systems: Microsoft Windows 2000 Professional and XP Professional)

Agilent Desktop EasyEXPERT Software

Desktop EasyEXPERT is the same software that is built-in to the PC-based Agilent B1500A Semiconductor Device Analyzer, except that it runs on a standalone PC. Just like standard EasyEXPERT, Desktop EasyEXPERT supports all aspects of parametric test, from basic manual measurements to test automation across a wafer in conjunction with a semi-automatic wafer prober.

Features and benefits

- Large application test library
Desktop EasyEXPERT comes with over 200 application tests conveniently organized by device type, application, and technology. Many of these application tests will run on the 4155/4156 without modification, and you can easily edit and customize the furnished application tests to fit your specific needs.
- Offline capability
Desktop EasyEXPERT can be run in either online or offline mode. In the offline mode you can perform tasks such as analyzing data and creating new application tests. This frees up your existing analyzer from being needed for development work and enables you to use it for its primary purpose: making measurements.
- GUI-based classic test mode
Desktop EasyEXPERT offers a classic test mode that maintains the look, feel, and terminology of the 4155/4156 user interface. In addition, it improves the 4155/4156 user interface by taking full advantage of Microsoft Windows GUI features.
- Easy test sequencing
A GUI-based Quick Test mode enables you to perform test sequencing without programming. You can select, copy, rearrange and cut-and-paste any application tests with a few simple mouse clicks. Once you have selected and arranged your tests, simply click on the measurement button to begin running an automated test sequence.
- Prober control
All popular semi-automatic wafer probers are supported by Desktop EasyEXPERT. You can define wafer, die, and module information for probing across an entire wafer. You can also combine wafer prober control with either Quick Test mode or an application test based test sequence to perform multiple testing on various devices across the wafer.

- Automatic data export

Desktop EasyEXPERT has the ability to automatically export measurement data in real time, in a variety of formats. You can save data to any drive connected to the PC. If you wish, you can export data to a network drive and view test results on your desktop PC as your instruments are performing the testing in your lab.

System requirements

The following are the minimum requirement for executing Desktop EasyEXPERT.

| | | |
|-----------------------------------|---|--------------------------------------|
| Operating system and service pack | Microsoft Windows XP Professional SP2 | Microsoft Windows Vista Business SP1 |
| Processor | Intel Celeron 2 GHz | Vista certified PC with 1 GB memory |
| Memory | 512 Megabytes DDR266 | |
| Display | XGA 1024×768 (SXGA 1280×1024 recommended) | |
| HDD | 1 GB free space on the C drive, 10 GB (30 GB recommended) free space on a drive for test setup/result data storage. | |
| .NET Framework | Microsoft .NET Framework Ver 2.0 Redistributable Package Microsoft .NET Framework 2.0 SP1 | Microsoft .NET Framework Ver 3.0 |
| IO libraries | Agilent IO Libraries Suite 15.0 (for online mode) | |

- Supported GPIB I/F (for online mode):

| | | |
|----------------|---------------|------------------|
| | B1500A | 4155B/C, 4156B/C |
| Agilent 82350B | Supported | Supported |
| Agilent 82357A | Not supported | Supported |
| Agilent 82357B | Not supported | Supported |

Introduction

Specifications

- Supported instruments:
B1500A, 4155B, 4156B, 4155C, and 4156C
Supported 4155/4156 firmware: HOSTC: 03.08 or later and SMUC: 04.08 or later
- External instruments supported by Desktop EasyEXPERT Standard edition:
Supported by switching matrix GUI: B2200A, B2201A
Supported by application tests: E5250A (E5252A cards), 4284A/E4980A, 81110A, 3458A
- External instruments supported by Desktop EasyEXPERT Plus edition:
All external instruments supported by Desktop EasyEXPERT Standard edition
Also supported by switching matrix GUI: E5250A (E5252A cards)

Supported 4155/4156 functionality

- Desktop EasyEXPERT Standard edition:
I/V Sweep, B2200A/B2201A switching matrix GUI control
- Desktop EasyEXPERT Plus edition:
The following functions are additionally supported.
I/V-t Sampling except thinned out mode, VSVMU except differential voltage measurement using VMU, PGU (41501B), E5250A/E5252A switching matrix GUI control
- Setup converter tool
In addition to Desktop EasyEXPERT, Agilent supplies a free setup converter tool that runs on any Windows-based PC. This tool can convert 4155 and 4156 setup files (file extension MES or DAT) into equivalent Desktop EasyEXPERT classic test mode setup files.

General Specifications

- Temperature range
 - Operating** +5 °C to +40 °C
 - Storage** -20 °C to +60 °C
- Humidity
 - Operating** 20 % to 70 %RH, non-condensing
 - Storage** 10 % to 90 %RH, non-condensing
- Altitude
 - Operating** 0 to 2,000 m (6,561 ft.)
 - Storage** 0 to 4,600 m (15,092 ft.)
- Power requirement: 90 to 264 V, 47 to 63 Hz
- Maximum volt-amps (VA): 900 VA
- Regulatory compliance
 - EMC** IEC61326-1:+A1 / EN61326-1:+A1
AS/NZS 2064.1
 - Safety** CSA C22.2 No.1010.1-1992
IEC61010-1:+A2 / EN61010-1:+A2
UL3111-1:1994
- Certification: CE, CSA, NRTL/C, C-Tick
- Dimensions
 - B1500A: 420 mm (W) × 330 mm (H) × 575 mm (D)
 - N1301A-100 SCUU: 148 mm (W) × 75 mm (H) × 70 mm (D)
 - N1301A-200 GSWU: 33.2 mm (W) × 41.5 mm (H) × 32.8 mm (D)
 - E5288A ASU: 132 mm (W) × 88.5 mm (H) × 50 mm (D)
 - B1531A RSU: 45.2 mm (W) × 70 mm (H) × 82 mm (D)
 - 16440A Selector: 250 mm (W) × 50 mm (H) × 275 mm (D)
 - 16445A Selector adapter: 250 mm (W) × 50 mm (H) × 260 mm (D)
- Weight
 - B1500A (empty) 20 kg, B1510A 2.0 kg, B1511A 1.0 kg, B1517A 1.2 kg,
E1520A 1.5 kg, E1525A 1.3 kg, E1530A 1.3 kg, E1531A 0.13 kg, E5288A 0.5
kg, N1301A-100 0.8 kg, N1301A-200 0.1 kg, 16440A 1.1 kg, 16445A 1.0 kg

Accessories and Options

Agilent B1500A is furnished with the following accessories.

- Power cable, 1 ea.
- Manual CD, 1 ea.
- Desktop EasyEXPERT CD-ROM, 1 ea.
- License-to-use for Desktop EasyEXPERT Standard edition, 1 license
- Software CD-ROM (including *VXIplug&play* driver and utility tools), 1 ea.
- Disk set for Agilent 4155B/4155C/4156B/4156C firmware update, 1 set
- SMU number label for the B1500A installed with SMU, 1 sheet
- PG number label for the B1500A installed with SPGU, 1 sheet

Table 2-36 lists the options and the available accessories for Agilent B1500A.

Table 2-36 Options and Accessories

| Model Number | Option Item | Description |
|---------------------|--------------------|--|
| B1500A | | Semiconductor Device Analyzer |
| | B1500A-050 | 50 Hz power line frequency |
| | B1500A-060 | 60 Hz power line frequency |
| | B1500A-A6J | ANSI Z540 compliant calibration |
| | B1500A-UK6 | Commercial cal. certificate w/ test data |
| | B1500A-ABA | Paper manual set, English |
| | B1500A-ABJ | Paper manual set, Japanese |
| B1510A | | High Power Source/Monitor Unit module (HPSMU) |
| B1511A | | Medium Power Source/Monitor Unit module (MPSMU) |
| B1517A | | High Resolution Source/Monitor Unit module (HRSMU) |
| B1520A | | Multi Frequency Capacitance Measurement Unit module (MFCMU) |
| B1525A | | Semiconductor Pulse Generator Unit module (SPGU) |
| B1530A | | Waveform Generator/Fast Measurement Unit (WGFMU) |
| B1531A | | Remote-sense and Switch Unit (RSU) |
| B1540A | | Agilent EasyEXPERT software |
| | B1540A-001 | Standard |
| | B1540A-002 | Adds support instrument (E5250A/E5252A switching matrix is supported) |
| B1541A | | Agilent Desktop EasyEXPERT software |
| | B1541A-001 | Standard |
| | B1541A-002 | Adds support instrument and function (E5250A/E5252A switching matrix is supported, and 4155/4156 support function is expanded) |

Introduction
Accessories and Options

| Model Number | Option Item | Description |
|--------------|-------------|---|
| E5288A | | Atto Sense and Switch Unit (ASU) |
| | E5288A-001 | Add triaxial and D-sub cables, 1.5 m |
| | E5288A-002 | Add triaxial and D-sub cables, 3 m |
| N1253A | | Accessories for Digital I/O |
| | N1253A-100 | Digital I/O T-cable |
| | N1253A-200 | Digital I/O BNC Box |
| N1254A | | Accessories |
| | N1254A-100 | GNDU to Kelvin Adapter |
| | N1254A-107 | Triax(m)-Triax(f) Adapter |
| | N1254A-108 | ASU Magnetic Stand |
| N1300A | | CMU cable |
| | N1300A-001 | 1.5 m length |
| | N1300A-002 | 3 m length |
| N1301A | | Accessories for CMU |
| | N1301A-100 | SMU CMU Unify Unit (SCUU) |
| | N1301A-102 | SCUU cable, 3 m |
| | N1301A-110 | SCUU magnetic stand |
| | N1301A-200 | Guard Switch Unit (GSWU) |
| | N1301A-201 | GSWU cable, 1.5 m |
| | N1301A-202 | GSWU cable, 3 m |
| 16435A | | Interlock cable adapter (B1500 type to BNC) |
| 16440A | | SMU/Pulse Generator selector |
| | 16440A-001 | Control cable, 1.5 m |
| | 16440A-002 | Control cable, 3.0 m |
| | 16440A-003 | Control cable, 40 cm for second selector |

| Model Number | Option Item | Description |
|--------------|-------------|---|
| 16442B | | Test fixture |
| | 16442B-010 | Add triaxial cables, 1.5 m, 4 ea. |
| | 16442B-011 | Add triaxial cables, 3 m, 4 ea. |
| | 16442B-800 | Extra blank teflon board |
| | 16442B-801 | Universal socket module, 0.1 inch pitch, with 10 pins |
| | 16442B-802 | Universal socket module, 0.075 inch pitch, with 10 pins |
| | 16442B-803 | Universal socket module, 0.05 inch pitch, with 10 pins |
| | 16442B-810 | Extra pin set (for universal socket module, 10 pins.) |
| | 16442B-811 | Extra wire set (mini banana to pin plug, 6 ea.) |
| | 16442B-812 | Extra wire set (pin plug to pin plug, 6 ea.) |
| | 16442B-813 | Extra wire set (mini banana to mini clip, 6 ea.) |
| | 16442B-814 | Extra wire set (mini banana to mini banana, 6 ea.) |
| | 16442B-821 | Socket module, 4-pin TO package |
| | 16442B-822 | Socket module, 18-pin DIP package |
| | 16442B-823 | Extra socket module, 28-pin DIP package |
| | 16442B-890 | Extra accessory case |
| 16444A | | Accessories for B1500A |
| | 16444A-001 | USB keyboard |
| | 16444A-002 | USB mouse |
| | 16444A-003 | Stylus pen |
| 16445A | | Selector adapter for 16440A |
| | 16445A-001 | Control cable (B1500 to 16445A), 1.5 m |
| | 16445A-002 | Control cable (B1500 to 16445A), 3.0 m |

Introduction
Accessories and Options

| Model Number | Option Item | Description |
|--------------|-------------|---|
| 16493G | | Digital I/O connection cable |
| | 16493G-001 | 1.5 m length |
| | 16493G-002 | 3 m length |
| 16493J | | Interlock cable |
| | 16493J-001 | 1.5 m length |
| | 16493J-002 | 3 m length |
| | 16493J-003 | 5 m length |
| 16493K | | Kelvin triaxial cable (B1500 to B1500) |
| | 16493K-001 | 1.5 m length |
| | 16493K-002 | 3 m length |
| 16493L | | GNDU cable |
| | 16493L-001 | 1.5 m length |
| | 16493L-002 | 3 m length |
| | 16493L-003 | 5 m length |
| 16493M | | Triaxial and D-sub cables for ASU |
| | 16493M-001 | 1.5 m length |
| | 16493M-002 | 3 m length |
| 16493N | | GNDU cable for B2200 Kelvin input |
| | 16493N-001 | 2 m length |
| 16493P | | SPGU output connection cable (SMA to BNC) |
| | 16493P-001 | 1.5 m length |
| | 16493P-002 | 3 m length |
| 16493Q | | SPGU-SPGU connection cable (SMA to SMA) |
| | 16493Q-001 | 8 cm length |

| Model Number | Option Item | Description |
|---------------------|--------------------|---|
| 16493R | | Accessories for WGF MU |
| | 16493R-001 | 60 cm cable between WGF MU and RSU |
| | 16493R-002 | 2.4 m cable between WGF MU and RSU |
| | 16493R-003 | 3 m cable between WGF MU and RSU |
| | 16493R-004 | 5 m cable between WGF MU and RSU |
| | 16493R-005 | 4.4 m cable between WGF MU and RSU |
| | 16493R-006 | 1.5 m cable between WGF MU and RSU |
| | 16493R-101 | 5 cm SSMC-SSMC cable for current return path |
| | 16493R-102 | 7 cm SSMC-SSMC cable for current return path |
| | 16493R-202 | 20 cm SMA-SSMC cable between RSU and DC probe |
| | 16493R-302 | 20 cm SMA-SMA cable between RSU and RF probe |
| | 16493R-801 | WGF MU connector adapter (male-female) |
| | 16493R-802 | Magnet stand for RSU |
| 16494A | | Triaxial cable |
| | 16494A-001 | 1.5 m length |
| | 16494A-002 | 3 m length |
| | 16494A-003 | 80 cm length |
| | 16494A-004 | 40 cm length |
| | 16494A-005 | 4 m length |
| 16494B | | Kelvin triaxial cable (B1500 to E5250) |
| | 16494B-001 | 1.5 m length |
| | 16494B-002 | 3 m length |
| | 16494B-003 | 80 cm length |

Introduction
Accessories and Options

| Model Number | Option Item | Description |
|--------------|-------------|---|
| 16495F | | Connector plate w/ 12×triax., Interlock, GNDU |
| | 16495F-001 | Bulkhead feedthrough connectors (female to female) |
| | 16495F-002 | Connectors to contacts for soldering |
| 16495G | | Connector plate w/ 24×triax., Interlock, GNDU |
| | 16495G-001 | Bulkhead feedthrough connectors (female to female) |
| | 16495G-002 | Connectors to contacts for soldering |
| 16495H | | Connector plate w/ 6×triax., 6×coax., Interlock, GNDU |
| | 16495H-001 | Bulkhead feedthrough connectors (female to female) |
| | 16495H-002 | Connectors to contacts for soldering |
| 16495J | | Connector plate w/ 8×triax., 4×coax., Interlock, GNDU |
| | 16495J-001 | Bulkhead feedthrough connectors (female to female) |
| | 16495J-002 | Connectors to contacts for soldering |
| 16495K | | Connector plate with universal cable holder |
| | 16495K-001 | Connector plate with rubber holder |

3

Installation

Installation

This chapter describes how to install Agilent B1500A and accessories.

- “Requirements”
- “Inspection and Installation”
- “Installing Accessories”
- “Mounting Connectors”
- “Connecting Measurement Devices”
- “Capacitance Compensation When Using Switching Matrix”
- “Maintenance”
- “About Plug-in Modules”

To change the GPIB address of the B1500A, see “To Change GPIB Address” on page 3-9. To control external GPIB devices from the B1500A/EasyEXPERT, see “To Enable System Controller” on page 3-10.

WARNING



There are potentially hazardous voltages (200 V for HPSMU, and 100 V for MPSMU/HRSMU/ASU) present at the Force, Sense, and Guard terminals of Agilent B1500A. To prevent electrical shock, the following safety precautions must be observed during the use of the B1500A.

- **Use a three-conductor AC power cable to connect the cabinet (if used) and the B1500A to an electrical ground (safety ground).**
- **If you do *not* use the 16442B test fixture, you must install and connect an interlock circuit that opens the Interlock terminal when the shielding box access door is opened.**
- **Confirm periodically that the interlock function works normally.**
- **Before touching the connections on the Force, Guard, and Sense terminals, turn the B1500A off and discharge any capacitors. If you do *not* turn the B1500A off, complete *all* of the following items, regardless of the B1500A settings.**
 - **Press the Stop key to set the module output off.**
 - **Confirm that the High Voltage indicator is not lit.**
 - **Open the shielding box access door (open the Interlock terminal).**
 - **Discharge any capacitors connected to an SMU.**
- **Warn persons working around the B1500A about dangerous conditions.**

Requirements

This section contains information on:

- “Power Requirements”
- “Operating Environment”
- “Storing/Shipping Environment”
- “Ventilation Requirements”
- “Power Cable”

Power Requirements

The B1500A can operate from any single-phase AC power source supplying 90 to 264 V at 47 to 63 Hz. The maximum power consumption is 900 VA.

Operating Environment

The B1500A is specified to operate within the following environmental conditions:

| | |
|---------------------|---------------------------------|
| Temperature: | 5 °C to 40 °C |
| Humidity: | 20 % to 70 % RH, non-condensing |
| Altitude: | 0 to 2,000 m (6,561 ft.) |

Storing/Shipping Environment

The B1500A is specified to store/ship within the following environmental conditions:

| | |
|---------------------|---|
| Temperature: | -20 °C to 60 °C |
| Humidity: | 20 % to 90 % RH, at 40 °C, non-condensing |
| Altitude: | 0 to 4,600 m (15,092 ft.) |

Ventilation Requirements

The B1500A has cooling fans. To ensure adequate airflow, make sure that there is sufficient clearance around the cooling fans: 6 inches (150 mm) behind, 3 inches (70 mm) on the sides, and 0.5 inch (12 mm) above and below.

If the airflow is restricted, the internal operating temperature will be higher. This may reduce the instrument's reliability, or cause the thermal-protection circuits to turn the instrument off.

Power Cable

CAUTION

Before applying AC line power to the B1500A, ensure that the correct power cable is used.

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

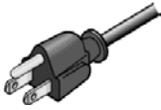
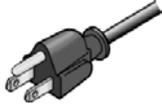
If the plug on the cable does not fit the power outlet, or the cable is to be attached to a terminal block, cut the cable at the plug end and re-wire it. This work should be performed by a qualified electrician, observing all local electrical codes.

The color coding used in the cable will depend on the cable supplied. If a new plug is to be connected, it must meet local safety requirements and include the following features:

- adequate load-carrying capacity (see “Specifications” on page 2-33.)
- ground connection
- cable clamp

WARNING

For protection from electrical shock, do *not* interrupt the power cable ground.

| | | | |
|---|--|---|---|
|  <ul style="list-style-type: none"> • Plug: BS 1363/A, 250 V, 10 A • Cable: 8120-4420, 8120-1351 |  <ul style="list-style-type: none"> • Plug: AS 3112, 250 V, 10 A • Cable: 8120-4419, 8120-1369 |  <ul style="list-style-type: none"> • Plug: CEE 7 sheet VII, 250 V, 10 A • Cable: 8120-4519, 8120-1689 |  <ul style="list-style-type: none"> • Plug: NEMA 5-15P, 125 V, 10 A • Cable: 8120-6825, 8120-1378, 8120-1395 |
|  <ul style="list-style-type: none"> • Plug: NEMA 6-15P, 250 V, 10 A • Cable: 8120-3996, 8120-0698 |  <ul style="list-style-type: none"> • Plug: SEV 1011, 250 V, 10 A • Cable: 8120-2104 |  <ul style="list-style-type: none"> • Plug: SR 107-2-D1, 250 V, 10 A • Cable: 8120-2956 |  <ul style="list-style-type: none"> • Plug: IS 1293 and IS 6538, 250 V, 10 A • Cable: 8121-1582, 8120-4211 |
|  <ul style="list-style-type: none"> • Plug: JIS C 8303, 125 V, 12 A • Cable: 8121-0743, 8120-4753 |  <ul style="list-style-type: none"> • Plug: Israel SI 32, 250 V, 10 A • Cable: 8120-5182 |  <ul style="list-style-type: none"> • Plug: IRAM 2073-10A, 250 V, 10 A • Cable: 8120-6870 |  <ul style="list-style-type: none"> • Plug: CEI 23-16, 250 V, 10 A • Cable: 8120-6978 |
|  <ul style="list-style-type: none"> • Plug: GB 1002 figure 3, 250 V, 10 A • Cable: 8120-8376 |  <ul style="list-style-type: none"> • Plug: SANS 164-1, 250 V, 10 A • Cable: 8121-0564, 8120-4211 |  <ul style="list-style-type: none"> • Plug: CNS 10917-2, 125 V, 10 A • Cable: 8121-1635, 8120-6825 |  <ul style="list-style-type: none"> • Plug: CS 0017:2003, 250 V, 10 A • Cable: 8120-8871, 8120-0674, 8121-1638 |

Inspection and Installation

This section describes what to do when you receive the B1500A and accessories.

1. Inspect the shipment. See “To Inspect B1500 and Accessories”.
2. Verify the B1500A operation and perform initial setup. See “To Perform Initial Setup”.
3. Install the B1500A in the appropriate place. See “Requirements” on page 3-3.

To use the B1500A briefly, see “Getting Started” on page 1-1.

To change the Windows logon setting, see “To Change Windows Logon Setting” on page 3-9.

To change the GPIB address of the B1500A, see “To Change GPIB Address” on page 3-9.

To allow the B1500A/EasyEXPERT to control external GPIB devices, see “To Enable System Controller” on page 3-10.

To Inspect B1500 and Accessories

Perform the following inspections when the B1500A and accessories arrive at your site.

1. Before unpacking any components, inspect all boxes for any signs of damage that might have occurred during shipment, such as:
 - dents
 - scratches
 - cuts
 - water marks

If you suspect any damage, notify your local Agilent Technologies sales or service office.

2. When you open the boxes that contain the B1500A and accessories, check the components against the contents lists attached to the boxes.

If anything is missing, notify your local Agilent Technologies sales or service office.

To Perform Initial Setup

After you receive the B1500A, perform the following setup.

1. Make sure that the Standby switch is set to off.
2. On the B1500A rear panel, connect the Circuit Common terminal to the frame ground terminal by using a shorting-bar.
3. If you use Agilent 16444A-001 USB keyboard and/or the 16444A-002 USB mouse, connect it to an USB port of the B1500A.
4. Connect the power cable from the B1500A to an AC power outlet.
5. Open the measurement terminals and press the Standby switch to turn on the B1500A.

If the B1500A is operating correctly, the power-on self-test is automatically performed. If problems arise, see “If You Have a Problem” on page 9-1.

6. Wait for the *Welcome to Microsoft Windows* screen. On the screen, select the Next button.
7. For the message *How should dates and currency appear?*, set as follows:
 - I live closest to this region: (for example, United States)
 - I type mostly in this language: (for example, English)
 - I use this type of keyboard: (for example, US)If you use the 16444A-001 USB keyboard, select US.
8. Select the Next button.
9. For the message *What time zone are you in?*, select your present location (for example, Pacific Time (US & Canada); Tijuana). Then select the Next button.
10. For *The End User License Agreement*, select *Yes, I accept*. Then select the Next button.
11. For the message *Help protect your PC*, select *Not right now*. Then select the Next button.
12. For the message *What's your computer's name?*, do not anything. Just select the Next button.
13. For the message *What's your Administrator password?*, do not anything. Just select the Next button.
14. For the message *Checking your internet connectivity*, select the Skip button.

Installation

Inspection and Installation

15. For the message *Thank you!*, select the Finish button.

The initial setup is completed by restarting Windows.

To use the B1500A briefly, see “Getting Started” on page 1-1.

After the initial setup, the B1500A internal Windows has the following setup:

- Location: United States
- Language: English
- Keyboard: English (US)
- Time Zone: Pacific Time (US & Canada); Tijuana
- Network connection: none
- Computer name: Unique name set by factory

You can change the computer name after the initial setup. It must be unique.

- Password of Administrator: not defined

You can set the password after the initial setup. If you set it, do not forget it.

- Pre-defined users: Administrator, Agilent B1500 User, and AgilentOnly

You can add users after the initial setup. Add users as you need.

Agilent B1500 User is the account for automatic logon. Password is not set to this account.

AgilentOnly is the account for Agilent service personnel. Do not delete this account. This account is password protected.

NOTE

Other Windows setup

You can set other setup of Windows after the initial setup. It is your responsibility.

If you connect Agilent B1500 to the network, take care to protect it from computer virus.

NOTE

Agilent Technologies cannot guarantee the performance and provide compatibility information for all B1500s under several conditions. If problems arise, perform Agilent B1500 system recovery. To perform recovery, see “B1500A System Recovery” on page 9-19.

To Change Windows Logon Setting

Agilent B1500A initially enables Windows automatic logon. If you want to change this setting, select *All Programs > Control Auto Logon* from the Start menu. Control Auto Logon is displayed on the browser. Then click one of the following buttons on the browser and follow the setup script.

- Enable Auto Logon
- Disable Auto Logon

NOTE

If you set a password for the user account *Agilent B1500 User*, disable the automatic logon.

To Change GPIB Address

When Agilent B1500A is shipped from the factory, the GPIB address is set to 17. To change the GPIB address, perform the following procedure.

1. If the EasyEXPERT software is running, terminate it as shown below:
 - a. Select the menu function *File > Exit* on the EasyEXPERT main screen.
 - b. Click [x] at the upper right corner of the Start EasyEXPERT button.
2. Select *All Programs > Agilent IO Libraries Suite > Agilent Connection Expert* from the Start menu. Agilent Connection Expert window appears.
3. At the *Instrument I/O on this PC* area, select GPIB0, and click the Change Properties... button. Agilent 82350 PCI GPIB Interface - GPIB0 window appears.
4. Change the GPIB Address value.
5. Remove the check from the *Auto-discover instruments connected to this interface* box.
6. Click the OK button on Agilent 82350 PCI GPIB Interface - GPIB0 window.
7. On the Reboot Required dialog box, click the Reboot Now button, and reboot the B1500A.

To Enable System Controller

To allow Agilent B1500A/EasyEXPERT to control external GPIB devices, perform the following procedure.

1. If the EasyEXPERT software is running, terminate it as shown below:
 - a. Select the menu function *File > Exit* on the EasyEXPERT main screen.
 - b. Click [x] at the upper right corner of the Start EasyEXPERT button.
2. Select *All Programs > Agilent IO Libraries Suite > Agilent Connection Expert* from the Start menu. Agilent Connection Expert window appears.
3. At the *Instrument I/O on this PC* area, select GPIB0, and click the *Change Properties...* button. Agilent 82350 PCI GPIB Interface - GPIB0 window appears.
4. Set the GPIB Address value to 21 that is the typical address number for the system controller.
5. Check the *System Controller* box.
6. Remove the check from the *Auto-discover instruments connected to this interface* box.

This disables the automatic device detection. So the Connection Expert cannot detect the instruments connected to the GPIB interface by itself.
7. Click the OK button on Agilent 82350 PCI GPIB Interface - GPIB0 window.
8. On the Reboot Required dialog box, click the Reboot Now button, and reboot the B1500A.

NOTE

To Disable System Controller

If the B1500A is the system controller, you cannot control the B1500A by using an external computer. To disable the system controller, change the steps 4 and 5 for setting the GPIB Address value to *not* 21 and removing the check from the *System Controller* box, and perform the procedure to the step 8.

Installing Accessories

This section describes how to install the B1500A and accessories. Additional information regarding airflow can be found in the “Ventilation Requirements” on page 3-4.

This section describes how to:

- “To Connect 16442B Test Fixture”
- “To Connect Connector Plate”
- “To Connect ASU”
- “To Connect SCUU/GSWU”
- “To Connect GNDU Adapter”
- “To Interconnect SPGUs”

NOTE

Before connecting accessory to MFCMU

Turn the B1500A off before connecting the SCUU, the SCUU cable, or the CMU cable to the MFCMU.

WARNING

There are potentially hazardous voltages of up to ± 100 V (MPSMU/HRSMU) or ± 200 V (HPSMU) at the Force, Sense, and Guard terminals. To prevent electrical shock, do *not* expose these lines.

WARNING

To prevent electrical shock during use, install an interlock circuit (see page 3-29) and connect the Interlock cable (see page 3-16).

CAUTION

The GNDU can sink current of up to 4.2 A. Use Agilent 16493L GNDU cable to connect the GNDU to a test fixture or a connector plate.

Do *not* use normal triaxial cable (Agilent 16494A) because the maximum current rating of the cable is 1 A.

CAUTION

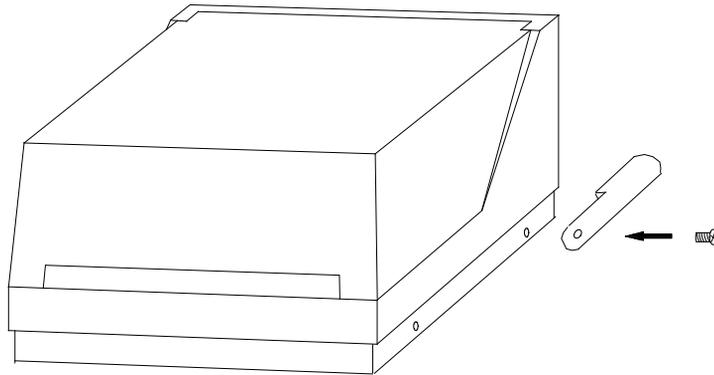
Never connect the Guard terminal to any output, including circuit common, chassis ground, or any other guard terminal. Doing so will damage the SMU.

To Connect 16442B Test Fixture

See this section if you use Agilent 16442B Test Fixture. This section describes how to set up the 16442B and how to connect the B1500A to the 16442B.

To Set up 16442B

You can stabilize the 16442B as shown in the figure below.



1. Put a stabilizer on both sides of the test fixture.
2. Attach each stabilizer to the unit with a flathead screw.

To Connect 16442B

Use the cables shown in Table 3-1 to connect from the B1500A connectors to the 16442B's relative connectors.

NOTE

Making non-Kelvin connection

The Force terminals can be used to force and measure DC voltage or current. If you want to simplify the cable connections, open the Sense terminals and connect the Force terminals only to the test fixture by using the triaxial cables.

If you make the Kelvin connection, use both Force and Sense terminals. Connecting the Force and Sense lines together at the terminal of the device under test minimizes the measurement error caused by the residual resistance of the connection cables. The Kelvin connection is effective for the low resistance measurement and the high current measurement.

Table 3-1 To Connect 16442B

| Cables | 16442B Terminals | B1500A Terminals | |
|--|------------------|------------------|-----------|
| Agilent 16493J Interlock Cable, 3 m or 1.5 m | Intlk | Interlock | |
| Agilent 16493L GNDU Cable, 3 m or 1.5 m | GNDU | GNDU | |
| Agilent 16493K Kelvin Triaxial Cable, 3 m or 1.5 m, for the Kelvin connection Up to 3 SMUs can be connected to the 16442B by the Kelvin connection. | SMU1 | SMU | Force |
| | SMU2 | | Sense |
| | SMU3 | SMU | Force |
| | SMU4 | | Sense |
| | SMU5 | SMU | Force |
| | SMU6 | | Sense |
| Agilent 16494A Triaxial Cable, 3 m or 1.5 m, for the non-Kelvin connection | SMU1 | SMU | Force |
| | SMU2 | SMU | Force |
| | SMU3 | SMU | Force |
| | SMU4 | SMU | Force |
| | SMU5 | SMU | Force |
| | SMU6 | SMU | Force |
| Agilent N1300A CMU Cable ^a , 3 m or 1.5 m | PGU1 | CMU | Hcur/Hpot |
| | PGU2 | | Lcur/Lpot |

- a. To extend the four-terminal pair (4TP) connection to the 16442B inputs, connect the Hcur and Hpot cables together and the Lcur and Lpot cables together by using the BNC T-type adapter (female-female-male, Agilent part number 1250-2405), then connect them to the 16442B inputs. To extend the 4TP connection to the socket module inputs, connect the cables to the PGU1, PGU2, VSU1, VSU2, VMU1, or VMU2 connector individually, and connect the Hcur and Hpot terminals together and the Lcur and Lpot terminals together at the socket module inputs. It is ok to leave open the ground wire extended from the CMU cable.

To Connect Connector Plate

The available connector plates are listed in Table 3-2. Option 001 provides the through connectors except for the Interlock connector that provides the soldering patterns at the back side. For the option 002, the back of each connector is designed for soldering. For connector plate installation information, refer to *Agilent 16495 Installation Guide*.

For the 16495H/J, the insulator is inserted between the panel and the outer conductor of Triax connectors/BNC connectors.

Use the cables shown in Table 3-3 to connect from the B1500A connectors to the connector plate's relative connectors. For the cable connections from the connector plate to the DUT interface such as manipulator and probe card, see "Mounting Connectors" on page 3-27 as reference.

NOTE

Making non-Kelvin connection

The Force terminals can be used to force and measure DC voltage or current. If you want to simplify the cable connections, open the Sense terminals and connect the Force terminals only to the connector plate by using the triaxial cables.

If you make the Kelvin connection, use both Force and Sense terminals. Connecting the Force and Sense lines together at the terminal of the device under test minimizes the measurement error caused by the residual resistance of the connection cables. The Kelvin connection is effective for the low resistance measurement and the high current measurement.

Table 3-2 Connector Plates

| Model | Option Item | Connectors |
|--------|-------------|--|
| 16495F | 16495F-001 | Triax. (f-f) ×12, GNDU (f-f) ×1, Interlock (f) ×1 |
| | 16495F-002 | Triax. (f) ×12, GNDU (f) ×1, Interlock (f) ×1 |
| 16495G | 16495G-001 | Triax. (f-f) ×24, GNDU (f-f) ×1, Interlock (f) ×1 |
| | 16495G-002 | Triax. (f) ×24, GNDU (f) ×1, Interlock (f) ×1 |
| 16495H | 16495H-001 | Triax. (f-f) ×6, Coax. (f-f) ×6, GNDU (f-f) ×1, Interlock (f) ×1 |
| | 16495H-002 | Triax. (f) ×6, Coax. (f) ×6, GNDU (f) ×1, Interlock (f) ×1 |
| 16495J | 16495J-001 | Triax. (f-f) ×8, Coax. (f-f) ×4, GNDU (f-f) ×1, Interlock (f) ×1 |
| | 16495J-002 | Triax. (f) ×8, Coax. (f) ×4, GNDU (f) ×1, Interlock (f) ×1 |
| 16495K | 16495K-001 | Connector plate, rubber holder |

Table 3-3 To Connect Connector Plate

| Cables | Connector Plate | B1500A Terminals | |
|--|---------------------------------|------------------|-----------|
| Agilent 16493J Interlock Cable, 3 m or 1.5 m | Intlk | Interlock | |
| Agilent 16493L GNDU Cable, 3 m or 1.5 m | GNDU | GNDU | |
| Agilent 16493K ^a Kelvin Triaxial Cable, 3 m or 1.5 m, for the Kelvin connection 16495F provides the inputs 1 to 12 (6 Kelvin). 16495H provides the inputs 1 to 6 (3 Kelvin). 16495J provides the inputs 1 to 8 (4 Kelvin). | odd number | SMU | Force |
| | even number | | Sense |
| Agilent 16494A Triaxial Cable, 3 m or 1.5 m, for non-Kelvin connection 16495H provides the inputs 1 to 6. 16495J provides the inputs 1 to 8. | odd number or even number | SMU | Force |
| Agilent N1300A CMU Cable ^b , 3 m or 1.5 m 16495H provides the inputs 7 to 12. 16495J provides the inputs 9 to 12. | odd number or even number | CMU | Hcur/Hpot |
| | | | Lcur/Lpot |

- a. Use Agilent 16494B Kelvin Triaxial Cable to connect to Agilent E5250A Low Leakage Switch Mainframe or the connector plate for Agilent 4142B Modular DC Source/Monitor by the Kelvin connection.
- b. To extend the four-terminal pair (4TP) connection to the connector plate inputs, connect the Hcur and Hpot cables together and the Lcur and Lpot cables together by using the BNC T-type adapter (female-female-male, Agilent part number 1250-2405), then connect them to the connector plate inputs. To extend the 4TP connection to the DUT interface, connect the cables to the connector plates input connectors individually, and connect the Hcur and Hpot terminals together and the Lcur and Lpot terminals together on the DUT interface. See Figure 3-17.
It is ok to leave open the ground wire extended from the CMU cable.



Connecting the interlock terminal

The B1500A provides the Interlock connector to prevent you from receiving an electrical shock from high voltage (more than ± 42 V). If the Interlock connector is open, the B1500A *cannot* force high voltage more than ± 42 V.

When using the 16442B test fixture, connect the Interlock connectors together using the 16493J interlock cable.

If you use the 16495F/G/H/J connector plate, your own connector plate, or your own test fixture, make an interlock circuit as shown in “To Make an Interlock Circuit” on page 3-29. Then connect the B1500A Interlock connector to the external interlock connector by using the 16493J interlock cable.

If you use a connector plate or test fixture that has a BNC coaxial connector for the interlock connector, connect the BNC interlock connector to the B1500A interlock terminal as follows:

- Required Parts:

| Model No. | Quantity | Description |
|----------------|----------|-------------------------|
| Agilent 16435A | 1 | Interlock Cable Adapter |
| Agilent 16493J | 1 | Interlock Cable |

- Procedure:
 1. Connect the Interlock connector on the B1500A rear panel to the interlock cable adapter using the 16493J interlock cable.
 2. Connect the interlock cable adapter to the BNC interlock connector using the coaxial cable furnished with the 16435A.

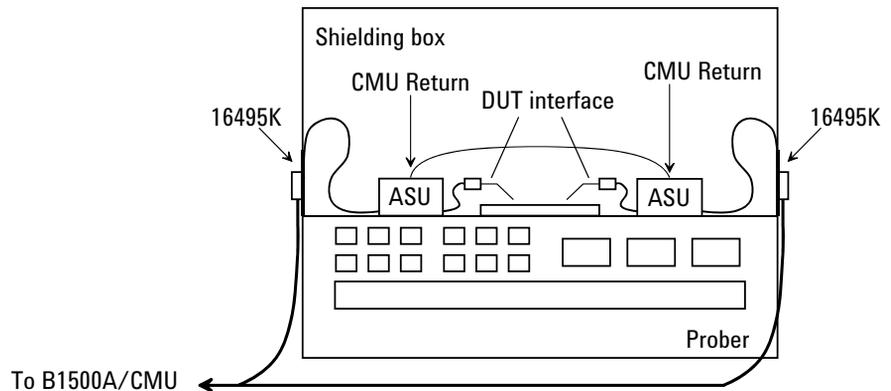
To Connect ASU

Agilent E5288A Atto Sense and Switch Unit (ASU) will add the 1 pA range to the high resolution SMU (HRSMU) when it is connected between the HRSMU and the device under test (DUT). The ASU also provides the input selection function when instruments are connected to the SMU input and the AUX input.

NOTE

For the installation of the ASU and the connection to the DUT interface (probe card, manipulators, and so on), contact your favorite prober vender. The prober vender will have the solutions. Dimensions of the ASU are 132 mm (W) × 88.5 mm (H) × 50 mm (D) excluding the connectors.

Figure 3-1 Image of ASU Installation



Required parts

- Agilent 16495K Connector plate
- Agilent 16493M ASU cable
- Agilent N1300A CMU cable or Agilent 16048D/E test leads
- Agilent N1254A-108 Magnet stand
- BNC cable, coaxial cable, manipulator, wire, and so on

To install 16495K

Fix the 16495K plate to the shielding box or something that will cover the DUT interface. See *Agilent 16495 Installation Guide*. The 16495K is the plate that has the mechanism to block the light from the cable hole used to pass the cables in the shielding box.

Installation

Installing Accessories

To install ASU

1. Fix the ASU in the shielding box. The ASU must be fixed to the best position for accessing its connectors. Agilent N1254A-108 Magnetic Stand will be useful for fixing the ASU.
2. Pass the 16493M (D-sub cable, triaxial cable), N1300A CMU cable, 16048D/E test leads, BNC cable and so on through the cable hole of the 16495K. They will be connected between the ASU and the instruments
3. Connect the D-sub cable to the ASU D-sub connector.
Connect the triaxial cable to the ASU Force terminal.
Connect the cable to the ASU CMU-cur/AUX In terminal. See Figure 3-2.
 - For the MFCMU, connect the N1300A CMU cable.
 - For Agilent 4284A LCR meter, connect Agilent 16048D/E test leads.
 - For the instrument other than the MFCMU or the 4284A, connect the BNC cable to the CMU-cur/AUX In terminal. And open the CMU-pot terminal or cover it by using the BNC open cap.
4. Adjust the cable length in the shielding box, and catch in the cables by using the cover of the 16495K.
5. Connect the cable extended from the DUT interface to the ASU output terminal.
For the non Kelvin connection, open the Sense terminal or cover it by using the triaxial open cap.

To connect B1500A

1. Turn the B1500A off.
2. Connect the D-sub cable from the ASU to the HRSMU D-sub connector.
3. Connect the triaxial cable from the ASU to the HRSMU Force terminal.

NOTE

The specifications of the ASU are guaranteed while it is connected to the exclusive HRSMU. Confirm the serial number of the ASU, and connect it properly. See “ASU” on page 4-43.

To connect other instrument to AUX

To connect the instrument other than the MFCMU or the 4284A:

1. Turn the instrument off.
2. Connect the BNC cable from the ASU CMU-cur/AUX In terminal to the instrument. Prepare an adapter if the instrument’s input/output connector is not BNC.

Figure 3-2

To Connect ASU

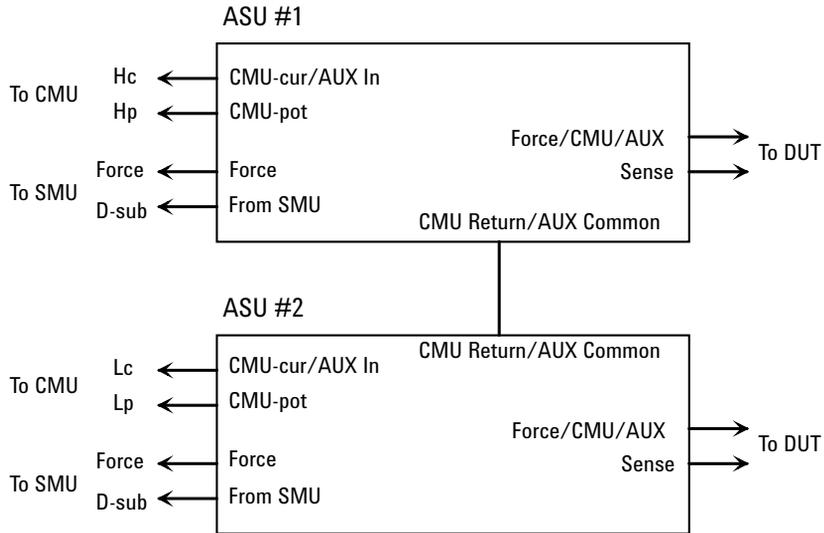
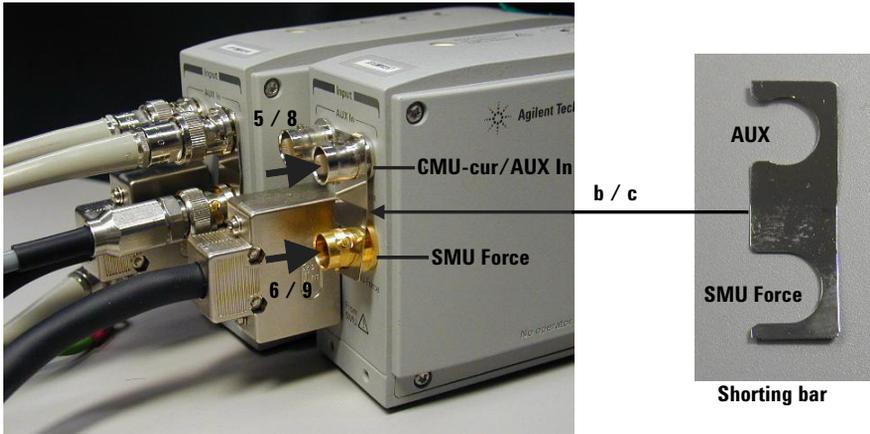


Figure 3-3

To Set Shorting Bar



Installation

Installing Accessories

To connect MFCMU/4284A to AUX

Perform the following procedure to connect the MFCMU or the 4284A. See Figure 3-2 and Figure 3-3.

Prepare a shorting bar furnished with the ASU. The shorting bar is effective for reducing the offset capacitance caused by connecting a measurement terminal to the chuck of a wafer prober.

1. Turn the instrument off.
2. Prepare two ASUs (#1 and #2) and two shorting bar. And perform the following procedure for each ASU.
 - a. Disconnect the triaxial cable from the ASU if it is connected to the ASU Force terminal.
 - b. Face the concave side of the shorting bar to front.
 - c. Slide the shorting bar from the right side of the connectors.
3. Connect the cable to the instrument. For the MFCMU, use the N1300A CMU cable. For the 4284A, use the 16048D/E test leads. It is ok to leave open the ground wire extended from the cable.
4. Connect the high potential (Hp) cable of the test leads to the ASU #1 CMU-pot terminal.
5. Connect the high current (Hc) cable to the ASU #1 CMU-cur/AUX In terminal. The shorting bar is fixed to the ASU #1 by the step 5 and 6.
6. Connect the triaxial cable from the HRSMU #1 Force terminal to the ASU #1 Force terminal.
7. Connect the low potential (Lp) cable to the ASU #2 CMU-pot terminal.
8. Connect the low current (Lc) cable to the ASU #2 CMU-cur/AUX In terminal. The shorting bar is fixed to the ASU #2 by the step 8 and 9.
9. Connect the triaxial cable from the HRSMU #2 Force terminal to the ASU #2 Force terminal.
10. Prepare the connection wire (both pin terminals) furnished with the ASU and connect it between the CMU Return terminals of the ASU #1 and ASU #2 together.

NOTE

About ASU output cables

To perform capacitance measurements accurately, the cable length between DUT and the ASU output must be as short as possible.

To Connect SCUU/GSWU

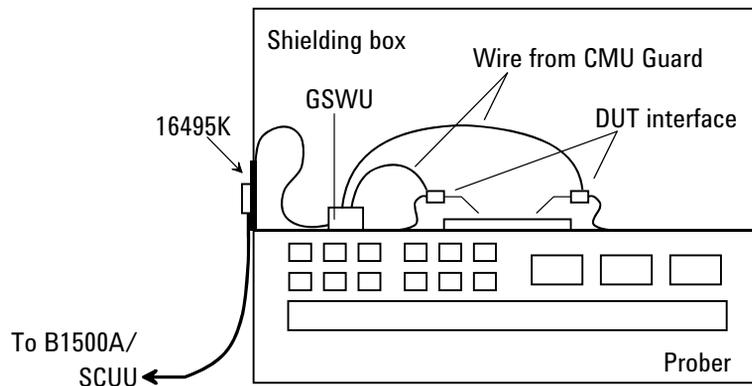
Agilent N1301A-100 SMU CMU Unify Unit (SCUU) is used to switch the module (CMU or SMU) to be connected to the DUT. The SCUU is available for the MPSMU and HRSMU.

Agilent N1301A-200 Guard Switch Unit (GSWU) is used to connect the CMU high and low guard lines together near the DUT. The connection is broken when the SCUU is in the SMU connection state. The GSWU is effective for the accurate impedance measurement.

NOTE

For the installation of the SCUU/GSWU and the connection to the DUT interface (probe card, manipulators, and so on), contact your favorite prober vender. The prober vender will have the solutions. Dimensions of the SCUU are 148 mm (W) × 75 mm (H) × 70 mm (D). Dimensions of the GSWU are 33.2 mm (W) × 41.5 mm (H) × 32.8 mm (D).

Figure 3-4 Image of GSWU Installation



Required parts

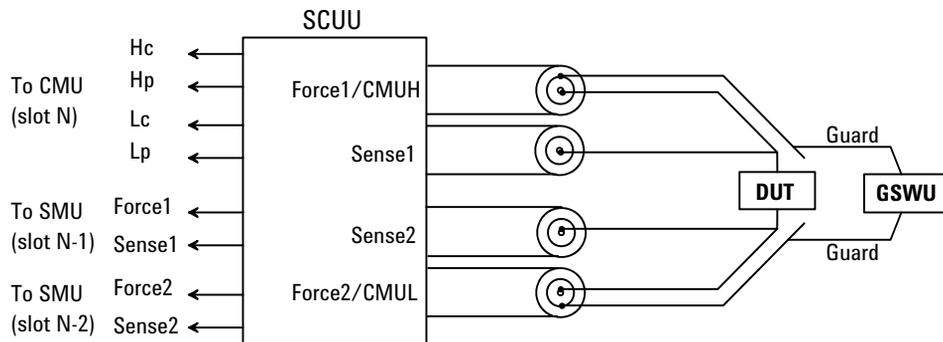
- Agilent 16495K Connector plate
- Agilent N1301A-201/202 GSWU cable (if GSWU is used)
- Agilent N1301A-102 SCUU cable (if SCUU is not attached to the MFCMU)
- Agilent N1301A-110 Magnet stand (if GSWU is used)
- BNC cable, coaxial cable, manipulator, wire, and so on

Installation
Installing Accessories

To install 16495K Fix your necessary 16495 connector plates to the shielding box or something that will cover the DUT interface. See *Agilent 16495 Installation Guide*. For the GSWU installation, the 16495K is required. It is the plate that has the mechanism to block the light from the cable hole used to pass the cables in the shielding box.

- Before starting**
1. GSWU is furnished with wires (2 ea.) for the connection between the GSWU and the DUT interface Guard terminal. If it is too short to connect them, prepare additional wire.
 2. Turn the B1500A off.

Figure 3-5 To Connect SCUU/GSWU



**To connect
SCUU/GSWU 1**

To attach the SCUU to the B1500A:

1. Attach the SCUU to the B1500A rear panel connectors for the MFCMU in the slot N and two SMUs in the slots N-1 and N-2 (N: integer, 3 to 10).

Connection will be easy by bringing the control connectors together before bringing the BNC connectors.
2. Fix the GSWU in the shielding box. The GSWU must be fixed to the best position for accessing its connectors.
3. Pass the GSWU cable (Agilent N1301A-201/202) through the cable hole of the 16495K. And connect it between the SCUU and the GSWU.
4. Adjust the cable length in the shielding box, and catch in the cables by using the cover of the 16495K.
5. Connect the proper cables from Force1/CMUH and Force2/CMUL to the 16495 connector plates or the DUT interface. See Figure 3-5.

For the Kelvin connections, also connect the proper cables from Sense1 and Sense2 to the 16495 connector plates or the DUT interface.

6. Connect the wires (furnished, 2 ea.) to the GSWU.
7. Connect one of the wires to the Guard terminal extended from CMUH of SCUU. Then the wire should contact the Guard terminal as close to the device as possible.
8. Connect another one to the Guard terminal extended from CMUL of SCUU. Then the wire should contact the Guard terminal as close to the device as possible.

NOTE

About SCUU output cables

To perform capacitance measurements accurately, the cable length between DUT and the SCUU output must be as short as possible.

**To connect
SCUU/GSWU 2**

1. Attach an end of the SCUU cable (Agilent N1301A-102) to the SCUU.

Connection will be easy by putting the SCUU and the cable connection box on the flat table, and bringing the control connectors together before bringing the BNC connectors.

If the SCUU is fixed inside the shielding box, pass the SCUU cable through the cable hole of the 16495K.

Installation

Installing Accessories

2. Fix the SCUU inside or outside the shielding box. The SCUU must be fixed to the best position for accessing its connectors. Agilent N1301A-110 Magnetic Stand will be useful for fixing the SCUU.
3. Attach the other end of the SCUU cable to the B1500A rear panel connectors for the MFCMU in the slot N and two SMUs in the slots N-1 and N-2 (N: integer, 3 to 10).

Connection will be easy by bringing the control connectors together before bringing the BNC connectors.

4. Fix the GSWU in the shielding box. The GSWU must be fixed to the best position for accessing its connectors.
5. Connect the GSWU cable (Agilent N1301A-201/202) between the SCUU and the GSWU.

If the SCUU is fixed outside the shielding box, pass the GSWU cable through the cable hole of the 16495K.

6. Adjust the cable length in the shielding box, and catch in the cables by using the cover of the 16495K.
7. Connect the proper cables from Force1/CMUH and Force2/CMUL to the 16495 connector plates or the DUT interface. See Figure 3-5.

For the Kelvin connections, also connect the proper cables from Sense1 and Sense2 to the 16495 connector plates or the DUT interface.

8. Connect the wires (furnished, 2 ea.) to the GSWU.
9. Connect one of the wires to the Guard terminal extended from CMUH of SCUU. Then the wire should contact the Guard terminal as close to the device as possible.
10. Connect another one to the Guard terminal extended from CMUL of SCUU. Then the wire should contact the Guard terminal as close to the device as possible.

NOTE

About SCUU output cables

To perform capacitance measurements accurately, the cable length between DUT and the SCUU output must be as short as possible.

To Connect GNDU Adapter

The ground unit (GNDU) output is the single triaxial connector. Agilent N1254A-100 GNDU to Kelvin Adapter enables to change it to the dual triaxial connector. Connect the adapter to the GNDU connector on the rear panel, then connect a Kelvin triaxial cable to extend the GNDU terminal. Maximum current is restricted when the Kelvin triaxial cable is used. See Table 3-4.

Figure 3-6

Agilent N1254A-100 GNDU to Kelvin Adapter

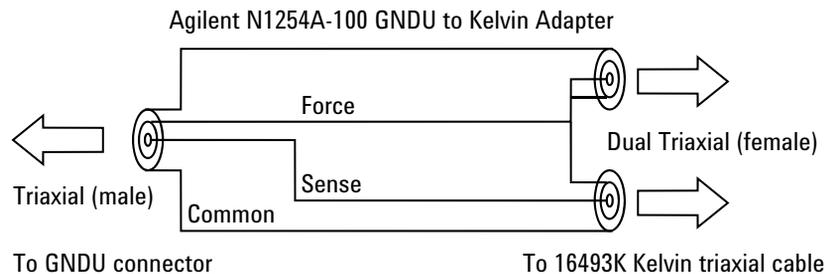


Table 3-4

Kelvin Triaxial Cable and Maximum Current

| Model No. or Option Item | Description | Maximum Current |
|--------------------------|-----------------------------|-----------------|
| 16493K-001 | 1.5 m Kelvin Triaxial Cable | 3.0 A |
| 16493K-002 | 3 m Kelvin Triaxial Cable | 2.6 A |

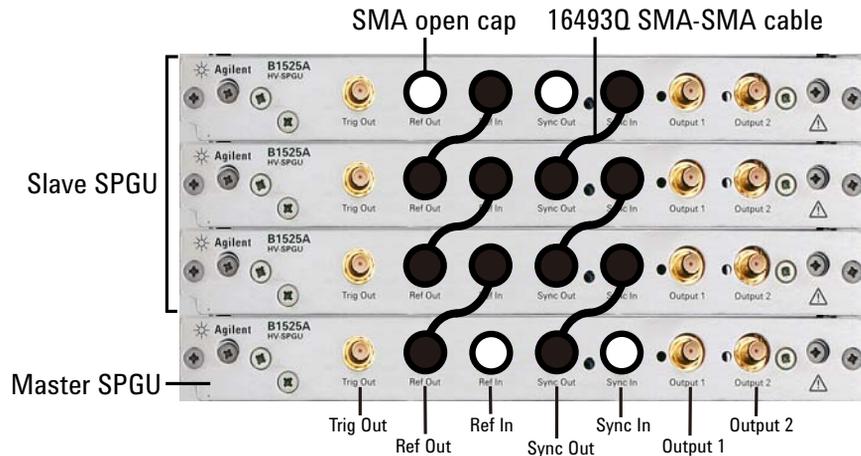
To Interconnect SPGUs

If multiple SPGUs have been installed, connect the SPGUs by using the following parts. See Figure 3-7.

- SPGU-SPGU connection cable 16493Q, (number of SPGUs-1)×2 ea.
- SMA open cap, 4 ea.

Figure 3-7

SPGU Module Connection Example, Four Modules



If multiple SPGUs have been installed, connect the SPGUs as shown in Figure 3-7. This connection makes it possible to perform the synchronous output by the multiple SPGU channels. In this figure, the master SPGU is the module which outputs the reference signal and the slave SPGUs are the modules which follow to the reference signal.

The Trig Out terminal must be connected to the trigger input terminal of the external equipment to make the synchronized operation of it.

CAUTION

Connect the Ref Out/In, Sync Out/In, and Trig Out terminals to the specified terminal properly. Connecting to the other terminal may result in damage to the SPGU.

Mounting Connectors

Previous sections described how to install the available accessories, and *Agilent 16495 Installation Guide* provides the information on how to install connector plates on the shielding box. However, you may choose to mount connectors directly on your own connector plate or test fixture.

To do this, you will need to make connector holes and mount the connectors yourself. This section contains information on connector hole dimensions.

To mount connectors:

1. Select the appropriate parts for your application. See Table 3-5.
2. Make the holes and mount the connectors. See Table 3-6.

For Kelvin connections, use Agilent 16493K Kelvin triaxial cable. The Kelvin triaxial cable requires a Kelvin triaxial connector, which has two connector holes and three screw holes.

3. Build the interlock circuit shown in “To Make an Interlock Circuit” on page 3-29.
4. Attach cables from the connectors to the DUT (device under test). See “To Connect GNDU Output” on page 3-32, “To Connect SMU Output” on page 3-33, and “To Connect MFCMU Output” on page 3-39.

Installation
Mounting Connectors

Table 3-5 Recommended Parts

| Usage | Agilent Part No. | Description |
|-----------------------------|------------------------|--|
| Making an interlock circuit | 1252-1419C | Interlock Connector (6 pin, female) |
| | 3101-0302 or 3101-3241 | Switch |
| | 1450-0641 | LED ($V_F \cong 2.1 \text{ V @ } I_F = 10 \text{ mA}$) |
| | 8150-5680 | Wire |
| Connecting GNDU to DUT | 1250-2457 | Triaxial Connector (female) |
| | 8121-1189 or 8150-2639 | Coaxial Cable or Wire |
| Connecting SMU to DUT | 1250-2457 | Triaxial Connector (female) |
| | 8121-1191 | Low Noise Coaxial Cable |
| Connecting MFCMU to DUT | 1250-0118 | BNC Connector (female) |
| | 8120-0367 | Coaxial Cable (50 Ω) |
| | 8150-0447 | Wire |

Table 3-6 Dimensions of Connector Holes

| Kelvin Triaxial Connector (in mm) | Triaxial Connector (in mm) |
|--|--|
| <p>Technical drawing of a Kelvin Triaxial Connector. It shows a circular base with two large holes (2 - $\phi 11.3$) and two smaller holes (2 - $M3 \times 0.5$). The distance between the centers of the large holes is 14 mm, and the distance between the centers of the small holes is 11 mm. The diameter of the base is 10.3 mm. The height of the base is 2.8 mm. The diameter of the small holes is $\phi 3.2$.</p> | <p>Technical drawing of a Triaxial Connector. It shows a circular base with a diameter of $\phi 11.3$ mm and a height of 10.3 mm.</p> |
| BNC Connector (in mm) | Interlock Connector (in mm) |
| <p>Technical drawing of a BNC Connector. It shows a circular base with a diameter of $\phi 12.8$ mm and a height of 12.1 mm.</p> | <p>Technical drawing of an Interlock Connector. It shows a circular base with a diameter of $\phi 8.2$ mm and a height of 5.1 mm. The distance from the top edge to the center of the base is 1.8 mm.</p> |

To Make an Interlock Circuit

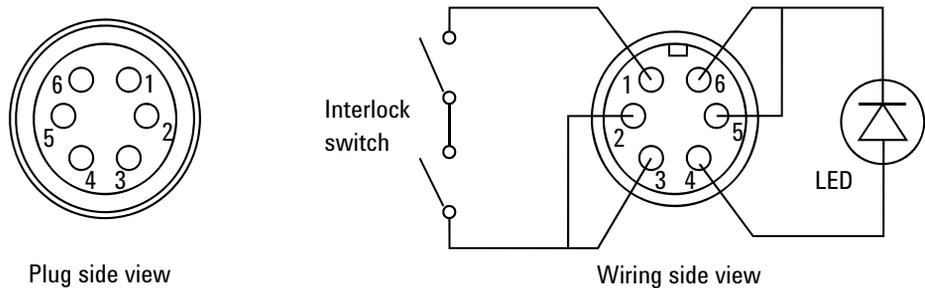
The interlock circuit is designed to prevent electrical shock when a user touches the measurement terminals.

CAUTION

You must install an interlock circuit on a shielding box to prevent hazardous voltages when the door of the shielding box is open.

Figure 3-8 shows the pin assignments of the interlock connector that should be mounted on a connector plate or test fixture.

Figure 3-8 Interlock Connector Pin Assignments



WARNING

Potentially hazardous voltages may be present at the Force, Guard, and Sense terminals when the interlock terminals are shorted.

Installing the interlock circuit

Install the interlock circuit as follows:

1. Mount two mechanical switches on your shielding box, so that the switches close when the door of the shielding box is closed, and open when the door is opened. For the dimensions of the switch, see Figure 3-10 and Figure 3-11 below.
2. Mount an LED on your shielding box. For the dimensions of the LED, see Figure 3-9.
3. Use wire to connect the two switches in series between pin number 1 and 2 (or 3) of the interlock connector. See Figure 3-8.
4. Use wire to connect the LED between pin number 4 and 5 (or 6) of the interlock connector. See Figure 3-8.

If Agilent B1500A Interlock connector is connected to the interlock circuit, Agilent B1500A SMU *cannot* force more than ± 42 V when the door is open. When the door is closed, it can force more than ± 42 V.

When more than ± 42 V is forced from an SMU, the LED lights to indicate *high voltage output*.

Figure 3-9

Dimensions of the LED (Agilent part number 1450-0641)

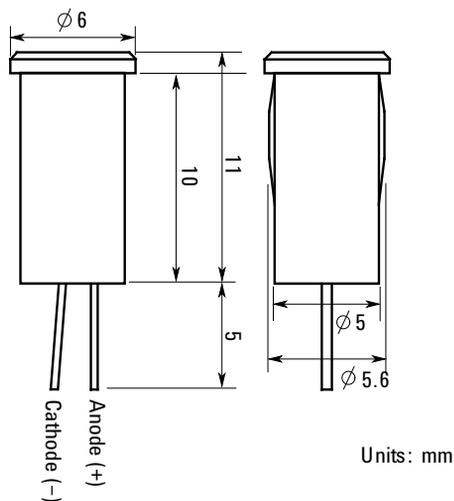


Figure 3-10

Dimensions of the Interlock Switch (Agilent part number 3101-0302)

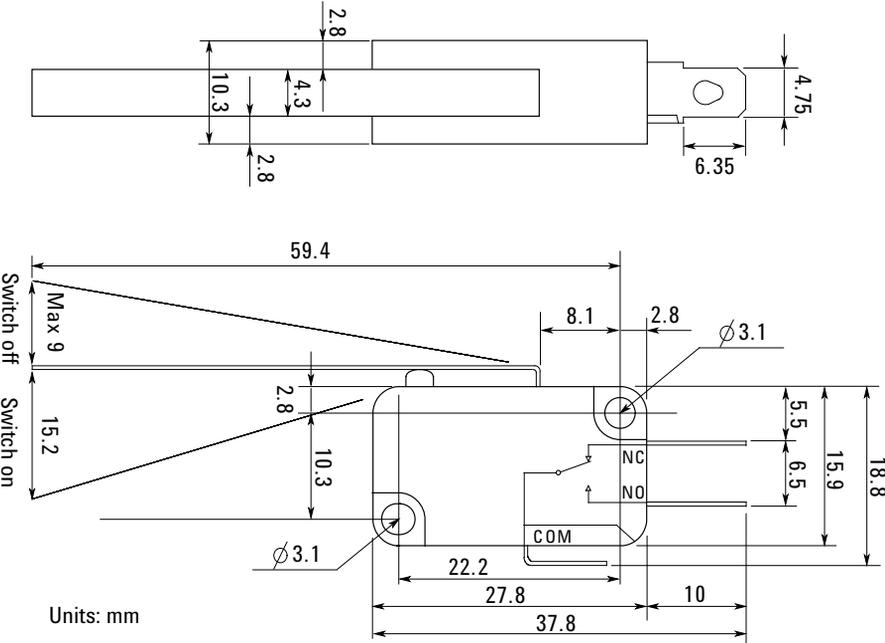
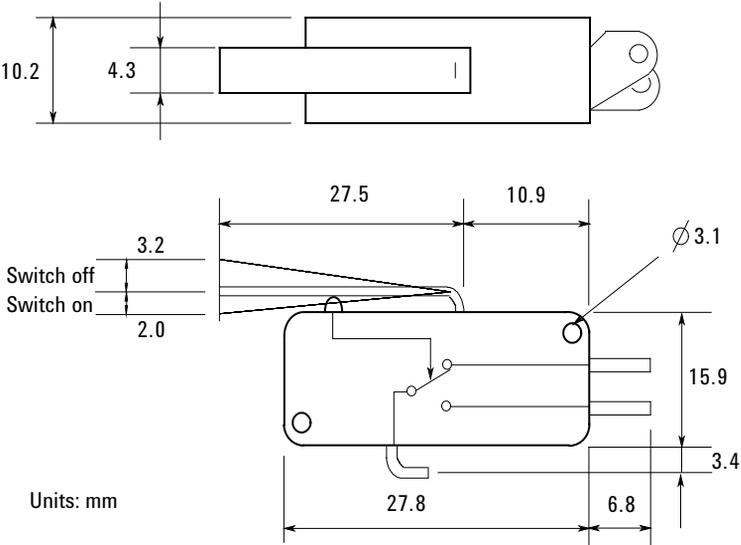


Figure 3-11

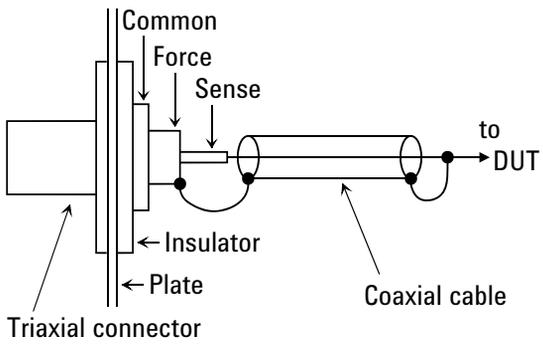
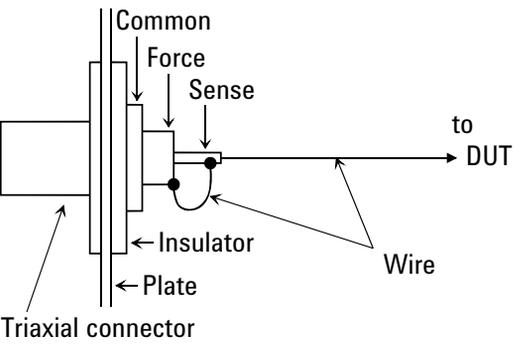
Dimensions of the Interlock Switch (Agilent part number 3101-3241)



To Connect GNDU Output

The GNDU output connection examples are shown in Table 3-7

Table 3-7 GNDU Output Connections

| Kelvin connections | non-Kelvin connections |
|--|---|
| <p>Use a low-noise coaxial cable (Agilent part number 8121-1189) from the connector to the prober, socket, or DUT as shown.</p> <p>To cancel the effects of cable resistance, connect the Sense line and Force line as close as possible to the terminal of the DUT.</p> | <p>Short the Sense and Force on the connector as shown below. Measurement data will include the residual resistance of the connection wire.</p> <p>Use AWG 22 single-strand insulated wire (Agilent part number 8150-2639) from the connector plate to the prober, socket, or DUT.</p> <p>For a quick connection where measurement accuracy is not critical, connect only Force to the DUT, without shorting the Sense and Force. With this connection, the measurement data will include residual resistance from the connection cable between the GNDU and the connector plate.</p> |
|  |  |

CAUTION

Use Agilent 16493L GNDU cable to connect the GNDU to your connector plate or test fixture. Do *not* use the triaxial cable. The GNDU is rated for up to 4.2 A, while the maximum current rating of the triaxial cable is 1 A.

To Connect SMU Output

The SMU output connection examples are shown in Table 3-8.

WARNING

Potentially hazardous voltages, up to ± 100 V (MPSMU/HRSMU) or ± 200 V (HPSMU), are present at the Force, Sense, and Guard terminals.

To prevent electrical shock, do not expose these lines.

Before turning Agilent B1500A on, connect the Interlock terminal to an interlock circuit.

Before you touch any connections to these terminals, turn Agilent B1500A off, disconnect the power cable, and discharge any capacitors.

CAUTION

Never connect the Guard terminal to any output, including circuit common, chassis ground, or any other guard terminal. Doing so will damage the SMU.

NOTE

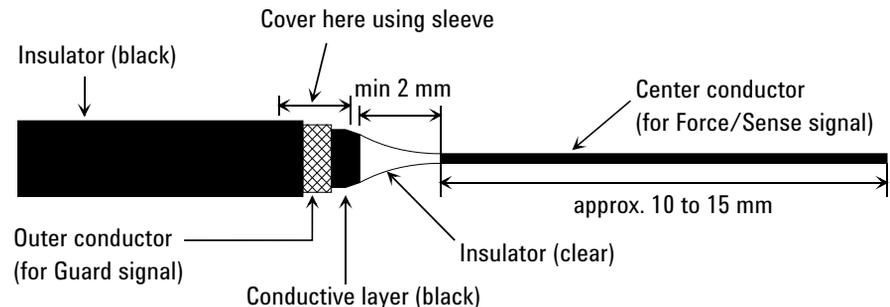
Low-Noise Coaxial Cable

For the extended measurement paths over the connector plate, use low-noise coaxial cable (Agilent part number 8121-1191). This cable can maximize the guard effects and minimize the impression of the external noise.

Figure 3-12 shows the cutting example of this cable. Key point is the isolation between the conductive layer and the center conductor. So, cut and trim the end of the cable as shown in this figure by using a cutter and so on.

Figure 3-12

Coaxial Cable Cutting Example



Installation
Mounting Connectors

Table 3-8 SMU Output Connections

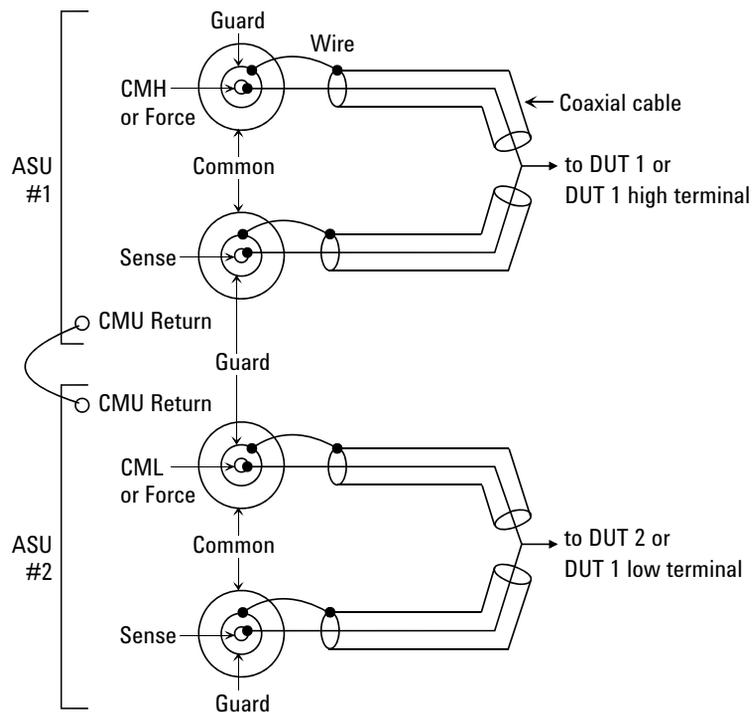
| Kelvin connections | non-Kelvin connections |
|--|---|
| <p>Use low-noise coaxial cable (Agilent part number 8121-1191) from the connector to the prober, socket, or DUT as shown.</p> <p>See Figure 3-13 and Figure 3-15 for the ASU and SCUU connections respectively.</p> <p>To cancel the effects of cable resistance, connect the Sense line and Force line as close as possible to the DUT terminal.</p> <p>To prevent oscillations, do not use cables longer than 1.5 m.</p> | <p>Use low-noise coaxial cable (Agilent part number 8121-1191). The following figure is for the connection using Kelvin triaxial cable.</p> <p>For the connection using triaxial cable, connect the cable to the Force terminal only.</p> <p>In this connection, measurement data will include residual resistance from the connection cable.</p> <p>See Figure 3-14 and Figure 3-16 for the ASU and SCUU connections respectively.</p> |
| | |

NOTE

To Minimize Leakage Current

For the highly accurate current forcing and measurements, surround all force and sense lines by a guard as far as possible, and physically stable the cables with tape.

Figure 3-13 ASU Output Kelvin Connection



The ASU inputs can be connected to the instruments by using a control cable, a triaxial cable, and two coaxial cables. The cables can be connected to the ASU inside the shielding box through the 16495K plate.

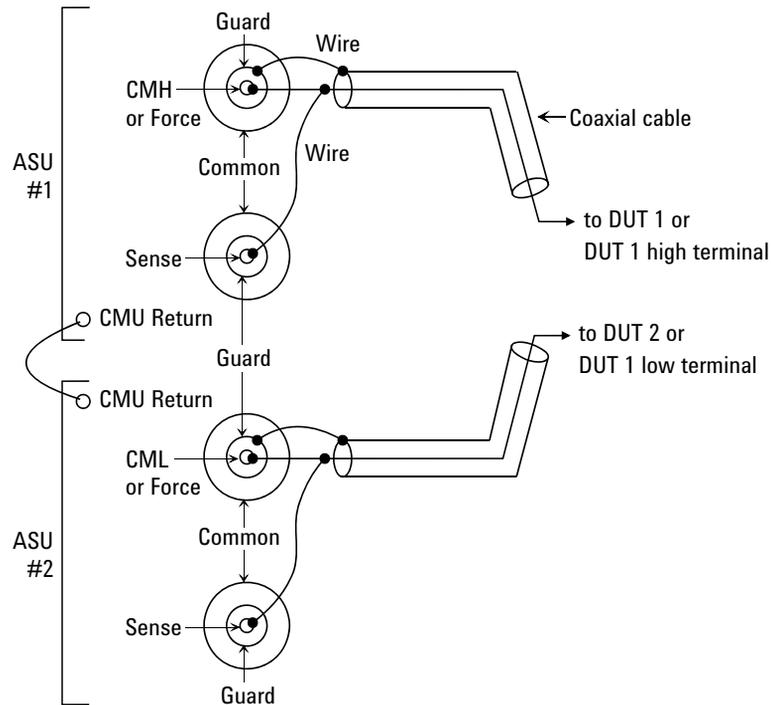
The ASU outputs should be connected to the DUT by using coaxial cables and wires as shown above.

When a SMU is used for the measurements, the Kelvin paths will work as same as Table 3-8.

When a four-terminal pair (4TP) instrument is used, the sense lines can be ignored. And a Kelvin path is used for the high signal, and the other one is used for the low signal. For the accurate impedance measurements, a wire must be connected between the ASU#1 CMU Return and the ASU#2 CMU Return.

If the 4TP instrument is not used, you can ignore the CMH, CML, CMU Return, and the DUT1 high and low terminals.

Figure 3-14 ASU Output non-Kelvin Connection



The ASU inputs can be connected to the instruments by using a control cable, a triaxial cable, and two coaxial cables. The cables can be connected to the ASU inside the shielding box through the 16495K plate.

The ASU outputs should be connected to the DUT by using coaxial cables and wires as shown above.

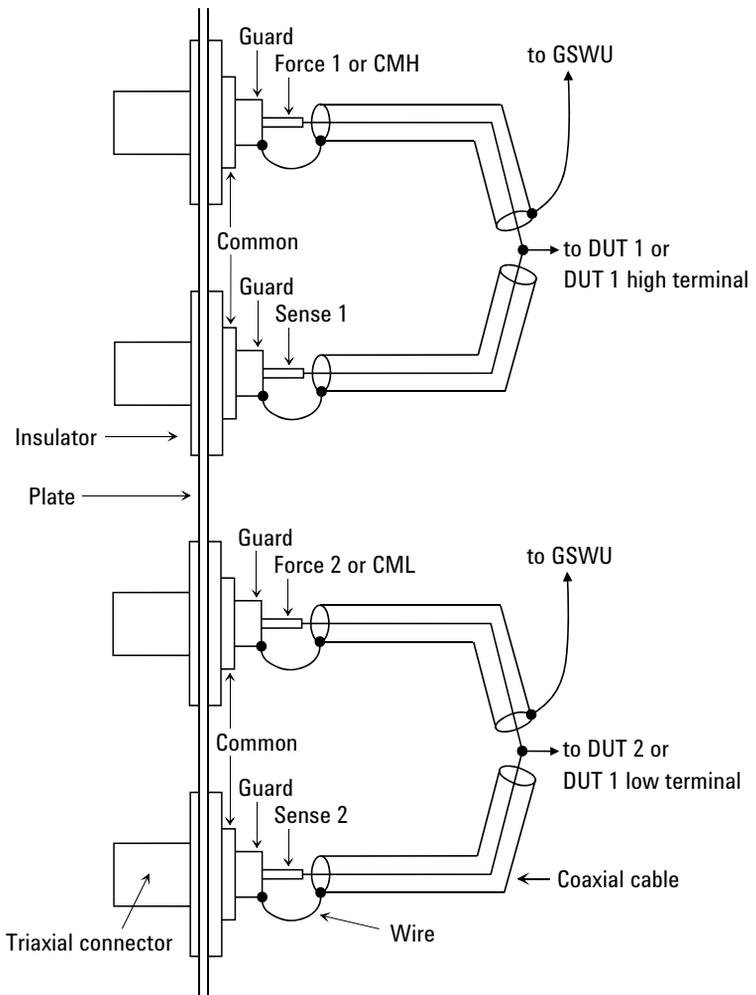
When a SMU is used for the measurements, the Kelvin paths/force lines will work as same as Table 3-8. Then the sense line is not extended to the DUT.

When a four-terminal pair (4TP) instrument is used, the sense lines can be ignored. And a force line is used for the high signal, and the other one is used for the low signal. For the accurate impedance measurements, a wire must be connected between the ASU#1 CMU Return and the ASU#2 CMU Return.

If the 4TP instrument is not used, you can ignore the CMH, CML, CMU Return, and the DUT1 high and low terminals shown above.

Figure 3-15

SCUU Output Kelvin Connection



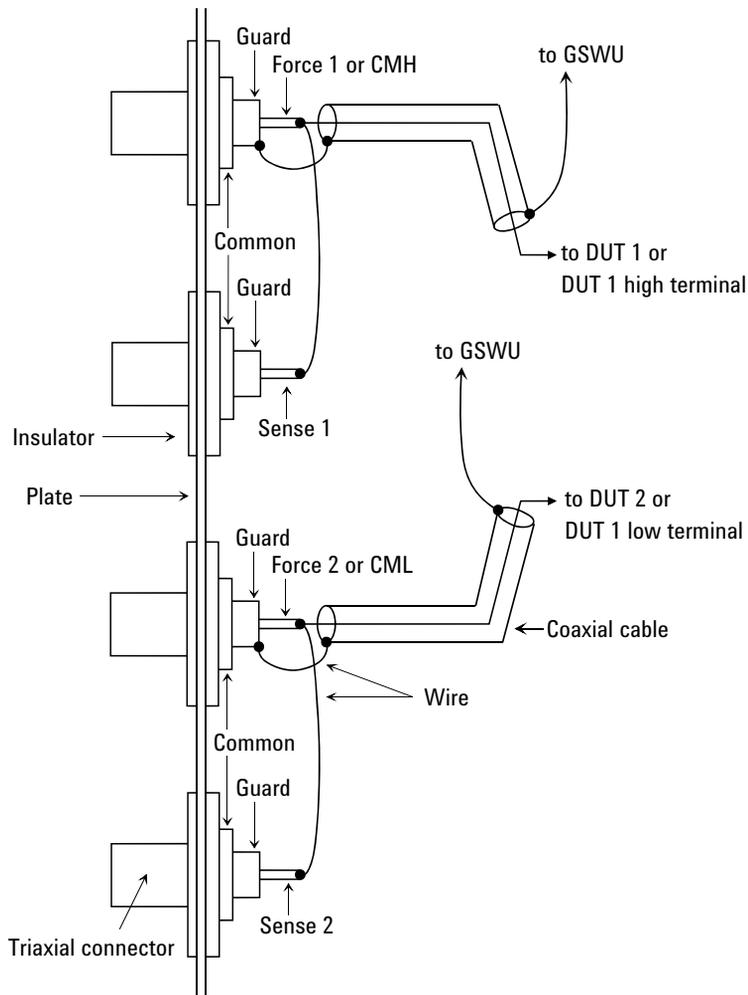
The SCUU should be connected to the DUT by using coaxial cables and wires as shown above. Also the SCUU should be connected to the GSWU inside the shielding box by using a control cable through the 16495K plate.

When a SMU is used for the measurements, the Kelvin paths will work as same as Table 3-8.

When the MFCMU is used, the sense lines can be ignored. And a Kelvin path is used for the CMU high, and the other one is used for the CMU low. For the accurate impedance measurements, wires must be connected to the GSWU from the CMH guard and the CML guard as near as possible to the DUT.

Figure 3-16

SCUU Output non-Kelvin Connection



The SCUU should be connected to the DUT by using coaxial cables and wires as shown above. Also the SCUU should be connected to the GSWU inside the shielding box by using a control cable through the 16495K plate.

When a SMU is used for the measurements, the Kelvin paths/force lines will work as same as Table 3-8. Then the sense line is not extended to the DUT.

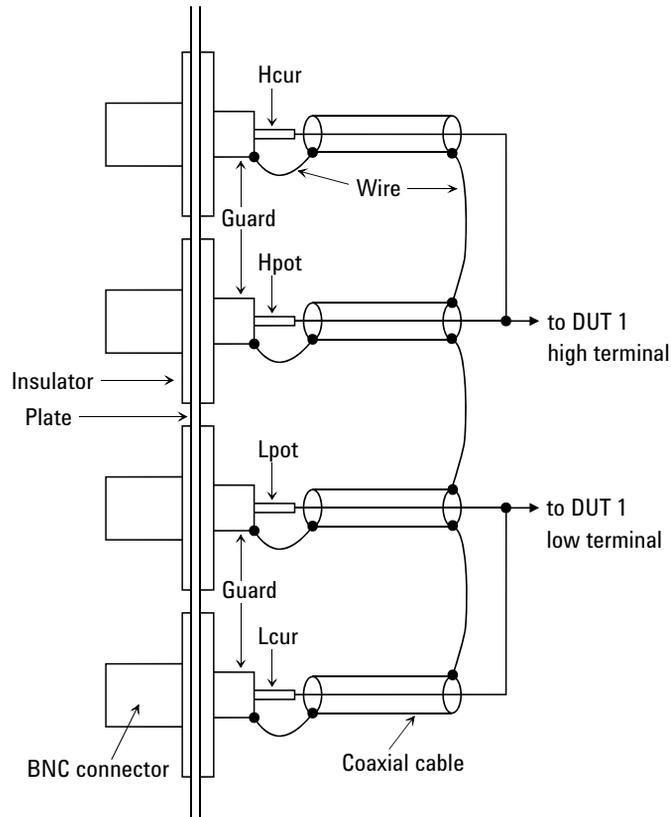
When the MFCMU is used, the sense lines can be ignored. And a force line is used for the CMU high signal, and the other one is used for the CMU low signal. For the accurate impedance measurements, wires must be connected to the GSWU from the CMH guard and the CML guard as near as possible to the DUT.

To Connect MFCMU Output

The MFCMU output connection example is shown in Figure 3-17. This connection is for the MFCMU without the SCUU. Then Agilent N1300A-001/002 CMU cable should be used for the connection between the MFCMU and the connectors you mount. It is ok to leave open the ground wire extended from the CMU cable.

Figure 3-17

MFCMU Output Connection



The Hcur/Hpot/Lcur/Lpot lines should be connected to the DUT as shown above.

Use a 50 Ω coaxial cable (Agilent part number: 8120-0367) for the Hcur/Hpot/Lcur/Lpot lines connection. Use a wire for the guard connection.

Connecting Measurement Devices

This section describes how to connect device under test (DUT) to the 16442B test fixture, and how to connect cables to the connector plate.

If you use a wafer prober, see wafer prober manuals.

Note that you must set the module output off when connecting or disconnecting DUTs. If not, the DUTs may be damaged.

To set the module output off, press the **Stop** key.

This section has the following descriptions:

- “Using Test Fixture”
- “Using Connector Plate”

NOTE

Kelvin connection and non-Kelvin connection

To make the Kelvin connection, use both Force and Sense terminals. Connecting the Force and Sense lines together at the terminal of the DUT (device under test) minimizes the measurement error caused by the residual resistance of the connection cables. The Kelvin connection is effective for the low resistance measurement and the high current measurement.

If you want to simplify the cable connections, open the Sense terminals and use the Force terminals only. This is the non-Kelvin connection. The Force terminals can be used to force and measure dc voltage or current.

Using Test Fixture

1. Press the **Stop** key to set the module output off.
2. Select a proper socket module for your DUT, then set the socket module on the test fixture.
3. Mount your DUT on the socket module.
4. Connect between the socket module and the test fixture by using the proper test leads.
5. Close the lid of the test fixture.

To force more than ± 42 V, close the lid of the test fixture. Otherwise, the interlock function will stop Agilent B1500A output.

To connect between the socket module and the test fixture, you can use test leads that have the following terminals:

- Miniature banana-to-miniature banana
- Miniature banana-to-pin plug
- Miniature banana-to-miniature clip

CAUTION

Do not connect or disconnect your DUT while Agilent B1500A is forcing voltage or current. Otherwise, your DUT may be damaged.

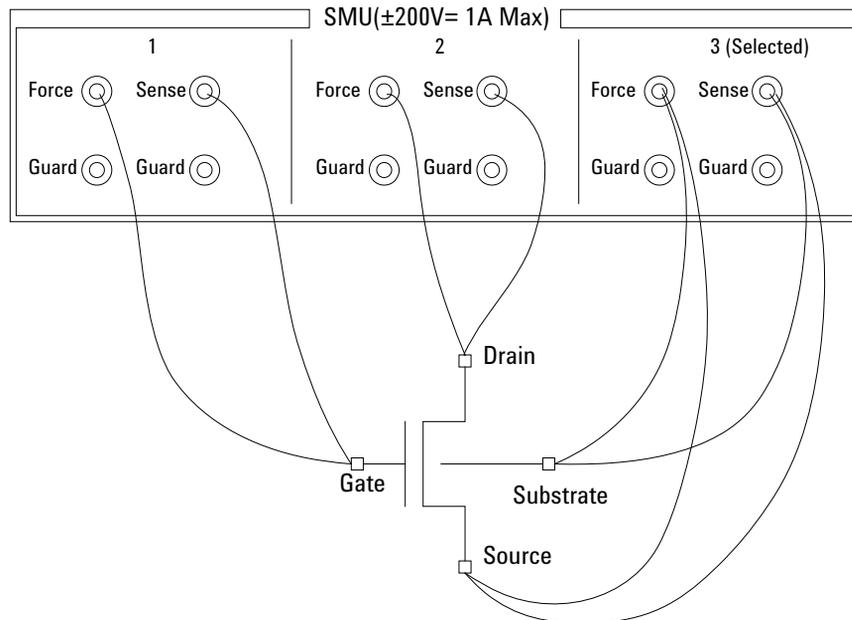
CAUTION

Do not touch the terminals of the test leads. Oil, perspiration, and dirt prevent good electrical contact, deteriorate insulation, and degrade measurement accuracy.

Connections for High Current Measurements

When you force or measure a large current, you may want to use a **Kelvin (4-wire) connection** to eliminate the residual resistance effects of test leads and contacts. For example, you can use the following connections as Kelvin connections on the test fixture.

Examples: Kelvin Connection



To cancel the effects of the residual resistance, test leads must be connected as close as possible to the DUT.

Using Connector Plate

This section provides the information useful for connecting cables and probing needles to a connector plate.

- “To Reduce Leakage Current”
- “To Measure Low Resistance”

To Reduce Leakage Current

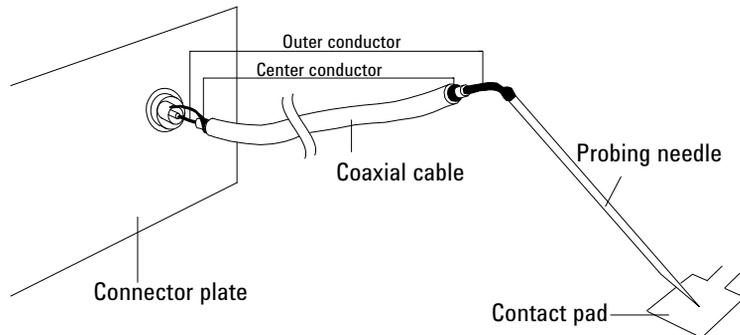
To reduce the leakage current caused by connection cables, the guard technique is effective. Connect the probing needles to the terminals of the connector plate by using coaxial cables as shown below:

1. At end of cable, connect coaxial center conductor to force terminal of connector plate, and connect coaxial outer conductor to guard terminal of connector plate.
2. At another end, connect coaxial center conductor to tail of the probing needle. Never connect the outer conductor at this cable end.

Extend the outer conductor as close as possible to the probing needle.

Example

The following example connection can be used to reduce the leakage current. Extend the outer conductor as close as possible to the probing needle. This also reduces the induced noise.



WARNING

Do not touch the guard terminal with bare hands because you may be shocked by high voltage. The potential of the guard terminal is equal to the output voltage.

CAUTION

Never connect the guard terminal to any other output, including circuit common, frame ground, or the terminals of any other unit. Doing so may damage the unit.

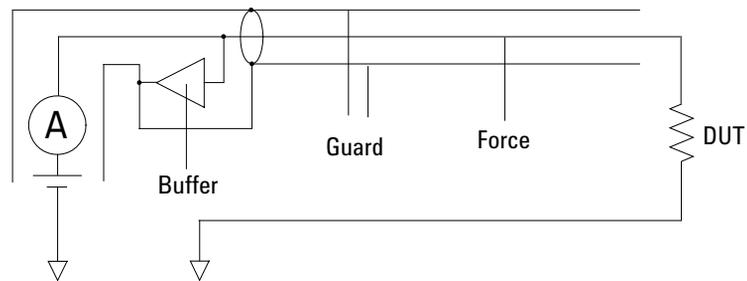
Installation

Connecting Measurement Devices

Guarding

Guarding reduces the leakage current between the measurement points and instrument. This is important when you measure low current.

The following figure shows the theory of guarding. The buffer amplifier ($\times 1$) keeps the potential of the guard conductor at the same potential as the force conductor, so current does not flow between the force and guard conductors. Therefore, the current measured by SMU is same as current at measurement point because no current is leaked.



To Measure Low Resistance

When you measure a low resistance, high current flows through the DUT. This high current increases the measurement error caused by the residual resistance of cables. To cancel the effect of this resistance, you can use *Kelvin connections* (4-wire), which means the force and sense lines are extended separately to the DUT.

Connect the probing needles to the terminals of the connector plate by using test leads or coaxial cables. Following instruction uses the coaxial cables:

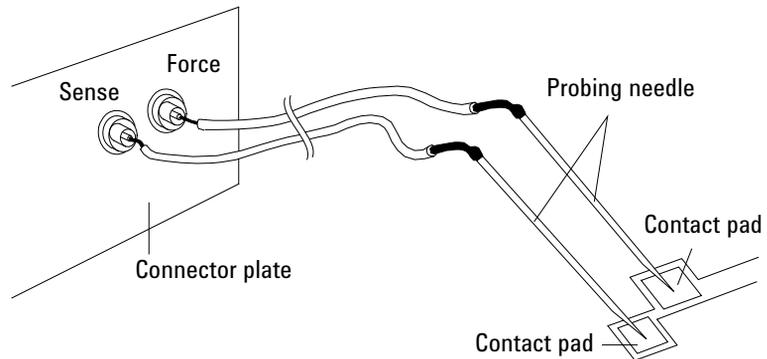
1. At end of cable, connect coaxial center conductor to force terminal of connector plate, and connect coaxial outer conductor to guard terminal of connector plate.
2. At another end, connect coaxial center conductor to tail of the probing needle. Never connect the outer conductor at this cable end.

Extend the outer conductor as close as possible to the probing needle.

3. Repeat 1 and 2 for the sense terminal of connector plate.
4. Contact the probing needles from force and sense terminals as close as possible to the DUT.

Example

The following example connection can be used to measure low resistance. The sense line is extended to the probing pad, and contacts the force line through the pad, so the voltage drop due to the residual resistance caused by cables and test leads is canceled.

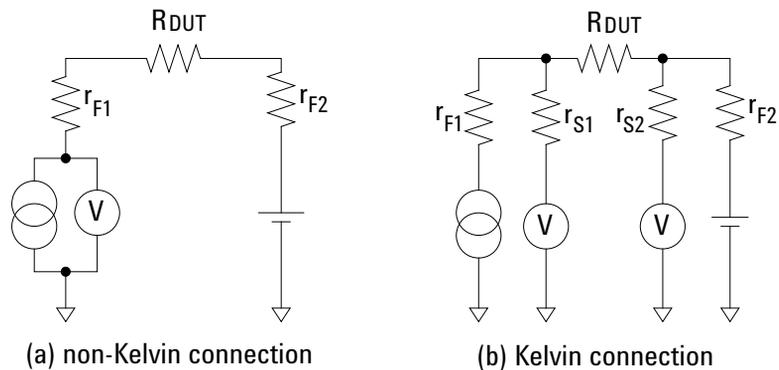


This example uses test leads. To reduce the leakage current, use coaxial cables.

Kelvin Connection

Kelvin connections give good measurement results when you force high-current. The following figure shows the equivalent circuits for Kelvin and non-Kelvin connections.

- For the non-Kelvin connection, the voltmeter measures the voltage drop of resistances r_{F1} , R_{DUT} , and r_{F2} .
- For the Kelvin connection, the voltmeter measures the voltage drop of resistance R_{DUT} only. The impedance of the voltmeter is very high, so the voltage drop of resistances r_{S1} and r_{S2} can be ignored.



The Kelvin connection is effective even when forcing voltage. The voltage drop due to the residual resistance of the force line wiring is fed back to the voltage source via a comparator in the sense line. The input impedance of comparator is high, and current flow into the sense line is very low. So output error is not significant if the sense line wiring has a residual resistance of $10\ \Omega$ or less. Therefore, the specified voltage appears at the sense point (point where sense line contacts force line)

Capacitance Compensation When Using Switching Matrix

When the capacitance/conductance measurement is performed through Agilent B2200A/B2201A/E5250A switching matrix, Agilent B1500A measures the capacitance/ conductance of the path including a DUT (device under test), matrix switches, extension cables and so on. So, the data measured by the B1500A is far from the DUT's capacitance/conductance.

Agilent EasyEXPERT provides the functions used to compensate the data measured in the environments described in “Required Conditions” on page 3-48. This section explains how to perform compensation.

- “Required Conditions”
- “To Create Compensation Data File”

NOTE

Corrected data by the function is not guaranteed. But typical data (supplemental data) is as follows.

Capacitance measurement accuracy (typical): $\pm 1\% \pm 0.5\text{ pF}$

This typical data is for the following measurement conditions:

Measurement frequency: 1 kHz to 5 MHz

Measurement range: Maximum 1000 pF

Measurement terminal: At the end of Agilent 16494A/B/C cable connected to the switch module output terminals.

The typical data does not apply to anything extended from the 16494A/B/C cable. The conditions described in “Required Conditions” on page 3-48 must be satisfied.

Required Conditions

The following conditions must be satisfied to use the capacitance compensation function. For the instrument connections, see Figure 3-18.

- Setting of the MFCMU
 - Range of the measurement frequency: 1 kHz to 5 MHz
 - Measurement function: Cp-G, Cp-D, Cs-Rs, or Z-Th. There is no limitation.
 - Calibration

Perform the MFCMU open calibration at the end of the measurement paths in front of the switching matrix inputs. If you also perform the short calibration (optional), prepare the BNC thru adapter (Agilent part number 1250-0080, 1 ea.).

- Total cable length of both Hc-Hp side and Lc-Lp side must be the same.
- Switching matrix input ports

Use Agilent N1300A CMU cable to connect the MFCMU. The BNC-T adapters (2 ea., Agilent part number 1250-2405 for each) are required to connect between the Hc and Hp terminals and between the Lc and Lp terminals. Connect the Hc-Hp cable and the Lc-Lp cable as follows. It is ok to leave open the ground wire extended from the CMU cable.

Hc-Hp: Input 13 (B2200A/B2201A) or AUX INPUT CV1 (E5250A)

Lc-Lp: Input 14 (B2200A/B2201A) or AUX INPUT CV2 (E5250A)

- Switching matrix output terminals

Use the Agilent 16494A triaxial cable to extend the outputs to the connector plate or the Agilent B2220A probe card interface (only for B2200A/B2201A). For the Kelvin connection, use the Agilent 16494B/C Kelvin triaxial cable.
- Ahead of the connector plate

Recommended cable: Agilent part number 8121-1191 Triaxial cable

You can also use another type of triaxial cable, coaxial cable, or combination of these.

To approximate the capacitance/conductance of the DUT, you need to obtain the appropriate compensation coefficients for your measurement environment, and create your compensation data file. See Figure 3-18.

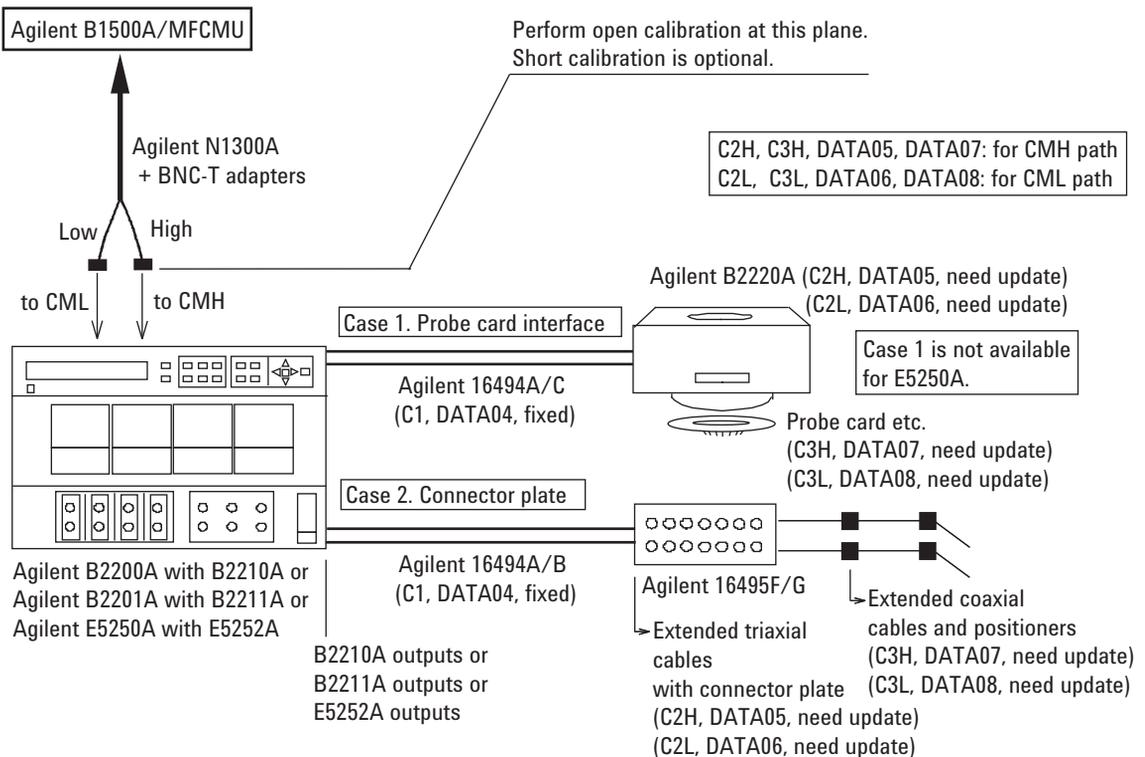
In Figure 3-18, C1 (DATA04), C2H (DATA05), C2L (DATA06), C3H (DATA07), C3L (DATA08) are the compensation coefficients defined in the compensation data file. where, CxH is for the path connected to the MFCMU Hc-Hp terminal, and CxL is for the path connected to the MFCMU Lc-Lp terminal.

When Agilent B2220A probe card interface is used, obtain the coefficients for C3x, and create your compensation data file. In this case, probe card will be used for the C3x path.

When the connector plate is used, obtain the coefficients for C2x and C3x, and create your compensation data file. In this case, triaxial cable with connector plate will be used for the C2x path. And coaxial cable with positioner will be used for the C3x path.

For obtaining the compensation coefficients and creating the compensation data file, see “To Create Compensation Data File” on page 3-50.

Figure 3-18 Extension Cables and Compensation Coefficients



To Create Compensation Data File

This section explains how to create the compensation data file. To perform the capacitance compensation, enter the file name of the compensation data file to the User Compensation Data File field of the “Extended Configuration” on page 4-46.

1. Create a text file (e.g. C:\temp\c_data.txt) that contains the information as shown below.

- For B2200A/B2201A:

```
#
# Compensation data file for B2210A/Cable connection/3m triax cable
#
#
# MB          Mother Board
# MH          Matrix Path High
# ML          Matrix Path Low
# C1          Agilent Triax Cable
# C2H         Probe card I/F or User Triax cable High
# C2L         Probe card I/F or User Triax cable Low
# C3H         Probe card or User Coax cable High
# C3L         Probe card or User Coax cable Low
#
format version 1.0
B2210A
CABLE
#
#          R[Ohm]          L[H]          C[F]
#-----
MB  0.000000e+00    5.250000e-08    2.940000e-11
MH  2.430000e+00    6.310000e-07    1.930000e-10
ML  2.490000e+00    5.970000e-07    1.920000e-10
C1  6.300000e-01    1.250000e-06    1.600000e-10
C2H 1.007000e-01    4.000000e-07    8.000000e-11
C2L 1.007000e-01    4.000000e-07    8.000000e-11
C3H 1.140000e-01    5.440000e-07    1.300000e-10
C3L 1.140000e-01    5.440000e-07    1.300000e-10
```

The 15th line specifies the used switch module, B2210A or B2211A.

The 16th line specifies the DUT interface, PCIF or CABLE. PCIF indicates that Agilent B2220A probe card interface is used. CABLE indicates that the connector plate is used.

The lines C2H to C3L should be modified for each measurement environment. See Table 3-9. Do not modify the other lines.

NOTE

EasyEXPERT provides the template of the compensation data file for the B2200A/B2201A. See Table 3-11. Select and use the template suitable for your measurement environment.

- For E5250A:

```
# E5250A C Compensation coefficient data table
#
# CAUTION : Do not add or delete "REVISION" line and "DATAxx" line.
#           Change the value for R,L,C of DATA05,06,07 or 08.
#
REVISION A.03.00
# R [ohm] L [H] C [F]
DATA00 74.65E-3 140.00E-9 58.44E-12 # Frame Path 1
DATA01 75.41E-3 90.00E-9 67.13E-12 # Frame Path 2
DATA02 231.41E-3 450.00E-9 178.85E-12 # Card Path High
DATA03 177.56E-3 390.00E-9 135.45E-12 # Card Path Low
DATA04 100.70E-3 400.00E-9 80.00E-12 # Triax Cable [ /m]
DATA05 100.70E-3 400.00E-9 80.00E-12 # User Triax Cbl H [ /m]
DATA06 100.70E-3 400.00E-9 80.00E-12 # User Triax Cbl L [ /m]
DATA07 114.00E-3 544.00E-9 130.00E-12 # User Coax Cbl H [ /m]
DATA08 114.00E-3 544.00E-9 130.00E-12 # User Coax Cbl L [ /m]
DATA09 0.00E-3 0.00E-9 1.20E-12 # Stray Capacitance
# END of Data
```

The lines DATA05 to DATA08 should be modified for each measurement environment. See Table 3-9. Do not modify the other lines.

Table 3-9 Compensation Coefficients and Modifications

| Compensation coefficients | Modifications of data file |
|--|--|
| C2H (DATA05) C2L (DATA06) | <p>For the connector plate, change the R, L, C values in the lines. The value must be changed to the R, L, C values of the C2H (DATA05) path and the C2L (DATA06) path (triaxial cable with connector plate) shown in Figure 3-18.</p> <p>For Agilent B2220A probe card interface, do not modify the lines.</p> |
| C3H (DATA07) C3L (DATA08) | <p>Change the R, L, C values in the lines. The value must be changed to the R, L, C values of the C3H (DATA07) path and the C3L (DATA08) path shown in Figure 3-18.</p> <p>For the connector plate, the coaxial cable with positioner will be the appropriate path.</p> <p>For Agilent B2220A probe card interface, the probe card will be the appropriate path.</p> |

Installation

Capacitance Compensation When Using Switching Matrix

2. Measure the R, L, C values of the for C2H (DATA05), C2L (DATA06), C3H (DATA07), and C3L (DATA08) by using the MFCMU. See “To obtain compensation coefficients” on page 3-53.

After the measurements, calculate the per meter value of the R, L, C, and record them into the following table.

| Compensation coefficients | Explanation | | |
|---------------------------|----------------|-------|-------|
| | R (Ω) | L (H) | C (F) |
| C2H (DATA05) | | | |
| C2L (DATA06) | | | |
| C3H (DATA07) | | | |
| C3L (DATA08) | | | |

3. Launch a text editor and open the compensation data file created at step 1.

Change the R, L, C values of the C2H (DATA05), C2L (DATA06), C3H (DATA07), and C3L (DATA08) lines to the values recorded at step 2. Do not change any other lines.

4. Save the file as your compensation data file (e.g. C:\temp\my_env_1.txt).

To perform the capacitance compensation, enter the file name of the compensation data file to the User Compensation Data File field of the “Extended Configuration” on page 4-46, and execute the measurement.

Before starting measurement, perform the CMU calibration. See “CMU Calibration” on page 4-37. Also see “C-V Sweep Measurement” on page 7-19.

To obtain compensation coefficients

Obtain the compensation coefficients as shown below.

1. Select the measurement frequency (F_{meas}) used for the capacitance measurement of a device under test (DUT), and set it to the MFCMU. The coefficients must be measured at the same frequency.
2. Perform the MFCMU open calibration at the measurement terminal. Optionally, perform short calibration if you want.
3. See Table 3-10 and Figure 3-19, and set the MFCMU.
4. Connect the path/cable corresponding to C3H (DATA07) shown in Figure 3-18 to the MFCMU. Then measure and record the R, L, and C values.
5. Connect the path/cable corresponding to C3L (DATA08) to the MFCMU. Then measure and record the R, L, and C values.
6. If you use the connector plate, perform the following procedure.
 - a. Connect the path/cable corresponding to C2H (DATA05) to the MFCMU. Then measure and record the R, L, and C values.
 - b. Connect the path/cable corresponding to C2L (DATA06) to the MFCMU. Then measure and record the R, L, and C values.

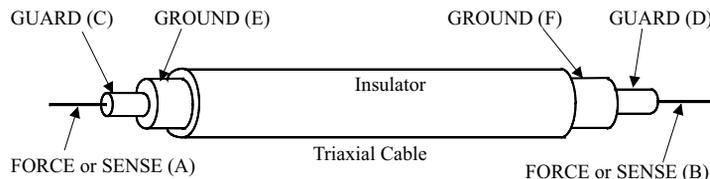
Table 3-10 R, L, C Measurement Conditions

| Parameter | Frequency | Function | Terminals |
|-----------|-----------------------------|----------|-----------------------|
| R | 1 kHz to 5 MHz ^a | – | A and B |
| L | | SERIES | see note ^b |
| C | | PARALLEL | A and C |

- a. R, L, C of all coefficients must be measured with the same frequency setting.
- b. For triaxial cable, connect B to F directly, and measure L between A and E. For coaxial cable, ignore E and F, and connect B to D directly, and measure L between A and C.

Figure 3-19

Compensation Coefficient Measurement Terminals of Extended Cables



Installation
Capacitance Compensation When Using Switching Matrix

Table 3-11 **Template Compensation Data Files for B2200A/B2201A**

| File name ^a | Measurement environment that template targets | | | | | | |
|--------------------------------------|---|--------------------|----------------------------|-----------------------------|------------|--------|-------------|
| | Switch module | Cable ^b | DUT interface ^c | Coefficients to be modified | | | |
| <path>\b2210a\pcif\triax\3m.data | B2210A | 16494A-002 | B2220A | C3H and C3L | | | |
| <path>\b2210a\pcif\triax\4m.data | | 16494A-005 | | | | | |
| <path>\b2210a\pcif\kelvin\3m.data | | 16494C-002 | | | | | |
| <path>\b2210a\pcif\kelvin\4m.data | | 16494C-005 | | | | | |
| <path>\b2210a\cable\triax\1_5m.data | B2210A | 16494A-001 | 16495F/G | C2H, C2L, C3H, and C3L | | | |
| <path>\b2210a\cable\triax\3m.data | | 16494A-002 | | | | | |
| <path>\b2210a\cable\triax\4m.data | | 16494A-005 | | | | | |
| <path>\b2210a\cable\kelvin\1_5m.data | | 16494B-001 | | | | | |
| <path>\b2210a\cable\kelvin\3m.data | | 16494B-002 | | | | | |
| <path>\b2210a\cable\kelvin\4m.data | | 16494C-005 | | | | | |
| <path>\b2211a\pcif\triax\3m.data | | B2211A | | | 16494A-002 | B2220A | C3H and C3L |
| <path>\b2211a\pcif\triax\4m.data | | | | | 16494A-005 | | |
| <path>\b2211a\pcif\kelvin\3m.data | | | | | 16494C-002 | | |
| <path>\b2211a\pcif\kelvin\4m.data | | | | | 16494C-005 | | |
| <path>\b2211a\cable\triax\1_5m.data | B2211A | 16494A-001 | 16495F/G | C2H, C2L, C3H, and C3L | | | |
| <path>\b2211a\cable\triax\3m.data | | 16494A-002 | | | | | |
| <path>\b2211a\cable\triax\4m.data | | 16494A-005 | | | | | |
| <path>\b2211a\cable\kelvin\1_5m.data | | 16494B-001 | | | | | |
| <path>\b2211a\cable\kelvin\3m.data | | 16494B-002 | | | | | |
| <path>\b2211a\cable\kelvin\4m.data | | 16494C-005 | | | | | |

a. <path>: \Program Files\Agilent\B1500\EasyEXPERT\B220xA\ccdata

b. Model number of the cable connected between the switch module and the DUT interface.

c. Agilent B2220A probe card interface or Agilent 16495F/G connector plate.

Maintenance

Maintenance should be performed periodically to keep Agilent B1500A in good condition.

Cleaning

Before performing cleaning, turn off the instrument, and disconnect power cable from the rear panel. Use a dry cloth to clean the external case parts.

To prevent electrical shock, do not perform cleaning when the instrument is turned on, and do not use a wet cloth.

Self-test and Diagnostics

Agilent B1500A provides the following functions to check the operation. Perform the following functions as necessary. Open the measurement terminals to perform self-test, self-calibration, or diagnostics.

- Self-test
Refer to “Modules” of “Configuration” on page 4-41.
- Self-calibration
Refer to “Calibration” on page 4-35.
- Diagnostics
Refer to “Main Frame” of “Configuration” on page 4-41.

If problems arise, contact Agilent Technologies. Also see “Before Shipping to Service Center” on page 9-12.

Calibration

Calibration and adjustments must be performed periodically so that the instruments satisfy the specifications, and keep a good condition. It is recommended to perform the calibration once a year at least. For the calibration and adjustments, contact Agilent Technologies. Trained service personnel will perform the calibration and adjustments. Also see “Before Shipping to Service Center” on page 9-12.

About Plug-in Modules

Agilent Technologies is responsible for the module installation of Agilent B1500A. Contact Agilent Technologies for the module installation. Then send the following equipment and accessories to Agilent Technologies.

- B1500A
- Plug-in modules to be installed
- ASU, for installing the exclusive HRSMU or retrofitting ASU only
- Connection cable between ASU and HRSMU, for installing the exclusive HRSMU or retrofitting ASU only
- RSU, for installing WGF MU
- Connection cable between RSU and WGF MU, for installing WGF MU

For returning ASU or RSU, do not forget to notify the combination of the unit, connection cable, and module channel.

WARNING

To prevent electrical shock, turn off Agilent B1500A and remove the power cable before removing the connection cables.

NOTE

About B1500A which supports SPGU and WGF MU

SPGU and WGF MU are supported by the B1500A serial numbered JP40Nxxxxx and later. The other B1500A needs the mainframe upgrade to support the module. Contact Agilent Technologies to upgrade the B1500A.

NOTE

Module locations after servicing

After the module installation, upgrade, and so on, the B1500A will be returned with the module configuration decided by the rule shown in Table 3-12. If you want to change the module locations, consult the service personnel before servicing.

Module Type and Locations

Module locations when the B1500A is shipped from the factory are shown in Table 3-12. This table shows the relative locations by the module types.

If the SPGUs are installed, the SPGUs must be installed in the slots from the slot number 1. And if the SPGU and the WGF MU are not installed and the HPSMUs are installed, the HPSMUs must be installed in the slots from the slot number 1. Then the same type of modules must be installed in the contiguous slots.

For example, if the module configuration is two HPSMU, two MPSMU, and one CMU, the B1500A will be shipped with the HPSMUs of the slots 1 to 4, the MPSMUs of the slots 5 to 6, the CMU of the slot 7, and the blank panels of the slots 8 to 10.

Table 3-12

Module Installation Rule

| Slot Number and Location | | Module Type |
|--------------------------|--------|-----------------------------|
| 10 | top | B1520A Multi Frequency CMU |
| : | : | B1511A Medium Power SMU |
| : | : | B1517A High Resolution SMU |
| : | : | B1510A High Power SMU |
| : | : | B1530A WGF MU |
| 1 | : | B1525A High Voltage SPGU |
| 0 | bottom | GNDU/ADC (always installed) |

Installation
About Plug-in Modules

Using EasyEXPERT

This chapter provides the reference information of Agilent EasyEXPERT software that is the graphical user interface of Agilent B1500A.

- “Start EasyEXPERT”
- “Workspace Configurator”
- “Main Screen”
- “Application Test”
- “Quick Test”
- “Repeat Measurement Setup”
- “Organize Preset Group”
- “Calibration”
- “Configuration”
- “Switching Matrix Operation Panel”
- “Standby Channel Definition”
- “Data Display”
- “Preview”
- “Text File Export settings”

To start EasyEXPERT, see “Start EasyEXPERT” on page 4-4 and “Workspace Configurator” on page 4-5.

To perform application test setup, see “Application Test” on page 4-27.

To perform classic test setup, see “Classic Test Definition” on page 5-1.

To perform quick test setup, see “Quick Test” on page 4-29.

To perform measurement, see “Main Screen” on page 4-10.

To display measurement data and perform data analysis, see “Data Display” on page 4-51.

To perform self-test or diagnostics, see “Configuration” on page 4-41.

To perform self-calibration, see “Calibration” on page 4-35.

To control Agilent B2200A/B2201A/E5250A switching matrix connection, see “Switching Matrix Operation Panel” on page 4-48.

To set the standby channels and the standby mode, see “Standby Channel Definition” on page 4-50.

To define your application test, see “Application Test Definition” on page 6-1.

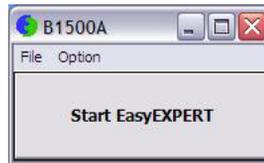
NOTE**Touch Screen Operation**

If you use touch screen operation than mouse, change the font size of menu. Font size 14 is recommended for the touch screen operation.

Open the Control Panel, select *Appearance and Themes*, and select *Display* to open the Display Properties dialog box. Select the *Appearance* tab, and click the *Advanced* button to open the Advanced Appearance dialog box. On the dialog box, set *Item* to Menu, and set the *Size of Font* to 14.

Start EasyEXPERT

The Start EasyEXPERT window is displayed by selecting the Start EasyEXPERT icon on Windows desktop or Start EasyEXPERT in the Start menu. This window provides the following graphical user interface.



Start EasyEXPERT This button launches EasyEXPERT.

File menu *Exit* closes the Start EasyEXPERT window.

Option menu *EasyEXPERT Database* provides the following two functions.

- *Backup EasyEXPERT Database*
Opens the EasyEXPERT Database Backup Creation Wizard used to make backup of the EasyEXPERT database. You can make backup easily by following the wizard. Required time depends on the database size.
- *Restore EasyEXPERT Database*
Opens the EasyEXPERT Database Restoration Wizard used to restore the EasyEXPERT database backup. You can restore the backup easily by following the wizard. Required time depends on the database size.

EasyEXPERT Database is the folder used to store your test setup data and such.

Workspace Configurator

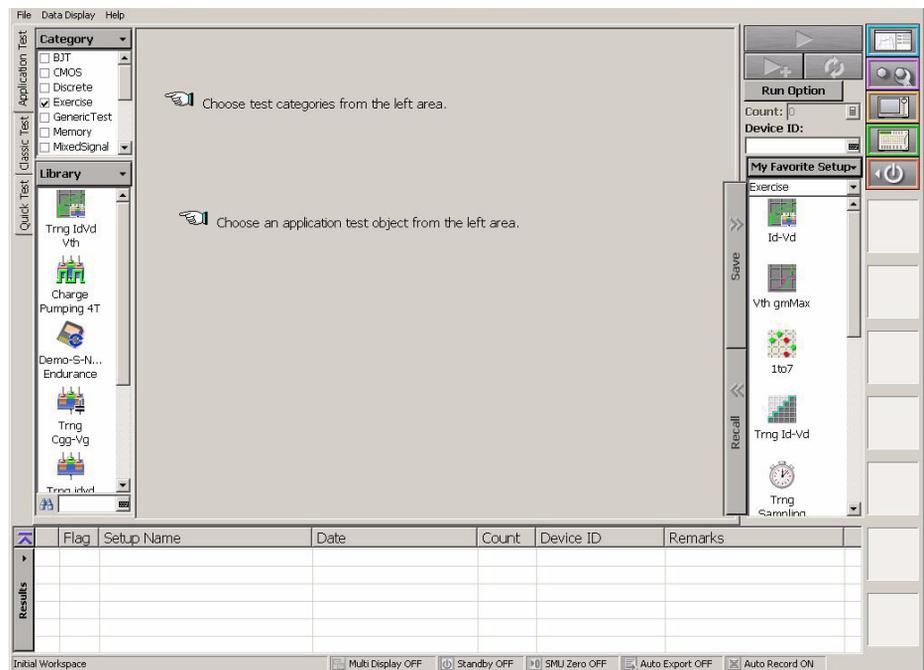
Workspace means the space created in Agilent B1500A's internal hard disk drive, and is used to store the test setup, test result data, and so on. The workspace can be created and allocated for each user.

The workspace configurator will run after you launch Agilent EasyEXPERT. The workspace configurator displays a screen used to select the workspace you use. There are three types of display, depending on the number of existing Workspace.

- “If there is no workspace”
- “If there is one workspace”
- “If there are Workspace more than two”

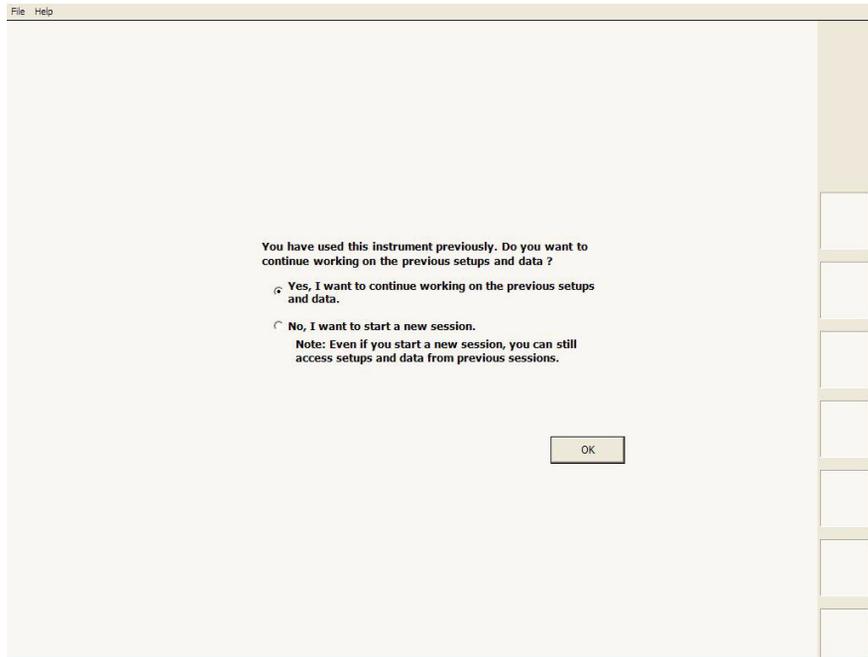
If there is no workspace

EasyEXPERT will automatically create a workspace and display the EasyEXPERT main screen.



If there is one workspace

You will see a message asking you if you want to create a workspace or not. Select one of the following radio buttons.



- *Yes, I want to continue working on the previous setups and data.*

This button must be selected if you do not want to create a new workspace, and want to use the workspace previously used.

The OK button will work to open the EasyEXPERT main screen.

- *No, I want to start a new session.*

This button must be selected if you want to create a new workspace, and want to use it instead of the workspace previously used. If you select No, the label of the OK button will change to Next.

The Next button will work to display the following entry fields used to set the workspace name.

- Entry field for the name of the new workspace
- Entry field for the new name of the existing workspace
This field is available only for the owner of the existing workspace.

Check the *Allow other users to access this workspace* box to create a *public* workspace that is opened for all users.

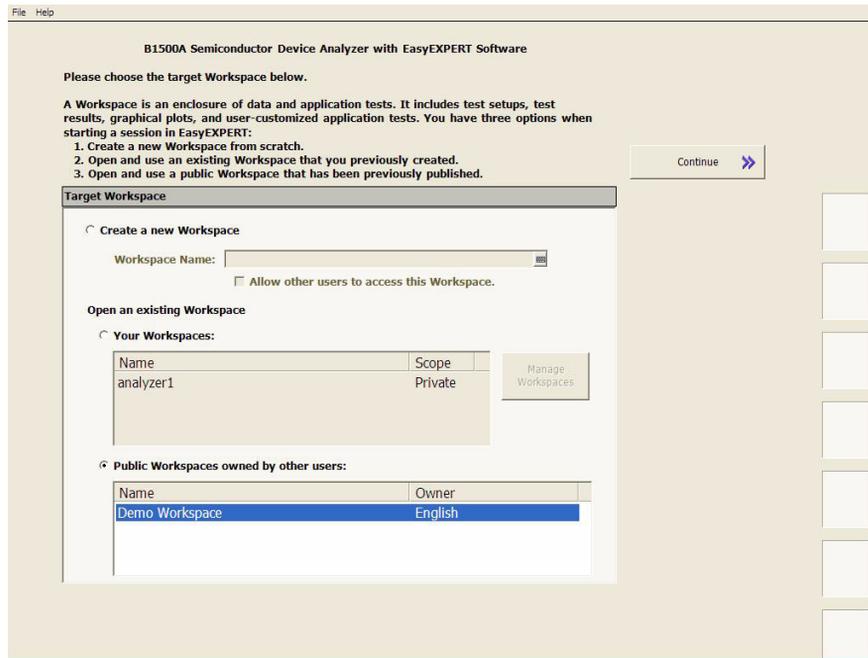
The OK button creates and/or renames the workspace, and opens the EasyEXPERT main screen.

The Prev button cancels the workspace creation and returns the screen message to the previous one.

The screenshot shows a dialog box titled "File Help" at the top. The main text reads: "Agilent EasyEXPERT software manages setups and data in enclosures known as 'Workspaces.' Since you want to start a new session, you should create a new Workspace with a distinctive name. Please specify a name for the new Workspace:". Below this text is a text input field containing "Untitled" and a small icon to its right. Underneath the input field is a checkbox labeled "Allow other users to access this Workspace." which is currently unchecked. The next line of text says: "You can also rename a previously defined Workspace:". Below this is another text input field containing "Demo Workspace" and a small icon to its right. Underneath this second input field is a checkbox labeled "Allow other users to access this Workspace." which is currently checked. At the bottom right of the dialog box are two buttons: "Prev" with a left-pointing arrow and "OK".

If there are Workspace more than two

You will see the message as shown in the following example.



- Create a new Workspace

This button must be selected if you want to create a new workspace. Enter the name of the new workspace in the Workspace Name field.

Check the *Allow other users to access this workspace* box to create a *public* workspace that is opened for all users.

- Open an existing Workspace

- Your Workspace

This button must be selected if you want to open your workspace. Select the name to specify the workspace to open.

- Name: Workspace name
- Scope: Private (only for owner) or Public (for all users)

The Manage Workspaces button opens Workspace Manager that allows you to delete, rename, or make a copy of the specified workspace. Select the workspace name and click a button.

- Delete: Deletes the selected workspace.
- Rename: Renames the selected workspace.
- Duplicate: Makes a copy of the selected workspace.
- Public: Changes the scope of the selected workspace to Public.
- Close: Closes the Workspace Manager.

- Public Workspace owned by other users

This button must be selected if you want to open a public workspace created by another user. Select the name to specify the workspace to open.

- Name: Workspace name
- Owner: Owner of the workspace

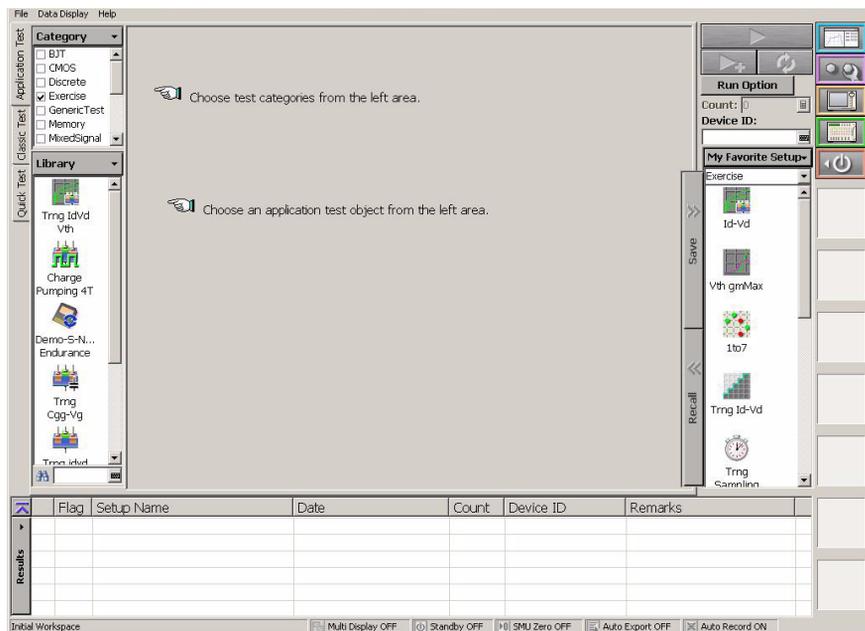
- Continue

This button displays the main screen with the specified workspace.

Main Screen

The EasyEXPERT main screen will be displayed after the workspace is specified or created by the workspace configurator. The main screen provides several tools and functions described in this section.

- “Main Screen GUI”
- “Run Option”
- “Data Display Manager”
- “Data Display Properties”
- “Test Result Editor”
- “Test Results Data Filter”
- “Export in My Format”
- “Test Results Data Folder Export”
- “Test Results Data Auto Export”
- “Test Results Data Properties”



Main Screen GUI

File menu

Provides the following four functions.

| | |
|-----------------------------|---|
| Import Test Setup... | Opens a dialog box used to specify a test setup to import. |
| Export Test Setup... | Opens a dialog box used to specify a destination file for exporting the present test setup. |
| Close Workspace | Closes the work space and returns to the workspace configurator. |
| Exit | Exits the EasyEXPERT software. |

Data Display menu Provides the following three functions.

| | |
|---|---|
| Show Data Display | Opens “Data Display (page 4-51)” used to display the test result data. |
| Manage Data Display... | Opens “Data Display Manager (page 4-19)” used to control the appearances of the Data Display windows. |
| Default Data Display Properties... | Opens “Data Display Properties (page 4-20)” used to set the default setting of the Data Display window. |

Help menu

Provides the following three functions.

| | |
|---------------------------------|--|
| About This Instrument... | Opens the Configuration window. |
| About This Test... | Opens the test description dialog box. |
| Agilent EasyEXPERT Help | Opens the EasyEXPERT help window. |

Application Test

This tab selects the application test mode of EasyEXPERT. For details of the graphical user interface in this mode, see “Application Test” on page 4-27.

Classic Test

This tab selects the classic test mode of the EasyEXPERT. For details of the graphical user interface in this mode, see “Classic Test Definition” on page 5-1.

Quick Test

This tab selects the quick test mode of the EasyEXPERT. For details of the graphical user interface in this mode, see “Quick Test” on page 4-29.

Using EasyEXPERT Main Screen

- Data Display**  Opens “Data Display (page 4-51)” used to display the test result data. EasyEXPERT always handles the test setup corresponding to the Data Display window now active or most recently activated.
- Calibration**  Opens “Calibration (page 4-35)” used to see the self-calibration results, to perform the self-calibration, or to perform the current offset cancel.
- Configuration**  Opens “Configuration (page 4-41)” used to see the module configuration, to see the self-test results, to perform self-test, to establish the GPIB connection with Agilent B2200A/B2201A/E5250A switching matrix, or to see the event log.
- Switching Matrix**  Opens “Switching Matrix Operation Panel (page 4-48)” used to control Agilent B2200A/B2201A/E5250A switching matrix.
- Standby**  Opens “Standby Channel Definition (page 4-50)” used to set the standby channel which is the channel to keep the specified output when the standby mode is ON and in the non-measurement state.
- Single**  Triggers a single measurement. To abort measurement, click Stop button that appears instead of the Single button.
- Append**  Triggers the append measurement. The measurement results will be appended to the Data Display window that shows the previous measurement results. The Data Display window can have maximum 10 layers for displaying measurement results. To abort measurement, click Stop button that appears instead of the Single button.
- Repeat**  This button provides a different function depending on the status of the data record functions (Auto Record and Auto Export). See “Run Option (page 4-18)” for the data record status.
- If Auto Record and Auto Export is OFF, this button starts the repeat measurement immediately.
- If Auto Record or Auto Export is ON, this button opens the “Repeat Measurement Setup (page 4-31)” dialog box for setting the repeat measurement condition.
- Run Option**  Opens the “Run Option (page 4-18)” dialog box for setting the data record functions (Auto Record and Auto Export) and the Multi Display function.
- Save Data**  This button will appear to the right side of the Run Option button if a measurement is performed when the data record functions (Auto Record and Auto Export) are OFF. Clicking the button will save the last measurement data as a test result record.

| | | | | | | | | | | | | | | | | | |
|------------------------------------|---|---------------|------------------|---------------------|---|-----------------------------|---|---------------------------------|--|------------------------------------|---|---------------------------------|--|-------------------------------|---|------------------------------------|---|
| Count | Displays the number of single measurements executed for the test setup now opened. Effective for the measurements triggered by both Single and Repeat. | | | | | | | | | | | | | | | | |
| Device ID | <p>This entry field is used to enter a string in the test record. The string can data ID, device ID, test ID, or anything you want.</p> <p>Performing measurement and changing setup do not change the value in this field. Change the value if you want.</p> | | | | | | | | | | | | | | | | |
| Save | The button saves the present test setup into the present preset group as a new test setup of the group. | | | | | | | | | | | | | | | | |
| Recall | The button recalls the selected test setup. This means opening and displaying the measurement definition of the selected test setup. | | | | | | | | | | | | | | | | |
| My Favorite Setup | <p>The test setups you create or modify MUST be saved to My Favorite group (preset group) to reuse them.</p> <p>Click the My Favorite Setup button to display the menu that provides the following functions. Select the preset group by using the field below the button. The test setups can be recalled by using the area below the field.</p> <table><tr><td>Cancel</td><td>Closes the menu.</td></tr><tr><td>Preset Group</td><td>Provides the following seven functions.</td></tr><tr><td>Add New Preset Group</td><td>Opens the Add Preset Group dialog box. Creates a new preset group and saves it as the specified name.</td></tr><tr><td>Rename This Preset Group</td><td>Opens the Rename Preset Group dialog box. You can change the name of the present preset group.</td></tr><tr><td>Duplicate This Preset Group</td><td>Opens the Duplicate Preset Group dialog box. Creates a copy of the present preset group and saves it as the specified name.</td></tr><tr><td>Delete This Preset Group</td><td>You can delete the present preset group.</td></tr><tr><td>Import Preset Group...</td><td>Opens the Preset Group Import dialog box. Imports the specified preset group.</td></tr><tr><td>Export This Preset Group...</td><td>Opens the Preset Group Export dialog box. Exports the present preset group as the specified name.</td></tr></table> | Cancel | Closes the menu. | Preset Group | Provides the following seven functions. | Add New Preset Group | Opens the Add Preset Group dialog box. Creates a new preset group and saves it as the specified name. | Rename This Preset Group | Opens the Rename Preset Group dialog box. You can change the name of the present preset group. | Duplicate This Preset Group | Opens the Duplicate Preset Group dialog box. Creates a copy of the present preset group and saves it as the specified name. | Delete This Preset Group | You can delete the present preset group. | Import Preset Group... | Opens the Preset Group Import dialog box. Imports the specified preset group. | Export This Preset Group... | Opens the Preset Group Export dialog box. Exports the present preset group as the specified name. |
| Cancel | Closes the menu. | | | | | | | | | | | | | | | | |
| Preset Group | Provides the following seven functions. | | | | | | | | | | | | | | | | |
| Add New Preset Group | Opens the Add Preset Group dialog box. Creates a new preset group and saves it as the specified name. | | | | | | | | | | | | | | | | |
| Rename This Preset Group | Opens the Rename Preset Group dialog box. You can change the name of the present preset group. | | | | | | | | | | | | | | | | |
| Duplicate This Preset Group | Opens the Duplicate Preset Group dialog box. Creates a copy of the present preset group and saves it as the specified name. | | | | | | | | | | | | | | | | |
| Delete This Preset Group | You can delete the present preset group. | | | | | | | | | | | | | | | | |
| Import Preset Group... | Opens the Preset Group Import dialog box. Imports the specified preset group. | | | | | | | | | | | | | | | | |
| Export This Preset Group... | Opens the Preset Group Export dialog box. Exports the present preset group as the specified name. | | | | | | | | | | | | | | | | |

Using EasyEXPERT Main Screen

| | |
|---|---|
| Organize Preset Group... | Opens the “Organize Preset Group (page 4-33)” dialog box used to organize the preset group. |
| Rename | You can change the name of the selected test setup. |
| Duplicate | Creates a copy of the selected test setup. |
| Delete | Deletes the selected test setup. |
| Delete All | Deletes all test setups in the present preset group. |
| Flag | <p>Shows the flag, Important (!), Valid (#), or Questionable (?) set to the record. The top button sorts the test records by the flag.</p> <p>While the “Show Deleted Data (page 4-15)” function is enabled, the list area can show the test records in Delete-group. For the records, * is set to the column to the left of the Flag column. The top button sorts the list by *.</p> |
| Setup Name | Shows the test setup name. The top button sorts the test records by name, in lexicographical order. |
| Date | Shows the date that the test result is recorded. The top button sorts the test records by date, in chronological order. |
| Count | Shows the measurement count shown in the Count field. The top button sorts the test records by count, in numerical order. |
| Device ID | Shows the string set to the record by using the Device ID field. The top button sorts the test records by device ID, in lexicographical order. |
| Remarks | Shows the remarks set to the record. The top button sorts the test records by the remarks in the lexicographic order. |
| Auto Record OFF | This indicator is located at the bottom of the EasyEXPERT main screen and is lit while the Auto Record (automatic data record) function is disabled. |
|  | |
| Auto Export ON | This indicator is located at the bottom of the EasyEXPERT main screen and is lit while the Auto Export (automatic data export) function is enabled. |
|  | |
| SMU Zero ON | This indicator is located at the bottom of the EasyEXPERT main screen and is lit while the SMU current offset cancel function is enabled. |
|  | |

Standby ON



This indicator is located at the bottom of the EasyEXPERT main screen and is lit while the standby function is enabled (standby mode is ON).

Multi Display ON



This indicator is located at the bottom of the EasyEXPERT main screen and is lit while the Multi Display function is enabled.

workspace name

Field below the Results button shows the present workspace name.

Results

This button provides the following functions. The list area shows the test records. The up or down arrow button is used to expand or reduce the list area.

- Cancel** Closes the menu.
- Select All** Selects all records.
- Unselect All** Unselects all records.
- Display Data** Opens the “Data Display (page 4-51)” and displays the test result data of the selected record. Up to 15 windows can be opened by this function.
- Recall** Recalls the test setup of the selected record.
- Filter** Provides the following four functions.
- Show Deleted Data** Check this function to see the test records of both Save-group and Delete-group. To set the data group, see “Flag and Remarks” on page 4-17. See also “Test Result Editor (page 4-21)”.
- Filter...** Opens the “Test Results Data Filter (page 4-22)” dialog box. You can filter the test records in the list area.
- Expand Application Test Results** Check this function to see all test records created by the test setups defined in an application test.

If a test record is exported when this function is not checked, the exported file will contain all records created by the test setups defined in an application test. However, if the test record is exported by the Export As Text File function, the exported file will contain only the test record of the application test.

Using EasyEXPERT Main Screen

| | |
|--|---|
| Show All Append Data | Check this function to see all test records created by the append measurement. In the test record list, S indicates the test records obtained by a single measurement, and A indicates the records obtained by an append measurement. |
| Transport Data | Provides the following ten functions. |
| Import... | Opens the Test Result Import dialog box. Imports the specified test record. |
| Export As Test Result... | Opens the Test Result Export dialog box. Exports the selected test record as the specified name in the EasyEXPERT data format. |
| Export As Compressed Test Result... | Opens the Compressed Test Result Export dialog box. Exports the selected test record as the specified name in the compressed EasyEXPERT data format. |
| Export As CSV... | Opens the CSV File Export dialog box. Exports the selected test record as the specified name in the CSV format that can be read by a spread sheet software. |
| Export As XML Spread Sheet... | Opens the XML Style Sheet Export dialog box. Exports the selected test record as the specified name in the XML spread sheet format that can be read by a spread sheet software. |
| Export in My Format... | Opens the “Export in My Format (page 4-22)” dialog box. Exports the selected test record as the specified name in the style converted by using the specified XSLT filter. |
| Export As Text File... | Opens the Text File Export dialog box. Exports the selected test record as the specified name in the style defined on the “Text File Export settings (page 4-77)” dialog box. |
| Text File Export Setting... | Opens the “Text File Export settings (page 4-77)” dialog box used to define the style of the test record exported by the Export As Text File function. |
| Folder Export... | Opens the “Test Results Data Folder Export (page 4-23)” dialog box used to export the selected multiple test records to the specified folder. |

| | |
|-------------------------------|---|
| Auto Export Setting... | Opens the “Test Results Data Auto Export (page 4-24)” dialog box used to set the automatic data export function and the automatic data save function. |
| Edit | Provides the following two functions. |
| Flag and Remarks | Opens the “Test Result Editor (page 4-21)” used to put the selected test record in Save-group or Delete-group. Also this dialog box can set a flag and remarks to the selected record. The available data flags are Important (!), Valid (#), and Questionable (?). |
| Delete | Puts the selected test records in Delete-group. The records can be displayed in the list area while the “Show Deleted Data (page 4-15)” is checked. |
| Properties... | Opens the “Test Results Data Properties (page 4-26)” dialog box used to set the number of test records listed in the list area and the number of recoverable records in Delete-group. |

Run Option

This dialog box appears by clicking the Run Option button and is used to set the data record functions (Auto Record and Auto Export) and the Multi Display function. This dialog box provides the following GUI.

- Record Test Result Data Automatically

This check box changes the status of the data record functions (Auto Record and Auto Export). The functions provide four status shown in Table 4-1. Removing the check sets Auto Export=Auto Record=OFF. And putting the check again returns the status to the previous one.

In the checked status, the data record functions can be set to one of three status except for Auto Export=Auto Record=OFF. To set the functions, use “Test Results Data Auto Export (page 4-24)”.

In the unchecked status (Auto Export=Auto Record=OFF), the test result data will not be recorded. If a measurement is performed in this status, the Save Data button will appear to the right side of the Run Option button. Clicking the Save Data button will save the last measurement data as a test result record.

When the automatic data record function is enabled, one test execution result is stored in one test record. For the classic test, one test result is stored in one test record. For the application test, all test results taken by executing one application test are stored in one test record. However, the automatic data export function using the Text File type exports the file for each test result.

Table 4-1

Record Test Result Data Automatically Check Box and Data Record Functions

| Checked status | | Unchecked status | |
|----------------|-------------|------------------|-------------|
| Auto Export | Auto Record | Auto Export | Auto Record |
| ON | OFF | OFF | OFF |
| ON | ON | | |
| OFF | ON | | |

- Allocate Data Display for each test

This check box sets the Multi Display function ON (checked) or OFF. This function controls the operation of the Data Display window.

OFF Test result data will be always displayed on the singular Data Display window even if the test setup is changed.

- ON** Test result data of the same test setup name will be displayed on the exclusive Data Display window and the test result data of the different test setup name will be displayed on the new Data Display window.

Data Display Manager

This dialog box is opened by selecting the Manage Data Display... function of the Data Display menu, and is used to control the appearances of the Data Display windows. This dialog box provides the following three action buttons.

- OK** Applies the setup changes and closes this dialog box.
- Cancel** Cancels the setup changes and closes this dialog box.
- Apply** Just applies the setup changes.

Data Display Window Order

This area lists the Setup Name of the Data Display windows opened. The list items from top to bottom correspond to the windows from front to back in the screen image. This area supports the following buttons. To select the item, click one in the list.

- Up** Moves the selected item upward.
- Down** Moves the selected item downward.
- Select All** Selects all items.
- Minimize** Minimizes the windows corresponding to the selected items. The list items move to the Minimized Data Displays area.
- Close** Closes the windows corresponding to the selected items.

Minimized Data Displays

This area lists the Setup Name of the Data Display windows minimized. This area supports the following buttons. To select the item, click one in the list.

- Select All** Selects all items.
- Restore** Restores the windows corresponding to the selected items.
- Close** Closes the windows corresponding to the selected items.

Data Display Window Configuration

This area provides the following radio buttons and a check box to change the appearances of the Data Display windows. All functions are available for the opened windows.

- Keep Setup** Keeps the present configuration of the Data Display windows.

Using EasyEXPERT

Main Screen

| | |
|-------------------|---|
| Tiling | Resize and collate the data display windows such that they fill up the entire screen. |
| Stacking | Resize and collate the data display windows so that they overlap slightly with an offset. |
| Overlaying | Resize, overlap, and make transparent the data display windows so that multiple graphs can be viewed and superimposed on one another. |

Apply same scale to all graph This check box must be checked to apply the same graph scale to all graphs.

Data Display Properties

This dialog box is opened by selecting the Default Data Display Properties... function of the Data Display menu, and is used to set the default setting of the Data Display window. Click the OK button to apply the setup and close this dialog box.

Effective Area This area is used to select the area effective when the Data Display window is opened, and provides the following check box.

X-Y Graph Check this button to enable the X-Y Graph area.

Grid ON Check this button to display the grid on the X-Y Graph.

List Display Check this button to enable the List Display area.

Parameters Check this button to enable the Parameters area.

Graph Color This area is used to set the color map for the X-Y Graph Plot area. You can change the color of the background, text, graph grid, and line/cursor. The color palette is opened by clicking the pattern of the item.

Graph Trace Color This area is used to set visibility, color, and thickness of the data traces Y1 to Y8 plotted on the graph. The color palette is opened by clicking the pattern of the item.

Log Scale This area is used to set the maximum number of decades to show the minor ticks for on the log axis. If the number of graph decades is less than or equal to the entered value, the minor ticks are displayed. If it is greater than the entered value, the minor ticks are not displayed.

Text Size This area is used to set the font size for the graph. The available settings are Largest, Large, Medium, Small, Smallest, and Fixed. For settings other than Fixed, the appropriate size is automatically selected. For Fixed, a font size entry field is provided, and the specified font size is always applied.

| | |
|-----------------------|---|
| X/Y Axis Title | Font size for the axis title |
| Scale | Font size for the X and Y coordinate values |
| Legend | Font size for the graph legend |

Test Result Editor

The Test Result Editor appears when measurement is completed or by clicking Results > Edit > Flag & Remarks. This is used to set a flag and remarks to the associated test record and provides the following GUI.

Save, Delete

Divides test records into groups, Save and Delete.

Test records in Save-group are always listed in the lower area of the EasyEXPERT main screen.

Test records in Delete-group can be listed while Results > Filter > Show Deleted Data is checked.

Flags

The following buttons are available. You can set one of the following flags.

- Important ! button
Sets the important flag (!) to the test record.
- Valid # button
Sets the valid flag (#) to the test record.
- Questionable ? button
Sets the questionable flag (?) to the test record.

Remarks

You can enter characters into this field. The characters will be recorded as the Remarks value of the test record.

OK

Applies the setup on the Test Result Editor, and closes this dialog box.

Test Results Data Filter

This dialog box appears by clicking Results > Filter > Filter... and is used to specify the test records listed in the lower area of the EasyEXPERT main screen.

| | |
|-------------------------------------|---|
| Data records in Save-group | Check this box to list the test records in Save-group. |
| Data records in Delete-group | Check this box to list the test records in Delete-group. |
| Flag | Select or enter a flag in this field to list the test records with the specified flag. |
| Setup Name | Select or enter a test name in this field to list the test records of the specified name. |
| Date | Specify the date to list the test records within the specified period. |
| Count | Specify the count values to list the test records within the specified range. |
| Device ID | Select or enter the device ID to list the test records of the specified device ID. |
| Remarks | Specify the remarks value to list the test records with the specified value. |
| OK | Performs filtering, and closes this dialog box. |
| Cancel | Cancels filtering, and closes this dialog box. |

Export in My Format

This dialog box appears by clicking Results > Transport Data > Export in My Format..., and is used to export the test record by performing the style conversion using the XSLT filter.

| | |
|---------------------|--|
| My Format | Specify the full path name of the XSLT filter (XML style sheet) used to convert the style of the test record. The Browse... button opens the Select XML Style Sheet File dialog box used to select the file. |
| Export As... | Opens the Export As dialog box. Specify the file name and the file type, and export the test record. |
| Cancel | Cancels data export, and closes this dialog box. |

Test Results Data Folder Export

This dialog box appears by clicking Results > Transport Data > Folder Export... after the test result records are selected (highlighted).

This function is used to export the multiple test records. The test records can be exported by specifying the records, the destination folder name, and the naming rule and the file type for the exported files.

Destination for Export

Selects the folder used to save the exported test records. The Browse... button opens the Browse For Folder dialog box used to select the folder.

File Name

Specifies the style of the file name for the exported test records.

File name is automatically generated by using Setup Name, Device ID, Count, and Date values defined in the main screen. If an impermissible character is used in a value, the character is automatically replaced with _ (underscore).

- Default Format: File name without extension is as follows.

Setup Name [Device ID (Count) ; Date]

Example: Id-Vd [cmos1 (1) ; 1_22_2006 3_44_55 PM]

- Custom Format: You can specify the style by the File Name Format dialog box.

The File Name Format dialog box appears by clicking the Settings... button. In the dialog box, enter the desired style into the Format field, for example, the next example sets the same style as the Default Format.

Example: {0} [{3} ({2}) ; {1}]

{0}: Setup Name

{1}: Date, mm_dd_yyyy hh_mm_ss AM/PM

{2}: Count

{3}: Device ID

File Type

Selects the file type (data format).

Test Result EasyEXPERT data format

Compressed Test Result Compressed EasyEXPERT data format

CSV CSV format

XML Spread Sheet XML spread sheet format

Using EasyEXPERT Main Screen

My Format Custom format created by the specified XSLT filter. The following two entry fields are available.

- **My Format**
Specifies the file name of the XSLT filter (XML style sheet) used to export test records. The Browse... button opens the Select XML Style Sheet File dialog box used to select the file.
- **Extension of Output File**
Enters the appropriate extension, or selects the extension from xml, txt, csv, or xls.

Text File Custom format defined in the “Text File Export settings (page 4-77)” dialog box. The Settings... button opens this dialog box.

Export Starts the folder export. This dialog box is closed after the folder export is completed.

Cancel Cancels the folder export, and closes this dialog box.

Test Results Data Auto Export

This dialog box appears by clicking Results > Transport Data > Auto Export Setting... and is used to set the data record functions (Auto Record and Auto Export).

There is the following check box at the top of this dialog box.

- *Enable automatic data export to the specified storage device*

Checking this box sets the Auto Export function (automatic data export) and enables the following GUI.

Destination for Export Selects the folder used to save the exported test records. The Browse... button opens the Browse For Folder dialog box used to select the folder.

File Name Specifies the style of the file name for the exported test records.

File name is automatically generated by using Setup Name, Device ID, Count, and Date values defined in the main screen. If an impermissible character is used in a value, the character is automatically replaced with _ (underscore).

- Default Format: File name without extension is as follows.

Setup Name [Device ID (Count) ; Date]

Example: Id-Vd [cmos1 (1) ; 1_22_2006 3_44_55 PM]

- Custom Format: You can specify the style by the File Name Format dialog box.

The File Name Format dialog box appears by clicking the Settings... button. In the dialog box, enter the desired style into the Format field, for example, the next example sets the same style as the Default Format.

Example: {0} [{3} ({2}) ; {1}]

{0}: Setup Name

{1}: Date, mm_dd_yyyy hh_mm_ss AM/PM

{2}: Count

{3}: Device ID

File Type

Selects the file type (data format).

Test Result EasyEXPERT data format

Compressed Test Result Compressed EasyEXPERT data format

CSV CSV format

XML Spread Sheet XML spread sheet format

My Format Custom format created by the specified XSLT filter. The following two entry fields are available.

- My Format

Specifies the file name of the XSLT filter (XML style sheet) used to export test records. The Browse... button opens the Select XML Style Sheet File dialog box used to select the file.

- Extension of Output File

Enters the appropriate extension, or selects the extension from xml, txt, csv, or xls.

Text File Custom format defined in the “Text File Export settings (page 4-77)” dialog box. The Settings... button opens this dialog box.

Using EasyEXPERT Main Screen

Data Storage Remove a check from the following check box to disable the Auto Record function (automatic data record).

- *Enable automatic data record to the internal storage device*

OK Applies the setup, and closes this dialog box.

Cancel Cancels the setup, and closes this dialog box.

NOTE

Automatic Data Record Output

When the automatic data record function is enabled, one test execution result is stored in one test record. For the classic test, one test result is stored in one test record. For the application test, all test results taken by executing one application test are stored in one test record. However, the automatic data export function using the Text File type exports the file for each test result.

Test Results Data Properties

This dialog box appears by clicking Results > Properties... and is used to set the maximum number of test records listed in the main screen and saved in the Delete-group.

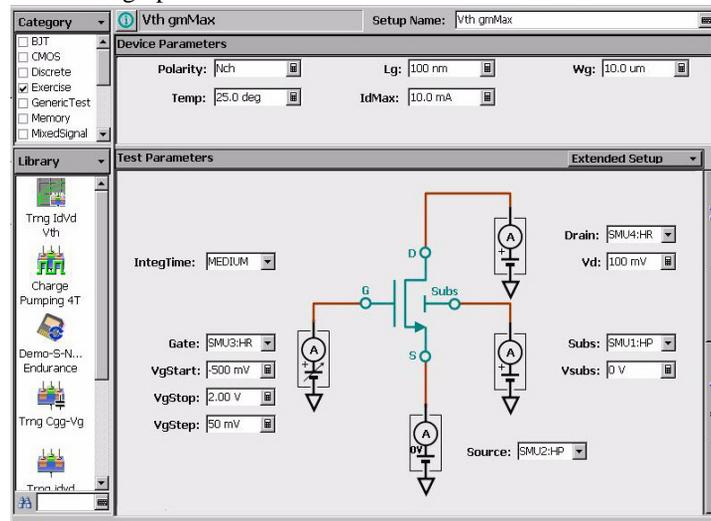
Test Result List View Sets the maximum number of test records listed in the main screen.

Non-preserved data Sets the maximum number of test records saved in the Delete-group.

Close Closes this dialog box.

Application Test

In the application test mode, the EasyEXPERT main screen has the following additional graphical user interface.



Category

Lists the categories of the application test definitions. You can select the categories by using the check box. The test definitions listed in the Library area depend on the selection of the categories.

The Category button opens the Categories dialog box used to select the categories.

i, test name

This field just displays the test definition name of the present application test. Clicking the left **i** button displays the help message for the test definition.

Library

Lists the application test definitions that belong to the categories selected by the Category area.

Clicking an icon displays its brief introduction message and the Select button. Clicking the Select button loads the application test definition. Now, the B1500 is ready to start measurement.

The Library button provides the following six functions.

Close Closes this menu.

Define New Test... Opens the “Test Definition Window (page 6-3)” used to create a new application test.

Using EasyEXPERT Application Test

Open Definition of This Test...

Opens the “Test Definition Window (page 6-3)” to display the definition of the present (selected) application test or to modify the definition.

Delete Definition of This Test Deletes the present (selected) application test. The test will be deleted from the application library.

Import Test Definition... Opens a dialog box used to specify the test definition to import.

Export Test Definition... Opens a dialog box used to export the present application test definition. The test definition will be saved to the specified file.

Search



Incremental search. Used to search the application test definitions listed in the Library area.

Setup Name

Used to set the name of test setup. The name must be the identification for the test setup saved to a My Favorite group (preset group). Enter a unique name that is distinct from other setup.

The name is stored in the test result data and is used to differentiate the records in the test record list area.

Device Parameters This area displays the device parameter entry fields if the device parameters are defined as the variables in the application test definition.

Enter the appropriate value to the entry fields before starting measurement.

Test Parameters This area displays the device connection diagram if it is specified in the application test definition.

This area also displays the test parameter entry fields if the test parameters are defined as the variables in the application test definition. Enter the appropriate value to the entry fields before starting measurement. If the entry field needs to enter a vector data, see “Define vector data” on page 5-18.

Extended Setup This button opens the Extended Setup dialog box that displays the extended parameter entry fields. See “Ext” on page 6-6 for the parameters shown in this dialog box.

Enter the appropriate value to the entry fields and click Close button.

Quick Test

In this mode, you can execute the test setups saved in a preset group (*My Favorite Setup*) sequentially.

In the quick test mode, the EasyEXPERT main screen has the following additional graphical user interface.

My Favorite Setup The following menu is displayed by clicking this button.

| | |
|------------------------------------|---|
| Cancel | Closes this menu. |
| Duplicate This Preset Group | Opens the Duplicate Preset Group dialog box. Creates a copy of the present preset group and saves it as the specified name. |
| Import Preset Group... | Opens the Preset Group Import dialog box. Imports the specified preset group. |
| Export Preset Group... | Opens the Preset Group Export dialog box. Exports the present preset group as the specified name. |
| Organize Preset Group | Opens the Organize Preset Group dialog box used to organize the preset group. See “Organize Preset Group” on page 4-33. |

Preset Group Selects the preset group to open.

Setup Name Lists all test setups saved in the preset group.

To select the test setup for the quick test setup operation, click the line.

When you are doing the quick test setup, the softkeys are available to start the associated test. The softkey label will show the Setup Name.

Quick Test List The following buttons are available for the quick test setup operation.

| | |
|---------------------|---|
| Select All | Selects all test setups for quick test. This button sets the • mark to the right cell of the Setup Name. |
| Unselect All | Unselects all test setups for quick test. This button deletes the • mark from the right cell of the Setup Name. |
| Up | Moves the selected test setup upward |

Using EasyEXPERT

Quick Test

| | |
|------------------|--|
| Down | Moves the selected test setup downward. |
| • | <p>Set the • mark to the right cell of the Setup Name to be executed in the quick test. To do so, select the test setup, then click this button.</p> <p>After the quick test is started, the test setup with the • mark will be executed in order from top to bottom of the setup table.</p> |
| Recall | Recalls the selected test setup. The screen is changed to Application Test or Classic Test. |
| Rename | You can change the name of the selected test setup. |
| Duplicate | Creates a copy of the selected test setup and places it at the bottom of the setup table. |
| Delete | You can delete the selected test setup. |

Repeat Measurement Setup

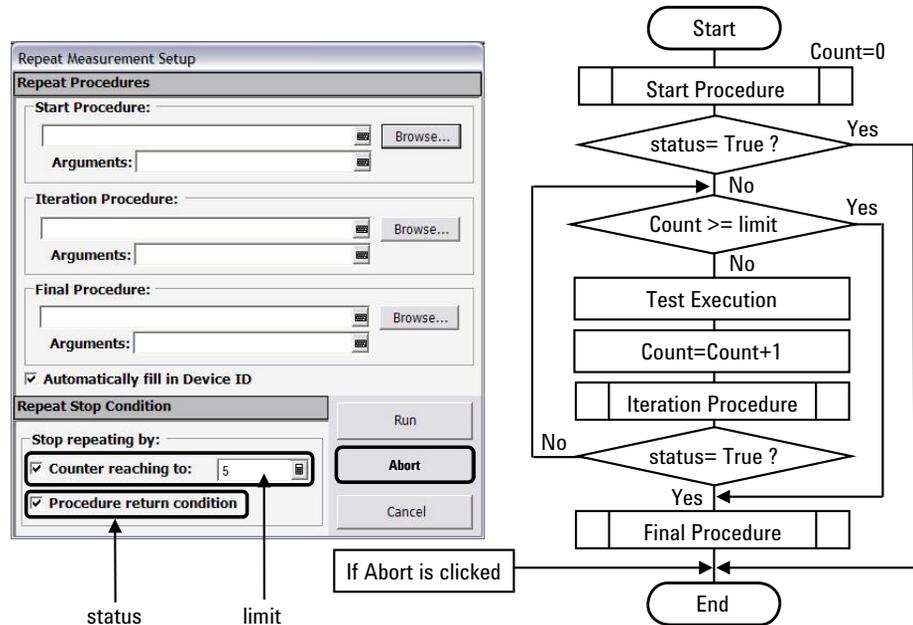
This dialog box is opened by clicking the Repeat button, and is used to set the repeat measurement condition. This dialog box supports the following action buttons.

| | |
|---------------|---|
| Run | Starts measurement. |
| Abort | Aborts the measurement. |
| Cancel | Cancels performing the repeat measurement and closes this dialog box. |

The repeat measurement is performed as shown in Figure 4-1. The repeat measurement operation is controlled by the value of *Count* and *status*. Where, *Count* is the number displayed in the Count field of the main screen, and *status* must be a parameter of the response created by Start Procedure and Iteration Procedure. For the response, see Figure 4-2.

Figure 4-1

Repeat Measurement Execution Flow



Repeat Procedures

This area is used to specify the procedure to be called while the repeat measurement is performed. The procedure must be the execution file (.exe file). If no procedure is needed, empty the field. The Browse button opens a file browser.

Using EasyEXPERT

Repeat Measurement Setup

Start Procedure Specifies the procedure executed before starting measurement.

Iteration

Procedure Specifies the procedure executed every single measurement.

Final Procedure Specifies the procedure executed after the repeat measurement.

If the procedure requires arguments, enter the values to the Arguments field.

If the procedure specified by Start Procedure or Iteration Procedure creates the response as shown in Figure 4-2, EasyEXPERT performs the operation following the response. See Figure 4-1. The parameter *status* value must be the string True or False, and the parameter *device_id* value should be any string. EasyEXPERT ignores the response of the different format.

Automatically fill in Device ID

This check box is available when the *Procedure return condition* box has been checked, and is used to enable the device ID automatic input function. This function enters the Device ID of the test record automatically. The value is given by *device_id* which is a parameter of the response created by Start Procedure and Iteration Procedure.

Repeat Stop Condition

This area is used to set the repeat measurement stop condition. The following stop conditions are available.

- Counter Reaching to: *limit*
The repeat measurement will be stopped if $Count \geq limit$.
- Procedure return condition
The repeat measurement will be stopped if the response shows *status* = True.

Figure 4-2

Procedure Response Expected by EasyEXPERT

- Response (input to EasyEXPERT):

XML format data

```
<Response>
  <Break>status</Break>
  <Target>device_id</Target>
</Response>
```

status: True (break) or False
device_id: Device ID

- Example:

```
<Response>
  <Break>False</Break>
  <Target>waf1a:3 1</Target>
</Response>
```

Organize Preset Group

This dialog box is opened by selecting the Organize Preset Group function of the main screen, the Quick Test setup screen, or the Switching Matrix Operation Panel, and is used to organize the preset group.

| | |
|--------------------------|--|
| Preset Group List | Lists the preset group saved in the workspace. The following buttons are available. |
| Add | Opens the Add Preset Group dialog box. Creates a new preset group and saves it as the specified name. |
| Rename | Opens the Rename Preset Group dialog box. You can change the name of the selected preset group. |
| Duplicate | Opens the Duplicate Preset Group dialog box. Creates a copy of the selected preset group and saves it as the specified name. |
| Delete | You can delete the selected preset group. |
| Import | Only for the quick test setup. Opens the Preset Group Import dialog box. Imports the specified preset group. |
| Export | Only for the quick test setup. Opens the Preset Group Export dialog box. Exports the selected preset group as the specified name. |
| Copy | Sets the operation of the >> button and the << button. They work as Copy when this box is checked, and as Move when this box is unchecked. |
| >> | Copies or moves the preset setup selected in the left Preset Group box to the right Preset Group box. |
| << | Copies or moves the preset setup selected in the right Preset Group box to the left Preset Group box. |
| Close | Closes the Organize Preset Group dialog box. |

Using EasyEXPERT
Organize Preset Group

Preset Group

Lists the preset setup saved in the preset group. The following buttons are available.

| | |
|---------------------|--|
| Preset Group | Selects the preset group to open. |
| Setup Name | Lists all preset setup saved in the preset group. |
| Select All | Selects all preset setup. |
| Unselect All | Unselects all preset setup. |
| Rename | You can change the name of the selected preset setup. |
| Duplicate | Creates a copy of the selected preset setup and places it at the bottom of the setup list. |
| Delete | You can delete the selected preset setup. |

Calibration

The Calibration window is opened by clicking the Calibration button, and is used to perform the self-calibration, SMU current offset cancel, CMU data correction, and so on.

- “Module Self Calibration”
- “SMU Zero Cancel”
- “CMU Calibration”

Module Self Calibration

The Module Self Calibration tab screen is used to perform the self-calibration of modules. Check the left check box of Name to select the module for self-calibration. Open the measurement terminals at the cable end before performing the self-calibration.

Module Self Calibration

Displays the following values.

| | |
|-------------------|---|
| Name | Name of module. |
| Full Range | Full range calibration On or Off. Only for the HRSMU/ASU. |
| Status | Calibration status. Pass or fail. |
| Notes | Error information when calibration failed. |

Select All

Selects all modules for calibration. This checks the check box for all modules.

Unselect All

Unselects all modules. This unchecks the check box for all modules.

Start Calibration

Starts calibration for the selected modules.

Abort

Aborts calibration.

Full Range Calibration

Check this box to enable the 1 pA range calibration of the HRSMU/ASU.

If you do not use the 1 pA range, uncheck this box. The B1500A does not perform the 1 pA range offset data measurement and calibration.

Using EasyEXPERT Calibration

Enable Auto Calibration

Enables or disables the auto-calibration capability. If this box has been checked (function ON), and the B1500 automatically starts calibration for all modules every 30 minutes if the output switches of all modules are off for 30 minutes. If auto-calibration is enabled, do not forget to open the measurement terminals or disconnect the device under test from the terminals after measurement.

SMU Zero Cancel

The SMU Zero Cancel tab screen is used to perform the SMU path offset current measurement, and set the offset cancel function. Check the left check box of Name to select the effective module. Open the measurement terminals at the cable end before performing the offset measurement.

See also “Current Offset Cancel” on page 7-42.

SMU Zero Cancel

Displays the following values.

| | |
|-------------------|---|
| Name | Name of module |
| Full Range | Full range measurement On or Off. Only for the HRSMU/ASU. |
| 1nA | Offset current measurement data in the 1 nA range. |
| 100pA | Offset current measurement data in the 100 pA range. Not available for MPSMU and HPSMU. |
| 10pA | Offset current measurement data in the 10 pA range. Not available for MPSMU and HPSMU. |
| 1pA | Offset current measurement data in the 1 pA range. Not available for MPSMU, HPSMU, and HRSMU. |

Full Range

Enables (On) or disables (Off) the 1 pA range of the HRSMU/ASU.

Integration Time

Sets the integration time for the SMU path offset current measurement. 1 PLC (power line cycle) to 100 PLC, initial setting 16 PLC.

Select All

Selects all modules. This checks the check box for all modules.

Unselect All

Unselects all modules. This unchecks the check box for all modules.

Measure...

Performs the SMU path offset current measurement for the effective modules.

CMU Calibration

The CMU calibration tab screen is used to perform the measurement data correction of the multi frequency capacitance measurement unit (MFCMU). For the easy way, perform the phase compensation and the open correction at least.

See also “Error Correction” on page 7-24.

NOTE

For a more accurate measurement, perform correction data measurement at the measurement frequency before starting the capacitance measurement.

If the measurement frequency is not included in the list of default frequencies below, click the Advanced Options... button and set the measurement frequency on the Frequency area of the Advanced Options for CMU Calibration window.

Default frequencies:

1 k, 2 k, 5 k, 10 k, 20 k, 50 k, 100 k, 200 k, 500 k, 1 M, 1.2 M, 1.5 M, 2 M, 2.5 M, 2.7 M, 3 M, 3.2 M, 3.5 M, 3.7 M, 4 M, 4.2 M, 4.5 M, 5 MHz

Measure...

Opens a dialog box used to perform correction/compensation data measurement. To perform the measurement, follow the dialog box.

The correction/compensation measurement data is saved and managed by the workspace. And the last measured correction/compensation data will be loaded when the workspace will be opened next time.

Advanced Options...

Opens the “Advanced Options for CMU Calibration (page 4-39)” dialog box used to set the frequencies for the correction data measurement and the reference values of the working standard.

Phase Compensation

This check box is effective after the phase compensation data is measured, and is used to enable or disable the phase compensation. Uncheck this box to disable the phase compensation.

To measure the compensation data, open the measurement terminals at the end of the device side and click the Measure... button.

If you extend the measurement cables to the device end by using the four terminal pairs method, do not forget to connect following terminals together at the device end.

- the high potential (Hp) terminal and the high current (Hc) terminal
- the low potential (Lp) terminal and the low current (Lc) terminal

Using EasyEXPERT Calibration

Open Correction This check box is effective after the open correction data is measured, and is used to enable or disable the open correction. Uncheck this box to disable the correction.

To measure the correction data, connect the open standard that has the calibration value or reference value, or open the measurement terminals at the end of the device side. Then, click the Measure... button.

If you extend the measurement cables to the device end by using the four terminal pairs method, do not forget to connect following terminals together at the device end.

- the high potential (Hp) terminal and the high current (Hc) terminal
- the low potential (Lp) terminal and the low current (Lc) terminal

If the standard is used, click the Advanced Options... button and enter the reference value to the OPEN Reference entry fields. If you do not use the standard, enter 0 to the fields.

Short Correction This check box is effective after the short correction data is measured, and is used to enable or disable the short correction. Uncheck this box to disable the correction.

To measure the correction data, connect the short standard that has the calibration value or reference value, or directly connect the measurement terminals at the end of the device side. Then, click the Measure... button.

If the standard is used, click the Advanced Options... button and enter the reference value to the SHORT Reference entry fields. If you do not use the standard, enter 0 to the fields.

Load Correction This check box is effective after the load correction data is measured, and is used to enable or disable the load correction. Uncheck this box to disable the correction.

To measure the correction data, connect the load standard that has the calibration value or reference value. Then, click the Measure... button.

Before performing the load correction data measurement, click the Advanced Options... button and enter the reference value to the LOAD Reference entry fields.

Advanced Options for CMU Calibration

This dialog box is opened by clicking the Advanced Options... button, and is used to set the information required to measure the open/short/load correction data and the phase compensation data. This dialog box provides the following action button.

OK Applies the setup changes and closes this dialog box.

Cancel Cancel the setup changes and closes this dialog box.

Frequency

You can select one of the following radio buttons to select the measurement frequency setup mode.

- Use factory specified frequencies (Default)

Usually, select this mode. 23 points are automatically set. They are 1 k, 2 k, 5 k, 10 k, 20 k, 50 k, 100 k, 200 k, 500 k, 1 M, 1.2 M, 1.5 M, 2 M, 2.5 M, 2.7 M, 3 M, 3.2 M, 3.5 M, 3.7 M, 4 M, 4.2 M, 4.5 M, and 5 MHz.

- Specify list of calibration frequencies

Select this mode when you want to set the frequencies independently. The frequency must be 1 kHz to 5 MHz. The number of frequencies must be 1 to 101.

Click Add to open a dialog box, and enter the value.

For the unnecessary value, select the value and click Delete.

- Specify frequencies by range

Select this mode when you want to set the frequencies sequentially and automatically.

Specify the start frequency, the stop frequency, the number of steps, and the scale LINEAR/LOG. The start frequency must be less than the Stop value and at least 1 kHz. The stop frequency must be more than the Start value and no more than 5 MHz. The number of steps must be 2 to 1001.

NOTE

If the device measurement frequency is not equal to the correction data measurement frequency, calculation will be performed automatically to get the correction data for the device measurement frequency, and the calculated correction data will be used for the data correction of the measurement data.

Using EasyEXPERT Calibration

Integration Time This area defines the integration time used for measuring phase compensation data or open/short/load correction data. The number of averaging samples (Mode=AUTO) or the averaging time (Mode=PLC) is set.

Mode A/D converter operation mode, AUTO or PLC

Factor Factor for the initial value. See “Mode, Factor” on page 7-20.

Reference Standard Values The following entry fields are available to set the calibration values or the reference values of the open/short/load standard. If you use the standard, enter the values to the following entry fields.

- OPEN Reference: Capacitance and Conductance
If you do not use the reference, enter 0 in the both fields.
- SHORT Reference: Inductance and Resistance
If you do not use the reference, enter 0 in the both fields.
- LOAD Reference: Inductance and Resistance

Configuration

The Configuration window is opened by clicking the Configuration button, and is used to display the system information and event log, as well as to perform diagnostics and self-test.

- “Main Frame”
- “Modules”
- “ASU”
- “Switching Matrix”
- “SMU/PG Selector”
- “Event Log”

Main Frame

The Main Frame tab screen is used to display the system information and perform diagnostics.

Model Identification

Displays the instrument ID. B1500A.

Line Frequency

Sets the power line frequency, 50 Hz or 60 Hz.

EasyEXPERT Rev.

Displays the revision number of the EasyEXPERT.

Firmware Rev.

Displays the revision number of the B1500 firmware.

HOST ID

Displays the host id of the B1500 internal computer.

Main Frame Diagnosis

This area lists Item and Status.

Item Name of diagnostics item. To select, check the left check box.

Status Diagnostics status. Pass or fail.

Select All

Selects all items for diagnostics. This checks the box for all items.

Unselect All

Unselects all items. This unchecks the box for all items.

Using EasyEXPERT Configuration

Start Diagnosis Starts diagnostics for the selected items. To perform diagnostics, specify the items to perform and click this button. A dialog box appears. Follow the dialog box to perform the diagnostics. Some items need your judgement, pass or fail. Also you will need to connect an adapter, press keys, check LEDs, and so on.

Modules

The Modules tab screen is used to perform self-test of modules.

Slot Configuration This area lists Slot, Module Type, Name, and Status.

| | |
|--------------------|---|
| Slot | Slot number where the module is installed. To select, check the left check box. |
| Module Type | Module model number |
| Name | Module name |
| Status | Self-test status, Passed, Failed, Recovered, or ---- (self-test has not been performed) |
| SCUU | Specifies if the module is connected to the SCUU. |
| Notes | Error information when the module self-test failed. |

Select All Selects all modules for self-test. This checks the check box for all modules.

Unselect All Unselects all modules. This unchecks the box for all modules.

Start Self Test Starts self-test for the selected modules.

Recover Module This button is for service use only. Makes the failed modules respond again. This button does not solve the problem that causes the Failed status.

Abort Aborts self-test.

Status LED Enables (ON) or disables (OFF) the status indicator (LED) of the ASU (Atto Sense and Switch Unit) and the SCUU (SMU CMU Unify Unit).

ASU

The ASU tab screen is available if the B1500A installs the HRSMU calibrated with the ASU (Atto Sense/Switch Unit) regardless of the ASU connection status, and shows the ASU information.

| | |
|--------------------------|---|
| Slot | Slot number |
| Module Type | Type of module |
| Name | Name of module |
| ASU Serial Number | <p>Serial number of the usable ASU. This cell shows the serial number even if the ASU is disconnected.</p> <p>If an incorrect ASU is connected to the HRSMU, this cell displays an error message instead of the serial number. Error message is also displayed if an ASU is connected to the HRSMU which is not available for using ASU.</p> |
| ASU I/O Path | <p>ASU input to output connection, SMU or AUX</p> <p>If this field is set to SMU, the ASU makes the path from the ASU Force input to the ASU output.</p> <p>If this field is set to AUX, the ASU performs automatic switching in every test. The ASU normally makes the path from the AUX In input to the ASU output and makes the path from the ASU Force input to the ASU output for the test with the HRSMU.</p> |

Switching Matrix

The Switching Matrix tab screen is used to confirm the GPIB connection with Agilent B2200A/B2201A/E5250A switching matrix, and defines the connections between the measurement units and the switching matrix input ports.

| | |
|------------------------------|---|
| Switching Matrix Type | <p>Displays the type of the switching matrix. One of the following.</p> <ul style="list-style-type: none"> • B2200A Femto Leakage Switch Mainframe (standard) • B2201A 14ch Low Leakage Switch Mainframe (standard) • E5250A Low Leakage Switch Mainframe (option) • No Switching Matrix (if switching matrix is not connected) |
| GPIB Address | Specifies the GPIB address of the switching matrix. 1 to 30. |

Using EasyEXPERT Configuration

| | |
|------------------------|--|
| Poll | Confirms if the switching matrix with the specified GPIB Address is connected to the B1500A. |
| Start Self Test | This button starts the selftest of the switching matrix. |
| SWM IN | <p>SWM INn means the switching matrix input port n. where, n is an integer 1 to 10 for the E5250A or an integer 1 to 14 for the B2200A/B2201A.</p> <p>Enter the label used to specify the input port to the right entry field. The port name and the connected module name can be the label. Or select one from the pull-down menu. There must be no colon (:) in the label.</p> <p>If the Kelvin check box is checked, the coupled even number port is grayed out.</p> <p>If the CMU check box is checked, the SWM IN10 for the E5250A or the SWM IN14 for the B2200A/B2201A is grayed out.</p> |
| Kelvin | <p>Check this box if this port is used for the Kelvin connection. Connect the switching matrix inputs to the SMU as follows.</p> <ul style="list-style-type: none">• for the E5250A (m: integer 1 to 3) SMU INPUT $2m-1$ to the SMU Force terminal SMU INPUT $2m$ to the SMU Sense terminal• for B2200A/B2201A (m: integer 1 to 6) Input $2m-1$ to the SMU Force terminal Input $2m$ to the SMU Sense terminal |
| CMU | <p>Check this check box if this port is connected to the CMU. Connect the switching matrix inputs to the CMU as follows.</p> <ul style="list-style-type: none">• for the E5250A AUX INPUT CV1 to the CMU Hpot/Hcur terminals AUX INPUT CV2 to the CMU Lpot/Lcur terminals• for B2200A/B2201A Input 13 to the CMU Hpot/Hcur terminals Input 14 to the CMU Lpot/Lcur terminals <p>To obtain accurate capacitance measurement result, perform capacitance compensation. See “Capacitance Compensation When Using Switching Matrix” on page 3-47. Also see “Extended Configuration” on page 4-46.</p> |

Extended Configuration

This button opens the “Extended Configuration” on page 4-46 dialog box.

SMU/PG Selector

The SMU/PG Selector tab screen is used to specify the input connection and the channel connection status of the Agilent 16440A SMU/PG selector. The selector can be controlled by the B1500A via the Digital I/O connector and the Agilent 16445A selector adapter.

Two selectors can be used. The first selector must be connected to the Digital I/O connector via the 16445A. And if the second selector is used, it must be connected to the first selector’s Control Output connector. See “SMU/PG Selector” on page 7-48.

Enable SMU/PG Selector

To use the selector, connect the selector to the B1500A, and check this check box.

Selector CH1/CH2

CH1 and CH2 indicates the channels 1 and 2 of the first selector respectively.

Selector CH3/CH4

CH3 and CH4 indicates the channels 1 and 2 of the second selector respectively.

SMU Assignment

Specifies the SMU connected to the SMU input of the selector channel CH1, CH2, CH3, or CH4.

Input/Output Path

Specifies the connection status of the selector channel CH1, CH2, CH3, or CH4.

If this field is set to Always SMU, the selector makes the path from Input SMU to Output.

If this field is set to Normally PGU (AUX), the selector performs automatic switching in every test. The selector normally makes the path from Input PGU to Output and makes the path from Input SMU to Output only for the test which uses the SMU connected to the Input SMU terminal.

The CH1 and CH3 also provides the PGU Open status which is set by using the Advanced window of the Measurement Setup.

Event Log

The event log tab screen displays the event log.

Date/Time

Displays date and time of the event.

Message

Event message

Using EasyEXPERT Configuration

| | |
|----------------|--------------------------------|
| ID | Process ID of the event |
| Process | Process name |
| User | User name. Windows login name. |
| Host | Host name of the B1500 |
| Refresh | Refreshes the event log. |

Extended Configuration

This dialog box opens by clicking the Extended Configuration button in the Configuration window's Switching Matrix screen.

Save as Hardware Profile Switching matrix hardware configuration can be saved as the hardware profile.

Save Saves the present hardware profile.

The hardware profile can be made for each workspace individually.

CMU Compensation

Selects the compensation mode of the capacitance measurement using the switching matrix. Click one of the radio buttons, No Compensation, Select, and User Compensation Data File. For the capacitance compensation, see "Capacitance Compensation When Using Switching Matrix" on page 3-47.

- No Compensation

Select this radio button if you do not need the capacitance compensation. The raw data without compensation is displayed and saved.

- B2200A/B2201A (standard)

The following setup is available for the B2200A/B2201A hardware profile.

- Select

Select this radio button to perform the capacitance compensation for the path from the B2200A/B2201A input ports to Agilent 16495F/G connector plate or Agilent B2220A probe card interface. The data after compensation is displayed and saved.

DUT I/F Specifies the model number of the path you use. The selections are the 16495F/G and B2220A.

Cable Specifies the model number of the cable from the B2200A/ B2201A output to the DUT I/F. The selections are the 16494A/B/C-001 (1.5 m) / 002 (3 m) / 005 (4 m).

This mode cannot perform the capacitance compensation for the cables to positioner/manipulator or the probe card.

- **User Compensation Data File**

Select this radio button and specify the compensation data file to perform the capacitance compensation for the path from the B2200A/B2201A input ports to the end of positioner/manipulator/probe card. See “To Create Compensation Data File” on page 3-50. The data after compensation is displayed and saved.

- **E5250A (option)**

The following setup is available for the E5250A hardware profile.

- **User Compensation Data File**

Select this radio button and specify the compensation data file to perform the capacitance compensation for the path from the E5250A input ports to the end of positioner/manipulator/probe card. See “To Create Compensation Data File” on page 3-50. The data after compensation is displayed and saved.

Clear Clears the User Compensation Data File field.

Triaxial Cable Enter the length of the 16494A triaxial cable connected between the E5250A outputs to the connector plate.

User Triaxial Cable Enter the length of the triaxial cable between the connector plate and the DUT. Enter 0 if the triaxial cable is not used.

User Coaxial Cable Enter the length of the coaxial cable between the connector plate and the DUT. Enter 0 if the coaxial cable is not used.

Close Closes the Extended Configuration dialog box.

Switching Matrix Operation Panel

The Switching Matrix Operation Panel is opened by clicking the Switching Matrix button, and is used to create the switch setup for Agilent B2200A/B2201A/E5250A switching matrix, send the setup to the switching matrix, and so on. The switch setup can be saved to the switch setup preset group. This group is different from the preset group for test setups.

Switch Setup

This area is used to create the switching matrix switch setup. You can create the setup by clicking the Input-Output cross point. The switch setup can be sent to the switching matrix by clicking the Apply Switch Setup button.

| Color of cross point | Switch setup |
|----------------------|--------------|
| green | close |
| gray | open |

| | |
|-------------------|---|
| Setup Name | Name of switch setup |
| Clear All | Sets all cross point open. |
| Input | Shows the switching matrix input port and the measurement resource connected to it. This information is set in the “Configuration”. |
| Label | Shows the label set to the measurement resource. The label is set in the application test definition or the classic test setup. |
| ALL | Checking this box sets all of this line to close. Unchecking this box sets all of this line to open. This box is gray and have a check when a cross point in this line is set to close. |
| Output | Output channels 1 to 12, 24, 36, or 48. Available numbers depend on the number of the matrix cards installed in the switching matrix. The field below the channel number is used to enter the label for the output channel. |

Export to Current My Favorite Group This button converts the switch setup to the switching matrix setup data format of the classic test, and saves it to the present My Favorite Setup group.

| | | | | | | | | | | | | | | | | | | | | | | | |
|------------------------------------|--|---------------|------------------|---------------------|---|-----------------------------|---|---------------------------------|---|------------------------------------|---|---------------------------------|---|---------------------------------|---|---------------|---|------------------|--|---------------|------------------------------------|-------------------|--|
| Apply Switch Setup | This button sends the switch setup to the switching matrix. | | | | | | | | | | | | | | | | | | | | | | |
| Read Switch Setup | This button reads the switch setup from the switching matrix. | | | | | | | | | | | | | | | | | | | | | | |
| Open All | This button opens all relays on the switching matrix. | | | | | | | | | | | | | | | | | | | | | | |
| Preset List | <p>The switch setups you create MUST be saved to the preset group to reuse them.</p> <p>Click the Preset List button to display the menu that provides the following functions. Select the preset group by using the field below the button. The switch setups can be recalled by using the area below the field.</p> <table><tr><td>Cancel</td><td>Closes the menu.</td></tr><tr><td>Preset Group</td><td>Provides the following three functions.</td></tr><tr><td>Add New Preset Group</td><td>Opens the Add Preset Group dialog box. Creates a new preset group and saves it as the specified name.</td></tr><tr><td>Rename This Preset Group</td><td>Opens the Rename Preset Group dialog box. You can change the name of the selected preset group.</td></tr><tr><td>Duplicate This Preset Group</td><td>Opens the Duplicate Preset Group dialog box. Creates a copy of the present preset group and saves it as the specified name.</td></tr><tr><td>Delete This Preset Group</td><td>You can delete the selected preset group.</td></tr><tr><td>Organize Preset Group...</td><td>Opens the Organize Preset Group dialog box used to organize the preset group. See “Organize Preset Group” on page 4-33.</td></tr><tr><td>Rename</td><td>You can change the name of the selected switch setup.</td></tr><tr><td>Duplicate</td><td>Creates a copy of the selected switch setup.</td></tr><tr><td>Delete</td><td>Deletes the selected switch setup.</td></tr><tr><td>Delete All</td><td>Deletes all switch setups in the present preset group.</td></tr></table> | Cancel | Closes the menu. | Preset Group | Provides the following three functions. | Add New Preset Group | Opens the Add Preset Group dialog box. Creates a new preset group and saves it as the specified name. | Rename This Preset Group | Opens the Rename Preset Group dialog box. You can change the name of the selected preset group. | Duplicate This Preset Group | Opens the Duplicate Preset Group dialog box. Creates a copy of the present preset group and saves it as the specified name. | Delete This Preset Group | You can delete the selected preset group. | Organize Preset Group... | Opens the Organize Preset Group dialog box used to organize the preset group. See “Organize Preset Group” on page 4-33. | Rename | You can change the name of the selected switch setup. | Duplicate | Creates a copy of the selected switch setup. | Delete | Deletes the selected switch setup. | Delete All | Deletes all switch setups in the present preset group. |
| Cancel | Closes the menu. | | | | | | | | | | | | | | | | | | | | | | |
| Preset Group | Provides the following three functions. | | | | | | | | | | | | | | | | | | | | | | |
| Add New Preset Group | Opens the Add Preset Group dialog box. Creates a new preset group and saves it as the specified name. | | | | | | | | | | | | | | | | | | | | | | |
| Rename This Preset Group | Opens the Rename Preset Group dialog box. You can change the name of the selected preset group. | | | | | | | | | | | | | | | | | | | | | | |
| Duplicate This Preset Group | Opens the Duplicate Preset Group dialog box. Creates a copy of the present preset group and saves it as the specified name. | | | | | | | | | | | | | | | | | | | | | | |
| Delete This Preset Group | You can delete the selected preset group. | | | | | | | | | | | | | | | | | | | | | | |
| Organize Preset Group... | Opens the Organize Preset Group dialog box used to organize the preset group. See “Organize Preset Group” on page 4-33. | | | | | | | | | | | | | | | | | | | | | | |
| Rename | You can change the name of the selected switch setup. | | | | | | | | | | | | | | | | | | | | | | |
| Duplicate | Creates a copy of the selected switch setup. | | | | | | | | | | | | | | | | | | | | | | |
| Delete | Deletes the selected switch setup. | | | | | | | | | | | | | | | | | | | | | | |
| Delete All | Deletes all switch setups in the present preset group. | | | | | | | | | | | | | | | | | | | | | | |
| Save | The button saves the present switch setup into the present preset group as a new setup of the group. | | | | | | | | | | | | | | | | | | | | | | |
| Recall | The button recalls the selected switch setup. This means opening and displaying the definition of the selected switch setup. | | | | | | | | | | | | | | | | | | | | | | |

Standby Channel Definition

The Standby Channel Definition window is opened by clicking the Standby button, and is used to define the standby channels and set the standby mode. See “Standby Function” on page 7-37.

The standby channel is the channel for maintaining specified output when the standby mode is ON and in the non-measurement state. The standby channels will be in the standby state, while the other channels will be in the idle state which is 0 V output and 100 μ A compliance. When the standby mode is OFF and in the non-measurement state, all channels will be in the idle state.

Standby Channel Control

This area provides the following button.

Standby ON/OFF Sets the standby mode ON or OFF.

Standby Channel Definition

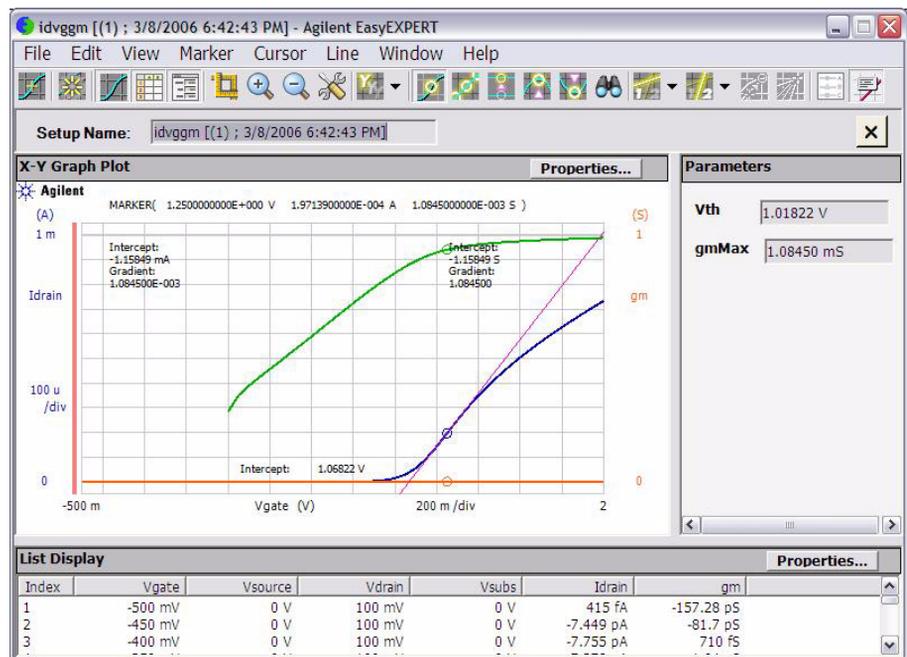
This area defines the standby channels. The standby channels will start to output in order, from the top to bottom, as listed in this area. The order of bias stop is bottom to top.

| | |
|-------------------|--|
| Standby | Check the check box to specify the standby channel. The radio button is used to select the channel setup available for the Up/Down button. |
| Unit | SMU (Source Monitor Unit) used for the standby output Standby channel cannot be set for the HRSMU connected to the ASU (Atto Sense and Switch Unit) which makes the path to the AUX port. |
| Mode | Output mode, V (voltage) or I (current) |
| Source | Standby channel output value, in V or A |
| Compliance | Compliance value, in A or V. Enter the current limit value for the voltage source, or the voltage limit value for the current source. |
| Up | Moves the selected channel setup upward. To select a channel setup, use the radio button on the left. |
| Down | Moves the selected channel setup downward. |

Data Display

The Data Display window is opened by clicking the Data Display button, and is used to display measurement data and analyze the data.

- “Data Display GUI”
- “Display Setup”
- “Graph Properties”
- “List Display Properties”
- “Tool Bar”
- “Data Status”
- “Miscellaneous Operations”



Using EasyEXPERT Data Display

NOTE

About Display Mode

The Data Display window provides two display mode Overwrite and Append.

In Overwrite mode, the “Display Data (page 4-15)” function opens a new Data Display window and displays data.

In Append mode, the “Display Data (page 4-15)” function creates a new display layer on the present Data Display window and displays data.

NOTE

Updating Data Calculation

When the classic test result is displayed, you can update the calculation results of the user function, analysis function, and auto analysis function. So use the Apply button. See “Function Setup (page 5-42)”.

NOTE

Append Measurement

After the Append measurement, you will see tabs between the tool bar and the graph plot area. The tabs are used to select the display layer for data display and analysis operation. The Data Display window can have maximum 10 display layers.

NOTE

Multi Display Function

In the Multi Display OFF status, the test result data will be always displayed on the singular Data Display window even if the test setup is changed.

In the Multi Display ON status, the test result data of the same test setup name will be displayed on the exclusive Data Display window and the test result data of the different test setup name will be displayed on the new Data Display window.

NOTE

The settings on the Display Setup are applied to the X-Y Graph on the Data Display window. The X-Y Graph can handle one X data on the X axis and up to eight Y data on the Y axis.

Define the X axis carefully when plotting Multi Channel I/V Sweep measurement results that may contain data measured by multiple VAR1 channels, as the result may contain multiple X data that can be selected for the X axis.

The Display Setup must be set properly to match the X axis data and the X data of the plot to be displayed.

Data Display GUI

| | |
|---|---|
| Setup Name | This field just displays the name of the test setup used to get this test record. |
| X-Y Graph Plot | This area displays the measurement result graph, traces, marker, cursor, and lines. The Properties button opens “Graph Properties (page 4-63)”. |
| Parameters | This area lists the user-defined output parameters if the output parameters are set. |
| List Display | This area displays the measurement result data list. The Properties button opens “List Display Properties (page 4-64)”. |
| pin | <p>The Data Display window can keep up to 10 display layers. And the earliest layer over 10 will be automatically deleted. This button is available when the window keeps at least two layers. If this button shows the standing pin, the layer will be kept. If this button shows the laid pin, the layer can be deleted.</p> <p>Double clicking the tab gives the same result as this button.</p> |
| X | This button closes the selected display layer. |
| File menu | Provides the following functions. |
| Switch to Append Mode / Switch to Overwrite Mode | Used to switch the display mode. |
| Update Test Result | Stores the information of the scale and the analysis tools. |
| Delete Test Result | Deletes the present display data or the selected display layer. |
| Close This Display | Closes the selected display layer. |
| Close All Displays | Closes all display layers. |
| Save Image As... | Opens the Save Image As... dialog box used to specify the file name of the graph image to save. See Figure 4-3. Available data formats are the BMP, EMF, GIF, and PNG. |
| Page Setup... | Opens the Page Setup dialog box used to set the print page. |

Using EasyEXPERT Data Display

Print Preview

Opens the Print Preview dialog box used to specify *Print Range/Data to print/Scaling* of the graph image to display. Clicking the Preview button opens the Print preview window. See Figure 4-4.

- Print Range sets Whole Data Display window or Graph Only.
- Data to print sets Current Data Display window only or All Data Display windows now opened.
- Scaling sets Adjust To the specified percent of the normal size or Fit To Page (automatic adjustment).

Print...

Opens the Print dialog box used to specify *Print Range/Data to print/Scaling* (see Print Preview) of the graph image to print. See Figure 4-3. Clicking the Next button opens another Print dialog box used to select the printer, print range, and number of copies, and start print.

Close

Closes the Data Display window.

Figure 4-3

Save Image As... and Print...

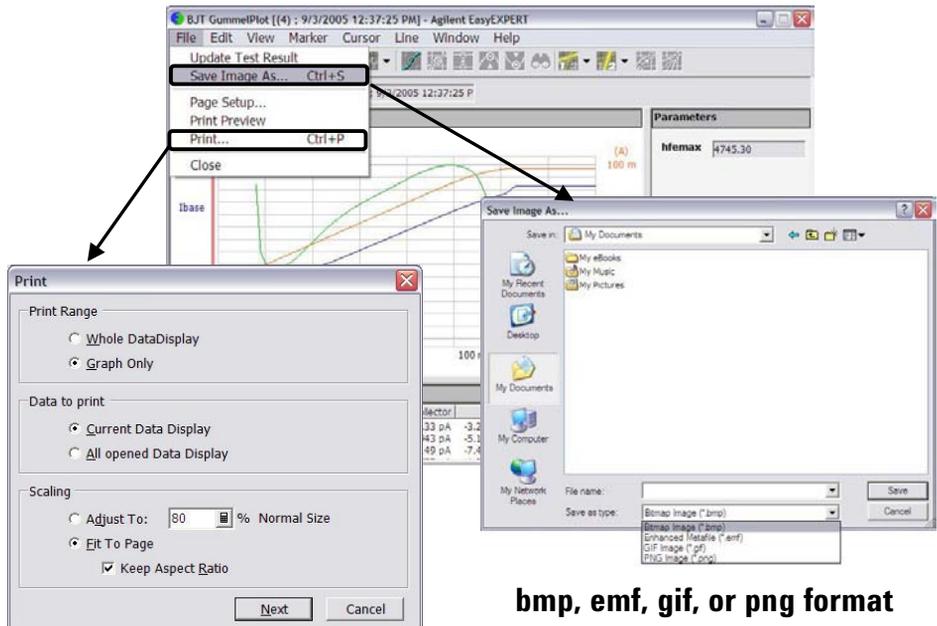
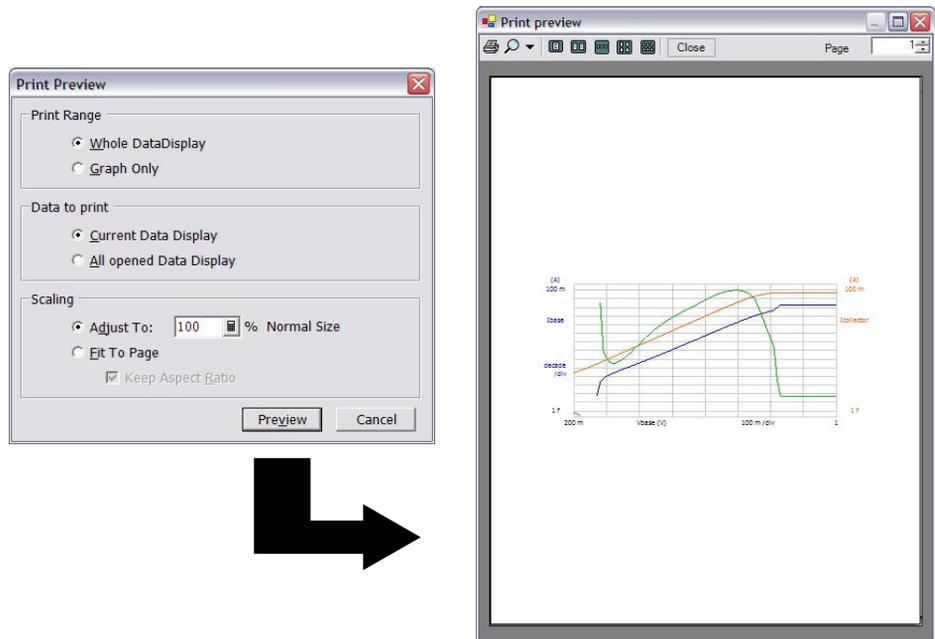


Figure 4-4 Print Preview Example



Edit menu

Provides the following functions.

Copy

When the X-Y Graph Plot area is active, this function copies the graph image as BMP and EMF into the clipboard.

When the line cursor in the List Display area is active, this function copies the data list as CSV.

When the Parameters area is active, this function copies the parameter data as CSV.

Copy Graph

Copies the graph image as BMP and EMF into the clipboard.

Copy List

Copies the list data as CSV.

Copy Parameters

Copies the parameter data as CSV.

Graph Properties...

Opens “Graph Properties (page 4-63)”.

List Display Properties...

Opens “List Display Properties (page 4-64)”.

Using EasyEXPERT Data Display

Figure 4-5 shows the graph copy and paste example. Click the X-Y Graph Plot area on the Data Display window, select Edit > Copy menu, and paste it to WordPad. You will see the result as shown in this example.

Figure 4-5 Graph Copy and Paste

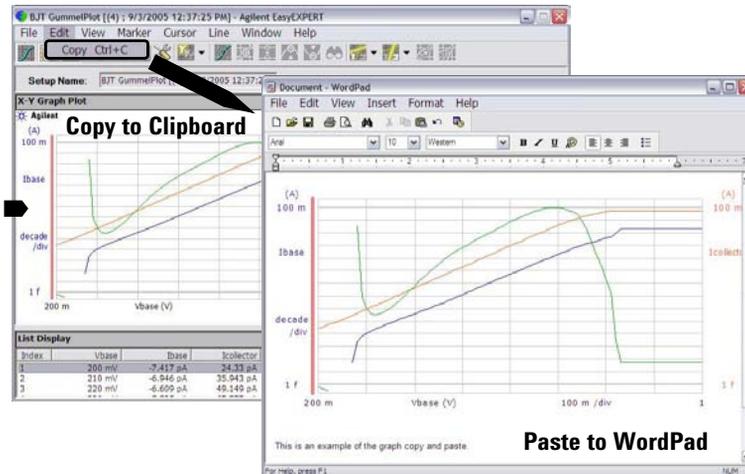
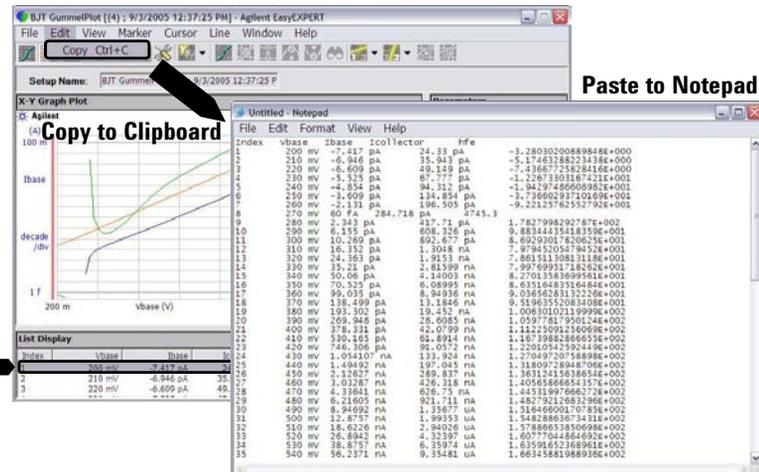


Figure 4-6 shows the list copy and paste example. Click a line of the List Display area on the Data Display window, select Edit > Copy menu, and paste it to Notepad. You will see the result as shown in this example. The data in Notepad is a CSV data (separated by a comma). Save it as a text file and open it by using a spreadsheet software. Each data (comma separated value) will be entered to a separate cell.

Figure 4-6 List Copy and Paste



View menu

Provides the following functions.

| | |
|--------------------------------|--|
| X-Y Graph | Displays or hides the X-Y Graph Plot area. |
| List Displays | Displays or hides the List Display area. |
| Parameters | Displays or hides the Parameters area. |
| Graph Legend ON/OFF | Displays or hides the graph legend below the plot area. |
| Line Information ON/OFF | Displays or hides the line information (X-intercept, Y-intercept, gradient) in the plot area. |
| Open Preview Window | Opens “Preview (page 4-74)” and “Preview Settings (page 4-76)”. |
| Auto Scale | Changes graph scale to fit the trace in the graph automatically. |
| Run Time Auto Scale | Enables or disables the run time auto scaling. This function is set to independently for the X and Y axes. If this function is enabled, the graph scale will be changed automatically to fit the trace in the graph during the measurement. |
| Zoom In | Zooms the data graph in the cursor. If the cursor is not displayed, zooms the data graph in the last cursor position or the graph center. This enlarges the trace in the graph. |
| Zoom Out | Zooms the data graph out the cursor. If the cursor is not displayed, zooms the data graph out the last cursor position or the graph center. This reduces the trace in the graph. |
| Cancel Scaling | Returns to the initial graph scale. This Display works only for the selected layer. All Displays works for the all display layers. |
| Choose Active Y Axis | Selects the Y-axis that is effective for the marker control and the auto scale. |
| Display Setup... | Opens “Display Setup (page 4-62)”. |

If multiple layers are opened on the Data Display window, the scale change is applied to all layers. This means that the X-Y graph scale will be shared by all display layers. The auto scaling is performed as follows.

Using EasyEXPERT Data Display

1. Graph scale is optimized for the data on the selected layer (top layer).
2. The graph scale is applied to the graph in all layers.

Note that auto scaling is performed independently for the left and right Y axes.

Marker menu

Marker can move on the measurement data curve. The Marker menu provides the following six functions.

| | |
|-----------------------------|--|
| Marker ON/OFF | Enables or disables the marker. |
| Interpolation ON/OFF | Enables or disables the interpolation function of measurement data. You can read the interpolation data between two actual measurement points. |
| Skip | Moves the marker to the next measurement curve that is added by the VAR2 variable. |
| Go To Maximum | Moves the marker to the maximum value point. |
| Go To Minimum | Moves the marker to the minimum value point. |
| Go To... | Opens the Direct Marker/Cursor dialog box used to specify the coordinate values to move the marker. |

Cursor menu

Cursor can move anywhere on the graph. The Cursor menu provides the following three functions.

| | |
|----------------------|---|
| Cursor ON/OFF | Enables or disables the cursor. |
| Go to Marker | Moves the cursor to the marker position. |
| Go to... | Opens the Direct Marker/Cursor dialog box used to specify the coordinate values to move the cursor. |

Line menu

Provides the following five functions. When a line is enabled, gradient, X-intercept, and Y-intercept are displayed in the graph. See Figure 4-7.

| | |
|------------------------|---|
| Line 1 ON/OFF | Enables or disables line 1. |
| Line 2 ON/OFF | Enables or disables line 2. |
| Line Mode | Selects the line mode: normal, gradient, tangent, regression, or fix. |
| Adjust Gradient | Available when a gradient line is active. Checking this function enables the rotary knob and the mouse wheel to increase/decrease the gradient of the line. Unchecking this function, clicking the rotary knob, or clicking the mouse wheel disables this function. |

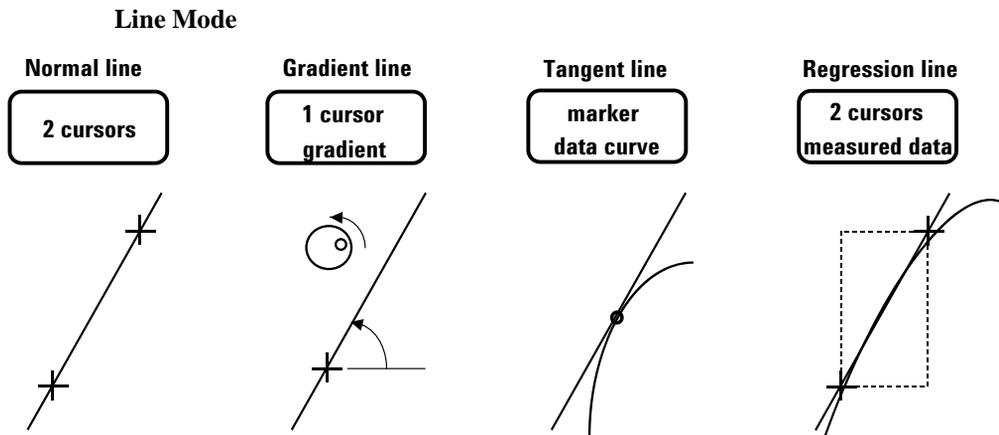
Gradient... Opens the Gradient Value dialog box used to specify the gradient value of the gradient line.

You can draw a line as shown below:

1. Set Line 1 or Line 2 on.
2. Select a Line Mode.

| | |
|-------------------|---|
| Normal | A line and two cursors appear. Move cursors to the points where the line passes through. |
| Gradient | A line and a cursor appear. Move cursor to the point where the line passes through. Enable Adjust Gradient function, then increase/decrease the gradient of the line by using the rotary knob or the mouse wheel. |
| Tangent | A line appears. Set the marker on. The tangent line appears on the marker point. |
| Regression | A line and two cursors appear. Move cursors for specifying the measurement data used for the regression calculation. The calculation is executed by using the data included in the square drawn by the extended cross cursor lines. For the subordinate sweep measurement data, specify the data curve by using the marker. |
| Fix | Fixes the line on the graph. |

Figure 4-7



Text menu

Up to 20 texts can be added to a graph. The following functions are provided.

New Opens the text editor for adding a new text.

Hide All/ Show All Hides or shows all texts.

Delete All Deletes all texts.

Clicking on a text will select the text. To select multiple texts, click the texts while holding down the Shift key on the keyboard.

The following functions are available for the selected text(s) via the Text menu, the Text icons, or the right-click menu.

Edit Mode Edits the selected text.

Size Sets the font size of the selected text(s). The available setting values are Largest, Large, Medium, Small, Smallest, and Fixed Point (6, 7, 8, 9, 10, 11, 12, 14, 16, 18, or 20). For settings other than Fixed Point, an appropriate size will automatically be applied. For Fixed Point, the specified font size will always be applied.

Font Sets the font of the selected text(s).

Text Color Sets the text color of the selected text(s). Click Customize to open the color palette.

Background Color Sets the background color of the selected text(s). Click Customize to open the color palette.

Hide Frame/Show Frame Hides or shows the frame for the selected text(s).

Delete Deletes the selected text(s).

Pointer menu

Up to 30 pointers can be added to a graph. The following functions are provided.

New This function is enabled when the marker is ON. Adds a new pointer at the position of the active marker.

Hide All/ Show All Hides or shows all pointers.

Show All Descriptions Shows all descriptions (pointer ID and X-Y coordinate values) of the pointers.

Hide All Descriptions Hides all descriptions of the pointers.

Delete All Deletes all pointers.

Clicking on a pointer will select the pointer. To select multiple pointers, click the pointers while holding down the Shift key on the keyboard.

The following functions are available for the selected pointer(s) via the Pointer menu, the Pointer icons, or the right-click menu.

Shape Sets the shape of the selected pointer(s).

Hide Description/Show Description Hides or shows the description of the selected pointer(s).

Delete Deletes the selected pointer(s).

Window menu

Provides the three functions below. The functions work for opened windows.

Tiling Tiles all Data Display windows on the screen.

Stacking Stacks all Data Display windows on the screen.

Overlaying Overlays all Data Display windows on the screen. Then the position, window size, and visibility of the most front window are applied to all windows on the screen. The background of the X-Y Graph area is cleared except for the most back window.

Help menu

Agilent EasyEXPERT Help Opens the EasyEXPERT help window.

Display Setup

This setup screen is displayed by selecting View > Display Setup..., and is used to select the data displayed in the Data Display window.

X-Y Graph

Selects the data to be displayed in the X-Y Graph Plot area. The X and Y1 to Y8 axes can be set.

| | |
|----------------|---|
| Name | Specifies the parameter for the axis. |
| Sharing | <p>Specifies the group for sharing the Y axis scale. Select from Group 1, Group 2, Group 3, Group 4, or None (no grouping).</p> <p>The Scale, Min, and Max values are shared by the Y axes in the same group. The scale set by Run Time Auto Scale, Auto Scale, Zoom in, and/or Zoom out are also shared.</p> <p>If another layer on the Data Display window contains an X-Y trace which has the same name for both its grouped Y parameter and its X parameter, the scaling will also be shared by this X-Y trace.</p> |
| Scale | Scale of the axis, Linear or Log |
| Min | Minimum value of the axis |
| Max | Maximum value of the axis |
| Add | Adds a parameter (or axis). |
| Delete | Deletes the parameter selected with the radio button on the left. |
| Up | Moves the selected parameter upward. |
| Down | Moves the selected parameter downward. |

List Display, Parameters

Selects the data displayed in the List Display area or the Parameters area. Up to 20 parameters can be set for each area.

| | |
|------------------|--|
| parameter | Specifies the parameter for the data output. |
| Add | Adds a row for the parameter. |
| Delete | Deletes the parameter selected by the left radio button. |
| Up | Moves the selected parameter upward. |
| Down | Moves the selected parameter downward. |

Graph Properties

This dialog box is opened by clicking the Properties... button in the X-Y Graph Plot area or by selecting Edit > Graph Properties..., and is used to set the graph plot area. Click the OK button to apply the setup and close this dialog box.

Effective Area

This area provides the following check box.

Grid ON Check this button to display the grid on the X-Y Graph.

Graph Color

This area is used to set the color map for the graph plot area. You can change the color of the background, text, graph grid, and line/cursor. The color palette is opened by clicking the pattern of the item.

Graph Trace Color

This area is used to set visibility, color, and thickness of the data traces Y1 to Y8 plotted on the graph. The color palette is opened by clicking the pattern of the item.

Log Scale

This area is used to set the maximum number of decades to show the minor ticks on the log axis. If the number of graph decades is less than or equal to the entered value, the minor ticks are displayed. If it is greater than the entered value, the minor ticks are not displayed.

Text Size

This area is used to set the font size for the graph. The available settings are Largest, Large, Medium, Small, Smallest, and Fixed. For settings other than Fixed, the appropriate size is automatically selected. For Fixed, a font size entry field is provided, and the specified font size is always applied.

X/Y Axis Title Font size for the axis title

Scale Font size for the X and Y coordinate values

Legend Font size for the graph legend

List Display Properties

This dialog box is opened by clicking the Properties... button in the List Display area or by selecting Edit > List Display Properties..., and is used to set the data display format in the List Display area. Click the OK button to apply the setup and close this dialog box.

Display

Check the following check box to add the data status or the physical unit to data. Unchecking the box removes it.

Data Status Adds or removes the status code before data.

Physical Unit Adds or removes the physical unit after data.

Number Format

Selects the data display format from the following formats.

- Engineering Format (Example: -1 . 2345 mA)
Data display with arithmetic point, SI prefix, and unit.
- Scientific Notation (Example: -1 . 23456789012345E-003 A)
Data display with arithmetic point, exponential part (E, +/- sign, and three-digit number), and unit.

Tool Bar

The Data Display window provides the 22 icons on the tool bar. You will see the following icons from left to right in the Data Display window.

Switch Display Mode

This icon switches the display mode.

In Overwrite mode, the “Display Data (page 4-15)” function opens a new Data Display window and displays data.

In Append mode, the “Display Data (page 4-15)” function creates a new display layer on the present Data Display window and displays data.

Close All Displays

This icon closes all display layers.

Show X-Y Graph

This icon displays or hides the X-Y Graph Plot area.

Show List Display

This icon displays or hides the List Display area.

Show Parameters

This icon displays or hides the Parameters area.

| | |
|-----------------------------|--|
| Auto Scale | <p>This icon will change the graph scale automatically to fit the trace in the graph.</p> <p>The right arrow button opens the menu for enabling or disabling the run time auto scaling. This function is set independently for the X and Y axes. If this function is enabled, the graph scale will be changed automatically to fit the trace in the graph during the measurement.</p> <p>If multiple layers are opened on the Data Display window, the scale change is applied to all layers. This means that the X-Y graph scale will be shared by all display layers. The auto scaling is performed as follows.</p> <ol style="list-style-type: none">1. Graph scale is optimized for the data on the selected layer (top layer).2. The graph scale is applied to the graph in all layers. <p>Note that the auto scaling is performed independently for the left and right Y axes individually.</p> <p>There is also a function for resetting the graph scale. Click View > Cancel Scaling > This Display or All Displays. This Display will reset the selected layer only. All Displays will reset for the all display layers.</p> |
| Zoom In | <p>This icon zooms the data graph in the cursor. If the cursor is not displayed, zooms the data graph in the last cursor position or the graph center. This enlarges the trace in the graph.</p> |
| Zoom Out | <p>This icon zooms the data graph out the cursor. If the cursor is not displayed, zooms the data graph out the last cursor position or the graph center. This reduces the trace in the graph.</p> |
| Display Setup... | <p>This icon opens “Display Setup (page 4-62)”.</p> |
| Choose Active Y-axis | <p>This icon selects the Y-axis that is effective for the marker control and the auto scale.</p> |
| Marker ON/OFF | <p>This icon enables or disables the marker.</p> |
| Interpolation ON/OFF | <p>This icon enables or disables the interpolation function of measurement data. You can read the interpolation data between two actual measurement points.</p> |
| Marker Skip | <p>This icon moves the marker to the next measurement curve that is added by the VAR2 variable.</p> |
| Marker Maximum | <p>This icon moves the marker to the maximum measurement point.</p> |

Using EasyEXPERT Data Display

| | |
|------------------------------|--|
| Marker Minimum | This icon moves the marker to the minimum measurement point. |
| Marker Search... | This icon opens the Direct Marker/Cursor dialog box used to specify the coordinate values to move the marker. |
| Line 1 State | This icon enables or disables line 1 and its function: disabled, normal, gradient, tangent, regression, or fix. |
| Line 2 State | This icon enables or disables line 2 and its function: disabled, normal, gradient, tangent, regression, or fix. |
| Cursor to Marker | This icon moves the cursor to the marker position. |
| Adjust Gradient | This icon is available when a regression line is active. Clicking this icon enables the rotary knob and the mouse wheel to increase/decrease the gradient of the line. Clicking this icon again, pressing the rotary knob, or pressing the mouse wheel disables this function. |
| Show Graph Legend | This icon displays or hides the graph legend below the plot area. |
| Show Line Information | This icon displays or hides the line information (X-intercept, Y-intercept, gradient) in the plot area. |

Data Status

If measurement unit detects any status while measurement, the status code is recorded with the measurement data. And the status code will be displayed in the Data Display window as shown in the following example.

Example

- X-Y Graph Plot area

```
MARKER( 5.9000000 C 1.8252000 XV 3.33249E-3 )
```

This line will be displayed at the top of the plot area when marker is ON. The marker is used to read data of the marker point.

- List Display area

| Index | V1 | V2 | I2 |
|-------|-------|------------|---------------|
| 123 | 5.9 V | C 1.8252 V | XV 3.33249 mA |

Status Code

SMU status code:

- C: Compliance
- T: Other channel compliance
- X: Oscillation
- V: Overflow

MFCMU status code:

- U: Unbalance
- D: I/V amp saturation
- V: Overflow

Miscellaneous Operations

The following user interfaces provide several miscellaneous functions when you operate the Data Display window.

- “Mouse/Touch Panel”
- “Rotary Knob”
- “Softkeys”
- “Keyboard”

Mouse/Touch Panel

While the Data Display window is focused, the mouse/touch panel operations shown in Table 4-7 (p. 4-72) are available.

Rotary Knob

The following miscellaneous functions are available by using the rotary knob.

- Marker movement in the VAR1 direction

While the Data Display window is focused and the marker is displayed on the graph, the rotary knob can be used to move the marker. Rotating the knob fast increases the marker speed.

- Marker movement in the VAR2 direction

Clicking the knob moves the marker in the VAR2 direction.

- Slope adjustment of the gradient line

In the slope adjustment mode (Line > Adjust Gradient) for the gradient line, the rotary knob can be used to adjust the slope. Clicking the knob quits this mode.

- Pointer movement in the VAR1 direction

The rotary knob can be used to move the selected pointer. The pointer can not be moved in the VAR2 direction.

Softkeys

The softkeys can be used for setting the following fields on the Display Setup (p. 4-62) window.

- Name (parameter name)
- Scale (Linear or Log)

Keyboard

While the Data Display window is focused, the key operations shown in Table 4-2 are available.

Table 4-2 Miscellaneous Key Operations on Data Display Window

| Key | Description |
|--------------|---|
| F1 | Displays the online help |
| F2 | Shortcut to View > X-Y Graph |
| F3 | Shortcut to View > List Display |
| F4 | Shortcut to View > Parameters |
| F12 | Changes the display mode, Append → Overwrite → Append |
| Ctrl+W | Shortcut to File > Close This Display |
| Ctrl+Shift+W | Shortcut to File > Close All Displays |
| Ctrl+S | Shortcut to File > Save Image As... |
| Ctrl+P | Shortcut to File > Print... |
| Ctrl+C | Shortcut to Edit > Copy |

While the X-Y Graph (graph display area) is focused, the key operations shown in the following tables are available.

- Table 4-3, “Controlling X-Y Graph.”
- Table 4-4, “Controlling Marker.”
- Table 4-5, “Controlling Cursor.”
- Table 4-6, “Controlling Line.”

Table 4-3 Controlling X-Y Graph

| Key | Description |
|---------|--|
| S | Shortcut to View > Auto Scale |
| Z | Shortcut to View > Zoom In |
| Shift+Z | Shortcut to View > Zoom Out |
| Ctrl+Z | Shortcut to View > Cancel Scaling |
| Y | Changes the active data, Y1 → Y2 → ... → Y8 → Y1 |
| R | Activates the right Y axis and changes the data set to the axis, Y2 → Y3 → ... → Y8 → Y2 |
| W | Shortcut to View > Graph Legend ON/OFF |
| K | Shortcut to View > Line Information ON/OFF |

Table 4-4 Controlling Marker

| Key | Description |
|---------|---|
| M | Shortcut to Marker > Marker ON/OFF |
| I | Shortcut to Marker > Interpolation ON/OFF |
| F | Moves the marker +1 ^a in the VAR1 direction |
| Shift+F | Moves the marker +10 ^a in the VAR1 direction |
| B | Moves the marker -1 ^a in the VAR1 direction |
| Shift+B | Moves the marker -10 ^a in the VAR1 direction |
| P | Moves the marker +1 ^a in the VAR2 direction |
| Shift+P | Moves the marker -1 ^a in the VAR2 direction |
| J | Shortcut to Marker > Go To... |
| X | Shortcut to Marker > Go To Maximum |
| N | Shortcut to Marker > Go To Minimum |

a. Multiply 1/10 if the interpolation is ON.

Table 4-5 Controlling Cursor

| Key | Description |
|------------|--|
| C | Shortcut to Cursor > Cursor ON/OFF |
| T | Shortcut to Cursor > Go To Marker |
| ↑ | Moves the cursor +1/1000 in the Y axis direction |
| Shift+ ↑ | Moves the cursor +1/100 in the Y axis direction |
| → | Moves the cursor +1/1000 in the X axis direction |
| Shift+ → | Moves the cursor +1/100 in the X axis direction |
| ↓ | Moves the cursor -1/1000 in the Y axis direction |
| Shift+ ↓ | Moves the cursor -1/100 in the Y axis direction |
| ← | Moves the cursor -1/1000 in the X axis direction |
| Shift+ ← | Moves the cursor -1/100 in the X axis direction |

Table 4-6 Controlling Line

| Key | Description |
|----------------|--|
| 1 ^a | Shortcut to Line > Line 1 ON/OFF |
| 2 ^a | Shortcut to Line > Line 2 ON/OFF |
| V | Changes the active line, Line 1 → Line 2 → Line 1 (available if both line 1 and line 2 are ON) |
| L | Changes the line mode of the active line, Normal → Gradient → Tangent → Regression → Normal |
| G | Shortcut to Line > Adjust Gradient |

a. 1 and 2 on the numeric pad cannot be used.

Table 4-7 Mouse/Touch Panel Operations on Data Display Window

| Location | Operation | Description |
|-----------|--------------------------------------|---|
| X-Y Graph | clicking on the left Y axis | Activates the Y1 data. |
| | clicking on the right Y axis | Activates the data of the right Y axis, or changes the active data if it is already active. |
| | clicking on a plot | Moves the marker to the position of the mouse pointer if the marker is displayed on the graph. |
| | clicking on a cursor | Specifies the active cursor if multiple cursors are displayed. |
| | dragging a cursor | Moves the cursor. |
| | clicking on a line | Specifies the active line if multiple lines are displayed. |
| | clicking on a text | Selects the text. Clicking with pressing the Shift key on the keyboard selects multiple texts. |
| | dragging a text | Moves the text. |
| | clicking on a pointer | Selects the pointer. Clicking with pressing the Shift key on the keyboard selects multiple pointers. |
| | clicking on a description of pointer | Selects the description of pointer. Clicking with pressing the Shift key on the key board selects multiple descriptions of pointers. |
| | dragging a description of pointer | Moves the description of pointer. |
| | rotating the mouse wheel | Moves the marker if the marker is displayed on the graph, moves the pointer if the pointer is selected, or adjusts the slope of the gradient line if it is in the slope adjustment mode (Line > Adjust Gradient). |

| Location | Operation | Description |
|--------------|--|---|
| X-Y Graph | clicking the mouse wheel | Same as clicking the rotary knob. This is effective if the mouse properties assign the center button functions to the wheel button. |
| List Display | dragging a column heading | Moves the column. |
| | dragging boundary of the column | Changes the width of the column. |
| | clicking on a row in the table | Moves the marker to the corresponding position. |
| | moving the scroll bar | Changes the data displayed in the List Display area. Scroll is effective for both portrait and landscape. |
| | rotating the mouse wheel | Changes the data displayed in the List Display area. |
| Others | clicking on a tab ^a under the tool bar | Specifies the display layer for the data display and analysis. |
| | double clicking on a tab ^a under the tool bar | Changes the status of the pin marked to the display layer. Standing pin must be marked to the display layer to be kept. Laid pin is marked to the display layer under the automatic delete. |
| | dragging boundary of the display area | Adjusts the size of the display area (X-Y Graph, List Display, Parameters) without changing the window size. |
| | dragging the frame of the Data Display window | Changes the window size with adjusting the size of the display area (X-Y Graph, List Display, Parameters). |

- a. Tab is displayed if the display mode is Append and the test result record contains the append measurement data.

Preview

The Preview window and the Preview Settings dialog box are opened by selecting View > Open Preview Window in the Data Display window. The Preview Settings dialog box is used to set the graph title, X axis title, Y axis title, and line style. And the Preview window displays a new plot, and is used to output it to the specified printer.

The Data Display window cannot do the above settings and display the new plot.

- “Preview Window GUI”
- “Preview Settings”

Preview Window GUI

The Preview window provides the following GUI.

| | |
|-----------------------------|---|
| Setup Name | This field just displays the name of the test setup used to get this test record. |
| X-Y Graph Plot | This area displays the measurement result graph, traces, marker, cursor, and lines. |
| Parameters | This area lists the user-defined output parameters if the output parameters are set. |
| List Display | This area displays the measurement result data list. |
| File menu | Provides the following functions. See also Figure 4-3 and Figure 4-4. |
| Page Setup... | Opens a dialog box used to set the print page. |
| Print Preview | Opens a dialog box used to specify the data graphs to make previews. After selecting the graphs, previews appear on the Print preview window. |
| Print... | Opens a dialog box used to specify the print target. After selecting the target, the Print dialog box is opened. The dialog box is used to start print. |
| Close Preview Window | Closes the Preview window. |

Edit menu

Provides the following functions. See also Figure 4-5 and Figure 4-6.

- | | |
|------------------------|--|
| Copy | While the X-Y Graph Plot area is active, this function copies the graph image as BMP and EMF into the clipboard. While the line cursor in the List Display area is active, this function copies the data list as CSV. While the Parameters area is active, this function copies the parameter data as CSV. |
| Copy Graph | Copies the graph image as BMP and EMF into the clipboard. |
| Copy List | Copies the list data as CSV. |
| Copy Parameters | Copies the parameter data as CSV. |

View menu

Provides the following functions.

- | | |
|----------------------------|--|
| X-Y Graph | Displays or hides the X-Y Graph Plot area. |
| List Displays | Displays or hides the List Display area. |
| Parameters | Displays or hides the Parameters area. |
| Preview Settings... | Opens “Preview Settings (page 4-76)”. |

Help menu

- | | |
|--------------------------------|-----------------------------------|
| Agilent EasyEXPERT Help | Opens the EasyEXPERT help window. |
|--------------------------------|-----------------------------------|

Preview Settings

The Preview Settings dialog box provides the following GUI.

| | |
|-------------------------------|---|
| General | Defines the graph title in the Graph Title field. The title will appear at the bottom of the plot area. |
| X/Y Axis Title | Defines the X axis title in the X field and the Y axis title in the Y field, Y1 to Y8. The title will appear near the axis. |
| Line Style | Selects the line style for the line 1, line 2, and trace Y1 to Y8. |
| Color and Thickness... | Opens the Color and Thickness dialog box that provides the same GUI as “Graph Properties (page 4-63)”. |
| OK | Applies the setup to the Preview window, and closes this dialog box. |
| Cancel | Cancels the setup, and closes this dialog box. |
| Apply | Applies the setup to the Preview window. |
| Reset | Clears the setup and returns to the default setting. |

Text File Export settings

This dialog box is opened by clicking Results > Transport Data > Text File Export Settings... or the Settings button on the Test Results Data Folder Export dialog box or the Test Results Data Auto Export dialog box. This dialog box is used to define the style of the test record exported by the Export As Text File function.

| | |
|---------------------------------|---|
| Reset | Applies the default value to the all setup items. |
| OK | Defines and memorizes the present setting, and closes this dialog box. |
| Cancel | Cancels and clears the setting changes, and closes this dialog box. |
| Miscellaneous, Save As | Specifies the delimiter (data separator) and file extension. CSV (comma separated, .csv, default), Text (tab separated, .txt), or Formatted Text (space separated, .prn). |
| Miscellaneous, Quotation | Specifies the quotation for the string values. Single (single quotes), Double (double quotes), or None (no quote, default). Even if None is specified, the string which contains delimiter and/or new line character will be double quoted. |
| Identification section | Record items which are used to identify and characterize the test record. They are a sub set of the meta data, test type, and test name. See Table 4-9 for the definition of the record items. Check the box for the items you want to record, and uncheck the box for the items you do not want to record. In the default, all items are checked. The pull-down menu specifies the action for recording the items in the Identification section. See Table 4-8 to specify the action. |

Table 4-8

Actions for Identification and Setup Data Items

| Action | Description |
|----------------------------|---|
| Save with measurement data | The checked items are recorded in the test record with the measurement data. Default. |
| Do not save | No item is recorded even if any box is checked. |
| Save as separate file | The checked items are recorded in a separate file. The name will be the test record's file name plus -s before the extension. |

Table 4-9

Identification Section Record Items

| Item | Description |
|-----------------------|---|
| Setup title | Test setup name |
| Classic test name | Classic test name. I/V Sweep, Multi Channel I/V Sweep, I/V-t Sampling, C-V Sweep, SPGU Control, Switching Matrix Control, or Direct Control. This record item is exclusive against the “Application test name” record item. |
| Application test name | Application test name. This record item is exclusive against the “Classic test name” record item. |
| Test date | Test execution date corresponding to the date part of the RecordTime meta data. |
| Test time | Test execution time corresponding to the time part of the RecordTime meta data. |
| Device ID | Device ID corresponding to the TestTarget meta data. |
| Count | Test count corresponding to the IterationIndex meta data. |
| Flags | Flags set to the test result data, corresponding to the Flag meta data. |
| Remarks | Remarks set to the test result data, corresponding to the Remarks meta data. |

Setup data section Record items which describes the test conditions. They are the test parameters, DUT parameters, and analysis setup. See Table 4-12 for the definition of the record items. Check the box for the items you want to record, and uncheck the box for the items you do not want to record.

Tag information for the setup data is string value; TestParameter, DutParameter, or AnalysisSetup, which means the type of data put in the same row in the exported test record. If *Tag information* box is unchecked (default), the tag information is not recorded. Then, the setup parameter names, such as Channel.Unit, are recorded in the first column in the test record and the parameter values are recorded in the following columns. If the *Tag information* box is checked, the tag information is recorded in the first column and the parameter names and values are shifted to the next columns.

The pull-down menu specifies the action for recording the items in the Setup data section. See Table 4-8 to specify the action.

Measurement data section Record items of the measurement data. It may contain the measurement parameter names, data units, and data size. See Table 4-13 for the definition of the record items. Check the box for the items you want to record, and uncheck the box for the items you do not want to record.

Tag information for the measurement data is string value; Dimension1, Dimension2, Data Name, Data Unit, or Data Value, which means the type of data put in the same row (in case of By Row orientation) or column (in case of By Column orientation) in the exported test record. The tag information will be recorded in the test record if the *Tag information* box is checked.

See Table 4-10 for the By Row orientation. All data relative to a measurement parameter will be put in the same column. The first column (ex. column A) contains the tag information. For the By Column orientation, see Table 4-11. All data relative to a measurement parameter will be put in the same row. And the first row (ex. row 1) contains the tag information. If the *Tag information* box is unchecked (default), the tag information is not recorded and the measurement data is shifted.

Table 4-10 By Row Orientation Export Example

| | A | B | C | D | E | F |
|---|------------|------|----------|----------|------|---|
| 1 | Dimension1 | 101 | 101 | 101 | 1 | |
| 2 | Dimension2 | 1 | 1 | 1 | 1 | |
| 3 | Data Name | Vg | Id | Gm | Vth | |
| 4 | Data Unit | V | A | S | V | |
| 5 | Data Value | 0 | 4.55E-09 | 1.24E-10 | 1.23 | |
| 6 | Data Value | 0.02 | 8.59E-09 | 5.25E-10 | | |

Table 4-11 By Column Orientation Export Example

| | A | B | C | D | E | F |
|---|------------|------------|-----------|-----------|------------|------------|
| 1 | Dimension1 | Dimension2 | Data Name | Data Unit | Data Value | Data Value |
| 2 | 101 | 1 | Vg | V | 0 | 0.02 |
| 3 | 101 | 1 | Id | A | 4.55E-09 | 8.59E-09 |
| 4 | 101 | 1 | Gm | S | 1.24E-10 | 5.25E-10 |
| 5 | 1 | 1 | Vth | V | 1.23 | |
| 6 | | | | | | |

Using EasyEXPERT
Text File Export settings

Table 4-12 Setup Data Section Record Items (ON: checked, OFF: unchecked)

| Item | Description | Default |
|-----------------|---|---------|
| Test parameters | Test parameters defined by the classic test or the application test. | ON |
| DUT parameters | DUT parameters defined by the application test. | ON |
| Analysis setup | Data Display setup status at and after the measurement, such as Graph configuration, Graph format, Graph text, Marker configuration, Cursor configuration, Line configurations, Pointer configuration, List configuration, and Scalar list configuration. | OFF |

Table 4-13 Measurement Data Section Record Items (ON: checked, OFF: unchecked)

| Item | Description | Default |
|--|--|----------------|
| Data names | Measurement parameter name. | ON |
| Data units | Unit of measurement data. | OFF |
| Size | Dimension1 (VAR1 size) and Dimension2 (VAR2 size) of the measurement data. | OFF |
| Data values | Record items can be specified by the following segments. | |
| | Segment | Default |
| | Data assigned to X-Y Graph | ON |
| | Data assigned to List Display | ON |
| | Data assigned to Parameter Display | ON |
| | User function defined but not displayed | OFF |
| | Analysis function defined but not displayed | OFF |
| | Any data referred to by the user function but not directly displayed | OFF |
| Any data referred to by the analysis function but not directly displayed | OFF | |

5

Classic Test Definition

Classic Test Definition

This chapter provides the reference information of the graphical user interface in the classic test mode of Agilent EasyEXPERT software.

- “I/V Sweep”
- “Multi Channel I/V Sweep”
- “I/V List Sweep”
- “I/V-t Sampling”
- “C-V Sweep”
- “Direct Control”
- “Function Setup”
- “Auto Analysis Setup”
- “Display Setup”
- “SMU Range Setup Window”
- “ADC and Integration Time Setup Window”
- “Advanced Setup Window”
- “CMU Range Setup Window”
- “Advanced Setup Window for C-V Sweep”
- “Switching Matrix Control”
- “SPGU Control”
- “SPGU Pulse Setup Window”
- “Load Z Setup Window”
- “Pulse Switch Setup Window”
- “SPGU ALWG Setup Window”
- “Define ALWG Waveform Window”

To perform measurement, see “Main Screen” on page 4-10.

To display measurement data and perform data analysis, see “Data Display” on page 4-51.

To perform self-test or diagnostics, see “Configuration” on page 4-41.

To perform self-calibration, see “Calibration” on page 4-35.

NOTE

If You Use GNDU (Ground Unit)

Keep to the following rule to use the ground unit.

1. Set Mode to COMMON.
2. Set Function to CONST.
3. Do not use the I Name assigned to the ground unit.

Missing any one will cause an execution error.

I/V Sweep

On the EasyEXPERT main screen, click the Classic Test tab and select the I/V Sweep icon. The main screen displays the I/V sweep test setup screen. For the measurement mode, see “I/V Sweep Measurement” on page 7-3.

| | |
|----------------------------|--|
| Setup Name | Used to set the name of test setup. The name must be the identification for the test setup saved to a My Favorite group (preset group). Enter a unique name that is distinct from other definitions. The name is recorded in the test result data and is used to differentiate the data in the test record list area. |
| Channel Setup | This tab displays the Channel Setup screen. See “Channel Setup” on page 5-5. |
| Measurement Setup | This tab displays the Measurement Setup screen. See “Measurement Setup” on page 5-6. |
| Function Setup | This tab displays the Function Setup screen. See “Function Setup” on page 5-42. |
| Auto Analysis Setup | This tab displays the Auto Analysis Setup screen. See “Auto Analysis Setup” on page 5-43. |
| Display Setup | This tab displays the Display Setup screen. See “Display Setup” on page 5-46. |

Channel Setup

This setup screen is used to define the channel setups and the variables for the channel output data, measurement data, time stamp data, and index data.

Channel Definition This area defines the channel setups and the variables for the channel output data and the measurement data.

| | |
|-----------------|---|
| Unit | Module used for the source output or measurement |
| V Name | Variable name of voltage output or measurement data |
| I Name | Variable name of current output or measurement data |
| Mode | Output mode. For SMU, V (voltage), I (current), VPULSE (voltage pulse), IPULSE (current pulse), or COMMON (ground). For SPGU, VPULSE (voltage pulse) or ALWG (arbitrary linear waveform voltage). |
| Function | Output function, VAR1 (primary sweep), VAR2 (secondary sweep), VAR1' (synchronous sweep), or CONST (constant) |
| Add SMU | Adds a row for the SMU channel setup. |
| Add SPGU | Adds a row for the SPGU channel setup. |
| Delete | Deletes the channel setup. To select the channel setup, use the left radio button. |
| Up | Moves the selected channel setup upward. |
| Down | Moves the selected channel setup downward. |

If multiple output channels are defined, the channels start output sequentially. The order is top to bottom of the channels defined in this screen. The output stops in the opposite order.

Miscellaneous Variables

This area defines the variables for the time stamp data and the index data.

| | |
|------------------------|---|
| Time Stamp Name | Variable name of the time stamp. Time stamp data gives the time when step measurement is started. |
| Index Name | Variable name of the data index. Integer above 0 is returned. |

Measurement Setup

This setup screen is used to set the source channel outputs, the measurement ranging mode, the sweep abort condition, the measurement channel A/D converter, the series resistor, the filter, and the source output/measurement wait time.

VAR1

This area defines the primary sweep source output.

| | |
|-------------------|--|
| Unit | Source monitor unit (SMU) used for the VAR1 output |
| Name | Variable name for the VAR1 output data |
| Direction | Sweep direction, single (start to stop) or double (start to stop to start) |
| Linear/Log | Sweep output, LINEAR, LOG10, LOG25, or LOG50. where the number following LOG means the number of sweep points in one decade. |
| Start | Sweep start value |
| Stop | Sweep stop value |
| Step | Incremental step value of the sweep output |
| No of Step | Number of steps. The value is automatically calculated by using the start, stop, and step values. |
| Compliance | Compliance value. Enter the current limit value for the voltage source, or the voltage limit value for the current source. |
| Pwr Comp | Power compliance value (in W), or OFF |

VAR2

This area defines the secondary sweep source output.

| | |
|-------------------|--|
| Unit | Source monitor unit (SMU) used for the VAR2 output |
| Name | Variable name for the VAR2 output data |
| Start | Sweep start value |
| Stop | Sweep stop value. The value is automatically calculated by using the start, step, and number of step values. |
| Step | Incremental step value of the sweep output |
| No of Step | Number of sweep steps |
| Compliance | Compliance value. Enter the current limit value for the voltage source, or the voltage limit value for the current source. |
| Pwr Comp | Power compliance value (in W), or OFF |

VAR1'

This area defines the synchronous sweep source output. The VAR1' output is given by the following formula.

$$VAR1' \text{ output} = \text{Offset} + \text{Ratio} \times VAR1 \text{ output}$$

| | |
|-------------------|--|
| Unit | Source monitor unit (SMU) used for the VAR1' output |
| Name | Variable name for the VAR1' output data |
| Offset | Offset value |
| Ratio | Ratio value |
| Compliance | Compliance value. Enter the current limit value for the voltage source, or the voltage limit value for the current source. |
| Pwr Comp | Power compliance value (in W), or OFF |

Timing

This area defines the hold time and the delay time. See “To Specify Source Output Time” on page 7-59.

| | |
|--------------|--|
| Hold | Hold time. This is the time from beginning of channel output to beginning of delay time. 0 to 655.35 s, 10 ms resolution. |
| Delay | Delay time. This is the time from end of hold time to beginning of measurement. The measurement channels start measurement as soon as the wait time elapses. 0 to 65.535 s, 0.1 ms resolution. |

Classic Test Definition

I/V Sweep

Constant

This area defines the constant output source.

| | |
|-------------------|--|
| Unit | Source monitor unit (SMU) used for the constant source |
| V Name | Variable name for the constant voltage output or measurement data |
| I Name | Variable name for the constant current output or measurement data |
| Mode | Output mode, V (voltage), I (current), VPULSE (voltage pulse), or IPULSE (current pulse) |
| Source | Output value |
| Compliance | Compliance value. Enter the current limit value for the voltage source, or the voltage limit value for the current source. |

SMU Pulse

This area defines the SMU pulse timing parameters. See “SMU Pulse” on page 7-56.

| | |
|---------------|--|
| Unit | Source monitor unit (SMU) used for the pulsed output |
| Period | Pulse period. 5 ms to 5 s, 0.1 ms resolution. |
| Width | Pulse width. 0.5 ms to 2 s, 0.1 ms resolution. |
| Base | Pulse base value |

Period and Width must satisfy the following conditions:

- $\text{Period} \geq \text{Width} + 2 \text{ ms}$ (for pulse width $\leq 100 \text{ ms}$)
- $\text{Period} \geq \text{Width} + 10 \text{ ms}$ (for pulse width $> 100 \text{ ms}$)

Sweep status

This field specifies the sweep abort condition, continue at any status, or stop at any abnormal status.

Range

This button opens a window used to set the measurement ranging operation. See “SMU Range Setup Window” on page 5-48.

ADC/Integ

This button opens a window used to set the A/D converter of the measurement channels. See “ADC and Integration Time Setup Window” on page 5-50.

Advanced

This button opens a window used to set the other functions of the measurement channel. See “Advanced Setup Window” on page 5-51.

SPGU Pulse / ALWG Setup

This button opens a window used to set the SPGU output. See “SPGU Pulse Setup Window” on page 5-59 or “SPGU ALWG Setup Window” on page 5-63.

Multi Channel I/V Sweep

On the EasyEXPERT main screen, click the Classic Test tab and select the Multi Channel I/V Sweep icon. The main screen displays the Multi Channel I/V Sweep test setup screen. For the measurement mode, see “Multi Channel I/V Sweep Measurement” on page 7-12.

| | |
|----------------------------|---|
| Setup Name | <p>Sets the name of the test setup. The name is used to identify the test setup saved to a My Favorite group (preset group). Enter a unique name that is distinct from other definitions.</p> <p>The name is recorded in the test result data and is used to differentiate the data in the test record list area.</p> |
| Channel Setup | <p>This tab displays the Channel Setup screen. See “Channel Setup” on page 5-10.</p> |
| Measurement Setup | <p>This tab displays the Measurement Setup screen. See “Measurement Setup” on page 5-11.</p> |
| Function Setup | <p>This tab displays the Function Setup screen. See “Function Setup” on page 5-42.</p> |
| Auto Analysis Setup | <p>This tab displays the Auto Analysis Setup screen. See “Auto Analysis Setup” on page 5-43.</p> |
| Display Setup | <p>This tab displays the Display Setup screen. See “Display Setup” on page 5-46.</p> |

| | |
|-------------|---|
| NOTE | <p>Setting of the Display Setup is applied to the X-Y Graph on the Data Display window. And the X-Y Graph can handle one X data for the X axis and the maximum eight Y data for the Y axis.</p> <p>Define the X axis carefully to plot the Multi Channel I/V Sweep measurement result which may have the data measured by the multiple VAR1 channels. Because the result may also contain the multiple X data which can be the selections of the X axis.</p> <p>The Display Setup must be set properly to match the X axis data and the X data of the plot you look at.</p> |
|-------------|---|

Channel Setup

This setup screen is used to define the channel setups and the variables for the channel output data, measurement data, time stamp data, and index data.

Channel Definition This area defines the channel setups and the variables for the channel output data and the measurement data.

| | |
|-----------------|---|
| Unit | Module used for the source output or measurement |
| V Name | Variable name of voltage output or measurement data |
| I Name | Variable name of current output or measurement data |
| Mode | Output mode. For SMU, V (voltage), I (current), or COMMON (ground). For SPGU, VPULSE (voltage pulse) or ALWG (arbitrary linear waveform voltage). |
| Function | Output function, VAR1 (primary sweep), VAR2 (secondary sweep), or CONST (constant) |
| Add SMU | Adds a row for the SMU channel setup. |
| Add SPGU | Adds a row for the SPGU channel setup. |
| Delete | Deletes selected channel setup. To select a channel, use the radio button on the left. |
| Up | Moves the selected channel setup upward. |
| Down | Moves the selected channel setup downward. |

If multiple output channels are defined, the channels start output sequentially. The order is top to bottom of the channels defined in this screen. The output stops in the opposite order.

Miscellaneous Variables

This area defines the variables for the time stamp data and the index data.

| | |
|------------------------|--|
| Time Stamp Name | Variable name of the time stamp. Time stamp data indicates the time at which step measurement was started. |
| Index Name | Variable name of the data index. Integer above 0 is returned. |

Measurement Setup

This setup screen is used to set the source channel outputs, the measurement ranging mode, the sweep abort condition, the measurement channel A/D converter, the series resistor, the filter, and the source output/measurement wait time.

VAR1

This area defines the primary sweep source output.

| | |
|-------------------|---|
| Direction | Sweep direction, single (start to stop) or double (start to stop to start) |
| Linear/Log | Sweep output, LINEAR, LOG10, LOG25, or LOG50 where the number following LOG indicates the number of sweep points in one decade. |
| No of Step | Number of sweep steps |
| Unit | Source monitor unit (SMU) used for the VAR1 output |
| Name | Variable name for the VAR1 output data |
| Start | Sweep start value |
| Stop | Sweep stop value |
| Compliance | Compliance value. Enter the current limit value for the voltage source, or the voltage limit value for the current source. |
| Pwr Comp | Power compliance value (in W), or OFF |

Constant

This area defines the constant output source.

| | |
|-------------------|--|
| Unit | Source monitor unit (SMU) used for the constant source |
| V Name | Variable name for the constant voltage output or measurement data |
| I Name | Variable name for the constant current output or measurement data |
| Mode | Output mode, V (voltage) or I (current) |
| Source | Output value |
| Compliance | Compliance value. Enter the current limit value for the voltage source, or the voltage limit value for the current source. |

Classic Test Definition

Multi Channel I/V Sweep

| | |
|--------------------------------|--|
| VAR2 | This area defines the secondary sweep source output. |
| Unit | Source monitor unit (SMU) used for the VAR2 output |
| Name | Variable name for the VAR2 output data |
| Start | Sweep start value |
| Stop | Sweep stop value. The value is automatically calculated from the start, step, and number of step values. |
| Step | Incremental step value for the sweep output |
| No of Step | Number of sweep steps |
| Compliance | Compliance value. Enter the current limit value for the voltage source, or the voltage limit value for the current source. |
| Pwr Comp | Power compliance value (in W), or OFF |
| Timing | This area defines the hold time and the delay time. See “To Specify Source Output Time” on page 7-59. |
| Hold | Hold time. This is the time between the beginning of channel output and the beginning of delay time. 0 to 655.35 s, 10 ms resolution. |
| Delay | Delay time. This is the time between the end of the hold time and the beginning of measurement. The measurement channels start measurement as soon as the wait time elapses. 0 to 65.535 s, 0.1 ms resolution. |
| Sweep status | This field specifies the sweep abort condition to continue at any status or to stop at any abnormal status. |
| Range | This button opens a window for setting measurement ranging operation. See “SMU Range Setup Window” on page 5-48. |
| ADC/Integ | This button opens a window for setting the A/D converter of the measurement channels. See “ADC and Integration Time Setup Window” on page 5-50. |
| Advanced | This button opens a window for setting other functions of the measurement channel. See “Advanced Setup Window” on page 5-51. |
| SPGU Pulse / ALWG Setup | This button opens a window used to set the SPGU output. See “SPGU Pulse Setup Window” on page 5-59 or “SPGU ALWG Setup Window” on page 5-63. |

I/V List Sweep

On the EasyEXPERT main screen, click the Classic Test tab and select the I/V Sweep icon. The main screen displays the I/V List sweep test setup screen.

I/V List Sweep measurement is similar to I/V Sweep measurement described in “I/V Sweep Measurement” on page 7-3.

Changes from the I/V Sweep are listed below.

- VAR1/VAR2 step output values are set by using a vector data. Vector data from a spreadsheet software, either tab separated or comma separated can be copied to the Define vector data dialog box via the Windows clipboard. See “Define vector data” on page 5-18.
- All SMU installed in the B1500A can be set to VAR1.
- VAR1' is not supported.

| | |
|----------------------------|--|
| Setup Name | Sets the name of the test setup. The name is used to identify the test setup saved to a My Favorite group (preset group). Enter a unique name that is distinct from other definitions. The name is recorded in the test result data and is used to differentiate the data in the test record list area. |
| Channel Setup | This tab displays the Channel Setup screen. See “Channel Setup” on page 5-5. |
| Measurement Setup | This tab displays the Measurement Setup screen. See “Measurement Setup” on page 5-6. |
| Function Setup | This tab displays the Function Setup screen. See “Function Setup” on page 5-42. |
| Auto Analysis Setup | This tab displays the Auto Analysis Setup screen. See “Auto Analysis Setup” on page 5-43. |
| Display Setup | This tab displays the Display Setup screen. See “Display Setup” on page 5-46. |

Channel Setup

This setup screen is used to define the channel setups and the variables for the channel output data, the measurement data, the time stamp data, and the index data.

Channel Definition This area defines the channel setups and the variables for the channel output data and the measurement data.

| | |
|-----------------|--|
| Unit | Module used for the source output or measurement |
| V Name | Variable name of voltage output or measurement data |
| I Name | Variable name of current output or measurement data |
| Mode | Output mode. For SMU, V (voltage), I (current), VPULSE (voltage pulse), IPULSE (current pulse), or COMMON (ground). For SPGU, VPULSE (voltage pulse) or ALWG (arbitrary linear waveform voltage). |
| Function | Output function, VAR1 (primary sweep), VAR2 (secondary sweep), or CONST (constant). If a SMU is set to Mode=VPULSE or IPULSE: <ul style="list-style-type: none">• Number of VAR1 channels must be one or two.• If a VAR1 channel is set to Mode=VPULSE, the other VAR1 channel must be Mode=V.• If a VAR1 channel is set to Mode=IPULSE, the other VAR1 channel must be Mode=I. |
| Add SMU | Adds a row for the SMU channel setup. |
| Add SPGU | Adds a row for the SPGU channel setup. |
| Delete | Deletes the selected channel setup. To select a channel setup, use the radio button on the left. |
| Up | Moves the selected channel setup upward. |
| Down | Moves the selected channel setup downward. |

If multiple output channels are defined, the channels start output sequentially. The order is top to bottom of the channels defined in this screen. The output stops in the opposite order.

Miscellaneous Variables

This area defines the variables for the time stamp data and the index data.

Time Stamp Name Variable name of the time stamp. Time stamp data indicates the time at which step measurement was started.

Index Name Variable name of the data index. Integer above 0 is returned.

Measurement Setup

This setup screen is used to set the source channel outputs, the measurement ranging mode, the sweep abort condition, the measurement channel A/D converter, the series resistor, the filter, and the source output/measurement wait time.

VAR1

This area defines the primary sweep source output.

Unit Source monitor unit (SMU) used for the VAR1 output

Source Click the grid button to open the Define vector data dialog box. See “Define vector data” on page 5-18.

Compliance Compliance value. Enter the current limit value for the voltage source, or the voltage limit value for the current source.

Pwr Comp Power compliance value (in W), or OFF

NOTE

To define VAR1/VAR2 step outputs

To define these parameters, create a vector data by using the Define vector data dialog box which is opened by clicking the grid button in the vector data entry field. See Figure 5-1.

Available array size for the vector data is as follows (column \times row).

- VAR1 step output value: $N_1 = 1 \times 1001$ maximum (initial setting: 1×1)
- VAR2 step output value: $N_2 = 1 \times 1001$ maximum (initial setting: 1×1)
- Delay time: $N_3 = 1 \times 1001$ maximum (initial setting: 1×1)

Then, the following formula must be satisfied.

$$1 \leq N_1 \times N_2 \leq 128128$$

Classic Test Definition

I/V List Sweep

VAR2

This area defines the secondary sweep source output.

| | |
|-------------------|--|
| Unit | Source monitor unit (SMU) used for the VAR2 output |
| Name | Variable name for the VAR2 output data |
| Source | Click the grid button to open the Define vector data dialog box. See “Define vector data” on page 5-18. |
| Compliance | Compliance value. Enter the current limit value for the voltage source, or the voltage limit value for the current source. |
| Pwr Comp | Power compliance value (in W), or OFF |

Timing

This area defines the hold time and the delay time. See “To Specify Source Output Time” on page 7-59.

| | |
|--------------|--|
| Hold | Hold time. This is the time from the beginning of channel output to the beginning of delay time. 0 to 655.35 s, 10 ms resolution. |
| Delay | Delay time. This is the time between end of step changing and the beginning of measurement. For the first step, this is the time between the end of hold time and the beginning of measurement. The measurement channels start measurement as soon as the wait time elapses. 0 to 65.535 s, 0.1 ms resolution. Click the grid button to open the Define vector data dialog box. See “Define vector data” on page 5-18. |

SMU Pulse

This area defines the SMU pulse timing parameters. See “SMU Pulse” on page 7-56.

| | |
|---------------|---|
| Unit | Shows the source monitor unit (SMU) used for the pulsed output. The setting cannot be changed. |
| Period | Pulse period is not specified. SMU forces the next pulse after a specified Delay time (Hold time + Delay time for the first pulse). |
| Width | Pulse width. 0.5 ms to 2 s, 0.1 ms resolution. |
| Base | Pulse base value |

| | |
|--------------------------------|---|
| Constant | This area defines the constant output source. |
| Unit | Source monitor unit (SMU) used for the constant source |
| V Name | Variable name for the constant voltage output or measurement data |
| I Name | Variable name for the constant current output or measurement data |
| Mode | Output mode, V (voltage), I (current), VPULSE (voltage pulse), or IPULSE (current pulse) |
| Source | Output value |
| Compliance | Compliance value. Enter the current limit value for the voltage source, or the voltage limit value for the current source. |
| Sweep status | This field specifies the sweep abort condition to continue at any status or to stop at any abnormal status. |
| Range | This button opens a window for setting the measurement ranging operation. See “SMU Range Setup Window” on page 5-48. |
| ADC/Integ | This button opens a window for setting the A/D converter of the measurement channels. See “ADC and Integration Time Setup Window” on page 5-50. |
| Advanced | This button opens a window for setting other functions of the measurement channel. See “Advanced Setup Window” on page 5-51. |
| SPGU Pulse / ALWG Setup | This button opens a window used to set the SPGU output. See “SPGU Pulse Setup Window” on page 5-59 or “SPGU ALWG Setup Window” on page 5-63. |

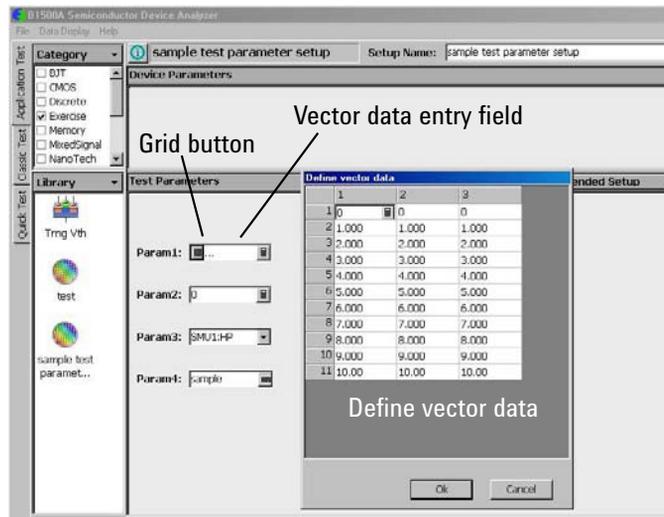
Define vector data

This dialog box is opened by clicking the grid button in the vector data entry field. See Figure 5-1. The vector data entry field can be displayed on the followings.

- Application test setup screen which contains the entry field for a vector type test parameter, on the EasyEXPERT main screen or the Test Definition window
- Test Specification setup screen which contains the definition of a vector type test parameter, on the Test Definition window
- Define symbols dialog box for a vector type test parameter

The Define vector data dialog box displays the array defined by using the Define dimensions dialog box opened from the Test Specification setup screen. Figure 5-1 shows the array created by setting Dim1Min=1, Dim1Max=11, Dim2Min=1, and Dim2Max=3, where Dim1 is the vertical direction (row) and Dim2 is the horizontal direction (columns). The array index always starts from 1.

Figure 5-1 Vector Data Entry Field



NOTE

Rotary knob and mouse wheel can be used to change the numeric value in the highlighted cell.

To delete column/row, highlight the line and press the Delete key.

The Define vector data dialog box provides the following GUI.

| | |
|----------------------|---|
| OK button | Saves the vector data displayed on the dialog box and closes the dialog box. |
| Cancel button | Displays a confirmation message and closes the dialog box. Vector data is not saved. |
| File menu | Provides the following function. Exit Displays a confirmation message and closes the dialog box. Vector data is not saved. |
| Edit menu | Provides the following four functions. Copy Copies the highlighted item to the clipboard. Paste Pastes the data in the clipboard to the specified location. Delete Deletes the highlighted item. Select All Selects and highlights all cells in the array. |
| Mouse menu 1 | The following menus are displayed when the right mouse button is clicked on a cell. Cut Moves the highlighted characters to the clipboard. Copy Copies the highlighted characters to the clipboard. Paste Pastes the data in the clipboard to the specified location. |
| Mouse menu 2 | The following menus are displayed when the right mouse button is clicked on the array display area. Copy Copies the highlighted item to the clipboard. Paste Pastes the data in the clipboard to the specified location. Insert Inserts a row before the selected row. Available when the row header provides the * button and a row header is selected. Delete Deletes the highlighted item. Select All Selects and highlights all cells in the array. |

Classic Test Definition

I/V List Sweep

To import vector data

The Define vector data dialog box can import comma separated data (each data must be separated by a comma, and have a CR/LF or LF at the end of each line) and tab separated data (each data must be separated by a tab, and have a CR/LF or LF at the end of each line). The procedure for importing vector data is as follows.

1. Open a vector data with Notepad.
2. Copy the data in Notepad.
3. On the Define vector data dialog box, click a cell to be used as the top left corner of the imported vector data.
4. Right click on the corner box between the column header and the row header, and select Paste.

Thus, the Define vector data dialog box can read vector data created on a spreadsheet software.

To export vector data

The Define vector data dialog box can export vector data in tab separated format. The procedure for exporting vector data is as follows.

1. Highlight a vector data on the Define vector data dialog box.
2. Select Copy from the Edit menu or the mouse menu.
3. Create a new file in Notepad, and paste the vector data.
4. Save the data as a file.

The data can then be read by opening the file with a spreadsheet software.

I/V-t Sampling

On the EasyEXPERT main screen, click the Classic Test tab and select the I/V-t Sampling icon. The main screen displays the I/V-t sampling test setup screen. For details of the measurement mode, see “I/V-t Sampling Measurement” on page 7-13.

| | |
|----------------------------|--|
| Setup Name | Used to set the name of test setup. The name must be the identification for the test setup saved to a My Favorite group (preset group). Enter a unique name that is distinct from other definitions. The name is recorded in the test result data and is used to differentiate the data in the test record list area. |
| Channel Setup | This tab displays the Channel Setup screen. See “Channel Setup” on page 5-22. |
| Measurement Setup | This tab displays the Measurement Setup screen. See “Measurement Setup” on page 5-23. |
| Function Setup | This tab displays the Function Setup screen. See “Function Setup” on page 5-42. |
| Auto Analysis Setup | This tab displays the Auto Analysis Setup screen. See “Auto Analysis Setup” on page 5-43. |
| Display Setup | This tab displays the Display Setup screen. See “Display Setup” on page 5-46. |

NOTE

If you set $Interval < 0.002 \text{ s}$

Sampling mode must be linear. This setting is not permitted for the log sampling.

All measurement channels must use the high speed A/D converter (ADC). This setting is not permitted if a measurement channel uses the high resolution ADC.

If the multiple measurement channels are used, all channels perform measurement in parallel.

If the measurement ranging mode is not the fixed mode, the measurement channels automatically select the minimum range that covers compliance value set to the channel.

If the measurement time is expected to be longer than *Interval*, the measurement channels automatically adjust the number of averaging samples (ADC settings) to keep the sampling interval.

Channel Setup

This setup screen is used to define the channel setups and the variables for the channel output data, measurement data, time stamp data, and index data.

Channel Definition This area defines the channel setups and the variables for the channel output data and the measurement data.

| | |
|-----------------|---|
| Unit | Module used for the source output or measurement |
| V Name | Variable name of voltage output or measurement data |
| I Name | Variable name of current output or measurement data |
| Mode | Output mode. For SMU, V (voltage), I (current), or COMMON (ground). For SPGU, VPULSE (voltage pulse) or ALWG (arbitrary linear waveform voltage). |
| Add SMU | Adds a row for the SMU channel setup. |
| Add SPGU | Adds a row for the SPGU channel setup. |
| Delete | Deletes the channel setup. To select the channel setup, use the left radio button. |
| Up | Moves the selected channel setup upward. |
| Down | Moves the selected channel setup downward. |

If multiple output channels are defined, the channels start output sequentially. The order is top to bottom of the channels defined in this screen. The output stops in the opposite order. However, if the Output Sequence is SIMULTANEOUS, the channels start and stop output simultaneously.

Miscellaneous Variables

This area defines the variables for the time stamp data and the index data.

| | |
|------------------------|---|
| Time Stamp Name | Variable name of the time stamp. Time stamp data gives the time when step measurement is started. |
| Index Name | Variable name of the data index. Integer above 0 is returned. |

Measurement Setup

This setup screen is used to set the sampling timing parameters, constant voltage/current outputs, and so on.

Sampling Parameter

This area defines the sampling timing parameters.

| | |
|----------------------------|---|
| Linear/Log | <p>Sampling mode. LINEAR for linear sampling. LOG10, LOG25, LOG50, LOG100, LOG250, or LOG500 for logarithmic sampling.</p> <p>For the logarithmic sampling, the number after LOG indicates the number of measurement data in a decade. For example, LOG10 mode is used to get 10 data/decade.</p> |
| Interval | <p>Interval of the sampling, in seconds. 0.002 to 65.535 s, 0.001 s resolution.</p> <p><i>Interval</i> < 0.002 s in 0.00001 s resolution is also available for the linear sampling. It must satisfy the following formula. See NOTE on page 5-21.</p> $Interval \geq 0.0001 + 0.00002 \times (\text{number of measurement channels} - 1)$ |
| No of Samples | <p>Number of samples. Integer. 1 to the following value.</p> <p>For linear: $100001 / (\text{number of measurement channels})$</p> <p>For logarithmic: $1 + (\text{number of data for 11 decades})$</p> |
| Total Sampling Time | <p>This field just displays the total sampling time that is the time from the measurement start time for the first point to the end of sampling measurement. It does not include the hold time.</p> $Total\ Sampling\ Time = Interval \times No\ of\ Samples$ |
| Output Sequence | <p>Source output sequence. SIMULTANEOUS or SEQUENTIAL. See “Source Output Sequence and Time Origin” on page 7-18.</p> |
| Hold Time | <p>Time since the <i>Source</i> value output until the first sampling point, in seconds. 0 to 655.35 s, resolution 0.01 s.</p> <p>The following values are also available for <i>Interval</i> < 0.002 s. $Hold\ Time$ will be the time since the sampling start until the <i>Source</i> value output.</p> <p>-0.09 to -0.0001 s, resolution 0.0001 s.</p> |

Classic Test Definition

I/V-t Sampling

Base Hold Time Hold time of the *Base* value output until the *Source* value output, in seconds. 0 to 655.35 s, resolution 0.01 s.

Stop Condition This area defines the sampling measurement stop condition. See “Stop Condition” on page 7-18 for this function.

Enable/Disable Enables or disables the stop condition.

Enable Delay Delay time, in second. This is the time from starting sampling measurement to enabling this function.

Name Name of measurement data or user function to monitor for stop condition. Val of Event.

Threshold Threshold value at which to stop sampling measurement. Th of Event.

Event Event for stop condition.

Val > Th True if Name parameter value is greater than Threshold value.

Val < Th True if Name parameter value is less than Threshold value.

|Val| > |Th| True if absolute Name parameter value is greater than absolute Threshold value.

|Val| < |Th| True if absolute Name parameter value is less than absolute Threshold value.

No. of Events Target value of the count the event occurs (true). When the count of true is this value, sampling is immediately stopped.

Constants This area defines the constant voltage/current source.

Unit Source monitor unit (SMU) used for the constant source

V Name Variable name for the constant voltage output or measurement data

I Name Variable name for the constant current output or measurement data

Mode Output mode, V (voltage), or I (current)

Base, Source Base or Source value, in V or A.

0 to ± 100 V (HRSMU/MPSMU) or ± 200 V (HPSMU)

0 to ± 0.1 A (HRSMU/MPSMU) or ± 1 A (HPSMU)

Base value is available for all output channels for the SIMULTANEOUS mode and the last source channel for the SEQUENTIAL mode.

Compliance Compliance value, in A or V.
0 to ± 0.1 A (HRSMU/MPSMU) or ± 1 A (HPSMU)
0 to ± 100 V (HRSMU/MPSMU) or ± 200 V (HPSMU)

Range This button opens a window used to set the measurement ranging operation. See “SMU Range Setup Window” on page 5-48.

ADC/Integ This button opens a window used to set the A/D converter of the measurement channels. See “ADC and Integration Time Setup Window” on page 5-50.

Advanced This button opens a window used to set the other functions of the measurement channel. See “Advanced Setup Window” on page 5-51.

SPGU Pulse / ALWG Setup This button opens a window used to set the SPGU output. See “SPGU Pulse Setup Window” on page 5-59 or “SPGU ALWG Setup Window” on page 5-63.
SPGU cannot be used for the sampling measurement of *Interval* < 0.002 s.

C-V Sweep

On the EasyEXPERT main screen, click the Classic Test tab and select the C-V Sweep icon. The main screen displays the C-V sweep test setup screen.

For details of the measurement mode, see “C-V Sweep Measurement” on page 7-19.

Setup Name

Used to set the name of test setup. The name must be the identification for the test setup saved to a My Favorite group (preset group). Enter a unique name that is distinct from other definitions.

The name is recorded in the test result data and is used to differentiate the data in the test record list area.

Channel Setup

This tab displays the Channel Setup screen. See “Channel Setup” on page 5-27.

Measurement Setup

This tab displays the Measurement Setup screen. See “Measurement Setup” on page 5-28.

Function Setup

This tab displays the Function Setup screen. See “Function Setup” on page 5-42.

Auto Analysis Setup

This tab displays the Auto Analysis Setup screen. See “Auto Analysis Setup” on page 5-43.

Display Setup

This tab displays the Display Setup screen. See “Display Setup” on page 5-46.

NOTE

Error Correction

Error correction must be performed before starting measurements. See “CMU Calibration” on page 4-37 that explains the error correction GUI. There are four techniques. For the easy way, perform the phase compensation and the open correction.

Channel Setup

This setup screen is used to define the channel setups and the variables for the channel output data, time stamp data, and index data.

Channel Definition This area defines the channel setups and the variables for the channel output data.

| | |
|---------------|---|
| Unit | Module used for the source output or measurement |
| V Name | Available for the MFCMU and the SMU used for voltage output. Variable name of voltage output data |
| I Name | Available for the SMU used for current output. Variable name of current output data. |
| Mode | SMU output mode, V (voltage), I (current), or COMMON (ground) |
| Add | Adds a row for the channel setup. |
| Delete | Deletes the channel setup. To select the channel setup, use the left radio button. |
| Up | Moves the selected channel setup upward. |
| Down | Moves the selected channel setup downward. |

If multiple output channels are defined, the channels start output sequentially. The order is top to bottom of the channels defined in this screen. However the last output channel is always the MFCMU. The output stops in the opposite order.

Miscellaneous Variables

This area defines the variables for the time stamp data and the index data.

| | |
|------------------------|---|
| Time Stamp Name | Variable name of the time stamp. Time stamp data gives the time when step measurement is started. |
| Index Name | Variable name of the data index. Integer above 0 is returned. |

Measurement Setup

This setup screen is used to set the MFCMU measurement mode, source channel outputs, the sweep abort condition, and the measurement time.

C-V

This area defines the MFCMU measurement mode and DC bias output.

| | |
|--------------------------|--|
| V Name | Variable name of the DC bias output data |
| Model | MFCMU measurement mode. Primary and secondary measurement parameters. Select one from the following four models. Cp-G: Parallel capacitance (F) and Conductance (S) Cp-D: Parallel capacitance (F) and Dissipation factor Cs-Rs: Series capacitance (F) and Series resistance (Ω) Z-Th: Impedance (Ω) and Phase (degree) |
| <i>para1</i> Name | Variable name of the primary measurement parameter, C or Z |
| <i>para2</i> Name | Variable name of the secondary measurement parameter, G, D, R, or Th |
| Direction | Sweep direction, single (start to stop) or double (start to stop to start) |
| Start | Sweep start value |
| Stop | Sweep stop value |
| Step | Incremental step value of the sweep output |
| No of Step | Number of steps. The value is automatically calculated by using the start, stop, and step values. |

Signal Source

This area defines the measurement signal.

| | |
|-----------------------|---|
| Frequency List | Frequency of the measurement signal |
| F Name | Variable name of the frequency data |
| AC Level | Oscillator level of the measurement signal, 10 mV to 250 mV, 1 mV resolution |
| Add | Adds a measurement frequency. |
| Delete | Deletes the selected frequency. To select the frequency, use the left radio button. |

| | | |
|-------------------------|-------------------|---|
| | Up | Moves the selected frequency upward. |
| | Down | Moves the selected frequency downward. |
| Integration Time | | This area sets the A/D converter of MFCMU. |
| | Mode | A/D converter operation mode, AUTO or PLC |
| | Factor | Factor for the initial value. See “Mode, Factor” on page 7-20. |
| Timing | | This area defines the hold time and the delay time. See “To Specify Source Output Time” on page 7-59. |
| | Hold | Hold time. This is the time from beginning of channel output to beginning of delay time. 0 to 655.35 s, 10 ms resolution. |
| | Delay | Hold time. This is the time from end of hold time to beginning of measurement. The MFCMU starts measurement as soon as the wait time elapses. 0 to 655.35 s, 0.1 ms resolution. |
| Constant | | This area defines the constant voltage/current source. |
| | Unit | Source monitor unit (SMU) used for the constant source |
| | V Name | Variable name for the constant voltage output data |
| | I Name | Variable name for the constant current output data |
| | Mode | Output mode, V (voltage), I (current), or COMMON (ground). |
| | Source | Output value |
| | Compliance | Compliance value. Enter the current limit value for the voltage source, or the voltage limit value for the current source. |
| Sweep status | | This field specifies the sweep abort condition, continue at any status or stop at any abnormal status. |
| Range | | This button opens a window used to set the measurement ranging operation. See “CMU Range Setup Window” on page 5-53. |
| Advanced | | This button opens a window used to set the other functions of the MFCMU (multi frequency capacitance measurement unit). See “Advanced Setup Window for C-V Sweep” on page 5-54. |

Direct Control

On the EasyEXPERT main screen, click the Classic Test tab and select the Direct Control icon. The main screen displays the Direct Control test setup screen.

Direct Control test mode performs measurement by controlling measurement resources, SMU, CMU, and SPGU directly. The instrument can be controlled by using GPIB commands. For the B1500A GPIB commands, see “Agilent B1500A Programming Guide”.

Available GPIB commands are listed in the Command pull-down menu on the Measurement Setup screen. Other commands are not supported by the Direct Control test.

| | |
|----------------------------|--|
| Setup Name | <p>Sets the name of the test setup. The name is used to identify the test setup saved to a My Favorite group (preset group). Enter a unique name that is distinct from other definitions.</p> <p>The name is recorded in the test result data and is used to differentiate the data in the test record list area.</p> |
| Channel Setup | <p>This tab displays the Channel Setup screen. See “Channel Setup” on page 5-31.</p> |
| Measurement Setup | <p>This tab displays the Measurement Setup screen. See “Measurement Setup” on page 5-33.</p> |
| Function Setup | <p>This tab displays the Function Setup screen. See “Function Setup” on page 5-42.</p> <p>If Agilent B2200A/B2201A/E5250A switching matrix is used, the CMU measurement data should be compensated. To perform the compensation, define a user function by using the “compenReZ” and “compenImZ” functions or the “compenReY” and “compenImY” functions.</p> |
| Auto Analysis Setup | <p>This tab displays the Auto Analysis Setup screen. See “Auto Analysis Setup” on page 5-43.</p> |
| Display Setup | <p>This tab displays the Display Setup screen. See “Display Setup” on page 5-46.</p> |

Channel Setup

This setup screen is used to define the channel setups and the variables for the channel output data, measurement data, time stamp data, and index data.

Channel Definition This area defines the channel setups and the variables for the channel output data and the measurement data.

| | |
|-----------------|--|
| Unit | Module used for the source output or measurement |
| V Name | Variable name of DC voltage output or measurement data |
| I Name | Variable name of DC current output or measurement data |
| Add SMU | Adds a row for the SMU channel setup. |
| Add CMU | Adds a row for the CMU channel setup. |
| Add SPGU | Adds a row for the SPGU channel setup. |
| Delete | Deletes the selected channel setup. To select a channel setup, use the radio button on the left. |
| Up | Moves the selected channel setup upward. |
| Down | Moves the selected channel setup downward. |

Additional Data Variables This area defines the variables for the measurement data other than DC voltage and DC current which can be defined in Channel Definition.

| | |
|---------------|--|
| Unit | Unit (SMU or CMU) used for the measurement |
| Type | Type of measurement data. See Table 5-1. |
| Name | Variable name of the measurement data |
| Add | Adds a row for the measurement variable. |
| Delete | Deletes the selected measurement variable. To select a variable, use the radio button on the left. |

Miscellaneous Variables This area defines the variables for the time stamp data and the index data.

| | |
|------------------------|--|
| Time Stamp Name | Variable name of the time stamp. Time stamp data indicates the time at which step measurement was started. |
| Index Name | Variable name of the data index. Integer above 0 is returned. |

Table 5-1

Available Type Values for Measurement Data Variables

| Type | Description |
|---------------------------|--|
| SMU Quasi-Static C | SMU capacitance measurement data (F) |
| CMU Re(Z) | CMU resistance measurement data (Ω) |
| CMU Im(Z) | CMU reactance measurement data (Ω) |
| CMU Re(Y) | CMU conductance measurement data (S) |
| CMU IM(Y) | CMU susceptance measurement data (S) |
| CMU Frequency | CMU output signal frequency data (Hz) |
| CMU AC Level Output Data | CMU oscillator level output data (Vac) |
| CMU DC Bias Monitor Data | CMU DC bias monitor data (Vdc) |
| CMU AC Level Monitor Data | CMU oscillator level monitor data (Vac) |

Measurement Setup

This setup screen is used to define GPIB commands for controlling the SMU and CMU directly, and is used to set the SMU series resistor, the SMU filter, and the bias hold function.

Advanced

This button opens a window for setting the SMU series resistor, the SMU filter, and the bias hold function. See “Advanced Setup” on page 5-34.

Command Setup

This area defines GPIB commands for controlling the SMU and CMU directly.

Command Select the command or function from the pull-down menu. See “Command Setup” on page 5-36.

Arguments Enter the command parameter. To enter multiple parameters, insert a comma (,) between parameters. Multiple spaces can be inserted before and after the comma.

All parameters should be entered. If an optional parameter is abbreviated, the initial value may be set, the last used value may be reused, or no value may be set. The result is unique and depends on the command. For a description of each command, see “Agilent B1500A Programming Guide”.

The parameter can be a numeric variable or a numeric expression with fundamental arithmetic operations.

In an application test definition, the parameter can be a numeric type test parameters, device parameters, or Symbol.

If the internal variable is used, it must be used as a string variable. For example, the variables must be entered as follows.

“%I1”, “%R1”, “%R2”

Ignore Check this box to comment out this command line.

Add Adds a row for the command setup.

Delete Deletes the selected command setup. To select a command setup, use the radio button on the left.

Up Moves the selected command setup upward.

Down Moves the selected command setup downward.

Advanced Setup

This window is opened by clicking the Advanced button on the Direct Control Measurement Setup screen, and is used to set the SMU series resistor, the SMU filter, and the bias hold function.

Options

The following setup is available.

Primary Setup Primary setup ON or OFF.

If Primary Setup=ON, the primary setup is applied to the instrument when the Direct Control test is started. For the setup condition, see “Primary Setup” on page 5-35.

If Primary Setup=OFF, the primary setup is not applied. Set the Primary Setup to OFF if a setup exists and is proven to problem-free for running a test with. The test execution time can be reduced by this setting.

Channel Settings

This area sets the series resistor and the filter.

| | |
|-------------------|--|
| Unit | Source monitor unit (SMU) used for the measurement |
| VName | Variable name of voltage output or measurement data |
| IName | Variable name of current output or measurement data |
| Series R | Series resistor NONE or 1MOHM. See “SMU Series Resistor” on page 7-63. |
| SMU Filter | SMU filter ON or OFF. See “SMU Filter” on page 7-62. |

After Measurement Setting

This area sets the bias hold function for maintaining the source output after measurement. The source module applies the specified bias between two consecutive measurements of a repeated measurement or quick test. See “Bias Hold Function” on page 7-40.

Bias Hold after Measurement Bias hold function ON or OFF

Semiconductor Relays (16440A SMU/PG Selector)

This area sets the Agilent 16440A selector CH1/CH3 status (*DEFAULT* or *PGU OPEN*). To use this function, set the *DEFAULT* setting to *Always SMU* or *Normally PGU (AUX)* by using the SMU/PG Selector tab screen on the Configuration window before starting the SPGU output.

CH1 CH1 status, *DEFAULT* or *PGU OPEN*.

CH3 CH3 status, *DEFAULT* or *PGU OPEN*.

CH1 represents channel 1 on the first selector and CH3 represents channel 1 on the second selector. See “SMU/PG Selector” on page 7-48 for details on the selector.

Agilent 16445A selector adapter is needed for connecting the 16440A.

Primary Setup

Primary setup is the initial setting set for when the Direct Control test is started. This setting is different from the initial setting set by the device clear or the *RST command. The differences are listed below.

- Data output format
FMT 13, 0 is set.
- Program memory
Setup is not changed. The last used setting is retained.
- Internal variables
Setup is not changed. The last used setting is retained.
- Measurement condition setup commands
Setup is not changed for the following commands. The last used setting is retained.

MM

WV, WI, WSV, WSI, WNX

PV, PI, PWV, PWI

BDV

QSV, QSO

LGI, LGV, LSI, LSV, LSSI, LSSV

BGI, BGV, BSI, BSV, BSSI, BSSV

FC, WDCV

PDCV, PWDCV

WFC

WACV

MDCV

Command Setup

To define the Command Setup, set a command or a function to the Command field, and enter the command parameters to the Argument field. Also, be aware of the following note.

- FMT command's first parameter must be 13.
- Use the Unit value of Channel Setup to specify the channel.
- Use the ReadDataBuffer function to read measurement data.
- Program memory number must be within the range of 1 to 1000.
- SCR command parameter cannot be abbreviated.
- VAR command's second parameter must be within the range of 1 to 40. Hence, internal variables %I1 to %I40 and %R1 to %R40 are available.

A setup example is shown in Table 5-2. This example uses SMU1 to perform voltage output and current spot measurement.

Table 5-2

Command Setup Example

| Command | Arguments | Description |
|----------------|----------------------|-------------------------------------|
| FMT | 13, 0 | Sets the data output format. |
| MM | 1, SMU1:HP | Sets the measurement mode. |
| TSC | 1 | Enables the time data output. |
| AV | 10, 1 | Sets the number of averaging. |
| DV | SMU1:HP, 0, 1.5, 0.1 | Forces the DC voltage. |
| CMM | SMU1:HP, 0 | Sets the SMU operation mode. |
| RI | SMU1:HP, 0 | Sets the current measurement range. |
| TSR | | Resets the timer. |
| XE | | Starts the measurement. |
| ReadDataBuffer | 1 | Reads the measurement data. |

ReadDataBuffer

This function reads the measurement data. The number of data blocks to be read is specified by the *count* parameter. If *count* is abbreviated, this function reads one data block.

Syntax `ReadDataBuffer [count]`

Parameters *count* Number of data blocks or the number of terminators to be read.
A data block is a group of data that ends with a terminator. For the data output format, see “Agilent B1500A Programming Guide”.

Example The following example performs three high speed spot measurements and then reads three measurement data blocks.

| Command | Arguments | Description |
|----------------|-----------|---|
| TI | 1, 0 | Measurement channel 1 performs the high speed spot measurement. |
| TI | 2, 0 | Measurement channel 2 performs the high speed spot measurement. |
| TI | 3, 0 | Measurement channel 3 performs the high speed spot measurement. |
| ReadDataBuffer | 3 | Reads three measurement data blocks. |

NOTE The data output buffer is cleared when the Direct Control test is started.

NOTE If a SMU performs the force side measurement operation and the source data output is enabled (by the FMT command), the SMU’s source data is deleted and the SMU’s measurement data is stored instead of the source data. The force side measurement operation is the SMU operation which performs the voltage force and voltage measurement or the current force and current measurement.

compenReZ

This built-in function performs compensation on the specified impedance data and returns the real data for the compensation results.

This function is effective for the CMU measurement data compensation while the switching matrix is used with the CMU to extend the measurement terminals. Define the `compenReZ` and `compenImZ` functions as the user functions on the Function Setup screen, so that the compensation is performed while the Direct Control test is being executed. Also enter the formula to calculate the measurement parameters. An example definition is shown in Figure 5-2. For the equations, see “About Impedance Measurements” on page 7-21.

Syntax

`compenReZ(frequency, Real, Imaginary)`

Parameters

| | |
|------------------|--|
| <i>frequency</i> | Measurement frequency. Hz. Numeric scalar or vector data. For the C-f measurement data, <i>frequency</i> should be a vector variable that stores multiple frequency values. |
| <i>Real</i> | CMU Re(Z) measurement result data. Ω . Numeric vector data. <i>Real</i> should be a vector variable that stores the impedance real data before compensation. |
| <i>Imaginary</i> | CMU Im(Z) measurement result data. Ω . Numeric vector data. <i>Imaginary</i> should be a vector variable that stores the impedance imaginary data before compensation. |

Example

| | |
|-------------------|--|
| Name | Rcompen |
| Definition | <code>compenReZ(Freq, ReZ, ImZ)</code> |

Rcompen returns the impedance real data for the compensation results.

compenImZ

This built-in function performs compensation on the specified impedance data and returns the imaginary data for the compensation results.

This function is effective for the CMU measurement data compensation while the switching matrix is used with the CMU to extend the measurement terminals. Define the `compenReZ` and `compenImZ` functions as the user functions on the Function Setup screen, so that the compensation is performed while the Direct Control test is being executed. Also enter the formula to calculate the measurement parameters. An example definition is shown in Figure 5-2. For the equations, see “About Impedance Measurements” on page 7-21.

Syntax

`compenImZ(frequency, Real, Imaginary)`

Parameters

| | |
|-------------------------|--|
| <i>frequency</i> | Measurement frequency. Hz. Numeric scalar or vector data. For the C-f measurement data, <i>frequency</i> should be a vector variable that stores multiple frequency values. |
| <i>Real</i> | CMU Re(Z) measurement result data. Ω . Numeric vector data. <i>Real</i> should be a vector variable that stores the impedance real data before compensation. |
| <i>Imaginary</i> | CMU Im(Z) measurement result data. Ω . Numeric vector data. <i>Imaginary</i> should be a vector variable that stores the impedance imaginary data before compensation. |

Example

Name Xcompen

Definition `compenImZ(Freq, ReZ, ImZ)`

Xcompen returns the impedance imaginary data for the compensation results.

compenReY

This built-in function performs compensation on the specified admittance data and returns the real data for the compensation results.

This function is effective for the CMU measurement data compensation while the switching matrix is used with the CMU to extend the measurement terminals. Define the `compenReY` and `compenImY` functions as the user functions on the Function Setup screen as shown in Figure 5-2, so that the compensation is performed while the Direct Control test is being executed. Also enter the formula to calculate the measurement parameters. For the equations, see “About Impedance Measurements” on page 7-21. Figure 5-2 defines the following formula to calculate capacitance.

$$C = \text{Im}Y / (2 \times \text{PI} \times \text{Freq})$$

Syntax

`compenReY(frequency, Real, Imaginary)`

Parameters

| | |
|-------------------------|--|
| <i>frequency</i> | Measurement frequency. Hz. Numeric scalar or vector data. For the C-f measurement data, <i>frequency</i> should be a vector variable that stores multiple frequency values. |
| <i>Real</i> | CMU Re(Y) measurement result data. S. Numeric vector data. <i>Real</i> should be a vector variable that stores the admittance real data before compensation. |
| <i>Imaginary</i> | CMU Im(Y) measurement result data. S. Numeric vector data. <i>Imaginary</i> should be a vector variable that stores the admittance imaginary data before compensation. |

Example

| | |
|-------------------|---------------------------|
| Name | Gcompen |
| Definition | compenReY(Freq, ReY, ImY) |

Gcompen returns the admittance real data for the compensation results.

Figure 5-2

Function Setup Example

| Name: | Unit: | Definition: |
|-------|-------|---------------------|
| PI | | 3.1415 |
| ImY | ohm | compenImY(Freq,G,B) |
| ReY | ohm | compenReY(Freq,G,B) |
| C | F | ImY/(2*PI*Freq) |

compenImY

This built-in function performs compensation on the specified admittance data and returns the imaginary data for the compensation results.

This function is effective for the CMU measurement data compensation while the switching matrix is used with the CMU to extend the measurement terminals. Define the compenReY and compenImY functions as the user functions on the Function Setup screen as shown in Figure 5-2, so that the compensation is performed while the Direct Control test is being executed. Also enter the formula to calculate the measurement parameters. For the equations, see “About Impedance Measurements” on page 7-21. Figure 5-2 defines the following formula to calculate capacitance.

$$C = \text{ImY} / (2 \times \text{PI} \times \text{Freq})$$

Syntax

`compenImY(frequency, Real, Imaginary)`

Parameters

| | |
|-------------------------|--|
| <i>frequency</i> | Measurement frequency. Hz. Numeric scalar or vector data. For the C-f measurement data, <i>frequency</i> should be a vector variable that stores multiple frequency values. |
| <i>Real</i> | CMU Re(Y) measurement result data. S. Numeric vector data. <i>Real</i> should be a vector variable that stores the admittance real data before compensation. |
| <i>Imaginary</i> | CMU Im(Y) measurement result data. S. Numeric vector data. <i>Imaginary</i> should be a vector variable that stores the admittance imaginary data before compensation. |

Example

| | |
|-------------------|--|
| Name | Bcompen |
| Definition | <code>compenImY(Freq, ReY, ImY)</code> |

Bcompen returns the admittance imaginary data for the compensation results.

Function Setup

This setup screen is displayed by clicking the Function Setup tab of the I/V Sweep / Multi Channel I/V Sweep / I/V List Sweep / I/V-t Sampling / C-V Sweep / Direct Control test setup screen, and is used to set the user function and the analysis function.

Calculation of the function is automatically performed after measurement. And the functions defined in the Display Setup screen will be displayed on the Data Display window. The user functions are available for the X-Y Graph Plot, List Display, and Parameters area. The analysis functions are available for the Parameters area.

Apply

This button performs calculation of the definition in this screen. If this button is clicked when the Data Display window associated with this test has been opened, the display is also updated.

The associated Data Display window will be the Data Display window that displays the last measurement data or that is recalled at last.

User Function, Analysis Function

The User/Analysis Function area sets the user/analysis functions effective for the test. Up to 20 functions can be set. The user function result is referable from the other user function defined in the following lines. The analysis function result is referable from the other analysis function defined in the following lines.

| | |
|--------------------|---|
| Name | Function name |
| Unit | Unit of the function |
| Definition | Definition of the function. The following identifiers can be used. <ul style="list-style-type: none">• Variables for the measurement/output data used in this test• Functions defined in the above lines• Local variables passed from the application test that calls this test as a component• Built-in functions and global variables• Read out functions (not available for the user functions) Also see Chapter 8, “Built-in Programming Tool.” |
| Add, Delete | Adds a function, or deletes the selected function. To select the function, use the left radio button. |
| Up, Down | Moves the selected function upward or downward. |

Auto Analysis Setup

This setup screen is displayed by clicking the Auto Analysis Setup tab of the I/V Sweep / Multi Channel I/V Sweep / I/V List Sweep / I/V-t Sampling / C-V Sweep / Direct Control test setup screen, and is used to set the automatic analysis function. When a measurement finishes, the function automatically draws lines, a marker, or both on the X-Y Graph of the Data Display window.

You can set up two lines and one marker for the automatic analysis function.

In the Line 1 and Line 2 areas, you can set up the lines to be drawn.

In the Marker area, you can set up the marker.

Apply

This button performs calculation of the definition in this screen. If this button is clicked when the Data Display window associated with this test has been opened, the display is also updated.

The associated Data Display window will be the Data Display window that displays the last measurement data or that is recalled at last.

Interpolation Mode

Check this box to enable the interpolation mode. You can position marker between measurement points.

Line 1, Line 2

This area sets the line 1 or line 2 automatically displayed and moved to the specified position after the measurement.

Enable Check this box to enable the line.

Fix Check this box to fix the line on the graph after the auto analysis is performed. Remove the check to make the line free.

Type Select one of the available line types listed below.

Axis Axis effective for the line. Specify one from Y1 to Y8.

First Point See the following description for the line you selected.

Second Point See the following description for the line you selected.

Available line types:

- “Normal line”: For drawing a line between *any two* points.
- “Gradient line”: For drawing a line through *any point* with a specified gradient.
- “Tangent line”: For drawing a tangent line to a *measurement* point.

Classic Test Definition

Auto Analysis Setup

- “Regression line”: For drawing a regression line by using the measurement data included in the area specified by *any two* points.

Marker

This area sets the marker automatically displayed and moved to the specified position after the measurement.

Enable Check this box to enable the marker.

Condition Enter a variable name and a condition expression to specify where you want the marker to appear.

After Check this box to enable the additional condition.

Enter a second variable and condition expression. This sets up a search start condition for finding specified point.

For example, you can specify the following expressions to search for a measurement point that satisfies the first condition after the second condition is satisfied.

Condition:[DGM]=[MAX(DGM)*0.01] [x] After [DGM]=[MAX(DGM)]

Normal line

The First Point area and the Second Point area are used to specify the points the line passes through. The following two ways are available to specify the point.

- X-Y Coordinate

Enter the desired X-Y coordinate values or expressions in the X and Y fields.

- Data Condition

Enter a variable name and condition expression to specify the point. This is the same method as specifying the Marker point.

Gradient line

The First Point area is used to specify the point the line passes through. The following two ways are available to specify the point.

- X-Y Coordinate

Enter the desired X-Y coordinate values or expressions in the X and Y fields.

- Data Condition

Enter a variable name and condition expression to specify the point. This is the same method as specifying the Marker point.

In the Gradient field, enter a gradient value or expression.

Tangent line

The First Point area is used to specify the measurement point the tangent line passes through.

Enter a variable name and condition expression to specify the point. This is the same method as specifying the Marker point.

Regression line

The First Point area and the Second Point area are used to specify the range of the measurement data used for the regression calculation. The following two ways are available to specify the point.

- X-Y Coordinate

Enter the desired X-Y coordinate values or expressions in the X and Y fields.

- Data Condition

Enter a variable name and condition expression to specify the point. This is the same method as specifying the Marker point.

Display Setup

This setup screen is displayed by clicking the Display Setup tab of the I/V Sweep / Multi Channel I/V Sweep / I/V List Sweep / I/V-t Sampling / C-V Sweep / Direct Control test setup screen or by checking the Define own Output Parameters box on the Test Definition window, and is used to set the test result output.

X-Y Graph

Selects the data to be displayed in the X-Y Graph Plot area. The X and Y1 to Y8 axes can be set.

| | |
|----------------|---|
| Name | Specifies the parameter for the axis. |
| Sharing | <p>Specifies the group for sharing the Y axis scale. Select from Group 1, Group 2, Group 3, Group 4, or None (no grouping).</p> <p>The Scale, Min, and Max values are shared by the Y axes in the same group. The scale set by Run Time Auto Scale, Auto Scale, Zoom in, and/or Zoom out are also shared.</p> <p>If another layer on the Data Display window contains an X-Y trace which has the same name for both its grouped Y parameter and its X parameter, the scaling will also be shared by this X-Y trace.</p> |
| Scale | Scale of the axis, Linear or Log |
| Min | Minimum value of the axis |
| Max | Maximum value of the axis |
| Add | Adds a parameter (or axis). |
| Delete | Deletes the parameter selected with the radio button on the left. |
| Up | Moves the selected parameter upward. |
| Down | Moves the selected parameter downward. |

List Display, Parameters

Selects the data displayed in the List Display area or the Parameters area of the Data Display window. Up to 20 parameters can be set for each area.

| | |
|------------------|---|
| parameter | Specifies the parameter for the data output. |
| Add | Adds a row for the parameter. |
| Delete | Deletes the selected parameter. To select the parameter, use the left radio button. |

| | |
|-------------|--|
| Up | Moves the selected parameter upward. |
| Down | Moves the selected parameter downward. |

SMU Range Setup Window

This window is opened by clicking the Range button on the I/V Sweep / Multi Channel I/V Sweep / I/V List Sweep / I/V-t Sampling Measurement Setup screen, and is used to set the measurement ranging operation.

For the measurement ranging function, see “SMU Ranging Mode” on page 7-49.

| | |
|--------------|--|
| Unit | Source monitor unit (SMU) used for the measurement |
| Name | Variable name for the measurement data |
| Mode | Ranging mode, auto, limited, or fixed |
| Range | Range value. For auto ranging, ignore this field. For limited auto ranging, the measurement channel never uses ranges less than the specified range. |

Range Change

Rule and Rate

Not available for voltage measurement or fixed ranging. See also “Enhanced Auto Ranging for Current Measurement” on page 7-52.

Available *Range Change Rule* values are BY FULL RANGE, GO UP AHEAD, and UP AND DOWN AHEAD.

BY FULL RANGE performs normal auto ranging operation.

For the GO UP AHEAD and UP AND DOWN AHEAD rules, specify the *Rate* value, 11 to 100, which fixes the boundary of the ranging. The ranging occurs when the measurement data goes across the *boundary* values shown below.

$$\text{go up boundary} = \text{present measurement range} \times \text{Rate} / 100$$

$$\text{go down boundary} = \text{present measurement range} \times \text{Rate} / 1000$$

The *go down boundary* is available only for the UP AND DOWN AHEAD rule.

Up Moves the selected measurement channel setup upward.

Down Moves the selected measurement channel setup downward.

If multiple measurement channels are defined, the channels perform measurement sequentially. The order is top to bottom of the channels defined in this screen. For exceptions and details, see “Multiple Measurement Channels” on page 7-61.

NOTE

To use 1 pA range

The measurement channel connected to the ASU (Atto Sense and Switch Unit) supports the 1 pA range. To use the 1 pA range, set the 1 pA fixed range or the 1 pA limited auto ranging.

The B1500A automatically performs the compensation of the data measured by the 1 pA range and returns the compensated data. You can use either the pre-stored offset data or the pre-measured offset data.

To measure the offset data, perform the self-calibration before starting the measurement for a DUT. This offset data is temporarily memorized until the B1500A is turned off.

ADC and Integration Time Setup Window

This window is opened by clicking the ADC/Integ button on the I/V Sweep / Multi Channel I/V Sweep / I/V List Sweep / I/V-t Sampling Measurement Setup screen, and is used to set the A/D converter of the measurement channels.

A/D Converter

This area selects the ADC type and enables/disables the auto zero function. See “Integration Time” on page 7-57.

| | |
|-------------|--|
| Unit | Source monitor unit (SMU) used for the measurement |
| Name | Variable name for the measurement data |
| ADC | ADC type, high resolution ADC or high speed ADC |

Integration Time

This area sets the ADC mode and its factor for each ADC type.

| | |
|------------------|--|
| Mode | ADC operation mode, auto, manual, or PLC |
| Factor | Factor value. This is the <i>N</i> value shown in Table 7-8. |
| Auto Zero | For the high resolution ADC. Auto zero function ON or OFF. See “ADC Zero Function” on page 7-57. |

Advanced Setup Window

This window is opened by clicking the Advanced button on the I/V Sweep / Multi Channel I/V Sweep / I/V List Sweep / I/V-t Sampling Measurement Setup screen, and is used to set the following functions of the measurement channel.

Channel Settings

This area sets the series resistor and the filter.

| | |
|-------------------|--|
| Unit | Source monitor unit (SMU) used for the measurement |
| VName | Variable name of voltage output or measurement data |
| IName | Variable name of current output or measurement data |
| Series R | Series resistor NONE or 1MOHM. See “SMU Series Resistor” on page 7-63. |
| SMU Filter | SMU filter ON or OFF. See “SMU Filter” on page 7-62. |

Wait Time Control

This area sets the source output wait time and the measurement wait time. See “Wait Time” on page 7-60. The Output Wait sets the source output wait time. The Measurement Wait sets the measurement wait time.

| | |
|---------------|--|
| Factor | Factor value. 0 to 10, 0.1 resolution. This is the <i>N</i> value shown in “Wait Time” on page 7-60. |
|---------------|--|

After Measurement Settings

This area sets the bias hold function used to keep the source output after measurement. The source module applies the specified bias between a measurement and the next measurement performed in the repeat measurement or quick test. See “Bias Hold Function” on page 7-40.

| | |
|------------------------------------|------------------------------|
| Bias Hold after Measurement | Bias hold function ON or OFF |
|------------------------------------|------------------------------|

| | |
|---------------------------------------|---|
| Output Value after Measurement | Source output value after measurement START (sweep start value), STOP (sweep stop value), SOURCE (sampling output source value), or BASE (sampling output base value) |
|---------------------------------------|---|

[Classic Test Definition](#)
[Advanced Setup Window](#)

**Semiconductor
Relays (16440A
SMU/PG Selector)**

This area sets the Agilent 16440A selector CH1/CH3 status (*DEFAULT* or *PGU OPEN*). To use this function, set the *DEFAULT* setting to *Always SMU* or *Normally PGU (AUX)* by using the SMU/PG Selector tab screen on the Configuration window before starting the SPGU output.

CH1 CH1 status, DEFAULT or PGU OPEN.

CH3 CH3 status, DEFAULT or PGU OPEN.

CH1 represents channel 1 on the first selector and CH3 represents channel 1 on the second selector. See “SMU/PG Selector” on page 7-48 for details on the selector.

Agilent 16445A selector adapter is needed for connecting the 16440A.

CMU Range Setup Window

This window is opened by clicking the Range button on the C-V Sweep Measurement Setup screen, and is used to set the measurement ranging operation.

| | |
|--------------|--|
| Unit | Module (MFCMU) used for the measurement |
| Mode | Ranging mode, AUTO (auto ranging) or FIXED (fixed range). If Mode=AUTO, the MFCMU automatically searches for and measures at the range that provides the best resolution. If Mode=FIXED, the MFCMU measures at the range specified by the Range field. |
| Range | Measurement range. This field is effective when Mode=FIXED. Available measurement ranges depend on the measurement frequency setting. See Table 5-3. |

Table 5-3

Available Measurement Ranges

| Frequency | Available measurement ranges |
|-----------|--|
| ≤ 200 kHz | 50 Ω, 100 Ω, 300 Ω, 1 kΩ, 3 kΩ, 10 kΩ, 30 kΩ, 100 kΩ, 300 kΩ |
| ≤ 2 MHz | 50 Ω, 100 Ω, 300 Ω, 1 kΩ, 3 kΩ, 10 kΩ, 30 kΩ |
| ≤ 5 MHz | 50 Ω, 100 Ω, 300 Ω, 1 kΩ, 3 kΩ |

Advanced Setup Window for C-V Sweep

This window is opened by clicking the Advanced button on the C-V Sweep Measurement Setup screen, and is used to set the following functions of the MFCMU.

AC Level/DC Bias Monitor Settings

This area defines the variables for the AC level data and the DC bias data monitored by the MFCMU while the capacitance measurement is performed.

Unit Module (MFCMU) used for the measurement

AC Level Monitor

Name Variable name of the AC level monitor data

DC Bias Monitor

Name Variable name of the DC bias monitor data

After Measurement Settings

This area sets the bias hold function used to keep the source output after measurement. The source module applies the specified bias between a measurement and the next measurement performed in the repeat measurement or quick test. See “Bias Hold Function” on page 7-40.

Bias Hold after

Measurement Bias hold function ON or OFF

Output Value after

Measurement Source output value after measurement

START (sweep start value) or STOP (sweep stop value)

Semiconductor Relays (16440A SMU/PG Selector)

This area sets the Agilent 16440A selector CH1/CH3 status (*DEFAULT* or *PGU OPEN*). To use this function, set the *DEFAULT* setting to *Always SMU* or *Normally PGU (AUX)* by using the SMU/PG Selector tab screen on the Configuration window before starting the SPGU output.

CH1 CH1 status, *DEFAULT* or *PGU OPEN*.

CH3 CH3 status, *DEFAULT* or *PGU OPEN*.

CH1 represents channel 1 on the first selector and CH3 represents channel 1 on the second selector. See “SMU/PG Selector” on page 7-48 for details on the selector.

Agilent 16445A selector adapter is needed for connecting the 16440A.

Switching Matrix Control

On the EasyEXPERT main screen, click the Classic Test tab and select the Switching Matrix Control icon. The main screen displays the Switching Matrix Control setup screen. This setup screen is used to create the relay control setup for Agilent B2200A/B2201A/E5250A Switching Matrix.

To apply the relay control setup, click the Single button. Before doing this, you have to establish the GPIB connection to the switching matrix by using the Switching Matrix tab screen of the Configuration window. See “Switching Matrix” on page 4-43.

Setup Name

Used to set the name of the relay control setup. The name must be the identification for the setup saved to a My Favorite group (preset group). Enter a unique name that is distinct from other definitions.

The name is recorded in the test result data and is used to differentiate the data in the test record list area.

Connection

This area is used to create the relay control setup for the switching matrix.

- | | |
|---------------|--|
| Add | Adds a row for the relay connection setup. |
| Delete | Deletes the setup row. To select the setup row, use the left radio button. |
| Up | Moves the selected setup row upward. |
| Down | Moves the selected setup row downward. |

The setup row provides the following entry fields.

- | | |
|------------------|--|
| Operation | Relay control operation Open All, Switch Setup, Close Range, Open Output, Open Range, or Open Input. See Table 5-4. |
| Input | Switching matrix input port number or label Available for the Switch Setup, Close Range, and Open Input operations. |

Classic Test Definition
Switching Matrix Control

| | |
|----------------|---|
| Outputs | Switching matrix output channel number or label Four entry fields are available for the Switch Setup and Open Output operations to specify the output channels. Two entry fields are available for the Close Range and Open Range operations to specify the range of output channels. |
| Rule | Relay connection rule BBM: Breaks the previous connection and then makes the new connection for the specified outputs. MBBR: Makes the new connection and then breaks the previous connection for the specified outputs. |

Table 5-4

Relay Control Operations

| Operation | Description |
|------------------|---|
| Open All | Opens all relays. |
| Switch Setup | Makes the connection from the specified input port to the specified output channels. Up to four output channels can be specified at once. |
| Close Range | Makes the connection from the specified input port to the specified output channels. They are between two channels given by the Outputs fields. |
| Open Output | Opens the relays connected to the specified output channels. Up to four output channels can be specified at once. |
| Open Range | Opens the relays connected to the specified output channels. They are between two channels given by the Outputs fields. |
| Open Input | Opens the relays connected to the specified input port. |

SPGU Control

On the EasyEXPERT main screen, click the Classic Test tab and select the SPGU Control icon. The main screen displays the SPGU control screen. See “SPGU Module” on page 7-26 for the function of the SPGU.

Setup Name

Used to set the name of the SPGU control setup. The name must be able to identify a setup saved in a My Favorite group (preset group). Enter a unique name that is distinct from other definitions.

The name is recorded in the execution result data and is used to differentiate the data in the test record list area.

Channel Definition

Defines the SPGU channel setups.

| | |
|---------------|--|
| Unit | Semiconductor pulse generator unit (SPGU) used for the voltage pulse output or the arbitrary linear waveform voltage output |
| VName | Name of voltage output data |
| Mode | Output mode VPULSE (voltage pulse output) or ALWG (arbitrary linear waveform voltage output). All SPGU channels must have the same output mode. |
| Add | Adds a row for the channel setup. |
| Delete | Deletes the channel setup. To select the channel setup, use the left radio button. |
| Up | Moves the selected channel setup upward. |
| Down | Moves the selected channel setup downward. |

SPGU Setup

Provides the following buttons used to open the following setup window.

| | |
|-------------------|---|
| Pulse/ALWG | Opens “SPGU Pulse Setup Window” if Mode=VPULSE. Opens “SPGU ALWG Setup Window” if Mode=ALWG. |
| Advanced | Opens “Advanced Setup Window for SPGU Control”. |

Classic Test Definition

SPGU Control

Progress Monitor Provides the following check boxes used to set the Data Display window displayed while the SPGU channel output is applied.

Graph: % of Progress Check this box to display the Percent of Progress vs. Time plot.

List: Time Data Check this box to display the Time data list.

No data may be displayed on the Data Display window if the SPGU output time is too short. The progress monitor will be used for long duration outputs, for example when the duration is longer than 30 seconds.

Advanced Setup Window for SPGU Control

This window is opened by clicking the Advanced button on the SPGU Control screen, and is used to set the following functions of the SPGU channel.

After Measurement Setting Sets the bias hold function used to decide the channel output after the SPGU output operation.

Bias Hold after Measurement Bias hold function ON or OFF

If the bias hold function is OFF, the channel stops the output immediately after the SPGU output operation.

If the function is ON, the channel maintains the base voltage output (in the VPULSE mode) or the initial voltage output (in the ALWG mode) between a SPGU output operation and the next operation performed in the repeat execution or quick test. Channel initialization occurs at the beginning of the next operation.

Semiconductor Relays (16440A SMU/PG Selector) Sets the Agilent 16440A selector CH1/CH3 status (*DEFAULT* or *PGU OPEN*). To use this function, set the *DEFAULT* setting to *Always SMU* or *Normally PGU (AUX)* by using the SMU/PG Selector tab screen on the Configuration window before starting the SPGU output.

CH1 CH1 status, DEFAULT or PGU OPEN.

CH3 CH3 status, DEFAULT or PGU OPEN.

CH1 represents channel 1 on the first selector and CH3 represents channel 1 on the second selector. See “SMU/PG Selector” on page 7-48 for details on the selector.

Agilent 16445A selector adapter is needed for connecting the 16440A.

SPGU Pulse Setup Window

This window is opened by clicking the Pulse/ALWG button on the SPGU Control screen when Mode=VPULSE, or by clicking the SPGU Pulse Setup button on the I/V Sweep / Multi Channel I/V Sweep / I/V List Sweep / I/V-t Sampling Measurement Setup screen. It is used to set the SPGU pulse output. See Figure 5-3 for the pulse setup parameters.

Global Settings

Provides the following entry field. The setting is effective for all channels.

Period Pulse period. 20 ns to 10 s, 10 ns resolution.

Operation

Provides the following radio buttons used to set the SPGU channel output operation mode, free run, pulse count, or duration. Select one of the following buttons to set the operation mode. The setting is effective for all channels.

FREE RUN In this mode, the SPGU continues the pulse output until the measurement is completed or stopped.

This mode is not available for the SPGU Control classic test.

PULSE COUNT In this mode, the SPGU outputs the specified number of pulses. Specify a number within the range of 1 to 1000000.

DURATION In this mode, the SPGU continues the output until the specified time elapses. Specify a time within the range of 1 μ s to 31556926 s (1 year).

Pulse Settings

Unit Semiconductor pulse generator unit (SPGU) used for the voltage pulse output

VName Name of voltage output data

Type 2-Level Pulse or 3-Level Pulse. If you choose 3-Level Pulse, the Additional Pulse fields become effective.

Base, Peak Pulse base and peak voltage. 0 to \pm 40 V, 1 mV resolution.

Delay Delay time. 0 s to *Period*-20 ns, resolution 2.5 ns or 10 ns (pulse transition time > 8 μ s).

Width Pulse width. 10 ns to *Period*-10 ns, resolution 2.5 ns or 10 ns (pulse transition time > 8 μ s).

Leading, Trailing Pulse transition time. 8 ns to 400 ms, resolution 2 ns or 8 ns (pulse transition time > 8 μ s).

Classic Test Definition
 SPGU Pulse Setup Window

SPGU setup view order

- Up** Moves the selected channel setup upward.
- Down** Moves the selected channel setup downward.

Changes are effective only for the display on the SPGU Pulse Setup window and not memorized. They are not applied to the Channel Setup.

Load Z

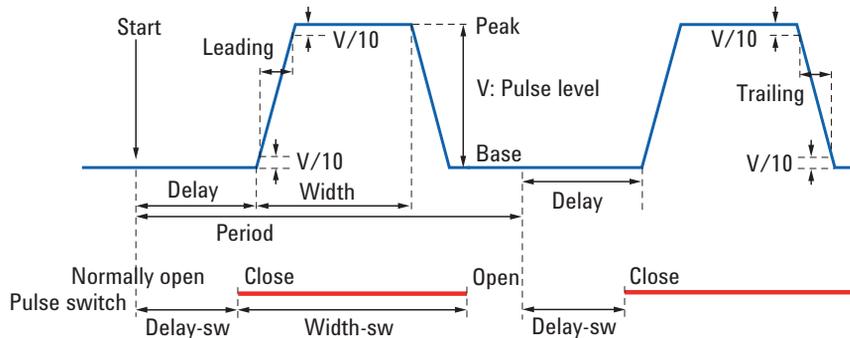
This button opens the “Load Z Setup Window” used to set the load impedance of the DUT (device under test) connected to the SPGU channel. The SPGU will automatically adjust the output voltage by using this value, and output the voltage close to the specified pulse base and peak values.

Pulse Switch

This button opens the “Pulse Switch Setup Window” used to set the pulse switch operation. The pulse switch is used to set the open condition of the SPGU output channel. The pulse switch is more durable than mechanical relays, and is better suited for frequent switching applications.

Figure 5-3

SPGU Pulse Setup Parameters



Load Z Setup Window

This window is opened by clicking the Load Z button on the SPGU Pulse Setup window or the SPGU ALWG Setup window, and is used to set the load impedance of the DUT (device under test) connected to the specified SPGU channel.

Set the correct impedance value. The SPGU will automatically adjust the output voltage by using this value, and output the voltage close to the specified pulse base and peak values.

Load Z

| | |
|---------------|---|
| Unit | Semiconductor pulse generator unit (SPGU) used for the voltage pulse output or the arbitrary linear waveform voltage output |
| VName | Name of voltage output data |
| Load Z | Load impedance of the DUT (device under test) connected to this channel in Ω . |

Pulse Switch Setup Window

This window is opened by clicking the Pulse Switch button on the SPGU Pulse Setup window, and is used to set the pulse switch operation. The pulse switch is used to set the open condition of the SPGU output channel. The pulse switch is more durable than mechanical relays, and is better suited for frequent switching applications.

| | | |
|---------------------|----------------|--|
| Pulse Switch | Unit | Semiconductor pulse generator unit (SPGU) used for the voltage pulse output |
| | VName | Name of voltage output data |
| | SW Sync | ENABLE (enables the pulse switch) or DISABLE (disables the pulse switch). Switching of the pulse switch status (open and close) will be controlled automatically and synchronized with the output pulse, as shown in Figure 5-3. |
| | Delay | Delay time from start of pulse output to changeover of pulse switch. 0 s to <i>Period</i> -100 ns, 10 ns resolution. |
| | Width | Duration to hold the switched state of the pulse switch. 100 ns to <i>Period</i> - <i>Delay</i> ns, 10 ns resolution. |
| | Normal | CLOSE (normally closes the pulse switch) or OPEN (normally opens the pulse switch). The pulse switch will change the status after the Delay-sw time and keep the status until the Width-sw time elapses as shown in Figure 5-3. This operation is repeated every pulse period. |

SPGU ALWG Setup Window

This window is opened by clicking the Pulse/ALWG button on the SPGU Control screen when Mode=ALWG, or by clicking the SPGU ALWG Setup button on the I/V Sweep / Multi Channel I/V Sweep / I/V List Sweep / I/V-t Sampling Measurement Setup screen. It is used to set the arbitrary linear waveform output.

Operation

Provides the following radio buttons used to set the SPGU channel output operation mode, free run, sequence count, or duration. Select one of the following buttons to set the operation mode. The setting is effective for all channels.

FREE RUN In this mode, the SPGU continues the ALWG sequence output until the measurement is completed or stopped.

This mode is not available for the SPGU Control classic test.

SEQUENCE COUNT

In this mode, the SPGU outputs the specified number of sequences. Specify a number within the range of 1 to 1000000.

DURATION

In this mode, the SPGU continues the output until the specified time elapses. Specify a time within the range of 1 μ s to 31556926 s (1 year).

ALWG Setting

Provides the following field.

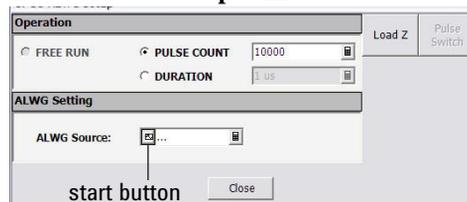
ALWG Source Click the start button in this field to open the Define ALWG Waveform window which is used to define the arbitrary linear waveform and its output sequence. See “Define ALWG Waveform Window” on page 5-64.

Load Z

This button opens the “Load Z Setup Window” used to set the load impedance of the DUT (device under test) connected to the SPGU channel. The SPGU will automatically adjust the output voltage by using this value, and output the voltage close to the specified pulse base and peak values.

Figure 5-4

SPGU ALWG Setup Window



Define ALWG Waveform Window

This window is opened by clicking the start button in the waveform data entry field or the ALWG Source field on the SPGU ALWG Setup window, and is used to create the arbitrary linear waveform data which is defined by the pattern data and the sequence data.

File menu

Provides the following five functions.

- Export ALWaveform...** Exports the waveform data.
- Import ALWaveform...** Imports the specified waveform data.
- Export Pattern...** Exports the pattern highlighted in the Patterns display area.
- Import Patterns...** Imports the specified pattern data.
- Close** Closes the Define ALWG Waveform window.

Pattern menu

Provides the following six functions.

- New** This is for creating a new pattern. Opens the New Pattern dialog box. Entering a new name opens Waveform Pattern Editor (p. 5-67).
- Edit** Opens the Waveform Pattern Editor with the pattern highlighted in the Pattern display area.
- Cut** Cuts the pattern highlighted in the Pattern display area and stores it on the Clipboard.
- Copy** Copies the pattern highlighted in the Pattern display area to the Clipboard.
- Paste** Pastes the pattern stored on the Clipboard.
- Rename** Renames the pattern highlighted in the Pattern display area.

Column menu

Provides the following five functions.

- Edit** Opens the Waveform Pattern Editor with the column data highlighted in the Sequence Editor area.
- Insert** Adds a column.

| | |
|---------------------|--|
| Delete | Deletes the column data highlighted in the Sequence Editor area. |
| Move | Moves the highlighted column to the left or the right. |
| Repeat Count | Opens the Repeat Count dialog box used to set the repeat count. |

Sequence Editor

Specifies the output channel, the output pattern, the repeat count of the pattern, and the output sequence of patterns. These setup information create the arbitrary linear waveform data.

| | |
|---------------------|--|
| Column No. | Number for specifying the output sequence. The pattern will be output in the order of this number. |
| Repeat Count | Output repeat count for the pattern specified by the <i>channel</i> field (e.g right field of the label “SPGU1:HV”). The repeat count must be entered in this field. |

channel

(e.g SPGU1:HV) Output channel and its output pattern. The channel is specified by the header (e.g SPGU1:HV) of this row. The pattern data must be specified by this entry field. A pre-defined pattern can be selected from the drop down menu in this field. The right button opens the Waveform Pattern Editor.

This area provides the following buttons.

| | |
|----------------------|---|
| Insert Column | Adds a column. |
| Delete Column | Deletes the highlighted column. |
| To Left | Move the highlighted column to the left. |
| To Right | Move the highlighted column to the right. |

This area also provides the following functions in the menu displayed by right-clicking this area.

| | |
|----------------------|--|
| Cancel | Closes the menu. |
| Insert Column | Adds a column. |
| Delete Column | Deletes the highlighted column. |
| Move Column | Moves the highlighted column to the left or the right. |
| Repeat Count | Opens the Repeat Count dialog box used to set the repeat count. |
| Edit | Opens the Waveform Pattern Editor with the specified pattern data (Pattern) or the specified column data (Column). |

Classic Test Definition

Define ALWG Waveform Window

The Repeat Count field provides the following functions in the menu displayed by right-clicking the field.

Cut Cuts the highlighted value and stores it on the Clipboard.

Copy Copies the highlighted value to the Clipboard.

Paste Pastes the value stored on the Clipboard.

When a column is highlighted (light blue), the highlighted area provides the following functions in the menu displayed by right-clicking the field.

Cancel Closes the menu.

Edit Column Opens the Waveform Pattern Editor with the specified column data.

When a *channel* field is highlighted (light blue), the highlighted field provides the following functions in the menu displayed by right-clicking the field.

Cancel Closes the menu.

Edit Pattern Opens the Waveform Pattern Editor with the specified pattern data.

Patterns

Displays icons for all pre-defined waveform patterns and provides the following functions in the menu displayed by right-clicking this area.

Cancel Closes the menu.

New Pattern This is for creating a new pattern. Opens the New Pattern dialog box. Entering a new name opens Waveform Pattern Editor (p. 5-67).

Edit Opens the Waveform Pattern Editor with the highlighted pattern.

Cut Cuts the highlighted pattern and stores it on the Clipboard.

Copy Copies the highlighted pattern to the Clipboard.

Paste Pastes the pattern stored on the Clipboard.

Rename Renames the highlighted pattern.

Export Pattern... Exports the highlighted pattern data.

Import Pattern... Imports the specified pattern data.

Double-clicking a pattern icon will open the Waveform Pattern Editor with the clicked pattern.

Waveform Pattern Editor

This window is opened by several actions, for example by selecting New from the Pattern menu, and is used to create or edit the pattern data.

File menu

Provides the following three functions.

| | |
|-------------------|--|
| Save | Saves the pattern data. |
| Save As... | Opens a dialog box used to specify a pattern name and save the pattern data. |
| Close | Closes the Waveform Pattern Editor without saving the data. |

Edit menu

Provides the following seven functions.

| | |
|-------------------------------------|---|
| Undo | Undoes the last action. |
| Redo | Cancels the Undo operation. |
| Add a New Point | Adds a point. |
| Delete a Point | Deletes the highlighted point. |
| Same Level As Left Point | Sets the highlighted point to the same level as the left point. |
| Copy Pattern to Clipboard | Copies the highlighted pattern data to the Clipboard in the tab-separated spreadsheet format. |
| Paste Pattern from Clipboard | Pastes the tab-separated spreadsheet format data stored on the Clipboard. |

Display menu

Provides the following function.

| | |
|----------------|---|
| Channel | Opens the Display Channels dialog box used to select the SPGU channels displayed on the Waveform Pattern Editor. This function is available if the Waveform Pattern Editor was opened with the column data. |
|----------------|---|

Pattern Editor

Defines the pattern data. The Pattern Editor provides two methods, graphic mode and tabular mode, for defining the pattern data.

In the graphic mode, you can define the pattern data by using the mouse pointer and GUIs on the graph (on the left side of the Pattern Editor).

In the tabular mode, you can define the pattern data by entering Time in seconds, Level in V, and Switch 0 (pulse switch open) or 1 (pulse switch close) into the table (on the right side of the Pattern Editor).

The Delta Time check box and the Delta Level check box are used to switch the data expression in the table. If the box is not checked, the value will be an absolute value; if the box is checked, the value will be the difference from the previous point.

The Pattern Editor provides the following buttons.

- Undo** Undoes the last action.
- Redo** Cancels the Undo operation.
- Add a New Point** Adds a point.
- Delete a Point** Deletes the highlighted point.

The Pattern Editor also provides the following functions in the menu displayed by right-clicking the area.

- Cancel** Closes the menu.
- Save** Saves the pattern data.
- Edit** Displays the Edit menu.
- Display** Displays the Display menu.

If the Pattern Editor is opened with the column data, the following GUI will be available.

- Ref Ch.** Specifies the channel or the pattern which contains the reference point.
- Ref Pt.** Specifies the reference point by the index number (No. column of table).
- Delta T** Displays the difference from the reference point. For time data.
- Delta V** Displays the difference from the reference point. For level data.

6

Application Test Definition

Application Test Definition

This chapter provides the reference information of the Test Definition window used to create the application test definitions.

- “Test Definition Window”
- “Test Specification”
- “Test Output”
- “Test Contents”
- “Local Variable Definition”
- “Program Component”
- “Auto Analysis”
- “Data Display Control”
- “Display Data Setup”
- “GPIB I/O”
- “Message”
- “Data Store Control”
- “Command Execution”
- “Using Command Execution”

Test Definition Window

The Test Definition window is opened by selecting the Define New Test... function or the Open Definition of This Test... function of the Library menu, and is used to create a test definition used in the application test mode.

The test definition consists of the elements shown in Figure 6-1. And the Test Definition window provides the following three tabs for creating a test definition.

- “Test Specification”

The test specification contains test name, description, device parameters, and test parameters. The parameters will be the variables used to pass the test conditions to the test execution flow or test setup defined in the test contents.

- “Test Contents”

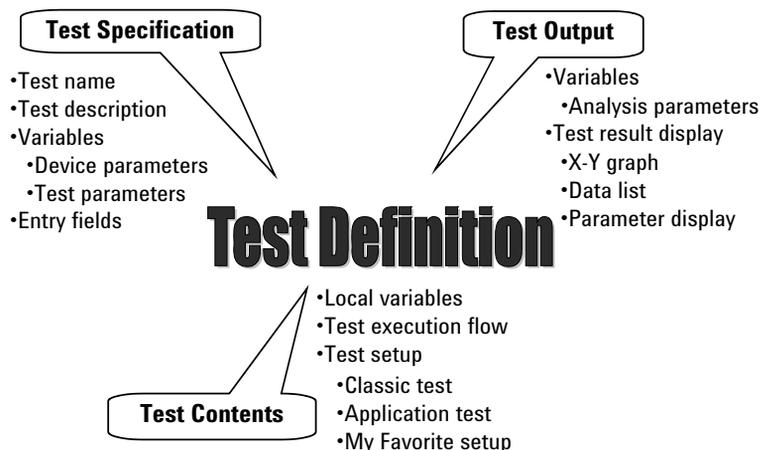
The test contents are the core of the test definition, and defines the local variables, test execution flow, and test setup. You can define the test setup by selecting application tests, classic tests, or My Favorite setup, and entering the test conditions.

- “Test Output”

The test output setup is optional. If you need the test result output (test result display and record) of the test definition, declare the variables (analysis parameters) and define the display setup.

Figure 6-1

Test Definition



Application Test Definition Test Definition Window

The Test Definition window provides the following menus.

File menu

Provides the following two functions.

- | | |
|--------------|---|
| Save | Saves the test definition. The sample application tests furnished with the EasyEXPERT and the application tests created by other users cannot be saved without changing the Test Name value. The Test Name must be your original. |
| Close | Opens a dialog box that asks if you want to save before closing the window. Selecting Yes saves the test definition and closes the Test Definition window. Selecting No closes the Test Definition window without saving the test definition. |

Help menu

Agilent EasyEXPERT Help Opens the EasyEXPERT help window.

Test Specification

This setup screen is used to define the test definition information and the input parameters for the test definition.

Test Information

The test information is defined in this area.

| | |
|--------------------|--|
| Category | Displays the category of the test definition. The button opens a dialog box used to set the category. It must be 1 to 30 characters. Multiple categories can be set to a test definition. |
| Test Name | Specifies the test definition name. It must be 1 to 30 characters. |
| Icon | Specifies a bitmap file used for the test definition icon listed in the Library area of the main screen. Browse...: Opens a dialog box used to select a bitmap file. Cancel: Returns to the default setting. |
| Description | Enters the description of the test definition. |

Device Parameters Definition

The device parameters are defined in this area. Type of the device parameter is Numeric.

| | |
|--------------------|--|
| Name | Device parameter name |
| Default | Default value of the parameter |
| Description | Description of the parameter |
| Add | Adds a row for the device parameter. |
| Delete | Deletes the selected device parameter. To select the parameter, use the left radio button. |
| Up | Moves the selected device parameter upward. |
| Down | Moves the selected device parameter downward. |

Application Test Definition

Test Specification

Test Parameters Definition

The test parameters are defined in this area.

| | |
|--------------------|--|
| Background | <p>Specifies a bitmap file used for the background in the Test Parameters area of the main screen.</p> <p>Browse...: Opens a dialog box used to select a bitmap file.</p> <p>Cancel: Returns to the default setting.</p> |
| Name | Test parameter name |
| Type | Type of the test parameter, Numeric, Module, String, Vector, or ALWaveform (SPGU ALWG output data) |
| Default | <p>Default value of the parameter</p> <p>For the Numeric, Vector, or ALWaveform type parameter, this field provides the button to open Numeric KeyPad at the right side.</p> <p>For the Vector type parameter, this field provides the button to open the “Define vector data (page 5-18)” dialog box at the left side.</p> <p>For the ALWaveform type parameter, this field provides the button to open the “Define ALWG Waveform Window (page 5-64)” at the left side.</p> |
| Description | Description of the parameter |
| Align | Specifies the X origin of the entry field in the main screen Test Parameters area. Check this box to set it to the left edge of the entry field. Uncheck this box to set it to the left edge of the parameter name placed to the left of the entry field. |
| X, Y | Specifies the entry field position. (X, Y)=(0, 0) specifies the upper left corner of the main screen Test Parameters area. Downward and rightward are positive. See “Layout...”. |
| Width | Specifies the width of the entry field. |
| Ext | <p>Do not check usually. The entry field for the parameter is put on the main screen.</p> <p>If the parameter is minor and do not need changes frequently, check the Ext check box. The entry field will be put on the dialog box displayed by clicking the “Extended Setup (page 4-28)” button.</p> |
| Layout... | Opens the “Define Layout (page 6-10)” dialog box. |

| | |
|---------------|--|
| Add | Adds a row for the test parameter. |
| Delete | Deletes the selected test parameter. To select the parameter, use the left radio button. |
| Up | Moves the selected test parameter upward. |
| Down | Moves the selected test parameter downward. |

Properties

The Properties area is used to define the following values for the specified device parameter or test parameter. See “Device Parameters Definition” on page 6-5 and “Test Parameters Definition” on page 6-6.

To specify the parameter, select the radio button to the left of the parameter name.

| | |
|--------------------------|---|
| Min | For Numeric or Vector parameters. Allowable minimum value. |
| Max | For Numeric or Vector parameters. Allowable maximum value. |
| Digits | For Numeric or Vector parameters. Number of effective digits. |
| Resolution | For Numeric or Vector parameters. Allowable setup resolution. |
| Unit | For Numeric or Vector parameters. Unit of the parameter. |
| Typical Values... | For Numeric or String parameters. |

Opens the Define typical values dialog box used to define the selections (typical values) for the specified parameter.

The values defined here are the selections for the parameter entry field displayed on the main screen in the application test mode. The selections for the active entry field are displayed on the softkey. And one of the selections can be set by using the softkey. Also, it can be set by using the Select sub menu displayed by right-clicking the entry field.

The selections are effective for the specified parameter only.

| | |
|----------------------|---|
| Resource Type | For Module parameters. Opens the Define Resource Types dialog box used to specify the type of measurement resource. Multiple resources can be set. SMU, HPSMU, HRSMU, MPSMU, HRSMU/ASU, GNDU, SPGU, HVSPGU, WGF MU, RSWGFMU, MFCMU, MFCMU/SCUU, SWM IN, SWM AUX IN, or SWM SMU IN |
|----------------------|---|

Application Test Definition Test Specification

Dimension...

For Vector parameters.

Opens the Define dimensions dialog box for defining the dimension of vector data.

Use Dim1Min and Dim1Max to specify the primary dimension of vector data. This direction can be for the primary sweep data.

Use Dim2Min and Dim2Max to specify the secondary dimension of vector data. This direction can be for the secondary sweep data.

The following conditions must be satisfied.

- $1 \leq \text{Dim1Min} \leq \text{Dim1Max}$ (ex. Dim1Min=1, Dim1Max=11)
- $1 \leq \text{Dim2Min} \leq \text{Dim2Max}$ (ex. Dim2Min=1, Dim2Max=3)

Assign Output Channels...

For ALWaveform parameters.

This button opens the Assign ALWaveform Output Channels dialog box which specifies the variables if they are used to identify the SPGU channels. The variables must be the Module type test parameter.

For example, when the parameters are defined as shown below, PG1 should be set to the Assign ALWaveform Output Channels dialog box for the WAVE1 parameter.

PG1: Module parameter to identify the SPGU channel

WAVE1: ALWaveform parameter for the PG1 setup data

Use “Define ALWG Waveform Window (page 5-64)” to create the SPGU ALWG setup data. For the above example, the PG1 is the SPGU channel identifier when creating the WAVE1 data.

Symbols... For Numeric or Vector parameters.

Opens the Define dimensions dialog box for assigning a symbol (string value) to a numeric value for the specified numeric parameter.

By defining the numeric-symbol assignment, the symbol value, instead of the numeric value, is set to the parameter entry field displayed on the main screen in the application test mode.

In the test definition, the parameter works as a numeric value. However, the numeric-to-string translation result will not be the string value simply translated from the numeric value but the symbol assigned to the numeric value.

For example, if Symbol=ON is assigned to Value=1 of the Param1 parameter, the string ON will be set to the Param1 entry field when numeric value 1 is entered into the Param1 field. Also, while the Param1 field shows ON, the Param1 value will be 1 in the test definition. And when the numeric value of Param1 is 1, the numeric-to-string translation result will not be the string 1 but the string ON.

The numeric-symbol assignment is effective for the specified parameter only.

Value and symbol must be in a one-to-one relationship.

The value must satisfy the Min, Max, Digits, and Resolution settings. The symbol must be between 1 and 30 characters.

NOTE

Symbols... numeric-symbol assignment

For parameters defined with a numeric-string assignment, the numeric-to-string translation result will be the symbol assigned to the numeric value. Be careful when using the *string* built-in function that is used to translate a numeric expression to a string value.

For the following example setup of a numeric-symbol assignment, `string(Mode)` execution result at `Mode=0` is the string OFF, not the string 0.

Name=Mode, Value=0, Symbol=OFF

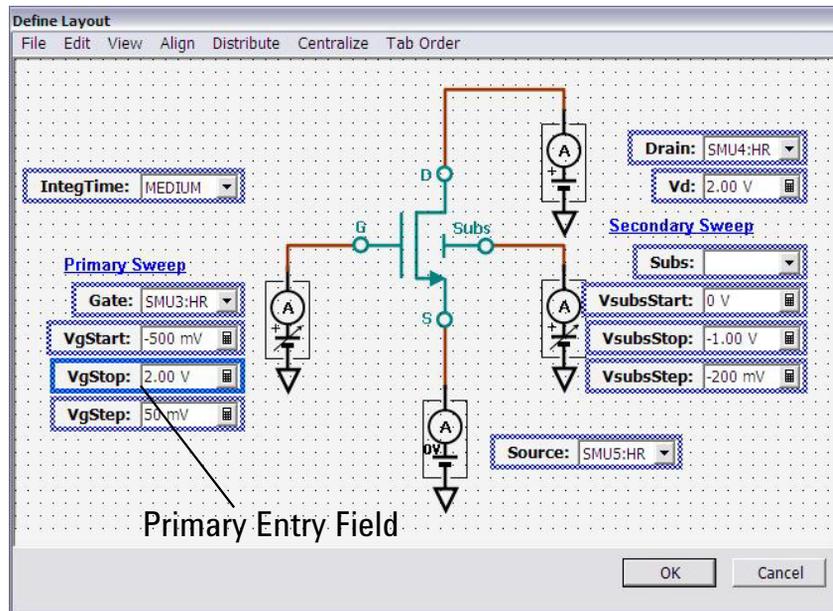
Define Layout

This dialog box is opened by clicking the Layout... button on the Test Specification screen of the Test Definition window, and is used to define the layout of the test parameter entry fields displayed on the application test setup screen. See Figure 6-2.

To define the layout of the entry field, follow the procedures below.

1. Select the entry fields to move. See “To Select Entry Fields” on page 6-13.
2. Move the selected entry fields. See “To Move Entry Fields” on page 6-13.

Figure 6-2 Define Layout dialog box



Define Layout GUI

This section describes the Graphical User Interface of the Define Layout dialog box.

The Define Layout dialog box provides the following buttons.

- | | |
|---------------|--|
| OK | Saves the layout definitions and closes the Define Layout dialog box. |
| Cancel | Closes the Define Layout dialog box without saving the layout definitions. |

The Define Layout dialog box provides the following menus.

| | | |
|------------------------|---------------------|---|
| File menu | Exit | Closes the Define Layout dialog box without saving the layout definitions. |
| Edit menu | Undo | Cancels an operation. Up to ten operations can be cancelled. |
| | Redo | Performs the canceled operation again. |
| | Select All | Selects all entry fields. |
| View menu | Property... | Opens the “Properties (page 6-12)” window. |
| Align menu | Left | Aligns the left ends of other selected entry fields to the left end of the primary entry field. |
| | Center | Aligns the horizontal centers of other selected entry fields to the horizontal center of the primary entry field. |
| | Right | Aligns the right ends of other selected entry fields to the right end of the primary entry field. |
| | Top | Aligns the upper ends of other entry fields to the upper end of the primary entry field. |
| | Middle | Aligns the vertical centers of other selected entry fields to the vertical center of the primary entry field. |
| | Bottom | Aligns the lower ends of other selected entry fields to the lower end of the primary entry field. |
| | To Grid | Aligns the upper left corner of the entry field to the nearest grid. |
| Distribute menu | Horizontally | Distributes the selected entry fields (3 or more) with even horizontal intervals. The leftmost entry field is used as the base point. |
| | Vertically | Distributes the selected entry fields (3 or more) with even vertical intervals. The leftmost entry field is used as the base point. |
| Centralize menu | Horizontally | Moves the horizontal center of all selected entry fields to the horizontal center of the entry field area. |
| | Vertically | Moves the vertical center of all selected entry fields to the vertical center of the entry field area. |

Application Test Definition Test Specification

| | | |
|-----------------------|----------------------|---|
| Tab Order menu | Top to Bottom | Sets the TabIndex in ascending order of the X of the entry fields, starting at the upper left entry field. If the X of the entry fields are equal, the TabIndex is set in ascending order of the Y of the entry fields. For more information on X/Y, see “Properties” on page 6-12. |
| | Left to Right | Sets the TabIndex in ascending order of the Y of the entry fields, starting at the upper left entry field. If the Y of the entry fields are equal, the TabIndex is set in ascending order of the X of entry fields. For more information on X/Y, see “Properties” on page 6-12. |

Properties

This window is opened by clicking the Property... button in the View menu of the Define Layout dialog box, and specifies characteristics of the entry field area or the entry fields.

When the entry field area is selected, the following characteristics can be specified.

| | | |
|-----------------|---|---|
| Design | DrawGrid | Sets whether to display the grid. |
| | GridSize | Sets the width and the height of the grid. |
| | SnapToGrid | Sets whether to snap to the grid. |
| Layout | Size | Sets the width and the height of the entry field area. |
| | When entry fields are selected, following characteristics can be specified. | |
| Behavior | TabIndex | Sets the tab traversing order for the test parameter entry fields of the application test. |
| Layout | Align | Specifies the X origin of the entry field. True: Left edge of the entry field False: Left edge of the parameter name placed to the left of the entry field |
| | Width | Specifies the width of the entry field. |
| | X, Y | Specifies the entry field position. The Y origin is the upper edge of the entry field. (X, Y)=(0, 0) specifies the upper left corner of the entry field area. Values increase downward and rightward. |

To Select Entry Fields

The following methods are available for selecting the entry fields.

- Click on the entry field. Multiple entry fields can be selected by clicking on the entry field while holding down the Ctrl key on the keyboard.
- Drag the mouse to draw a rectangle around multiple entry fields.
- Select Select All from the EDIT menu to select all entry fields.

The selected entry fields are outlined by the blue rectangles. The primary entry field, which is the base for layout operations, is surrounded by a highlighted blue rectangle, as shown in Figure 5-5. Only one primary entry field can be selected. To change the primary entry field, click on a selected entry field. The selected entry field that was most recently clicked will be the primary entry field.

The following methods are available for releasing (unselecting) the selected entry fields.

- Click the selected entry field while holding down the Shift key on the keyboard.
- Click outside of the selected entry fields to release all selected entry fields.

To Move Entry Fields

The following methods are available for defining the layout of the selected entry fields.

- Drag & drop with the mouse to move the selected entry field(s).
- Change the X/Y values in the property window to move the selected entry field(s).
- Press the arrow keys on the keyboard to move the selected entry field(s).
- Using the functions in the Align menu, the selected single or multiple entry fields can be aligned to the primary entry field.
- Use the functions in the Distribute menu to evenly distribute the selected entry horizontally or vertically.
- Use the functions in the Centralize menu to move the horizontal or vertical center of all selected entry fields to the horizontal or vertical center of the entry field area.

Test Output

This setup screen is used to set the test result output (test result display and record) that is the output of the test definition.

The test output setup is optional. If you have the following requirements, define the analysis parameters and set the display parameters.

- To send the test result data to the subsequent tests in an application test
- To make the program branching depends on the test result
- To make the calculation using the test data in the Test Contents
- To display/record the test result of this application test

To read the analysis parameters defined in the application test used in a test definition, use the “External Variable Setup (page 6-23)” dialog box.

Define Own Output Parameters Check this check box to set the test result outputs of the test definition. While this box is checked, the X-Y Graph, List Display, and Parameters areas are available. The test result output will be obtained every execution of the test definition.

Allocate Data Display for each test This field sets the Multi Display function to *Enable*, *Disable*, or *Comply with above level*.

If *Enable* is selected, the test result data of the same test setup name will be displayed on the exclusive Data Display window and the test result data of the different test setup name will be displayed on the new Data Display window.

If *Disable* is selected, the test result data will be always displayed on the singular Data Display window even if it is the test result data of the different test setup name.

Select *Comply with above level* for complying with the Multi Display ON/OFF status or the setting of the application test which uses this application test internally.

Define Analysis Parameters... This button opens the window. This “Analysis Parameter Definition (page 6-15)” window is used to define the vector data and the scalar data used in the test result output. The defined variable is called as the analysis parameter.

X-Y Graph, List Display, Parameters The areas are used to set the test result output (test result display and record) that is the output of the test definition. See “Display Setup” on page 5-46.

Analysis Parameter Definition

This window is opened by clicking the Define Analysis Parameters button, and is used to define the vector variables and the scalar variables used in the test result output. The variables are called as the analysis parameters. This window is closed by the Close button.

NOTE

Analysis parameters can be referred from a test definition which uses this application test. To read the value, make a mapping table between the analysis parameters and the local variables, device parameters, test parameters, or analysis parameters defined in the test definition by using the “External Variable Setup (page 6-23)” dialog box.

Vector Parameters

This area sets the analysis parameters for the vector data. The vector data is an array data that contains numeric data more than one.

| | |
|--------------------|---|
| Name | Name of the analysis parameter |
| Unit | Unit of the analysis parameter |
| Description | Description of the analysis parameter |
| Add | Adds a row for the parameter. |
| Delete | Deletes the selected parameter. To select the parameter, use the left radio button. |
| Up | Moves the selected parameter upward. |
| Down | Moves the selected parameter downward. |

Scalar Parameters

This area sets the analysis parameters for the scalar data. The scalar data is a numeric data.

| | |
|--------------------|---|
| Name | Name of the analysis parameter |
| Unit | Unit of the analysis parameter |
| Description | Description of the analysis parameter |
| Add | Adds a row for the parameter. |
| Delete | Deletes the selected parameter. To select the parameter, use the left radio button. |
| Up | Moves the selected parameter upward. |
| Down | Moves the selected parameter downward. |

Test Contents

Test contents are the core of the test definition, and consists of the local variables, test setups, and test execution flow. In the test contents, the following elements can be defined. See Figure 6-3.

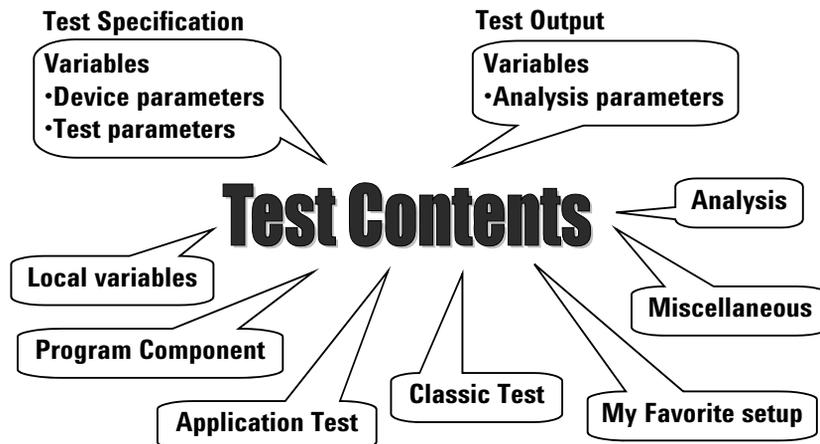
- Local variables
- Program components
- Application tests
- Classic tests
- My Favorite setup
- Analysis components
- Miscellaneous components
- Device parameters defined in Test Specification
- Test parameters defined in Test Specification
- Analysis parameters defined in Test Output

The device parameters, test parameters, and analysis parameters can be used in the Test Contents without defining as the local variables.

For the available components, see Figure 6-4.

Figure 6-3

Test Contents



Defining/Editing Test Contents

The Test Contents setup screen is used to define the test execution flow that is the core of the test definition. To define the test execution flow, use the test flow list area at the lower left of the window, and do following. Also see Figure 6-5.

1. Define local variables by using the Local Variables Definition statement.
2. Select a component from the component selection area. See Figure 6-4 for the available components.
3. Insert it between the BLOCK and END BLOCK statements.
4. Repeat this until your test execution flow is completed.

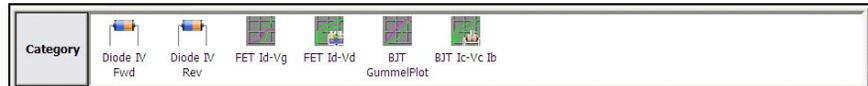
Figure 6-4

Available Components

Program Component



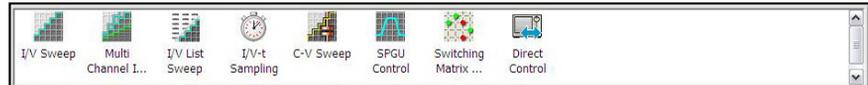
Application Test



Analysis



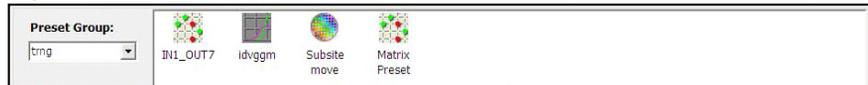
Classic Test



Miscellaneous



My Favorite



Application Test Definition

Test Contents

- Program Component** This component selection menu lists the program components available for the test flow. See “Program Component” on page 6-26.
- Application Test** This menu lists the application test setups available for the user. Inserting an application test setup to the test flow displays the test setup screen almost same as the “Application Test” on page 4-27. You set the test condition on this screen.
- Variables can be used for setting the test condition. To use a Numeric or Module variable, enter the variable name to the entry field. To use a String variable, type an equal sign (=) and enter the variable name (for example, =VAR).
- Clicking the Assign to external variables... button opens the External Variable Setup dialog box. See “External Variable Setup” on page 6-23.
- Analysis** This component selection menu lists the analysis functions available for the test flow, and provides the following components.
- “Auto Analysis” on page 6-27
 - “Display Data Setup” on page 6-31
 - “Data Display Control” on page 6-30
- Classic Test** This component selection menu lists the classic test objects, I/V Sweep, Multi Channel I/V Sweep, I/V List Sweep, I/V-t Sampling, C-V Sweep, SPGU Control Switching Matrix Control, and Direct Control.
- Inserting a classic test component to the test flow displays the test setup screen almost same as the “I/V Sweep” on page 5-4, “Multi Channel I/V Sweep” on page 5-9, “I/V List Sweep” on page 5-13, “I/V-t Sampling” on page 5-21, “C-V Sweep” on page 5-26, “SPGU Control” on page 5-57, “Switching Matrix Control” on page 5-55, or “Direct Control” on page 5-30. You set the test condition on the screen.
- Clicking the Assign to external variables... button opens the External Variable Setup dialog box. See “External Variable Setup” on page 6-23.
- My Favorite Setup** This component selection menu is used to select the My Favorite setup inserted to the test flow. Specify the preset group, then select the setup.

Miscellaneous

This component selection menu lists the miscellaneous functions available for the test flow, and provides the following components.

- “GPIB I/O” on page 6-33
- “Message” on page 6-38
- “Command Execution” on page 6-40
- “Data Store Control” on page 6-39

To add a component to the test flow, select the destination line for the component and drag the component from the component selection area to the test flow list area. Instead, you can select a line and a component, then click the Insert button. The component will be put on the line after the selected line, and the following lines will shift downward.

After adding a component to the test flow, selecting the new line might display an editor at the center to lower right of the window. The editor is used to define the setup. Some components provide the editor, and some components do not. For example, the Local Variables Definition provides the editor used to define the local variables. See “Local Variable Definition” on page 6-24.

You can edit the test flow by using the Block Selection/Line Selection, Insert, Delete, Copy, Cut, and Paste buttons. Also you can debug the test flow by using the Run/Pause, Abort, Step, Break, and Inspect buttons. See “Debugging Test Contents” on page 6-21.

Edit / Debug

The Edit tab displays the buttons Block Selection/Line Selection, Insert, Delete, Copy, Cut, and Paste.

The Debug tab displays the buttons Run, Abort, Step, Break, and Inspect.

Only the buttons effective for the selected line in the list area are active.

Block Selection / Line Selection

The Line Selection button changes the list area selection mode to the line selection mode. The Block Selection button changes the selection mode to the block selection.

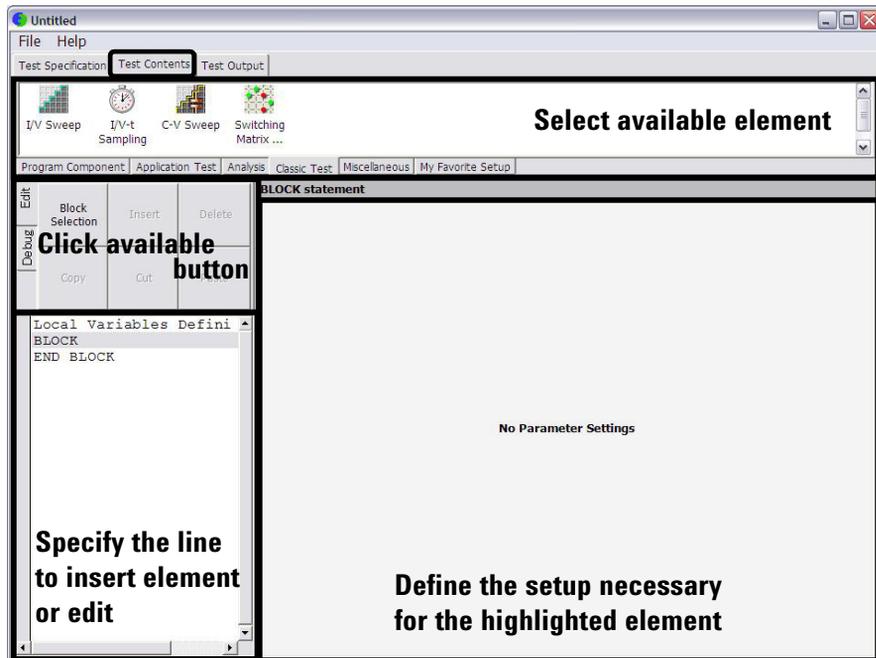
In the line selection mode, the line cursor selects every line.

In the block selection mode, the line cursor selects every block. For example, the lines from the IF statement to END IF statement can be a block.

Application Test Definition Test Contents

- Insert** This button puts the selected component on the next line of the selected line. The following lines will shift downward.
- Delete** This button deletes the selected line. The following lines will shift upward.
- Copy** This button copies the selected line to the clipboard.
- Cut** This button moves the selected line to the clipboard. The following lines will shift upward.
- Paste** This button puts the components in the clipboard on the next line of the selected line. The following lines will shift downward.

Figure 6-5 Test Contents Screen

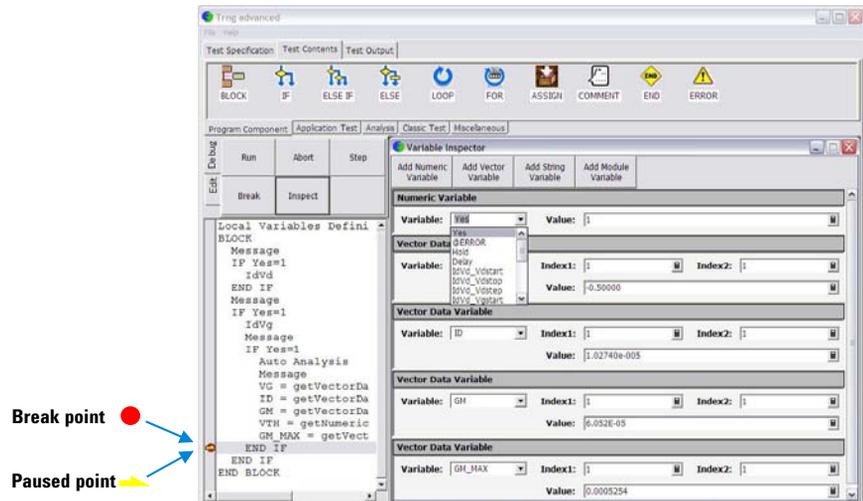


Debugging Test Contents

On the Test Contents tab screen, click the Debug tab. The following buttons will appear. They are useful for debug of your test contents.

Set the break point, and click the Run button. And check the operation of the test contents, the value of variables by using the Variable Inspector, and so on.

Figure 6-6 Debugging Test Contents



Run/Pause

This button starts the debug (executes the test flow). During execution, the label changes to Pause. Clicking Pause pauses the execution, and changes the label to Run that is used to continue the debug (execution).

Abort

This button aborts the debug (execution).

Step

This button executes the selected line of the test flow. Clicking the button repeatedly continues the execution by a line.

Break

This button sets/releases the break point. For the break point, this button releases the break point from the selected line. Program execution will break at the break point automatically.

Inspect

This button is available when the debug (execution) is paused or broken. This button opens the Variable Inspector used to monitor value of device parameters, test parameters, analysis parameters, local variables, or system variables. See “Variable Inspector” on page 6-22.

Variable Inspector

This Variable Inspector is displayed by clicking the “Inspect (page 6-21)” button on the Test Contents screen, and is used to monitor or change the value of the local variables, device parameters, test parameters, and analysis parameters. For the vector variables, only data monitor is available. The Variable Inspector provides the following buttons to add the variable monitor area.

Add Numeric Variable Adds the numeric variable monitor area.

Add Vector Variable Adds the vector variable monitor area.

Add String Variable Adds the string variable monitor area.

Add Module Variable Adds the module variable monitor area.

The following functions are available for the menu displayed by clicking the banner of the variable monitor area.

Up This button shifts the variable monitor area upward.

Down This button shifts the variable monitor area downward.

Remove This button deletes the variable monitor area.

Numeric Variable You can monitor or change the following information.

Variable Numeric variable name

Value Value of the variable

Vector Variable You can monitor the following information.

Name Vector variable name. Two dimensional array.

Index1/2 Index for the primary/secondary plane of the two-dimensional array

Value Value of the variable

String Variable You can monitor or change the following information.

Variable String variable name

Value Value of the variable

Module Variable You can monitor or change the following information.

Variable Module variable name

Value Value of the variable

External Variable Setup

This dialog box is displayed by clicking the Assign to external variable... button on an Application Test setup screen or a Classic Test setup screen, and is used to make a mapping table between the test setup internal variables and the local variables, device parameters, test parameters, or analysis parameters defined in the test definition which uses this test setup. After making the mapping table, you can read the value by using the external variables.

This dialog box provides the following buttons.

- Add** Adds the variable entry fields.
- Delete** Deletes the variable entry fields selected by the radio button.
- Up** Shifts the selected variable entry fields upward.
- Down** Shifts the selected variable entry fields downward.

This dialog box provides the following entry fields.

- External variable** Name of local variable, device parameter, test parameter, or analysis parameter connected with the variable set to the Measurement data field
- Measurement data** Name of internal variable used in a test setup and to be read. For the Application Test, only the analysis parameters are available.
- Example**

The following example connects the internal vector variable Vdata with the local variable VDATA.

 1. Define VDATA as a local variable by using the Local Variables Definition statement.
 2. Click the Assign to external variable... button on a test setup screen.
 3. Click the Add button on the External Variable Setup dialog box.
 4. Set VDATA to the External variable field.
 5. Set Vdata to the Measurement data field.
 6. Click the Close button.

Local Variable Definition

This setup editor is displayed while the Local Variable Definition is selected in the test execution flow list area, and is used to define the variables used in the test definition. The setup editor provides the following buttons to add the variables.

Add Numeric Variable Adds the numeric variable.

Add Vector Variable Adds the vector variable.

Add String Variable Adds the string variable.

Add Module Variable Adds the module variable.

The following functions are available for the menu appeared by clicking the banner of the variable area.

Up This button shifts the variable area upward.

Down This button shifts the variable area downward.

Remove This button deletes the variable.

Numeric Variable This area provides the following entry fields.

Name Numeric variable name

Value Initial value of the variable

Description Additional information for the variable

Vector Variable

This area provides the following entry fields.

Name Vector variable name. Two dimensional array.

Count Number of elements, or array size

Description Additional information for the variable

This area also provides the following radio button used to specify how to set the initial value of the array data automatically.

- Assign Linear Values FROM [*value of first element*] TO [*value of last element*]
If *Count* > 1, this sets $first\ value + (N-1) \times (last\ value - first\ value) / (Count - 1)$ to the *N*-th element. If *Count* = 1, this sets *first value* (=last value) to the element.
- Assign Linear Values FROM [*value of first element*] STEP [*step value*]
This sets $first\ value + (N-1) \times step$ to the *N*-th element.

String Variable

This area provides the following entry fields.

Name String variable name

Value Initial value of the variable

Description Additional information for the variable

Module Variable

This area provides the following entry fields.

Name Module variable name

Description Additional information for the variable

Program Component

The Program Component selection menu provides the components described in “Script Program Statements” on page 8-19. Especially, the following components provide the setup editor.

- “ASSIGN”
- “COMMENT”
- “IF”
- “ELSE IF”
- “FOR”

ASSIGN

This component provides the setup editor that contains the following entry fields used to define the value of the variable.

| | |
|-------------------|----------------------------|
| Variable | Variable name |
| Expression | Definition of the variable |

COMMENT

This component provides the setup editor used to enter the comment for the line.

IF

This component provides the setup editor used to enter the condition for the IF statement.

ELSE IF

This component provides the setup editor used to enter the condition for the ELSE IF statement.

FOR

This component provides the setup editor that contains the following entry fields used to define the FOR NEXT loop condition.

| | |
|------------------------|--------------------------------------|
| Variable | Variable name |
| Initial Value | Count to start the FOR NEXT loop |
| Terminate Value | Count to terminate the FOR NEXT loop |
| Step Value | Loop count incremental step value |

Auto Analysis

This component provides the setup editor used to set up the automatic analysis function. When a measurement finishes, the function automatically draws lines, a marker, or both on the X-Y Graph of the Data Display window.

You can set up two lines and one marker for the automatic analysis function by using the setup editor.

In the Line 1 and Line 2 areas, you can set up the lines to be drawn.

In the Marker area, you can set up the marker.

Interpolation Mode Check this box to enable the interpolation mode. You can position marker between measurement points.

Line 1, Line 2 This area sets the line 1 or line 2 automatically displayed and moved to the specified position after the measurement.

Enable Check this box to enable the line.

Fix Check this box to fix the line on the graph after the auto analysis is performed. Remove the check to make the line free.

Type Select one of the available line types listed below.

Axis Axis effective for the line. Specify one from Y1 to Y8.

First Point See the following description for the line you selected.

Second Point See the following description for the line you selected.

Available line types:

- “Normal line”: For drawing a line between *any two* points.
- “Gradient line”: For drawing a line through *any point* with a specified gradient.
- “Tangent line”: For drawing a tangent line to a *measurement* point.
- “Regression line”: For drawing a regression line by using the measurement data included in the area specified by *any two* points.

Application Test Definition

Auto Analysis

Marker

This area sets the marker automatically displayed and moved to the specified position after the measurement.

Enable Check this box to enable the marker.

Condition Enter a variable name and a condition expression to specify where you want the marker to appear.

After Check this box to enable the additional condition.

Enter a second variable and condition expression. This sets up a search start condition for finding specified point.

For example, you can specify the following expressions to search for a measurement point that satisfies the first condition after the second condition is satisfied.

Condition:[DGM]=[MAX(DGM)*0.01] [x] After [DGM]=[MAX(DGM)]

Normal line

The First Point area and the Second Point area are used to specify the points the line passes through. The following two ways are available to specify the point.

- X-Y Coordinate

Enter the desired X-Y coordinate values or expressions in the X and Y fields.

- Data Condition

Enter a variable name and condition expression to specify the point. This is the same method as specifying the Marker point.

Gradient line

The First Point area is used to specify the point the line passes through. The following two ways are available to specify the point.

- X-Y Coordinate

Enter the desired X-Y coordinate values or expressions in the X and Y fields.

- Data Condition

Enter a variable name and condition expression to specify the point. This is the same method as specifying the Marker point.

In the Gradient field, enter a gradient value or expression.

Tangent line

The First Point area is used to specify the measurement point the tangent line passes through.

Enter a variable name and condition expression to specify the point. This is the same method as specifying the Marker point.

Regression line

The First Point area and the Second Point area are used to specify the range of the measurement data used for the regression calculation. The following two ways are available to specify the point.

- X-Y Coordinate

Enter the desired X-Y coordinate values or expressions in the X and Y fields.

- Data Condition

Enter a variable name and condition expression to specify the point. This is the same method as specifying the Marker point.

Data Display Control

This component enables or disables the test result display of the application test or the classic test used in the test definition.

Enable Data Display Checking this box enables the test result display.

If you do not use this component, the test result display is enabled.

This component cannot control the test result display of the test definition. The test result display is always enabled for the test definition. For the test result output of the test definition, see “Test Output” on page 6-14.

Display Data Setup

This component is used to set the data output of the local variables defined in the test execution flow. The values can be displayed on the Data Display window.

X-Y Graph

Selects the data to be displayed in the X-Y Graph Plot area. The X and Y1 to Y8 axes can be set.

| | |
|----------------|---|
| Name | Specifies the parameter for the axis. |
| Sharing | <p>Specifies the group for sharing the Y axis scale. Select from Group 1, Group 2, Group 3, Group 4, or None (no grouping).</p> <p>The Scale, Min, and Max values are shared by the Y axes in the same group. The scale set by Run Time Auto Scale, Auto Scale, Zoom in, and/or Zoom out are also shared.</p> <p>If another layer on the Data Display window contains an X-Y trace which has the same name for both its grouped Y parameter and its X parameter, the scaling will also be shared by this X-Y trace.</p> |
| Scale | Scale of the axis, Linear or Log |
| Min | Minimum value of the axis |
| Max | Maximum value of the axis |
| Add | Adds a parameter (or axis). |
| Delete | Deletes the parameter selected with the radio button on the left. |
| Up | Moves the selected parameter upward. |
| Down | Moves the selected parameter downward. |

Application Test Definition
Display Data Setup

**List Display,
Parameters**

The List Display area sets the output for the List Display area of the Data Display window. The Parameters area sets the output for the Parameters area of the Data Display window. Up to 20 parameters can be set for each area.

| | |
|------------------|---|
| parameter | Specifies the parameter for the data output. |
| Add | Adds a row for the parameter. |
| Delete | Deletes the selected parameter. To select the parameter, use the left radio button. |
| Up | Moves the selected parameter upward. |
| Down | Moves the selected parameter downward. |

GPIB I/O

This component provides the setup editor that contains the following entry fields. This component is used to control the GPIB interface. For the fields to enter a variable name, only the variable name defined in the test definition can be entered.

CAUTION

Do not set the GPIB address of the B1500A to the Address parameter of this component even if this is on the Desktop EasyEXPERT software. Operation of the B1500A is not guaranteed.

Write String

Sends the specified string data to the specified GPIB device.

| | |
|-------------------|---|
| Address | GPIB address of the target device |
| String | String value to send |
| Terminator | Terminator, DEFAULT, EOI, CR/LF+EOI, LF+EOI, CR/LF, LF, or NONE (not specified) |

Write Value

Translates the specified numeric data to the string data, and sends it to the specified GPIB device.

| | |
|-------------------|--|
| Address | GPIB address of the target device |
| Format | Format of Write Value. Follow Agilent T&M Programmers Toolkit. |
| Value0 | Numeric value or string value to send |
| Value1 | Numeric value or string value to send |
| Value2 | Numeric value or string value to send |
| Value3 | Numeric value or string value to send |
| Terminator | Terminator, DEFAULT, EOI, CR/LF+EOI, LF+EOI, CR/LF, LF, or NONE (not specified). |

Application Test Definition

GPIB I/O

Read String

Reads a string value from the specified GPIB device.

| | |
|-----------------------------|---|
| Address | GPIB address of the target device |
| String | String variable name. Used to store the returned value. |
| Length To Read | Byte length of the string value to read |
| Length Actually Read | Numeric variable name. Used to store the byte length of the returned value. If the Length To Read is large enough and the terminator is sent with the returned string value, the value of this numeric variable is smaller than the specified Length To Read. |
| Terminator | Terminator, DEFAULT, EOI, CR/LF+EOI, LF+EOI, CR/LF, LF, or NONE (not specified) |
| Terminated | Numeric variable name. Used to store the execution result. If reading is completed by the terminator, 1 is entered. Otherwise, 0 is entered. |
| Timeout | Timeout. The value must be less than 2^{31} s, 1 ms resolution. 0 does not set timeout. |

Read Value

Reads a numeric value from the specified GPIB device.

| | |
|-------------------|---|
| Address | GPIB address of the target device |
| Value | Numeric variable name. Used to store the returned value. |
| Preamble | String variable name. Used to store preamble of the returned value. The preamble is a part considered as non-numeric value. If this field is not set, the preamble is deleted. |
| Postamble | String variable name. Used to store postamble of the returned value. The postamble is a part considered as non-numeric value. If this field is not set, the postamble is deleted. |
| Success | Numeric variable name. Used to store the execution result. For the successful result, 1 is entered. Otherwise, 0 is entered. |
| Terminator | Terminator, DEFAULT, EOI, CR/LF+EOI, LF+EOI, CR/LF, LF, or NONE (not specified) |
| Timeout | Timeout. The value must be less than 2^{31} s, 1 ms resolution. 0 does not set timeout. |

Read List

Reads a vector data from the specified GPIB device.

| | |
|-----------------------------|---|
| Address | GPIB address of the target device |
| Values | Vector variable name. Used to store the returned value. |
| Delimiter | Delimiter. 1 character. 0 to 9, E, e, +, -, and . (comma) cannot be specified. |
| Length Actually Read | Numeric variable name. Used to store the number of data stored in the vector variable. |
| Terminator | Terminator, DEFAULT, EOI, CR/LF+EOI, LF+EOI, CR/LF, LF, or NONE (not specified) |
| Timeout | Timeout. The value must be less than 2^{31} s, 1 ms resolution. 0 does not set timeout. |

Read STB

Reads the status byte of the specified GPIB device.

| | |
|--------------------|---|
| Address | GPIB address of the target device |
| Status Byte | Numeric variable name. Used to store the status byte to read. |
| Timeout | Timeout. The value must be less than 2^{31} s, 1 ms resolution. 0 does not set timeout. |

GP-IB Control

This area selects one from the following GPIB statements to execute.

- Group Execution Trigger

Sends a trigger to the specified GPIB device.

| | |
|----------------|---|
| Address | GPIB address of the target device |
| Timeout | Timeout. The value must be less than 2^{31} s, 1 ms resolution. 0 does not set timeout. |

- Device Clear

Sends a device clear to the specified GPIB device.

| | |
|----------------|---|
| Address | GPIB address of the target device |
| Timeout | Timeout. The value must be less than 2^{31} s, 1 ms resolution. 0 does not set timeout. |

Application Test Definition

GPIB I/O

- Go To Local

Returns the specified GPIB device to the local state.

Address GPIB address of the target device

Timeout Timeout. The value must be less than 2^{31} s, 1 ms resolution. 0 does not set timeout.

- Local LockOut

Locks the specified GPIB device.

Address GPIB address of the target device

Timeout Timeout. The value must be less than 2^{31} s, 1 ms resolution. 0 does not set timeout.

Example 1

To send the following command to Agilent B2200A switching matrix (GPIB address 22), use Write Value function and enter the parameters as shown below.

```
:ROUT:SYMB:CHAN 0, 1, "Gate"
```

This command assigns the string Gate to the output 1 of the B2200A in the auto configuration mode.

- Write Value:

Address 22

Format :ROUT:SYMB:CHAN {0}, {1}, "{2}"

Value0 0

Value1 1

Value2 Gate

Value3 (blank)

Terminator LF+EOI

where, {0}, {1}, {2}, and {3} are the variables that can be used in the Format field, and corresponds to the Value0, Value1, Value2, and Value3 respectively.

Example 2

After performing Example 1, enter the following query command and read the response by using Write String and Read String functions as shown below. Use Write String to send the command, after that use Read String to read the response.

:ROUT:SYMB:CHAN? 0, 1

This command returns the string assigned to the output 1 of the B2200A in the auto configuration mode.

- Write String:

| | |
|-------------------|-----------------------|
| Address | 22 |
| String | :ROUT:SYMB:CHAN? 0, 1 |
| Terminator | LF+EOI |

- Read String:

| | |
|-----------------------------|---------------|
| Address | 22 |
| String | ReturnedValue |
| Length To Read | 10 |
| Length Actually Read | Length1 |
| Terminator | LF+EOI |
| Terminated | Term |
| Timeout | 1.00 s |

where, ReturnedValue is a string variable to store the response of the :ROUT:SYMB:CHAN? 0, 1 command, Length1 is a numeric variable to store the byte length of the ReturnedValue value, and Term is a numeric variable to store the execution result. They must be defined in the Local Variables Definition statement.

Message

This component provides the setup editor that contains the following entry fields. These are used to set up the message box that pauses program execution, appears on the screen, and waits for the response of the user.

Message

Enter the message displayed on the message box.

User Response

This area provides the Button 1, Button 2, Button 3, and Button 4 areas.

Button 1

This area provides the following entry fields.

Label Label or name of the button placed at the left side

Selected Variable name used in the test definition. The variable is used to store the response of the user. The returned value is 1 if the message box is closed by clicking this button. Otherwise, the returned value is 0.

Button 2

This area provides the following entry fields.

Label Label or name of the button placed at the second from the left

Selected Variable name used in the test definition. The variable is used to store the response of the user. The returned value is 1 if the message box is closed by clicking this button. Otherwise, the returned value is 0.

Button 3

This area provides the following entry fields.

Label Label or name of the button placed at the second from the right

Selected Variable name used in the test definition. The variable is used to store the response of the user. The returned value is 1 if the message box is closed by clicking this button. Otherwise, the returned value is 0.

Button 4

This area provides the following entry fields.

Label Label or name of the button placed at the right side

Selected Variable name used in the test definition. The variable is used to store the response of the user. The returned value is 1 if the message box is closed by clicking this button. Otherwise, the returned value is 0.

Data Store Control

This component enables or disables the test record of the application test or the classic test used in the test definition.

Enable Creating Test Result Record

Checking this box enables the test record.

If you do not use this component, the test record is enabled.

This component cannot control the test record of the test definition. The test record is always enabled for the test definition. For the test result output of the test definition, see “Test Output” on page 6-14.

Command Execution

This component provides the setup editor that contains the following entry fields. This component is used to execute the specified execution file (EXE file) and obtain the execution results. For the fields to enter a variable name, only the variable name defined in the test definition can be entered. See “Using Command Execution” on page 6-42.

**Command
Filename**

File name of the Windows execution file (EXE file) to execute.

Argument

Argument or parameter to pass to the EXE file.

Write Type

Type of data to write. String (string data) or List (vector data).

- String

Displays the Write String area used to specify the string data to write. Up to 20 string data can be defined.

- List

Displays the Write List area that provides the following entry fields.

Values Variable name of the List data to be passed to the EXE file.

Format

If you do not specify Format, this function passes the List data to the EXE file. To pass a data in the List data, enter the keyword to specify the element. See “Defining Format Field” on page 6-45.

Read Type

Type of data to read. String (string data), Value (numeric data), List (vector data), or None (no response).

- String

Displays the Read String area that provides the following entry fields.

Result Numeric variable name. Used to store the execution result.

String String variable name. Used to store the returned value.

Length

Actually Read Numeric variable name. Used to store the byte length of the returned value.

- Value

Displays the Read Value area that provides the following entry fields.

Result Numeric variable name. Used to store the execution result.

Value Numeric variable name. Used to store the returned value.

- List

Displays the Read List area that provides the following entry fields.

Result Numeric variable name. Used to store the execution result.

Values Vector variable name. Used to store the returned value.

- None

This type is for the EXE file without response or data to read.

Using Command Execution

Windows execution file (.exe file) can be executed by using the Command Execution component. Most execution files will need parameters to be sent or returned. The parameters will be variables that can be defined on the Test Specification tab screen or the Local Variable Definition component on the Test Contents tab screen.

This section describes how to enter the windows execution file.

- “Command Parameters”
- “Defining Numeric/Vector Input Parameter”
- “Defining String/Numeric Input Parameters”
- “Defining Numeric Output Parameter”
- “Defining Vector Output Parameter”
- “Defining String Output Parameter”
- “Defining Format Field”

Command Parameters

The Windows Command Execution component supports one input variable and one output variable. To use multiple string input parameters or multiple numeric input parameters, set the variable as shown below. Multiple vector input parameters and multiple output parameters are not supported.

- If the command requires multiple string input parameters, use string variables. In the Windows Command Execution component, set the Write Type to String. Up to 20 string data can be defined.
- If the command requires multiple numeric input parameters, use numeric variables and set the Write Type to String. To enter the numeric variable name, use the *string* built-in function. For example, enter `string(Rz)` to set the Rz numeric variable.
- If the command requires both numeric and string input parameters, use numeric and string variables respectively, and set the Write Type to String.

NOTE

Before calling the command, enter the value to the input variable by using the ASSIGN statement.

NOTE

string built-in function

The *string* built-in function is used to translate a numeric expression to a string value. Be careful about the argument for this function. If it is a numeric variable defined with the numeric-symbol assignment, the *string* function execution result will be the symbol assigned to the numeric value, not the string value just translated from the numeric value. The numeric-symbol assignment is defined in the “Test Specification” on page 6-5.

For the following example setup of the numeric-symbol assignment, `string(Mode)` execution result at `Mode=0` is the string `OFF`, not the string `0`.

Parameter `Mode`, `Value=0`, `Symbol=OFF`

Defining Numeric/Vector Input Parameter

1. Define a vector variable in the Test Specification tab screen or the Local Variable Definition component of the Test Contents tab screen.
2. Set the Write Type to List in the Windows Command Execution component.
3. Enter the variable name in the Values field of the Write List area.

For the numeric parameter, a data element of vector variable is used to store the data for the parameter. Specify the data by using the Format field. For example, enter `{ 0 }` to specify the data in the first element of the vector variable. For the Format field, see “Defining Format Field” on page 6-45.

For the vector parameter, ignore the Format field.

Defining String/Numeric Input Parameters

1. Define string or numeric variables in the Test Specification tab screen or the Local Variable Definition component in the Test Contents tab screen.
2. Set the Write Type to String in the Windows Command Execution component.
3. Add a line in the Write String area.
4. Enter the variable name for the first input parameter in the first line.

If the command needs multiple input parameters, add a line and enter the variable name for the variable in the added line. Then observe the order of parameters.

To enter a numeric variable name, use the *string* built-in function. For example, enter `string(Rz)` to set the `Rz` numeric variable.

Defining Numeric Output Parameter

1. Define a numeric variable in the Test Specification tab screen or the Local Variable Definition component of the Test Contents tab screen.
2. Set the Read Type to Value in the Windows Command Execution component.
3. Enter the variable name in the Value field of the Read Value area.

The Result field can be blank or the name of another numeric variable defined in the Test Specification or Local Variable Definition. The variable will be used to receive the command execution result.

Defining Vector Output Parameter

1. Define a vector variable in the Test Specification tab screen or the Local Variable Definition component of the Test Contents tab screen.
2. Set the Read Type to List in the Windows Command Execution component.
3. Enter the variable name in the Values field of the Read List area.

The Result field can be blank or the name of a numeric variable defined in the Test Specification or Local Variable Definition. The variable will be used to receive the command execution result.

Defining String Output Parameter

1. Define a string variable in the Test Specification tab screen or the Local Variable Definition component of the Test Contents tab screen.
2. Set the Read Type to String in the Windows Command Execution component.
3. Enter the variable name in the String field of the Read String area.

The Result field and the Length Actually Read field can be blank or the name of a numeric variable defined in the Test Specification or Local Variable Definition. The variable will be used to receive the command execution result or the length of the returned string data.

Defining Format Field

The Format field requires a keyword to specify a data in vector variable. The keyword must have the style such as {I,A:F}. where,

- I** Index used to specify the element. Integer, 0 or positive number. Mandatory. 0 specifies the first element.
- A** Character length of the specified data element. Positive integer for right-aligned, or negative integer for left-aligned. If this value is not set, the length is not specified (no limit).
- F** Style of the data. See Table 6-1. If this value is not set, G is selected..

Following are the example formats. For more information, see online help or manual of Agilent T&M Programmers Toolkit.

- {0,5:E} First element, five characters, exponential notation
- {1,10} Second element, 10 characters, general
- {2:x} Third element, no limit for length, hexadecimal numeric
- {3} Fourth element, no limit for length, general

Table 6-1

Available F values

| F | Meaning | F | Meaning |
|----------|----------------------|----------|---------------------|
| C or c | Circulation | N or n | Numeric |
| D or d | Decimal numeric | P or p | Percent |
| E or e | Exponential notation | R or r | Round trip |
| F or f | Fixed point | X or x | Hexadecimal numeric |
| G or g | General | | |

Setup Example

The following example setup is used to execute a `PlsdivMeasureId` command that has two numeric inputs and four numeric outputs.

ranging and *id_range* are numeric variables used for the input parameters, *read_data* is a vector variable used for the output parameters, and *PassFail* is a numeric variable used to store the command execution result. They must be defined in the Test Specification tab screen or the Local Variable Definition component on the Test Contents tab screen. Input parameter values must be set to the variables before executing the command. Four data will be assigned to *read_data* in sequence.

Figure 6-7

Windows Command Execution Setup Example

Windows Command Execution

Command Filename: Browse...

Argument:

Write Type: String List

Read Type: String Value List None

Write String

Add Delete Up Down

string(ranging)

string(id_range)

Read List

Result:

Values:

7

Function Details

Function Details

This chapter explains the following measurement functions of Agilent B1500A/EasyEXPERT, and the efficient functions of the EasyEXPERT software.

- “I/V Sweep Measurement”
- “Multi Channel I/V Sweep Measurement”
- “I/V-t Sampling Measurement”
- “C-V Sweep Measurement”
- “SPGU Module”
- “Sweep Abort Function”
- “Standby Function”
- “Bias Hold Function”
- “Current Offset Cancel”
- “SMU CMU Unify Unit”
- “Atto Sense and Switch Unit”
- “SMU/PG Selector”
- “SMU Ranging Mode”
- “SMU Compliance”
- “SMU Pulse”
- “SMU Measurement Time”
- “SMU Filter”
- “SMU Series Resistor”
- “Interlock Function”
- “Auto Power Off Function”
- “Initial Settings”

I/V Sweep Measurement

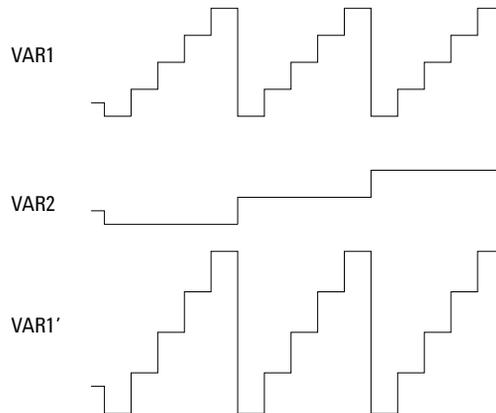
For the I/V sweep measurements, sweep source channels (SMU) perform staircase sweep output of voltage or current, while monitor channels (SMU) measure voltage or current for each sweep step. According to the output function, the following measurements are available. See Figure 7-1 for the SMU output function.

- “Basic Sweep Measurement” by using VAR1 function
- “Subordinate Sweep Measurement” by using VAR1 and VAR1’ functions
- “Synchronous Sweep Measurement” by using VAR1 and VAR2 functions, VAR1’ function is also available
- “Pulsed Sweep Measurement”

This is the basic, subordinate, or synchronous sweep measurement using a pulse output SMU. Only one pulse output SMU is available.

Figure 7-1

SMU Output Function and Sweep Output



Available Modules

SMUs and SPGUs can be used. SMU can be constant voltage/current source or pulse voltage/current source and perform voltage/current measurement. SPGU can be pulse voltage source. See “SPGU Module” on page 7-26 for using the SPGU.

If multiple measurement channels are used, the channels perform measurement in order. See “Multiple Measurement Channels” on page 7-61.

Output Range

Output range of the sweep source channel is automatically set to the following range.

- minimum range covers all sweep output values in Linear sweep.
- minimum range covers all sweep output values in Log voltage sweep.
- optimum range for output value every sweep step in Log current sweep.

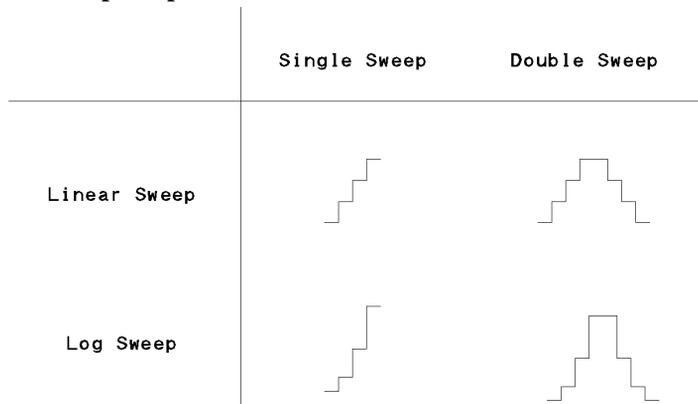
Basic Sweep Measurement

Basic sweep measurement uses the primary sweep source (VAR1). You can select any combination of Direction and Linear/Log as shown in Figure 7-2.

- Direction
 - Single source channel sweeps the output from user specified *start* value to *stop* value.
 - Double source channel sweeps the output from user specified *start* value to *stop* value, then from *stop* value to *start* value.
- Linear/Log
 - Linear staircase
 - Logarithmic staircase

Figure 7-2

Staircase Sweep Outputs



See “I/V Sweep” on page 5-4 for the GUI.

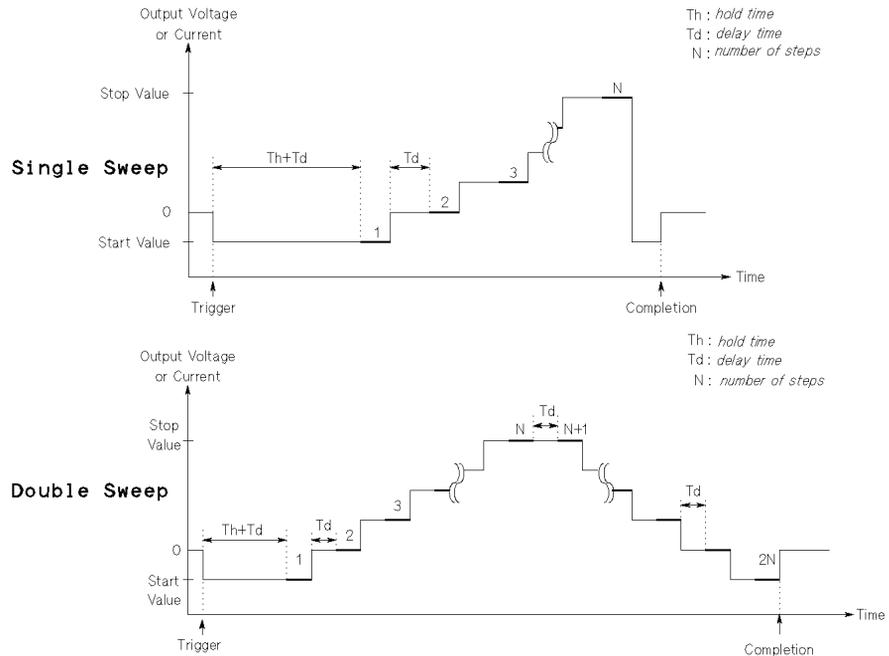
The following setup is required to perform the basic sweep measurements.

1. Select the following on the Channel Setup tab screen.
 - Select VAR1 for the Function of the SMU used for VAR1.
 - Select V, VPULSE, or COMMON for the Mode of current monitor SMU, or I or IPULSE for voltage monitor SMU. Pulse is available only for one SMU.
2. Specify the following parameters for VAR1 on the Measurement Setup tab screen.

| | |
|--------------------------------|---|
| <i>Direction</i> | Single or double sweep. |
| <i>Linear/Log</i> | Linear or logarithmic sweep. For logarithmic sweep, the number steps in one decade is 10, 25, or 50. |
| <i>Start</i> | Start value of sweep. Allowable range of <i>start</i> depends on output range of sweep source. For logarithmic sweep, <i>start</i> must not be zero. |
| <i>Stop</i> | Stop value of single sweep or turning back value of double sweep. Allowable range of <i>stop</i> depends on output range of sweep source. For logarithmic sweep, <i>stop</i> must have same polarity as <i>start</i> , and must not be zero. |
| <i>Step, No of Step</i> | <p>For linear sweep, <i>step</i> is step increment of sweep. <i>No of Step</i> is calculated from <i>start</i>, <i>stop</i>, and <i>step</i>.</p> <p>For logarithmic sweep, <i>step</i> is invalid. Number of sweep steps is calculated from <i>start</i>, <i>stop</i>, and number of steps in one decade.</p> <p>Calculated number of steps must be in range: 1 to 1001.</p> |
| <i>Compliance</i> | Compliance value of sweep source. Allowable range of <i>compliance</i> depends on the compliance range of sweep source. |
| <i>Pwr Comp</i> | (Optional) Power compliance value of sweep source. Allowable range depends on power compliance range of sweep source. |
| <i>Hold</i> | Time required for DUT to settle after forcing start value. 0 to 655.35 s with 10 ms resolution. |
| <i>Delay</i> | Time required for DUT to settle after stepping the output. 0 to 65.535 s with 100 μ s resolution. |

Figure 7-3

Basic Sweep Measurement



Subordinate Sweep Measurement

For subordinate sweep measurement, you set up a secondary sweep source (VAR2) in addition to a primary sweep source (VAR1). After VAR1 sweep is completed, the output of VAR2 sweep source is increased or decreased by the specified step value, then the VAR1 sweep source is swept again.

Only the linear single sweep is available for the VAR2.

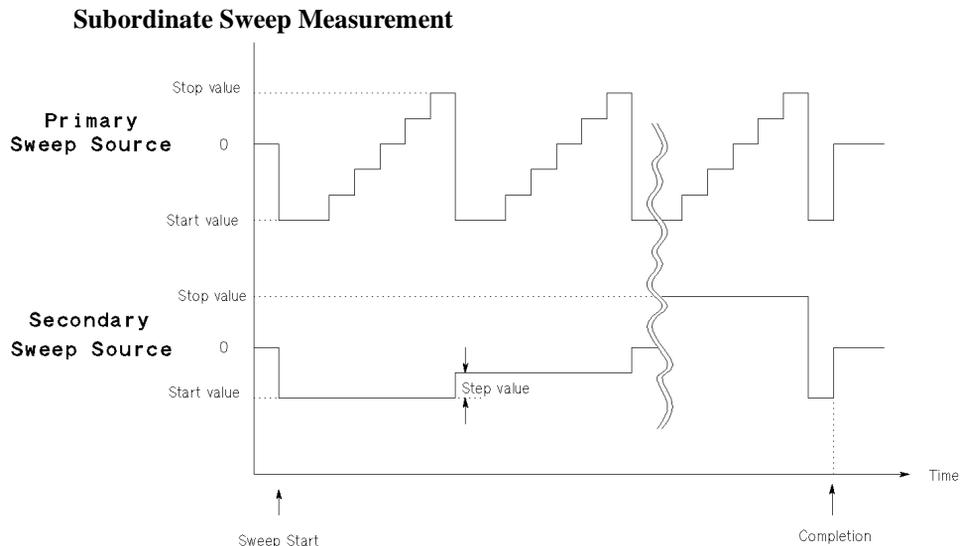
The following setup is required to perform the subordinate sweep measurements. See “I/V Sweep” on page 5-4 for the GUI.

1. Select the following on the Channel Setup tab screen.
 - Select VAR1 for the Function of the SMU used for VAR1.
 - Select VAR2 for the Function of the SMU used for VAR2.
 - Select V, VPULSE, or COMMON for the Mode of current monitor SMU, or I or IPULSE for voltage monitor SMU. Pulse is available only for one SMU.

- Set the VAR1 channel as shown in “Basic Sweep Measurement”.
- Specify the following parameters for VAR2 on the Measurement Setup tab screen.

| | |
|-------------------|--|
| Start | Start value of secondary sweep. Allowable range of <i>start</i> depends on the output range of secondary sweep source. |
| Stop | Stop value of secondary sweep is calculated from <i>start</i> , <i>step</i> , and <i>number of steps</i> . Allowable range of <i>stop</i> depends on the output range of secondary sweep source. |
| Step | Step increment of secondary sweep. |
| No of Step | Number of secondary sweep steps (N_2). 1 to 1001. Then, the following formula must be satisfied. $1 \leq N_1 \times N_2 \leq 128128$ (N_1 : number of primary sweep steps) |
| Compliance | Compliance value of secondary sweep source. Allowable range of <i>compliance</i> depends on the compliance range of secondary sweep source. |
| Pwr Comp | (Optional) Power compliance value of secondary sweep source. Allowable range of <i>power compliance</i> depends on the power compliance range of sweep source. |

Figure 7-4



Synchronous Sweep Measurement

For synchronous sweep measurement, you set up a synchronous sweep source (VAR1') in addition to a primary sweep source (VAR1).

The relationship between the output of primary and synchronous sweep sources is determined by the following equation:

$$\text{synchronous output} = \text{primary output} \times \text{ratio} + \text{offset}$$

The synchronous output determined by above equation must not exceed the output range of synchronous sweep source.

The following parameter settings are effective for the VAR1' sweep source.

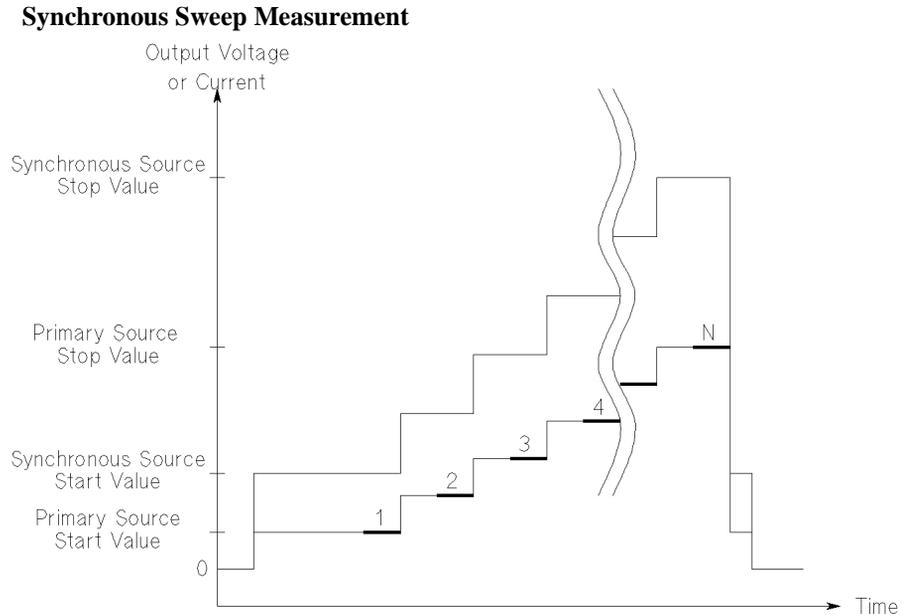
- Direction (Single or Double)
- Linear/Log

The following setup is required to perform the synchronous sweep measurements. See "I/V Sweep" on page 5-4 for the GUI.

1. Select the following on the Channel Setup tab screen.
 - Select VAR1 for the Function of the SMU used for VAR1.
 - Select VAR1' for the Function of the SMU used for VAR1'.
 - Select V, VPULSE, or COMMON for the Mode of current monitor SMU, or I or IPULSE for voltage monitor SMU. Pulse is available only for one SMU.Mode of VAR1 and VAR1' must be the same, voltage or current.
2. Set the VAR1 channel as shown in "Basic Sweep Measurement".
3. Specify the following parameters for VAR1' on the Measurement Setup tab screen.

| | |
|-------------------|--|
| Offset | Offset between outputs of primary and synchronous sweep sources. |
| Ratio | Ratio between outputs of primary and synchronous sweep sources. |
| Compliance | Compliance value of synchronous sweep source. Allowable range of <i>compliance</i> depends on the compliance range of synchronous sweep source. |
| Pwr Comp | (Optional) Power compliance value of synchronous sweep source. Allowable range of <i>power compliance</i> depends on the power compliance range of synchronous sweep source. |

Figure 7-5



Pulsed Sweep Measurement

For a sweep measurement, a sweep or constant source SMU can be a pulse source. But *only one* SMU can be a pulse source.

Figure 7-6 shows the relationship between pulse source and other sources. Each step of the primary sweep source is synchronized with output of the SMU pulse source. Measurements are made during the pulse output. For the pulsed sweep measurement, the delay time setting is ignored.

The following setup is required to perform the pulsed sweep measurements. See “I/V Sweep” on page 5-4 for the GUI.

1. Select the following on the Channel Setup tab screen.
 - Select VAR1 for the Function of the SMU used for VAR1.
 - Select V, VPULSE, or COMMON for the Mode of current monitor SMU, or I or IPULSE for voltage monitor SMU. Pulse is available only for one SMU.
2. Set the VAR1 channel as shown in “Basic Sweep Measurement”.
3. Specify the following parameters for the SMU Pulse on the Measurement Setup tab screen.

Function Details
I/V Sweep Measurement

| | |
|---------------|--|
| Period | SMU forces the next pulse after specified <i>pulse period</i> . 5 ms to 5 s with 100 μ s resolution. |
| Width | Time from when SMU output starts to change from <i>base value</i> to time when SMU starts to return from peak value. Measurements are made while the peak value is output. 0.5 ms to 2 s with 100 μ s resolution. |
| Base | The base output value of the SMU pulse. |

Pulse peak value Pulse peak value depends on the Function setting of the pulse source SMU. See Table 7-1.

Table 7-1 Pulse Peak and Function

| Function | Pulse peak |
|----------|--|
| CONST | Source value in the Constants area |
| VAR1 | Calculated from the Start, Stop, Step values of the VAR1. |
| VAR2 | Calculated from the Start, Stop, No of Step values of the VAR2. |
| VAR1' | Calculated from the Start, Stop, Step values of the VAR1 and the Offset and Ratio values of the VAR1'. |

Measurement channel

Only one SMU can be used for the measurement channel.

The measurement channel always uses the compliance range which covers the setting compliance value. The Range button in the Measurement Setup is not available.

The measurement integration time cannot be changed. The ADC/Integ button in the Measurement Setup is not available.

Figure 7-6

Pulse Source and Other Sources

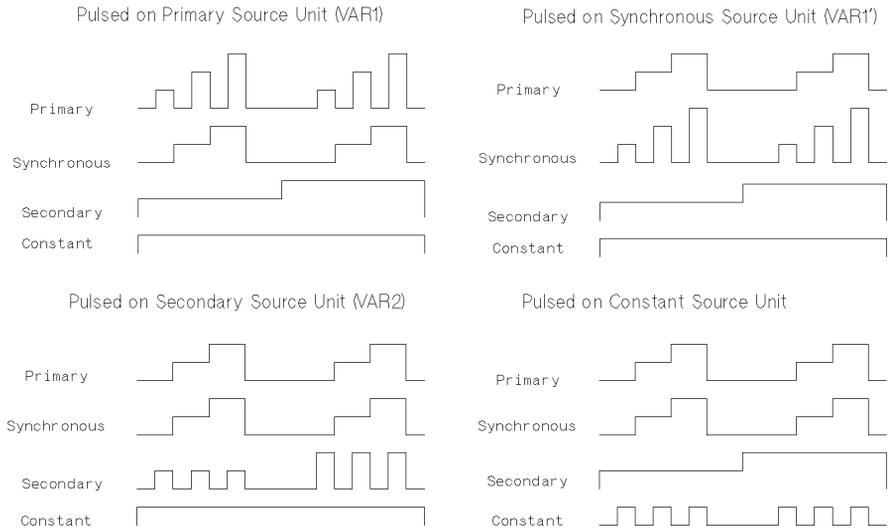
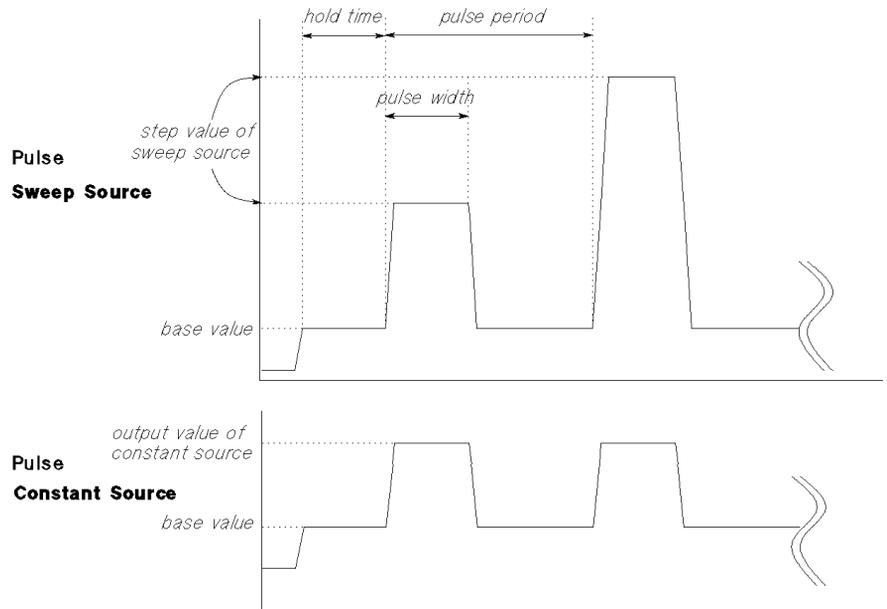


Figure 7-7

SMU Pulse



Multi Channel I/V Sweep Measurement

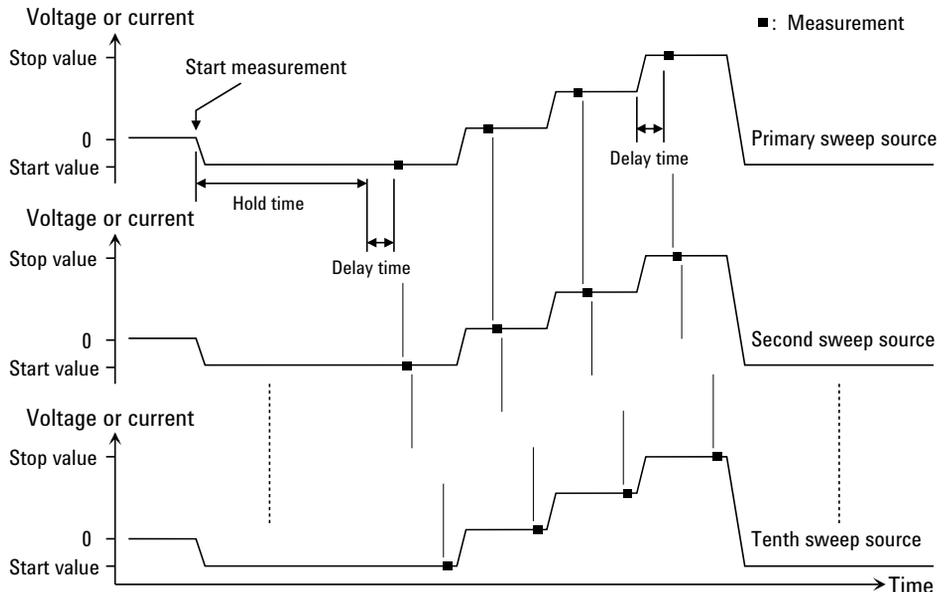
Multi Channel I/V Sweep measurement is similar to I/V Sweep measurement. Changes from I/V Sweep are listed below.

- All SMU can be set to the VAR1 sweep source (up to 10 channels)
- Both voltage mode and current mode are available for the VAR1 sweep output
- VAR1' sweep output is not available
- SMU pulse output is not available

The timing of the sweep output and measurements are shown in Figure 7-8. The output channels start to output in the order in which they are listed on the Channel Setup screen. If multiple measurement channels are used, the channels perform the measurements in order. See “Multiple Measurement Channels” on page 7-61.

Figure 7-8

Multi Channel I/V Sweep Measurements using High-Resolution A/D Converter



I/V-t Sampling Measurement

For the I/V-t sampling measurements, source channels (SMU) force constant current or voltage, and monitor channels (SMU) measure current or voltage changes at a device under test (DUT) with a specified sampling interval.

Available Modules

SMUs and SPGUs can be used. SMU can be constant voltage source or constant current source and perform voltage measurement or current measurement. SPGU can be pulse voltage source. See “SPGU Module” on page 7-26 for using the SPGU.

NOTE

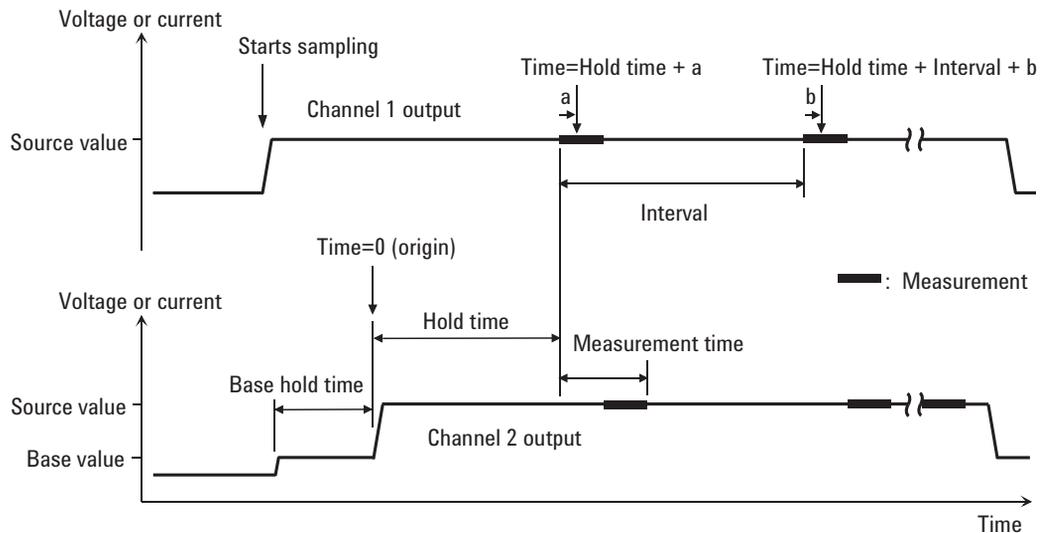
To use the SPGU, the sampling interval must be ≥ 2 ms.

Operation Summary

I/V-t sampling measurement is executed as explained below. See Figure 7-9. In this example, the Output Sequence is set to SEQUENTIAL. And the bias hold function sets the bias to the *Base* value.

Figure 7-9

Operation Summary



In this figure, *a* and *b* in the formula of *Time* indicate the time from the start of one point measurement to the start of integration by the A/D converter.

Function Details

I/V-t Sampling Measurement

1. When the Output Sequence is SEQUENTIAL, source channels start the *Source* value output in order, and the last source channel starts the *Base* value output (Starts sampling). See “Source Output Sequence and Time Origin” on page 7-18.

When the Output Sequence is SIMULTANEOUS, source channels start the *Base* value output simultaneously (Starts sampling).

Base value is available for all output channels for the SIMULTANEOUS mode and the last source channel for the SEQUENTIAL mode.

2. *Base Hold Time* later, the source channels change the output to the *Source* value. The channels keep the value until the end of the sampling measurement.
3. Another *Hold Time* later, the measurement channel starts measurement for the first sampling point. If multiple channels are used, the channels perform measurement in order. See “Multiple Measurement Channels” on page 7-61.
4. After that, the following operation is repeated with the specified time *Interval*.

This operation is repeated until the number of measurement result data reaches the specified *No of Samples* of measurement data.

- Measurement channels start measurement if they are ready to measure.
- Measurement channels keep the condition if they are busy.

For the log sampling, the B1500A holds only the data that can be plotted on the log scale in the same distance as close as possible. Only the held data is counted in the number of measurement result data.

For the linear sampling with $Interval < 2$ ms, if the total measurement time runs over the specified time $Interval \times No\ of\ Samples$, the sampling measurement will be stopped even if the number of measurement result data is less than the specified *No of Samples*.

5. The source channels stop the output, and the I/V-t sampling measurement is completed.

If the bias hold function is enabled, the source channels force the *Base* or *Source* value.

NOTE

Time data and index

For the log sampling, the recorded data will be only the data that can be plotted on the log scale in the same distance as close as possible. The index of the first data is 1. And the index of the following data will increase by 1. For the linear sampling, see “Time Data and Index” on page 7-17.

Setup Parameters

The following setup is required to perform the I/V-t sampling measurements. See “I/V-t Sampling” on page 5-21 for the GUI.

NOTE

If you set $Interval < 0.002$ s

Sampling mode must be linear. This setting is not permitted for the log sampling. Also SPGU is not available.

All measurement channels must use the high speed A/D converter (ADC). This setting is not permitted if a measurement channel uses the high resolution ADC.

If the multiple measurement channels are used, all channels perform measurement in parallel.

If the measurement ranging mode is not the fixed mode, the measurement channels automatically select the minimum range that covers compliance value set to the channel.

If the measurement time is expected to be longer than *Interval*, the measurement channels automatically adjust the number of averaging samples (ADC settings) to keep the sampling interval.

-
1. Select the following on the Channel Setup screen.
 - Select SMUs used for constant voltage sources or constant current sources.
 - Select V or COMMON for Mode of current monitor SMU, or I for voltage monitor SMU.
 2. Specify the following parameters for the SMU in the Sampling Parameter area on the Measurement Setup screen.

Linear/Log

Sampling mode. LINEAR for linear sampling. LOG10, LOG25, LOG50, LOG100, LOG250, or LOG500 for logarithmic sampling.

For the logarithmic sampling, the number after LOG indicates the number of measurement data in a decade. For example, LOG10 mode is used to get 10 data/decade.

Interval

Interval of the sampling, in seconds. 0.002 to 65.535 s, 0.001 s resolution.

$Interval < 0.002$ s in 0.00001 s resolution is also available for the linear sampling. It must satisfy the following formula. See NOTE above.

Function Details

I/V-t Sampling Measurement

$Interval \geq 0.0001 + 0.00002 \times (\text{number of measurement channels} - 1)$

No of Samples Number of samples. Integer. 1 to the following value.
For linear: $100001 / (\text{number of measurement channels})$
For logarithmic: $1 + (\text{number of data for 11 decades})$

Total Sampling Time This field just displays the total sampling time that is the time from the measurement start time for the first point to the end of sampling measurement. It does not include the hold time.

$Total\ Sampling\ Time = Interval \times No\ of\ Samples$

Output Sequence Source output sequence. SIMULTANEOUS or SEQUENTIAL. See “Source Output Sequence and Time Origin” on page 7-18.

Hold Time Time since the *Source* value output until the first sampling point, in seconds. 0 to 655.35 s, resolution 0.01 s.
The following values are also available for $Interval < 0.002$ s. $|Hold\ Time|$ will be the time since the sampling start until the *Source* value output.
-0.09 to -0.0001 s, resolution 0.0001 s.

Base Hold Time Hold time of the *Base* value output until the *Source* value output, in seconds. 0 to 655.35 s, resolution 0.01 s.

3. Specify the following parameters for the SMU in the Constants area on the Measurement Setup screen.

Base, Source Base or Source value, in V or A.
Base value is available for all output channels for the SIMULTANEOUS mode and the last source channel for the SEQUENTIAL mode.

Compliance Compliance value, in A or V.

Value effective for Base, Source, and Compliance:

0 to ± 0.1 A (HRSMU/MPSMU) or ± 1 A (HPSMU)

0 to ± 100 V (HRSMU/MPSMU) or ± 200 V (HPSMU)

Time Data and Index

To obtain the time data, enter a variable name (e.g. Time) into the Time Stamp Name field of the Channel Setup screen. The time data can be obtained after the *linear* sampling measurement is executed, and can be expressed by the following formula.

$$\text{Time} = \text{Hold Time} + \text{Interval} \times [(\text{Index} - 1) + N] + \alpha$$

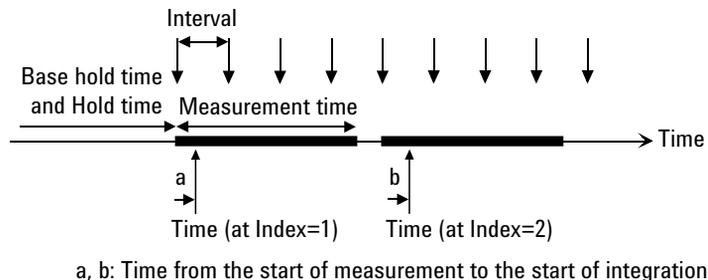
- Time :** Variable name set to the Time Stamp Name field of the Measurement Setup screen. Time data is returned.
- Index :** Variable name set to the Index Name field of the Measurement Setup screen. Data index is returned. Maximum value is 2147483647.
- Interval :** Sampling interval. Defined in the Measurement Setup screen.
- Hold Time :** Hold time. Defined in the Measurement Setup screen.
- N :** Number of samplings performed while one point measurement was executed. This value is 0 if the sampling interval is longer than the measurement time.
- α :** Time from the start of one point measurement to the start of integration by the A/D converter.

If the sampling interval is longer than the actual measurement time, measurement channels repeat measurement with the specified sampling interval. However, if the sampling interval is shorter than the measurement time, the measurement interval will be integral multiples of the specified sampling interval. Example for *Hold Time* = 10 ms, *Interval* = 5 ms, and the following *Time* values is shown in Figure 7-10. In this case, $N=3$.

- Time (for Index=1) = 10 ms = 10 + 5 × [(1 - 1) + 0] ms
- Time (for Index=2) = 30 ms = 10 + 5 × [(2 - 1) + 3] ms

Figure 7-10

Sampling and Measurement Timing



Source Output Sequence and Time Origin

When the Output Sequence is SEQUENTIAL, source channels start output in order. The order is top to bottom of the channels defined in the Channel Setup screen. The order of bias stop is bottom to top.

When the Output Sequence is SIMULTANEOUS, source channels start output simultaneously. And the source channels stop output at the same time.

The time origin is when the source output value is changed from *Base* to *Source*.

Sampling Completion

The sampling measurement completes when one of the following conditions is satisfied:

- The event of the stop condition occurs. See “Stop Condition” on page 7-18.
- The measurement channels obtain the specified number (*No of Samples*) of measurement data.
- The total measurement time runs over the time $Interval \times No\ of\ Samples$ for the linear sampling with $Interval < 2\ ms$.
- The Stop button is clicked.
- An emergency condition occurs on Agilent B1500A.
- Interlock terminal is opened when a channel is in the high voltage output status.

Stop Condition

The stop condition is defined by using the Stop Condition fields on the Measurement Setup screen. This function stops the measurement as shown below.

1. Compares the value of parameter set to the Name field and the value defined in the Threshold field.
2. Counts how many times the selected Event occurs.
3. When the count reaches the value defined in the No. of Events field, sampling is stopped immediately.

For the setup parameters of the stop condition, see “I/V-t Sampling” on page 5-21.

C-V Sweep Measurement

For the C-V sweep measurements, the multi frequency capacitance measurement unit (MFCMU) forces AC signal, performs staircase sweep output of DC bias voltage, and measures impedance for each sweep step.

Available Module

MFCMU can be used for the C-V sweep measurements. For the DC bias output over ± 25 V, use the SMU CMU Unify Unit (SCUU) and SMUs. This expands the voltage range up to ± 100 V.

Setup Parameters

The following setup is required to perform the C-V sweep measurements. See “C-V Sweep” on page 5-26 for the GUI.

1. Set the following on the Channel Setup tab screen.
 - Set V Name of the CMU.
 - If you use a constant current or voltage source, set Mode (I, V, or COMMON) and V Name or I Name of the SMU.
2. Specify the following parameters for the CMU on the Measurement Setup tab screen.

| | |
|--------------------------------|---|
| <i>Model, x Name</i> | Measurement parameters, Cp-G, Cp-D, Cs-Rs, or Z- θ . See Table 7-2. |
| <i>Direction</i> | Single or double sweep. |
| <i>Start, Stop</i> | <p><i>Start</i> is the DC bias sweep start value. <i>Stop</i> is the stop value of single sweep or turning back value of double sweep. The CMU can force up to ± 25 V. Setting resolution is 1 mV.</p> <p>If the SCUU (SMU CMU Unify Unit) is used, up to ± 100 V output is available. For the output over ± 25 V, setting resolution is 5 mV.</p> |
| <i>Step, No of Step</i> | <p><i>Step</i> is step increment of sweep. <i>No of Step</i> value is calculated from <i>start</i>, <i>stop</i>, and <i>step</i>. Calculated number of steps must be in range: 2 to 1001.</p> |

Function Details

C-V Sweep Measurement

| | |
|------------------------------|---|
| <i>Frequency List</i> | AC signal frequency. 1 kHz to 5 MHz. Resolution: 6 digits. |
| <i>F Name</i> | Variable name of frequency list. |
| <i>AC Level</i> | AC signal level. 10 mV to 250 mV, 1 mV resolution. |
| <i>Mode, Factor</i> | One of the following is used for setting the measurement time. For <i>Mode</i> =AUTO, you set the number of samples used for averaging of the measurement data. The initial value is the predefined constant, and you set the multiple number to <i>Factor</i> . Available <i>Factor</i> values are 1 to 1023, integer. For <i>Mode</i> =PLC, you set the integration time of the A/D converter. The initial value is 1 power line cycle (20 ms for 50 Hz, 16.7 ms for 60 Hz), and you set the multiple number to <i>Factor</i> . Available <i>Factor</i> values are 1 to 100, integer. |
| <i>Hold</i> | Hold time. The time required for DUT to settle after forcing start value. 0 to 655.35 s with 10 ms resolution. |
| <i>Delay</i> | Time required for DUT to settle after stepping the DC bias output value. 0 to 65.535 s with 100 μ s resolution. |

NOTE

For a more accurate measurement, perform correction data measurement at the measurement frequency before starting the capacitance measurement.

If the measurement frequency is not included in the list of default frequencies below, click the Advanced Options... button and set the measurement frequency on the Frequency area of the Advanced Options for CMU Calibration window.

Default frequencies:

1 k, 2 k, 5 k, 10 k, 20 k, 50 k, 100 k, 200 k, 500 k, 1 M, 1.2 M, 1.5 M, 2 M, 2.5 M, 2.7 M, 3 M, 3.2 M, 3.5 M, 3.7 M, 4 M, 4.2 M, 4.5 M, 5 MHz

Measurement Parameters

MFCMU performs impedance measurement, calculates parameters shown in Table 7-2, and returns the calculated data. A combination can be selected for the return data. For your reference, select the parallel measurement mode (Cp-G or Cp-D) for the low capacitance measurements (100 Ω or more of impedance), and select the series measurement mode (Cs-Rs) for the high capacitance measurements (100 Ω or less of impedance). Because the low capacitance yields high reactance, which implies that the effect of the parallel resistance has relatively more significance than that of series resistance.

Table 7-2 Measurement Parameters

| Primary Parameter | Secondary Parameter |
|------------------------------|-----------------------------------|
| Cp (parallel capacitance, F) | G (conductance, S) |
| Cp (parallel capacitance, F) | D (dissipation factor) |
| Cs (series capacitance, F) | Rs (series resistance, Ω) |
| Z (impedance, Ω) | θ (phase, degree) |

NOTE

GPIB remote mode

In the remote mode, the MFCMU can calculate and return the other measurement parameters. See Table 2-13 and Programming Guide. In Agilent EasyEXPERT operation environment, only the parameters shown in Table 7-2 are available.

About Impedance Measurements

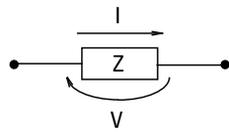
All circuit components, resistors, capacitors, or inductors, have parasitic components, for example unwanted resistance in capacitors, unwanted resistance in inductors, and unwanted inductance in resistors. Thus simple components should be modeled as complex impedances.

Impedance definitions and vector representation of impedance are shown in Figure 7-11. Impedance Z is the total opposition that a circuit or device offers to the flow of alternating current at a given frequency. Z contains a real and an imaginary part, and it is expressed in rectangular form as resistance R and reactance X , or in polar form as magnitude of impedance $|Z|$ and phase θ .

In addition to these parameters, the quality factor Q and dissipation factor D are used to describe the quality of components.

Figure 7-11

Impedance and Parameter Calculation



$$Z = \frac{V}{I}$$

(I: current (A)
V: voltage (V)

$$Z = R + jX = |Z| \angle \theta$$

$$|Z| = \sqrt{R^2 + X^2}$$

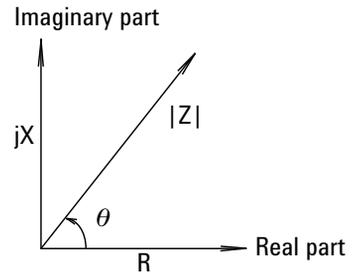
$$\theta = \tan^{-1} \left(\frac{|X|}{R} \right)$$

$$R = R_s$$

$$X = 2 \pi f L$$

$$Q = \frac{1}{D} = \frac{|X|}{R}$$

- Z: impedance (Ω)
- R: resistance (Ω)
- X: reactance (Ω)
- θ : phase (degree or radian)
- R_s : series resistance (Ω)
- f: frequency (Hz)
- L: inductance (H)
- Q: quality factor
- D: dissipation factor



In the GPIB remote mode, you can get the inductance data. For your reference, select the parallel measurement mode (Lp-G, Lp-D, or anything) for the high inductance measurements (100 Ω or more of impedance), and select the series measurement mode (Ls-Rs, or anything) for the low inductance measurements (100 Ω or less of impedance). Because the reactance of high inductance at a given frequency is relatively high (compared with that of a low inductance), so the parallel resistance becomes more significant than the series component.

Figure 7-12

Admittance and Parameter Calculation

$$Y = \frac{1}{Z} = G + jB = |Y| \angle \phi$$

$$|Y| = \sqrt{G^2 + B^2}$$

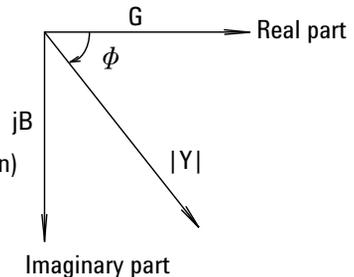
$$\phi = \tan^{-1} \left(\frac{|B|}{G} \right) = -\theta$$

$$B = 2 \pi f C$$

$$Q = \frac{1}{D} = \frac{|B|}{G}$$

$$G = \frac{1}{R_p}$$

- Y: admittance (S)
- G: conductance (S)
- B: susceptance (S)
- ϕ : phase (degree or radian)
- f: frequency (Hz)
- C: capacitance (F)
- Q: quality factor
- D: dissipation factor
- R_p : parallel resistance (Ω)



In some case, the reciprocal of impedance (admittance) Y is used. Figure 7-12 shows the vector representation of admittance. As impedance Z, Y contains a real and an imaginary part, and is expressed in rectangular form as conductance G and susceptance B, or in polar form as magnitude of admittance |Y| and phase ϕ .

Four-Terminal Pair Configuration

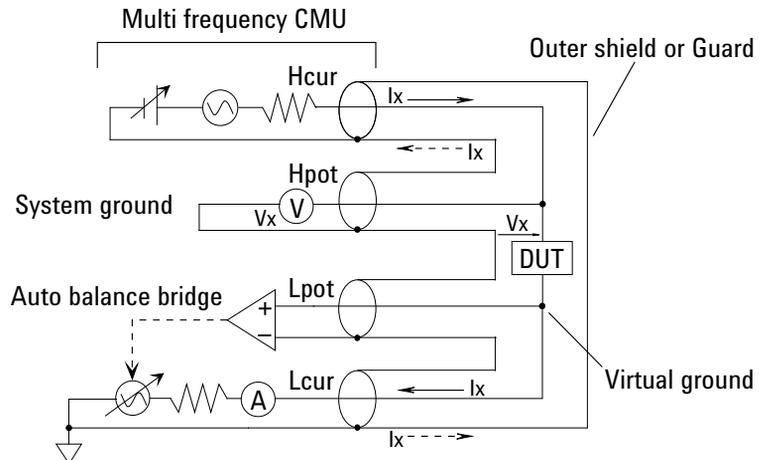
Generally, any mutual inductance, interference of the measurement signals, and unwanted residual factors in the connection method incidental to ordinary termination methods will have significant effects on the measurements, especially at a high frequency. The MFCMU employs the four-terminal pair (4TP) measurement configuration which permits easy, stable, and accurate measurements and avoids the measurement limitations inherent to such factors.

Figure 7-13 shows the four-terminal pair measurement principle. The measurement terminals consist of the following four coaxial connectors.

- Hcur: High current
- Hpot: High potential
- Lpot: Low potential
- Lcur: Low current

Figure 7-13

Four-Terminal Pair Measurement Principle



The four-terminal pair measurement method has the advantage in both low and high impedance measurements. The outer shield conductors work as the return path for the measurement signal current (they are not grounded). The same current flows through both the center conductors and outer shield conductors (in opposite directions), but no external magnetic fields are generated around the conductors (the magnetic fields produced by the inner and outer current completely cancel each other). Because the measurement signal current does not develop an inductive magnetic field, test leads do not contribute additional errors due to self or mutual inductance between the individual leads.

Function Details

C-V Sweep Measurement

To realize accurate measurements using the four-terminal pair measurement method, the following connection tips are important. See Figure 7-13 and Figure 7-14.

- The signal path from MFCMU to DUT must be as short as possible.
- The four-terminal pair configuration must be extended as close as possible to the DUT.
- The outer shield conductors must be connected together at the extended cable ends. Then take care of contacts. They must be electrically isolated.

This is the same as connecting the CMU return terminals of the atto sense/switch unit (ASU) or the guard switch unit (GSWU).

- The signal path from the shield ends to the DUT must be as short as possible.
- If it is possible, make protective guard (plate, shield, or anything) around the DUT, and connect it to the outer shield conductor of the four-terminal pair configuration. This minimizes the effects of stray capacitance and electrical noise. Then take care of contacts. The guard must be electrically isolated.
- The Low (Lcur, Lpot) terminal must be prevented from stray capacitance and guard capacitance. If the measurement terminal has to be connected to the wafer chuck, use the High (Hcur, Hpot) terminal to connect to the wafer chuck.

Error Correction

The MFCMU is equipped with the error correction function used to realize accurate impedance measurements. The correction function minimizes the effects of the error elements in the extension cables and the DUT interface such as manipulator and probe card.

- Phase compensation
Corrects phase error caused by extending measurement cables.
- Open correction
Corrects for stray admittance. Effective for high impedance measurements.
- Short correction
Corrects for residual impedance. Effective for low impedance measurements.
- Load correction
Corrects any error by using the working standard.

The MFCMU will internally perform the error correction for the CMU cables and CMU accessories that keep the four-terminal pair configuration.

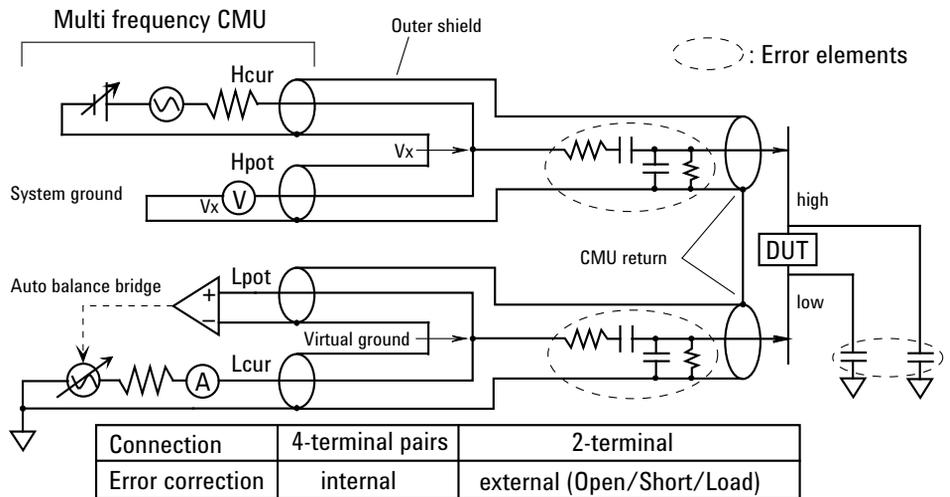
For the measurements for evaluating DUT against a working standard, perform the open/short/load correction.

However, you have to consider that some parasitic remain in measurement path even after performing corrections. To minimize the influence of parasitic, make the signal path from the shield ends to the DUT as short as possible.

To perform the phase compensation and error correction, see “CMU Calibration” on page 4-37.

Figure 7-14

Error Correction



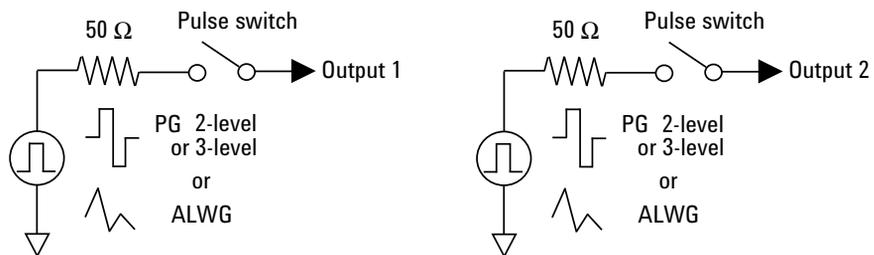
SPGU Module

High voltage SPGU is a pulse generator module designed for semiconductor parametric test applications and provides the following key functions. The SPGU can be controlled by using the SPGU Control classic test or the SPGU setup function in the I/V Sweep, Multi Channel I/V Sweep, I/V List Sweep, and I/V-t Sampling classic tests.

- Number of output channels: 2 channels per module
- Output impedance: $50\ \Omega$
- Output level: 0 to $\pm 40\ \text{V}$ (open load), $\pm 20\ \text{V}$ ($50\ \Omega$ load)
- SPGU operation mode (effective for all channels installed in B1500A):
PG (pulse generator) or ALWG (arbitrary linear waveform generator)
- Channel output operation mode:
Free run, duration, or pulse count (PG mode)/sequence count (ALWG mode)
Free run mode is not available for the SPGU Control classic test.
- PG output mode:
2-level pulse or 3-level pulse, for each channel
- Pulse switch, which is more durable than mechanical relays, and better suited for frequent switching applications.
- Automatic voltage level adjustment by specifying load impedance of DUT

Figure 7-15

SPGU Simplified Circuit Diagram



NOTE

To use the SPGU for I/V-t Sampling tests, the sampling interval must be $\geq 2\ \text{ms}$.

PG Operation Mode

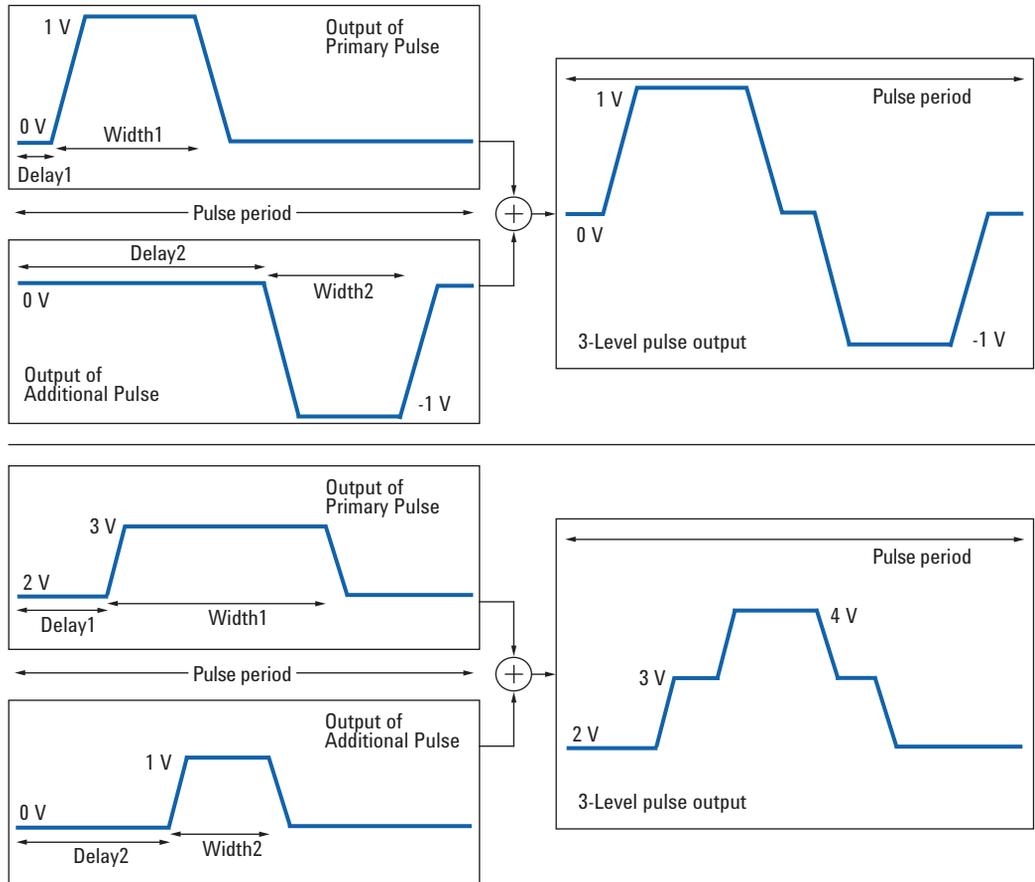
In the PG mode (pulse generator operation mode), the SPGU outputs 2-level or 3-level pulse voltage as shown in Figure 7-16.

The SPGU channels simultaneously start the pulse output and repeat the output every pulse period. The channels continue the pulse output until the specified time elapses or the repeat count reaches the specified number of pulses.

For the SPGU pulse setup, see “SPGU Pulse Setup Parameters” on page 7-28.

For a summary of source output operation in sweep or sampling measurement mode, see “Pulse Output Operation Summary” on page 7-30.

Figure 7-16 3-Level Pulse Output Examples



SPGU Pulse Setup Parameters

The following setup is required to apply the SPGU pulse. See “SPGU Control” on page 5-57 for the GUI.

1. Set the following for the SPGU channel on the Channel Setup tab screen.
 - Set the V Name of the SPGU.
 - Set the Mode to VPULSE. This sets the PG mode. Do not set to ALWG.
2. On the SPGU Pulse Setup window, specify the following parameters for the SPGU. See Figure 7-17 for the pulse setup parameters.

| | |
|---------------------------------|---|
| <i>Period</i> | Pulse period. 20 ns to 10 s, 10 ns resolution. |
| <i>Operation</i> | FREE RUN, PULSE COUNT, or DURATION. In the FREE RUN mode, the SPGU continues the pulse output until the measurement is completed or stopped. Not available for the SPGU Control classic test. For the PULSE COUNT mode, specify the number of pulses, within the range of 1 to 1000000. The SPGU will output the specified number of pulses. For the DURATION mode, specify the total time to output, within the range of 1 μ s to 31556926 s (1 year). The SPGU will continue to output until the specified time elapses. |
| <i>Type</i> | 2-Level Pulse or 3-Level Pulse. If you choose 3-Level Pulse, the Additional Pulse fields become effective. |
| <i>Base, Peak</i> | Pulse base and peak voltage. 0 to \pm 40 V (open load), \pm 20 V (50 Ω load), 1 mV resolution. |
| <i>Delay</i> | Delay time. 0 s to <i>Period</i> -20 ns, 2.5 ns resolution. Resolution will be set at 10 ns if the pulse transition time is $>$ 8 μ s. |
| <i>Width</i> | Pulse width. 10 ns to <i>Period</i> -10 ns, 2.5 ns resolution. Resolution will be set at 10 ns if the pulse transition time is $>$ 8 μ s. |
| <i>Leading, Trailing</i> | Pulse transition time. 8 ns to 400 ms, 2 ns resolution. Resolution will be set at 8 ns if the pulse transition time is $>$ 8 μ s. |

3. (Optional) Set the Additional Pulse fields for the 3-Level Pulse. 3-level pulses can be achieved by the Primary Pulse and the Additional Pulse. See Figure 7-16 for examples.
4. On the Load Z Setup window, specify the load impedance of the DUT (device under test). The value is used to adjust the SPGU output voltage automatically. The SPGU will output the voltage close to the specified *Base* or *Peak* value.
5. (Optional) On the Pulse Switch Setup window, enable the pulse switch, which is the semiconductor relay mounted in the SPGU output and is used to open the SPGU channel output. This relay is more durable than mechanical relays, and is better suited for frequent switching applications.

SW Sync ENABLE (enables the pulse switch) or DISABLE (disables the pulse switch).

Switching of the pulse switch status (open and close) will be controlled automatically and synchronized with the output pulse, as shown in Figure 7-17.

Delay, *Width*, and *Normal* fields will be active when *SW Sync*=ENABLE.

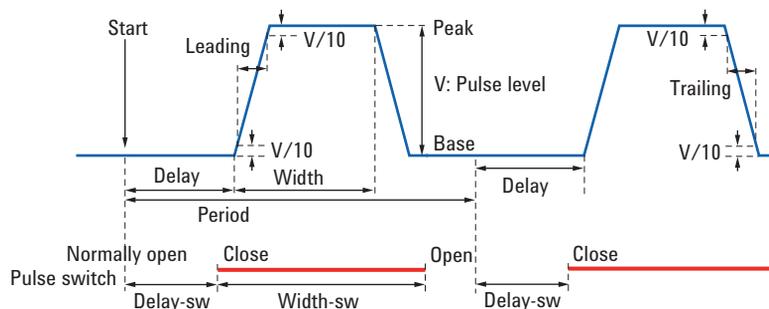
Delay Delay time from start of pulse output to changeover of pulse switch. 0 s to *Period*-100 ns, 10 ns resolution.

Width Duration to hold the switched state of the pulse switch. 100 ns to *Period*-*Delay* ns, 10 ns resolution.

Normal Switch status in the pulse switch normal condition. CLOSE (normally closes the pulse switch) or OPEN (normally opens the pulse switch). The pulse switch will change the status after the *Delay-sw* time and keep the status until the *Width-sw* time elapses, as shown in Figure 7-17. This operation is repeated every pulse period.

Figure 7-17

Pulse Setup Parameters



Pulse Output Operation Summary

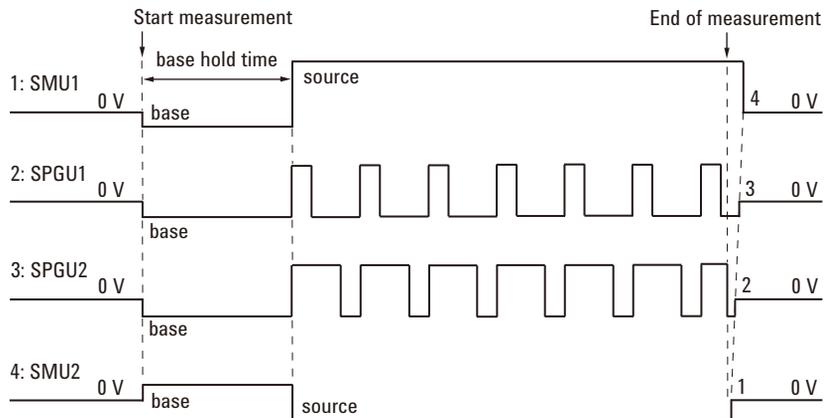
The SPGU can be used for I/V Sweep, Multi Channel I/V Sweep, I/V List Sweep, and I/V-t Sampling classic tests. The SPGU pulse output operation will differ as shown in the following cases. Pulse output example of the sampling measurement is shown in Figure 7-18.

- Sampling measurement, simultaneous output mode. See Table 7-3.
- Sampling measurement, sequential output mode. See Table 7-4
- Sweep measurement mode. See Table 7-5.

Figure 7-18

SPGU Pulse Output Example for Sampling Measurement in Free Run Mode

Simultaneous output:



Sequential output:

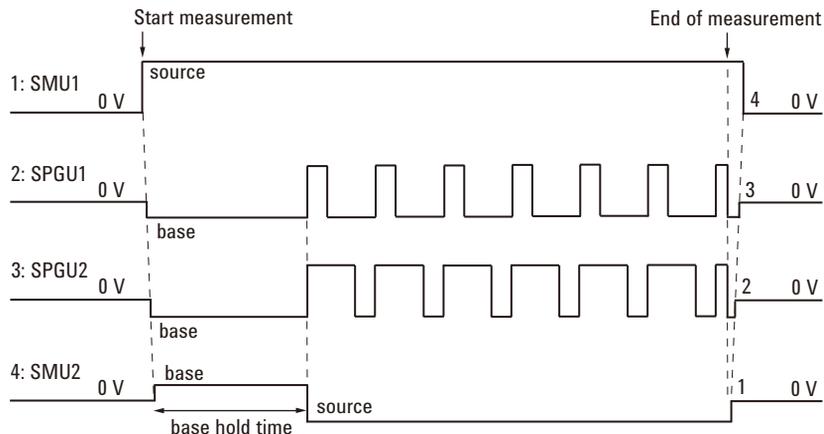


Table 7-3 Output Timing for I/V-t Sampling, Simultaneous

| Pulse output conditions | Source Channel Operation | | | |
|-----------------------------|---|--|--|--|
| | Starting | During measurement | After measurement | Ending |
| Duration > Measurement time | SMUs and SPGUs start the base value output simultaneously. SMUs start sampling measurement operation. | After the base hold time, SMUs start the source value output and SPGUs start pulse output simultaneously. | SMUs continue the source value output and SPGUs continue pulse output until the specified time elapses or the repeat count reaches the specified number. After that, SMUs output the base or source value set by the Output Value after Measurement, and SPGUs output the base value. | If the bias hold function is ON, all source channels continue the output. Else, all source output goes to 0 V in the reverse order of the Channel Setup definition. |
| Free run | | | SMUs output the base or source value set by the Output Value after Measurement, and SPGUs continue pulse output. If the bias hold function is OFF, SPGUs output the base value. | |
| Duration < Measurement time | | After the base hold time, SMUs start the source value output and SPGUs start pulse output simultaneously. After the specified time elapses or the repeat count reaches the specified number, SPGUs output the base value. | SMUs output the base or source value set by the Output Value after Measurement, and SPGUs output the base value. | |

Table 7-4 Output Timing for I/V-t Sampling, Sequential

| Pulse output conditions | Source Channel Operation | | | |
|-----------------------------|--|--|---|--|
| | Starting | During measurement | After measurement | Ending |
| Duration > Measurement time | Except for the last SMU, SMUs start the source value output. And SPGUs and the last SMU start the base value output. The source output sequence is the definition order on the Channel Setup screen (top to bottom). SMUs start sampling measurement operation. | After the base hold time, the last SMU start the source value output and SPGUs start pulse output simultaneously. | SMUs continue the source value output and SPGUs continue pulse output until the specified time elapses or the repeat count reaches the specified number. After that, the last SMU outputs the base or source value set by the Output Value after Measurement, and SPGUs output the base value. | If the bias hold function is ON, all source channels continue the output. Else, all source output goes to 0 V in the reverse order of the Channel Setup definition. |
| Free run | | | The last SMU outputs the base or source value set by the Output Value after Measurement, and SPGUs continue pulse output. If the bias hold function is OFF, SPGUs output the base value. | |
| Duration < Measurement time | | After the base hold time, the last SMU start the source value output and SPGUs start pulse output simultaneously. After the specified time elapses or the repeat count reaches the specified number, SPGUs output the base value. | The last SMU outputs the base or source value set by the Output Value after Measurement, and SPGUs output the base value. | |

Table 7-5 Output Timing for I/V Sweep, Multi Channel I/V Sweep, I/V List Sweep

| Pulse output conditions | Source Channel Operation | | | |
|-----------------------------|---|--|---|---|
| | Starting | During measurement | After measurement | Ending |
| Duration > Measurement time | <p>SMUs and SPGUs start output. The source output sequence is the definition order on the Channel Setup screen (top to bottom).</p> <p>Then, sweep sources output the start value, constant sources output the source value, and SPGUs output the base value.</p> | <p>SPGUs start and continue the pulse output.</p> <p>SMUs start and perform sweep measurement operation.</p> | <p>Sweep sources output the start or stop value set by the Output Value after Measurement.</p> <p>SPGUs continue the pulse output until the specified time elapses or the repeat count reaches the specified number. After that, SPGUs output the base value.</p> | <p>If the bias hold function is ON, all source channels continue the output.</p> <p>Else, all source output goes to 0 V in the reverse order of the Channel Setup definition.</p> |
| Free run | | | <p>Sweep sources output the start or stop value set by the Output Value after Measurement.</p> <p>SPGUs continue pulse output.</p> <p>If the bias hold function is OFF, SPGUs output the base value.</p> | |
| Duration < Measurement time | <p>The constant sources continue the output until Ending.</p> | <p>SPGUs start the pulse output.</p> <p>SMUs start and perform sweep measurement operation.</p> <p>SPGUs continue the pulse output until the specified time elapses or the repeat count reaches the specified number. After that, SPGUs output the base value.</p> | <p>Sweep sources output the start or stop value set by the Output Value after Measurement.</p> <p>SPGUs output the base value.</p> | |

ALWG Operation Mode

In the ALWG mode (arbitrary linear waveform generator operation mode), SPGU can output an arbitrary linear waveform voltage as shown in Figure 7-19. The waveform is the voltage pattern sequence specified by the pattern data and the sequence data, which can be created by using the Define ALWG Waveform Window (p. 5-64).

For a summary of source output operation in sweep or sampling measurement mode, see “Pulse Output Operation Summary” on page 7-30. One sequence output will be handled as same as one pulse output.

Pattern data

Specifies all of the voltage patterns set to a channel. A pattern consists of some vector data. A vector data is defined by the output level and the time data.

- Number of patterns: maximum 512 for a channel
- Number of vector data: maximum 1024-N (N: number of patterns) for defining all patterns to a channel
- Output level: 0 to ± 40 V (open load, 1 mV resolution)
- Time data (incremental time): 10 ns to 671.088630 ms (10 ns resolution)

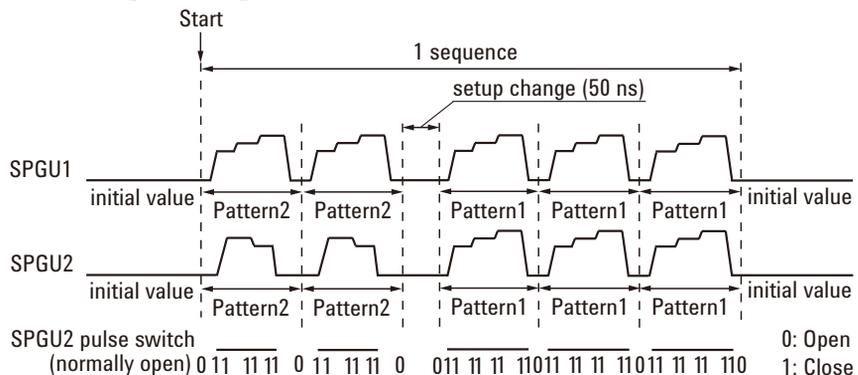
Sequence data

Specifies the output channel, the output pattern, the repeat count of the pattern, and the output sequence of patterns applied in a single sequence.

- Repeat count of a pattern: 1,048,576
- Number of patterns in a sequence: maximum 512

Figure 7-19

ALWG Output Example



In the example in Figure 7-19, SPGU1 and SPGU2 are used. The channels output Pattern2 twice and Pattern1 three times in one sequence, although the two patterns for SPGU1 are the same.

The SPGU channels simultaneously start the sequence output. The sequence will be repeated in the same way as for the pulse period. The channels continue the sequence output until the specified time elapses or the repeat count reaches the specified number of sequences.

NOTE

Setup delay time between the different patterns

When the pattern is changed to a pattern of a differing index, a 50 ns setup delay will always be inserted.

There is no delay between patterns of the same index.

Sweep Abort Function

The automatic sweep abort function is used to stop sweep measurement (increasing or decreasing source output value) when one of the following conditions occurs. This function is useful to reduce sweep time and to prevent damage to the device during measurement.

- The output reaches voltage compliance or current compliance
- A measurement value exceeds the specified measurement range
- An SMU oscillates
- An error is caused in the MFCMU

The automatic abort function is enabled by using the Sweep [xxxx] status field on the Measurement Setup screen of the Classic Test definition.

- Sweep [CONTINUE AT ANY] status: Sets the abort function OFF.
- Sweep [STOP AT ANY ABNORMAL] status: Sets the abort function ON.

This function is available for the following measurement modes:

- “I/V Sweep Measurement”
- “C-V Sweep Measurement”

When abort occurs

After measurement is aborted, the source forces the following value.

- Sweep source: Start value
- Pulsed source or Pulsed sweep source: Pulse base value

Standby Function

This function forces the specified DC bias outputs (standby outputs) before starting or after stopping a measurement.

Standby Channels

Standby channels are source monitor units (SMU) that force the standby output. Standby channels maintain the specified DC bias output when the standby mode is ON and in the non-measurement state.

Standby channel cannot be set for CMU, GNDU, and HRSMU connected to the atto sense and switch unit (ASU) which makes the path to the AUX port.

See “Standby Channel Definition” on page 4-50 to define the standby channels and set the standby mode.

Standby State

Standby state is the state before starting or after stopping a measurement, in which only the standby channels perform DC bias outputs. The other channels will be in the idle state, which is 0 V output, 100 μ A compliance, SMU filter OFF, and series resistor OFF. When the standby mode is OFF and in the non-measurement state, all channels will be in the idle state.

When B1500A is in the standby state, the measurement trigger stops the standby state, so the standby channels stop the standby output and the measurement channels perform a measurement (measurement state). After the measurement, the standby channels start the standby output (standby state). During this series of operations, the state is never changed to the idle state. See Figure 7-20 for an example operation.

If the bias hold function is enabled for the standby channel, after the measurement, the channel forces the bias output set by the bias hold function. After the bias hold period, the channel starts the standby output. During this series of operations, the state is never changed to the idle state.

Output Sequence of Standby Channels

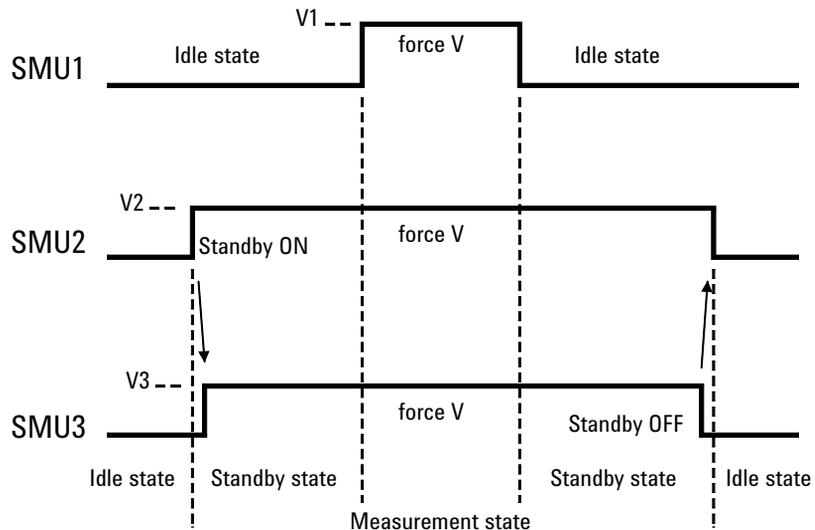
The standby channels will start to output in order, from the top to bottom, as listed in the Standby Channel Definition on the Standby Channel Definition window. The order of bias stop is bottom to top.

Figure 7-20 shows the standby and measurement operations for the following example setup. This example assumes that the channel setup is defined in the Standby Channel Definition as follows in the order show, and that the output value in the standby state is the same as the output value in the measurement state.

- SMU1: Voltage source, non-standby channel
- SMU2: Voltage source, standby channel
- SMU3: Voltage source, standby channel

Figure 7-20

Standby Function



To Use Standby Function

To start the standby output, click the Standby ON button on the Standby Channel Definition window. However, if no channel has been defined as the standby channel, the standby mode cannot be turned ON. In the standby state, the Standby ON indicator appears at the bottom of the EasyEXPERT main screen. The Standby Channel Definition window is opened by clicking the Standby button on the main screen.

To stop the standby output, click the Standby OFF button on the Standby Channel Definition window.

In the standby state, you can change the setting parameters for non-standby channels without changing the operation state. However, if you modify the settings for the standby channels, the operation state is changed from the standby state to the idle state.

In the standby state, the following functions are set to OFF.

- SMU filter
- Series resistor

In the standby state, the following functions cannot be performed.

- Diagnostics
- Self-test
- Self-calibration (SMU calibration and CMU calibration)
- SMU zero offset measurement
- ASU connection path change

In the standby state, self-calibration is not performed even if auto calibration is set to ON. Also the state cannot be changed to the standby state while self-calibration is being performed.

When the workspace is opened, it will be in the idle state.

If the workspace or EasyEXPERT is closed while the standby mode is ON, the mode is automatically changed to OFF in the closing process.

If Windows session is stopped while the standby mode is ON, the mode is not changed to OFF in the closing process.

Bias Hold Function

This function is used to keep source output after measurement. Source modules apply the specified bias between measurements in a quick test or application test that defines some classic test setups, or a repeat measurement. And the source modules change the output value and the unused modules are disconnected when the next measurement is started.

Output channels and output value

If the bias hold function is OFF, the channel stops the output immediately after measurement.

If the function is ON, the channel continues the output as shown below.

I/V Sweep measurement:

- VAR1 and VAR1' output channels: Sweep start or stop value
- VAR2 output channel: Sweep stop value
- CONST output channels: Output value
- SMU pulse output channels: Base value

C-V Sweep measurement:

- Bias sweep output channel: Sweep start or stop value
- CONST output channels: Output value

I/V-t Sampling measurement:

- Constant source output channels: Base or source value

SPGU output:

- SPGU keeps the output as shown in Table 7-6.

Period of bias hold

- From the end of a measurement to the end of a single measurement
- From the end of a measurement to the start of the next measurement during a quick test, application test, or repeat measurement

Reset of source output

The source output is reset after a quick test, application test, repeat measurement, or single measurement. The SMU is set to 0 V output and 0.1 mA compliance. The MFCMU is set to 0 V DC bias and 0 V oscillator level.

Setup method

This function can be set by using the Advanced Setup window.

- Bias hold after measurement
Set the function ON (enable) or OFF (disable, default setting).
- Output value after measurement
Select the bias output value START (default) or STOP for the I/V or C-V sweep measurement, or BASE or SOURCE (default) for the sampling measurement. This is invalid for the VAR2, CONST, and constant source for C-V Sweep.

Table 7-6

SPGU Channel Output after Execution when Bias Hold is ON

| SPGU output operation mode | SPGU output |
|-----------------------------------|--|
| FREE RUN | Continues the pulse output in the VPULSE mode or the sequence output in the ALWG mode. SPGU trigger reset is performed at the beginning of the simultaneous sampling measurement. |
| COUNT | Continues the base voltage output in the VPULSE mode or the initial voltage output in the ALWG mode. |
| DURATION | SPGU channel initialization is performed at the beginning of the next measurement. |

Current Offset Cancel

This function subtracts the offset current from the current measurement raw data, and returns the result as the measurement data. This function is used to compensate the error factor (offset current) caused by the measurement path such as the measurement cables, manipulators, or probe card.

The offset cancel is not available for measurement over 100 nA range. For 10 nA range measurement, the offset cancel is performed by using the 1 nA range offset value. For measurement by a range less than 10 nA, the offset value measured by each range is used. See Table 7-7 for the effective measurement range, the allowable offset value, and the module type of the measurement channel.

Enabling offset cancel function

You can perform the offset current measurement and enable the offset cancel function as shown below.

1. Click the Calibration button on the main screen to open the Calibration window. See “Calibration” on page 4-35.
2. Specify the channels to perform the offset current measurement on the SMU Zero Cancel tab screen of the Calibration window. To specify the channel, check the check box to the left of the Name field.
3. To enable the 1 pA range offset current measurement of the HR/ASU channel, check the Full Range check box.
4. Set the integration time for the offset measurement to the Integration Time field. Available value: 1 PLC (power line cycle) to 100 PLC, initial setting 16 PLC.

Set the value longer than the integration time for the measurement of the device under test. Otherwise, the offset cancel will not be performed.

5. Click the Measure... button. A dialog box is opened.

Follow the instruction of the dialog box, and perform the offset measurement. After the measurement, the offset cancel function is automatically enabled.

Open the measurement terminals at the cable end of the device side during the offset current measurement.

NOTE

The high resolution A/D converter is used for the offset current measurement.

To disable the offset cancel function, remove the check from the check box to the left of the Name field.

Table 7-7

Measurement range, allowable offset value, and module type

| Measurement range | Allowable offset value | Module type |
|-------------------|------------------------|--------------------|
| 1 nA | ± 10 pA | HR/ASU, HR, MP, HP |
| 100 pA | ± 1 pA | HR/ASU, HR |
| 10 pA | ± 400 fA | HR/ASU, HR |
| 1 pA | ± 100 fA | HR/ASU |

If the offset value for a measurement range of a channel exceeds the allowable value, the offset data is not effective in this range and lower for this channel. Then, if the ranging mode setting of this channel covers this range or lower, the offset cancel is not performed for any data measured by this channel.

SMU CMU Unify Unit

The SMU CMU Unify Unit (SCUU) is available for Agilent B1500A installed with the multi frequency capacitance measurement unit (MFCMU). The MFCMU must be installed in the slot N (integer, 3 to 10) and the SMUs must be installed in the slot N-1 and N-2. See “To Connect SCUU/GSWU” on page 3-21 to install the SCUU properly. The SCUU cannot be connected to the high power SMU (HPSMU).

The Guard Switch Unit (GSWU) controls the connection of the CMU High and Low guard lines (CMU return). The connection will be broken when using the SMU and made when using the MFCMU.

The SCUU can switch the measurement resources, MFCMU or SMU, and can configure four setups shown in Figure 7-21. When the B1500A is turned on, no measurement resource is connected to the output. The SCUU has input connectors, four coaxial and four triaxial, connected to the MFCMU and SMU directly or by using the dedicated SCUU cable.

The SCUU front panel LEDs indicate the following conditions of the SCUU.

- | | |
|--------------------------|---|
| SMU | SMU in the slot N-1/N-2 can be used. |
| CMU Internal Bias | MFCMU can be used. CMU internal DC bias source is used. |
| CMU SMU Bias | MFCMU can be used. SMU is used as DC bias source. |

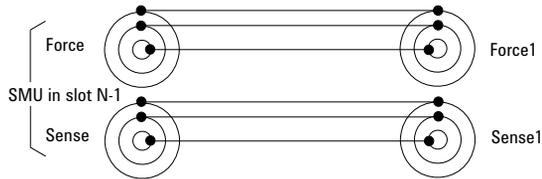
The SCUU has output connectors, four triaxial, that must be connected to the DUT interface such as manipulators and probe card. When the measurement resource is the SMU, they are the Force1/Sense1 and Force2/Sense2 connectors for the Kelvin connection. And when the resource is the MFCMU, the CMU High/Low are connected to the Force1/Force2 respectively, and the Sense1/Sense2 are not used.

To realize accurate impedance measurements, connect the CMU return terminals together. The CMU return terminal means the shield end of the outer shield conductor extended to the DUT interface. The shield end must be opened as close as possible to the DUT. See Figure 7-14 on page 7-25.

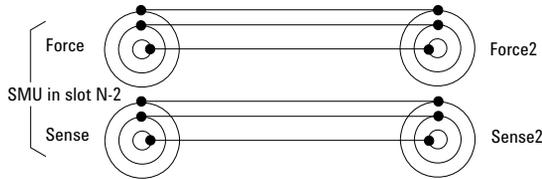
The GSWU has one connector and two terminals. The connector must be connected to the SCUU by using the SCUU cable. And the terminals must be connected to the CMU High/Low guard lines at the shield ends of the DUT interface by using a wire.

Figure 7-21 SCUU Input/Output Connections

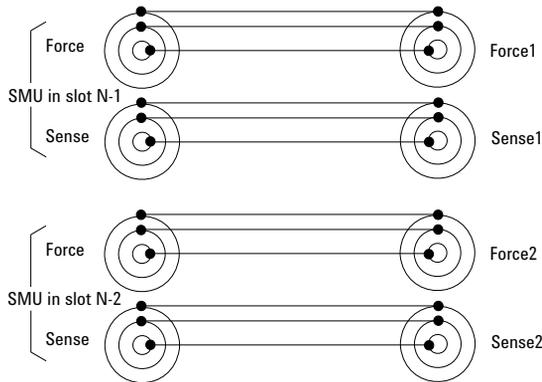
Setup 1: CMH/Force1/Sense1: SMU (slot N-1)
CML/Force2/Sense2: Open



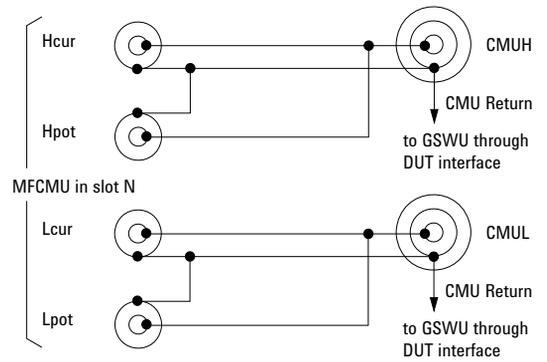
Setup 2: CMH/Force1/Sense1: Open
CML/Force2/Sense2: SMU (slot N-2)



Setup 3: CMH/Force1/Sense1: SMU (slot N-1)
CML/Force2/Sense2: SMU (slot N-2)



Setup 4: CMH/Force1: CMUH (slot N)
CML/Force2: CMUL (slot N)
Sense1/Sense2: Open



NOTE

Before using SCUU

Instrument connection must be done before Agilent B1500A is turned on.

Atto Sense and Switch Unit

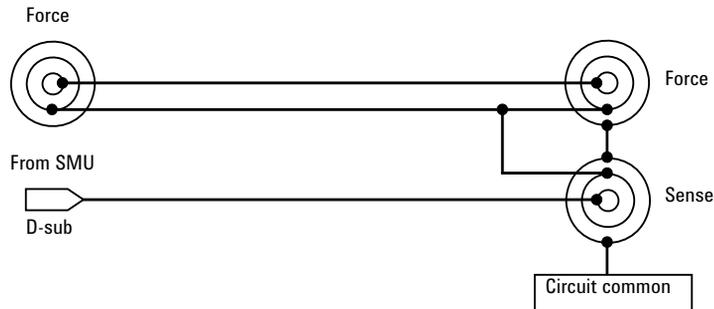
The Atto Sense and Switch Unit (ASU) can be used with the high resolution SMU (HRSMU). Using the ASU permits use of the 1 pA range. Also the ASU can switch the measurement resources, HRSMU or an instrument connected to the AUX input connectors. The ASU can configure two setups shown in Figure 7-22. When the B1500A is turned on, the ASU will be the Setup 1 condition. See “To Connect ASU” on page 3-17 to install the ASU properly.

The ASU has input connectors, one triaxial and two coaxial. The triaxial connector must be connected to the HRSMU Force, and the coaxial connectors must be connected to an instrument. Also the ASU has the control connector to be connected to the HRSMU by using the ASU cable.

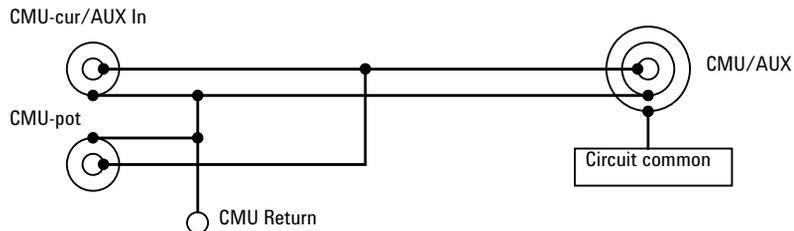
Figure 7-22

ASU Input/Output Connections

Setup 1: AUX Off (SMU input to ASU output)



Setup 2: AUX On (CMU/AUX input to ASU output)



The ASU has the following status indicators (LED).

- | | |
|------------|---|
| SMU | The HRSMU can be used (Setup 1). |
| AUX | The AUX instrument can be used (Setup 2). |

The ASU has output connectors, two triaxial, that must be connected to the DUT interface such as manipulators and probe card. When the measurement resource is the HRSMU, they are the Force/Sense connectors for the Kelvin connection. And when the resource is not HRSMU, the CMU/AUX is connected to the Force, and the Sense is not used.

If you connect the MFCMU or the LCR meter with the four-terminal pair configuration, two ASUs are required. Then the CMU-pot/CMU-cur connectors of a ASU must be connected to the Hpot/Hcur of the instrument. And the other one must be connected to the Lpot/Lcur in like manner.

To realize accurate impedance measurements using the four-terminal pair measurement method, connect the CMU Return terminals of ASUs together. See “Four-Terminal Pair Configuration” on page 7-23 and Figure 7-14 on page 7-25.

NOTE**To use 1 pA range**

The measurement channel connected to the ASU (Atto Sense and Switch Unit) supports the 1 pA range. To use the 1 pA range, set the 1 pA fixed range or the 1 pA limited auto ranging.

The B1500A automatically performs the compensation of the data measured by the 1 pA range and returns the compensated data. You can use either the pre-stored offset data or the pre-measured offset data.

To measure the offset data, perform the self-calibration before starting the measurement for a DUT. This offset data is temporarily memorized until the B1500A is turned off.

NOTE**Before using ASU**

ASU connection must be done before Agilent B1500A is turned on.

The combination of ASU and HRSMU is important. The B1500A can work with wrong combination, but it cannot satisfy its specifications. The specifications are guaranteed for the correct combination which the performance verification was performed. See “ASU” on page 4-43 and check if the combination is correct.

The CMU-pot connector is for the MFCMU or the LCR meter that uses the four-terminal pair. For the other instrument, connect a BNC open connector or nothing to there. The line will be internally connected to the CMU-cur/AUX-in line.

It is unavailable to use the series resistor in the HRSMU connected to the ASU.

SMU/PG Selector

Agilent 16440A SMU/PG Selector provides the built-in switching capability to select a measurement path connected to the Output port. See Figure 7-23 for the simplified circuit diagram of the selector. The selector has the channels CH 1 and CH 2 which provide the following conditions. It can be controlled by using the SMU/PG Selector tab screen of the Configuration window.

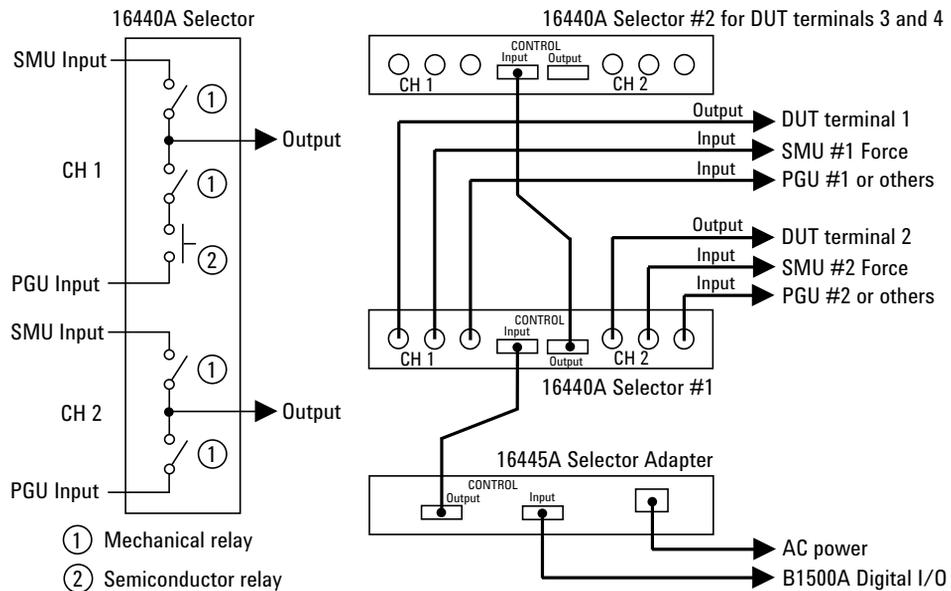
CH 1 Open (no connection), SMU connect, PGU connect, and PGU open

CH 2 Open (no connection), SMU connect, and PGU connect

The PGU open is available only for the CH 1, and is made by keeping the PGU side mechanical relay close and opening the semiconductor relay. This is effective for frequent switching applications because the semiconductor relay is more durable than mechanical relays. The PGU open can be set by using the Advanced window of the Measurement Setup.

Figure 7-23

SMU/PG Selector Circuit Diagram and Connections



The selector must be connected to the B1500A through the Digital I/O connector and the Agilent 16445A Selector Adapter. Up to two selectors can be used by connecting the selector control cable between the CONTROL Output connector of the first selector and the CONTROL Input connector of the second selector.

SMU Ranging Mode

Agilent B1500 provides the following operation modes for the measurement range and the output range. The ranging mode must be set for each channel.

- “Auto Ranging”
- “Limited Auto Ranging”
- “Fixed Range”
- “Compliance Range”
- “Enhanced Auto Ranging for Current Measurement”

To Set Ranging Mode

The following points must be noted when setting the ranging mode.

For measurement channels

- If you do not specify the ranging mode, the auto ranging mode is set automatically.
- For the channels that perform Vf/Vm (voltage force and voltage measurement) or If/Im (current force and current measurement), the measurement range is always the same as the output range.
- For measurement with pulse output, the measurement channel uses the compliance range or the specified fixed range. The channel cannot perform the auto ranging operation or the limited auto ranging operation.
- For the HRSMU connected to the atto sense/switch unit (ASU), the 10 pA range is the minimum for the auto ranging operation. To use the 1 pA range, select the 1 pA limited auto ranging mode or the 1 pA fixed range mode.

For output channels

- The auto ranging mode and the limited auto ranging mode are available for the output channels.
- When the voltage output range or the voltage compliance range is changed, the channel forces 0 V at that moment.

Auto Ranging

Range changing is performed as below.

For measurement channels

The measurement channel automatically searches for and measures at the range that provides the best resolution as follows:

- For current measurement, the measurement channel uses the present range if the following formula is satisfied; otherwise, the channel changes the range.

$$\text{Range} \times 0.1 \leq \text{Measurement value} \leq \text{Range} \times X/100$$

where X=115, or 100 at the maximum range.

See also “Enhanced Auto Ranging for Current Measurement” on page 7-52.

- For voltage measurement, the measurement channel uses the present range if the following formula is satisfied; otherwise, the channel changes the range.

$$\text{Next lower range value} \leq \text{Measurement value} \leq \text{Range} \times X/100$$

where X=110, or 100 at the maximum range.

For output channels

The output channel automatically searches for and forces at the lowest range that covers the output value as follows:

- For staircase sweep output, the output channel uses the lowest range that covers the start and stop values. However, it uses the lowest range that covers the step output value for the logarithmic current sweep. For the voltage sweep that sets the power compliance, the channel uses the lowest range (20 V range or more) that covers the step output value.
- For pulsed bias output, the output channel uses the lowest range that covers the base and peak values.
- For pulsed sweep output, the output channel uses the lowest range that covers the base, start, and stop values.
- For quasi-pulsed output and search source output, the output channel uses the lowest range that covers the start and stop values.

The maximum output value is as follows:

- Maximum current output value = $\text{Range} \times X/100$

where X=115, or 100 at the maximum range.

- Maximum voltage output value = Range value

Limited Auto Ranging

Limited auto ranging is similar to auto ranging. However, limited auto ranging does not use the range(s) less than what you specified. For example, if you select 10 mA limited auto ranging, the measurement unit does not use the 1 mA range or less. Consequently, the measurement time for limited auto ranging is less than for auto ranging.

Fixed Range

The channel uses the specified range only.

For the current measurement channel, if you specify a range higher than the minimum range that covers the compliance value, the measurement channel uses this range (compliance range).

Compliance Range

The compliance range is effective for the Vf/Im (voltage output and current measurement) or If/Vm (current output and voltage measurement) channel. The measurement channel automatically selects and uses the lowest range that covers the specified compliance value.

For the measurement channel that performs constant voltage or current output, you can set the compliance range.

For the measurement channel that performs sweep output, you can set the power compliance value. If you set the power compliance value, the channel uses the lowest range that covers the lower value of either the specified compliance value or the compliance value given by the following formula.

Current compliance = Specified power compliance value / Step voltage

Voltage compliance = Specified power compliance value / Step current

For details about setting compliance, refer to “SMU Compliance” on page 7-53.

NOTE

Range change is performed when the compliance value is set, not when the measurement is performed.

Enhanced Auto Ranging for Current Measurement

Expanded functions are available for the auto ranging operation of the current measurement channel. To use the functions, set *Range Change Rule*. See “SMU Range Setup Window” on page 5-48. *Rate* value defines the boundary of ranging.

- *Range Change Rule*=BY FULL RANGE:
Performs normal auto ranging operation. If a condition shown below is satisfied, the range changes immediately, even during measurement.
$$\text{Measurement value} > \text{Range} \times X/100$$
$$\text{Measurement value} \leq \text{Range} \times 0.1$$
where $X=115$, or 100 at the maximum range.
- *Range Change Rule*=GO UP AHEAD:
If the following condition is satisfied, the range changes up after measurement.
$$\text{Measurement value} \geq \text{current1}$$
- *Range Change Rule*=UP AND DOWN AHEAD:
If the following condition is satisfied, the range changes down immediately, even during measurement.
$$\text{Measurement value} \leq \text{current2}$$

If the following condition is satisfied, the range changes up after measurement.
$$\text{Measurement value} \geq \text{current1}$$

where *current1* and *current2* are given by the following formula. Then *rate* must be an integer, 11 to 100.

$$\text{current1} = \text{Range} \times \text{rate}/100$$

$$\text{current2} = \text{Range} \times \text{rate}/1000$$

For example, if the range value is 10 mA and *rate* is 90, they are:

$$\text{current1} = 9 \text{ mA}$$

$$\text{current2} = 0.9 \text{ mA}$$

SMU Compliance

Compliance is the output limiter to prevent damage to the test device from overcurrent, overvoltage, or overpower. Voltage compliance is for the current output channels, and current compliance is for the voltage output channels.

When a channel reaches compliance, the channel acts as a constant voltage source or a constant current source. The channel keeps the output value when reaching compliance.

Compliance can be set with the same resolution and accuracy as output current or output voltage. For the values, refer to “Specifications” on page 2-33.

Polarity and Output Area

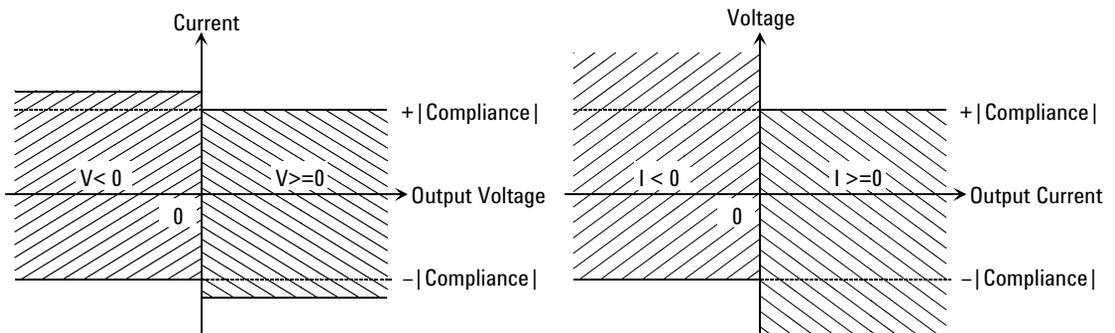
- Polarity of current compliance

Agilent B1500 automatically sets current compliance for both positive and negative polarity. For opposite polarity as the output voltage, the compliance value is increased by an amount that is 2.5 % to 12 % of the range value in the lowest range that covers the specified compliance value. See Figure 7-24.

- Polarity of voltage compliance

Agilent B1500 automatically sets voltage compliance to the same polarity as the output current. There is no compliance for opposite polarity.

Figure 7-24 Relation of Compliance and Output



Power Compliance

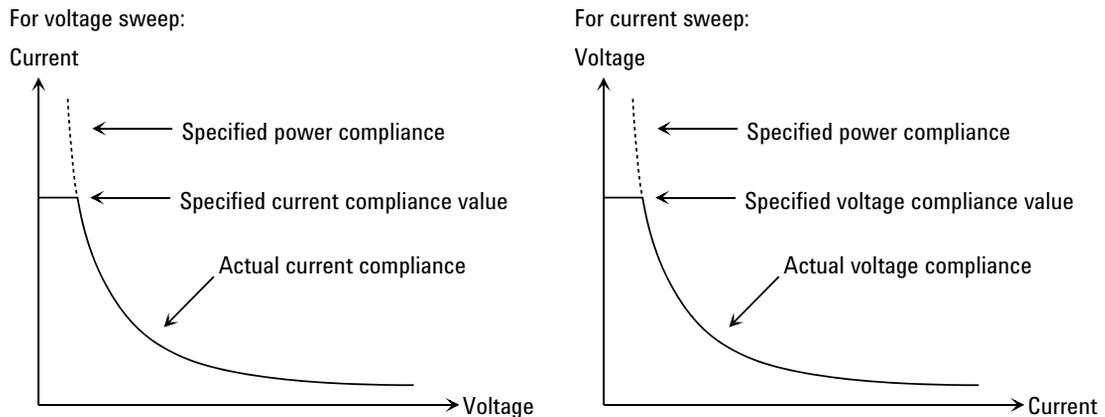
In addition to V compliance or I compliance, you can set power compliance for the staircase sweep source.

If you specify power compliance, the source/monitor unit (SMU) changes the current or voltage compliance value every sweep step. The value is the lower value of either the specified compliance value or the compliance value given by the following formula. See Figure 7-25.

Current compliance = Specified power compliance value / Step voltage

Voltage compliance = Specified power compliance value / Step current

Figure 7-25 Power Compliance Output Area



Available values The following values are available for the power compliance:

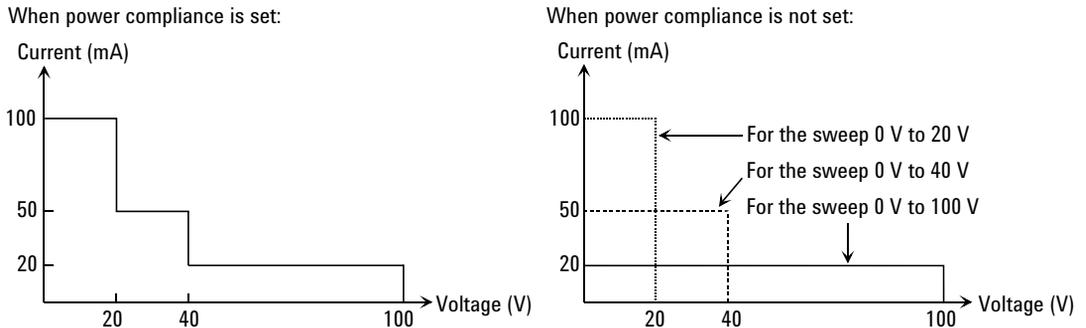
MPSMU/HRSMU 1 mW to 2 W

HPSMU 1 mW to 20 W

Conditions after compliance When a channel reaches compliance, the staircase sweep source automatically stops the sweep and forces the start value. After reaching the compliance, the measurement data will be “NaN”.

SMU output values If you specify power compliance, the SMU changes the current or voltage compliance every sweep step. Hence, the SMU can apply voltage or current with the maximum power. Figure 7-26 shows the differences between the output with power compliance and the output without power compliance, for MPSMU.

Figure 7-26 Allowable Current in Voltage Sweep (0 V to 100 V, MPSMU)



NOTE

If you specify power compliance, the measurement time increases slightly because the B1500 adjusts the compliance for every sweep step.

To Set Compliance

The following points must be noted when setting the compliance.

- If the current compliance value is too low, the SMU will take a long settling time.
- The SMU will reach voltage compliance if the SMU cannot force the specified current for the following reasons:
 - Over current for test device.
 - Another channel has reached compliance.
 - Current measurement data of another channel has reached the limit for the present measurement range.

SMU Pulse

The source/monitor unit (SMU) can apply voltage or current pulse. The pulse width and pulse period must be the following values.

Pulse width 0.5 ms to 2 s, 0.1 ms resolution

Pulse period 5 ms to 5 s, 0.1 ms resolution

The setup values must satisfy the following conditions.

- $\text{period} \geq \text{width} + 2 \text{ ms}$ (for pulse width $\leq 100 \text{ ms}$)
- $\text{period} \geq \text{width} + 10 \text{ ms}$ (for pulse width $> 100 \text{ ms}$)

To Set Pulse Output

The following points must be noted when setting the pulse output.

- Cannot use the 1 nA output range and lower ranges.
- Cannot use multiple measurement channels.
- The measurement channel uses the compliance range. The channel cannot perform the auto ranging operation or the limited auto ranging operation.

SMU Measurement Time

Measurement time depends on integration time, measurement range, and other measurement conditions, and can be expressed by the following formula:

$$\text{Measurement time} = \text{Integration time} + \text{Overhead time}$$

Integration time is the time required for measurement, and does not include such factors as range changing or data compensation, which would be the overhead time.

Integration Time

Integration time is the time required to get measurement data. For accurate and reliable measurement, integration time should be increased. Integration time can be set for each type of A/D converter (ADC) used by the measurement channel.

- High-speed ADC

You can adjust the number of averaging samples instead of the integration time. For high speed measurement. Installed in each measurement module.

- High-resolution ADC

You can adjust the integration time directly. For high accuracy and high resolution measurement. This ADC is mounted on the mainframe, and used by the multiple modules alternately.

To set the integration time or the number of averaging samples, select the mode and set the value as shown in Table 7-8.

ADC Zero Function

The ADC zero function is available for the high-resolution A/D converter (ADC) and not available for the high-speed ADC. This function measures the internal offset of the high-resolution ADC and compensates it automatically. The measurement data displayed on the LCD will be the data after compensation.

NOTE

This function is especially effective for the low voltage measurement. Disable the function in cases where measurement speed is more important than measurement accuracy. This approximately halves integration time.

Table 7-8

Integration Time and Number of Samples

| ADC | Mode | Description |
|---------------------|--------|---|
| High Speed ADC | AUTO | <p>$Number\ of\ averaging\ samples = N \times reference$</p> <p>where <i>reference</i> is the number of averaging samples automatically set by Agilent B1500; this cannot be changed.</p> <p>Specify the <i>N</i> value shown above. Available values are 1 to 1023. Initial value is 1.</p> |
| | MANUAL | <p>Specify the number of averaging samples (<i>N</i>).</p> <p>Available values are 1 to 1023. Initial value is 1.</p> |
| | PLC | <p>$Number\ of\ averaging\ samples = N \times 128$</p> <p>Specify the <i>N</i> value shown above. Available values are 1 to 100. Initial value is 1.</p> <p>Agilent B1500 gets 128 samples in a power line cycle. Hence, the <i>N</i> value is equal to the number of power line cycles.</p> |
| High Resolution ADC | AUTO | <p>$Integration\ time = N \times reference$</p> <p>where <i>reference</i> is the integration time automatically set by Agilent B1500A; it cannot be changed.</p> <p>Specify the <i>N</i> value shown above. Available values are 1 to 127. Initial value is 6.</p> |
| | MANUAL | <p>$Integration\ time = N \times 80\ \mu sec$</p> <p>Specify the <i>N</i> value shown above. Available values are 1 to 127. Initial value is 3.</p> |
| | PLC | <p>$Integration\ time = N / power\ line\ frequency$</p> <p>Specify the <i>N</i> value shown above. Available values are 1 to 100. Initial value is 1.</p> <p>The <i>N</i> value means the number of power line cycles.</p> |

Overhead Time

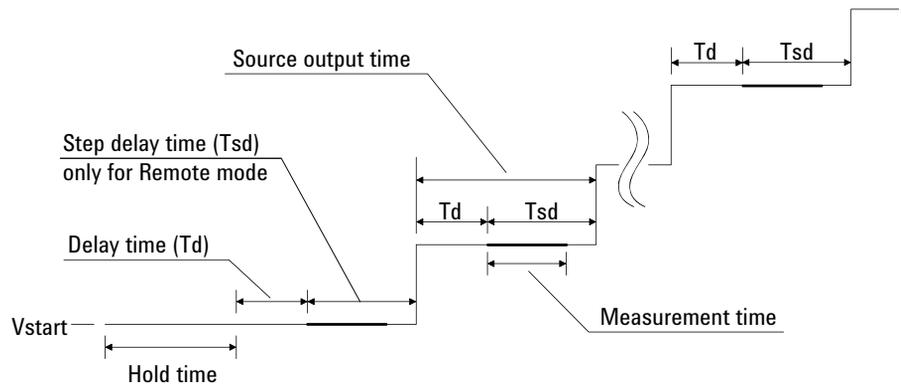
The overhead time is the time required for range changing and so on. This time depends on the measurement condition, and cannot be specified. Major elements of the overhead time are:

- Range changing time during measurement (when measurement ranging mode is set to auto or limited auto)
- Range changing time at measurement start (when the measurement range is less than the compliance value)

To Specify Source Output Time

You cannot specify the measurement time. However, in sweep measurement mode, you can specify a source output time that includes the measurement time. To specify the source output time, set the delay time and the step delay time. The step delay time is defined as the time from the measurement trigger up to the trigger for changing the source output value. See the figure below. The step delay time must cover the measurement time to keep the source output time constant.

The EasyEXPERT does not support the step delay time. It is available only for the GPIB remote mode.



Wait Time

Wait time is the time after starting source output until changing the source output value or until starting measurement. You can set the source wait time and the measurement wait time individually.

The source wait time is the time the source channel always waits after it starts output until it changes the output value. The measurement wait time is the time the measurement channel always waits after the source channel starts output until the measurement channel starts measurement. Refer to Figure 7-27. The wait time is given by the following formula:

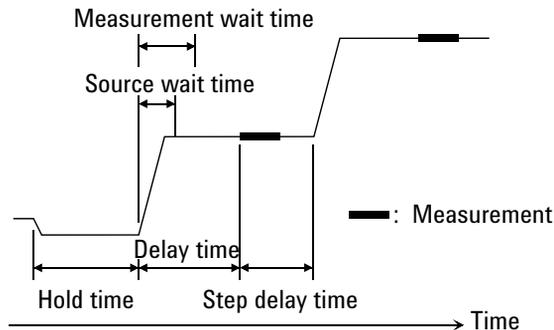
$$\text{wait time} = N \times \text{reference}$$

where *reference* is the wait time Agilent B1500 automatically sets according to the present settings; this wait time cannot change. Available *N* values are 0 to 10, 0.1 step. Initial value is 1.

It is not easy to determine the best wait time. If you specify it too short, the measurement may start before device characteristics stable. If too long, time will be wasted. For measurements of low capacitance or fast response devices, if measurement speed has top priority or is more important than reliability and accuracy, set the wait time shorter. The initial wait time may be too short for measurements of high capacitance or slow response devices. Then set the wait time longer.

Figure 7-27

Source/Measurement Wait Time



NOTE

In the GPIB remote mode, if the delay time is longer than the wait time, the wait time can be ignored.

The EasyEXPERT does not support the step delay time.

Multiple Measurement Channels

To use multiple measurement channels, define multiple measurement parameters in the Display Setup screen or the Function Setup screen. Then, measurement sequence, time data, and measurement time for each measurement point are as follows.

- Sequence of measurement execution

Measurement channels perform measurement in the order shown below.

1. Measurement channels which use the high speed AD converter and the FIXED measurement range start measurement simultaneously (parallel measurement).
2. After the parallel measurement, the other measurement channels perform measurement sequentially. The order is top to bottom of the channels defined in the SMU Range Setup screen.

As a special case, for the linear sampling measurement with *Interval* < 2 ms, all channels start measurement simultaneously.

- Time data

Only the measurement start time of the channel which starts measurement at first is recorded.

- Measurement time

Measurement time is the sum of the measurement time by all channels.

SMU Filter

The filter is mounted on each source/monitor unit (SMU) module. It assures clean source output with no spikes or overshooting. However, using a filter may increase the SMU settling time.

To set the filter, refer to “Advanced Setup Window” on page 5-51.

NOTE

The SMU filter is set to OFF for the standby channels in the standby state.

SMU Series Resistor

The series resistor (approx. 1 M Ω) is mounted on each source/monitor unit (SMU) module. The series resistor may be used for the device protection, negative resistance measurement, and so on. It depends on the characteristics of test device and measurement environment.

If you use a series resistor, the voltage you set is applied to the near side of the series resistor. Thus, the voltage will be divided by the series resistor and the device under test. Then, the measurement data is not compensated.

To set the series resistor, refer to “Advanced Setup Window” on page 5-51.

NOTE

Restrictions

The series resistor cannot be used for the measurements that use the high resolution SMU (HRSMU) connected to the Atto Sense and Switch Unit (ASU) or the measurements that use 1 A range of the high power SMU (HPSMU).

The series resistor is set to OFF for the standby channels in the standby state.

Interlock Function

The interlock function is designed to prevent electrical shock when a user touches the measurement terminals. If the Interlock terminal is open, maximum output is limited to ± 42 V.

To perform high voltage measurement more than ± 42 V, connect the Interlock terminal to an interlock circuit of test fixture or connector plate. The interlock circuit must have one LED and two mechanical switches placed near the shielding box opening doors. And they must be connected together. For details on how to install the interlock circuit, see “To Make an Interlock Circuit” on page 3-29.

The interlock function works as shown below.

- When the interlock circuit is open, maximum output is limited to ± 42 V.
- When the interlock circuit is close, source channel can force its maximum output value.
- When the interlock circuit is opened in the high voltage condition more than ± 42 V, output voltage is set to 0 V immediately.

CAUTION

If the actual output value is not set to 0 V within 120 msec, Agilent B1500 automatically performs the initialization. Then perform self-test. Any module may be defective.

WARNING

Dangerous voltage of up to the maximum voltage of SMUs may be present at force, guard, and sense terminals if the Interlock terminal is closed.

Auto Power Off Function

If an abnormal voltage or current is detected in Agilent B1500, Agilent B1500 automatically turns off to prevent damage.

If this function is activated, Agilent B1500 is turned off, but the Standby switch is left ON. Perform the following steps to turn Agilent B1500 on again.

1. If Windows is running, end all tasks, and shutdown Windows.
2. Open the measurement terminals.
3. Press the Standby switch to set it to the OFF position.
4. Remove the power cable from the B1500 rear panel.
5. Wait for 10 seconds or more.
6. Connect the power cable from the B1500 rear panel.
7. Press the Standby switch to set it to the ON position.

Abnormal voltage or current can be caused by incorrect connections of Agilent B1500 to the test device, excess voltage or current input, momentary power loss, defects of the instrument, and so on.

If no cable is connected to the measurement terminals of Agilent B1500, and the line voltage is correct, Agilent B1500 may have a defect. Contact the nearest Agilent Technologies Service Center for assistance.

Initial Settings

Agilent B1500 is initialized by turning the B1500 on, the *RST command, or the device clear. Initial settings of the B1500 are shown in the following tables.

Table 7-9 Initial Settings

| | Setup Item | Initial Setting | | |
|--------------|--------------------------------|-------------------------------|------------------|--|
| Mainframe | Auto calibration | off | | |
| SMU | Output switch | close | | |
| | Filter | on | | |
| | Series resistor | off | | |
| | ASU path/indicator | SMU side/enable | | |
| | ASU 1 pA auto range | disable | | |
| | Current measurement range | with pulse | compliance range | |
| | | without pulse | auto | |
| | Voltage measurement range | with pulse | compliance range | |
| | | without pulse | auto | |
| | A/D converter | high resolution A/D converter | | |
| | ADC integration time | high speed ADC: auto | | |
| | | high resolution ADC: auto | | |
| | ADC zero function | off | | |
| | Sweep automatic abort function | off | | |
| | Hold time | 0 s | | |
| | Delay time | 0 s | | |
| Pulse width | 0.001 s | | | |
| Pulse period | 0.01 s | | | |

| | Setup Item | Initial Setting |
|------|------------------------------|---|
| CMU | SCUU path/indicator | open/enable |
| | Measurement parameter | Cp-G |
| | Measurement range | auto |
| | Measurement time | auto |
| | Open/short/load correction | off |
| | Phase compensation mode | auto |
| | Measurement signal frequency | 1 k, 2 k, 5 k, 10 k, 20 k, 50 k, 100 k, 200 k, 500 k, 1 M, 2 M, 5 MHz |
| | Automatic abort function | off |
| | Hold time | 0 s |
| | Delay time | 0 s |
| SPGU | Operation mode | VPULSE (PG mode) |
| | Pulse period | 1.0 μ s |
| | Channel output mode | Primary Pulse, 2-level pulse output |
| | Pulse source setup | Delay: 0 s Width 100 ns Leading: 20 ns Trailing: 20 ns |
| | ALWG setup | Cleared |
| | Pulse switch | Disable |
| | DUT load impedance | 50 Ω |
| | SPGU trigger output | Disable |

Function Details

Initial Settings

8

Built-in Programming Tool

Built-in Programming Tool

This chapter explains the programming tool built into Agilent B1500A/EasyEXPERT. The programming tool is used to define user functions and analysis functions in the Classic Test definitions and to define the test contents in the Application Test definitions.

This chapter contains the following sections.

- “Variables and Expressions”
- “Built-in Functions”
- “Read Out Functions”
- “Script Program Statements”

Variables and Expressions

Variables can be used in Agilent EasyEXPERT setup editor for the following applications. User functions and analysis functions can also be used for variables.

- To store the value of the measurement condition input parameter
- To store the value of the measurement result data or analysis data
- Variable used in the test execution flow of the Application Test definition
- User function of the Classic Test definition
- Analysis function of the Classic Test definition

The following characters can be used for the variable name.

- Alphabetic characters A to Z and a to z, case sensitive
- _ (underscore)
- Numeric characters 0 to 9
- @ (at mark)

Numeric characters and at mark cannot be used for the first character of variable name.

NOTE

About variable names

The variable name must be unique. If a variable is defined as a local variable in an application test definition and its name is the same as one of the following variables, the local variable is effective and the following variable is not effective.

- variable that defines a built-in function in a test setup
- variable that defines a read out function in a test setup
- variable defined as a test parameter
- variable defined as a device parameter
- variable defined as an analysis parameter

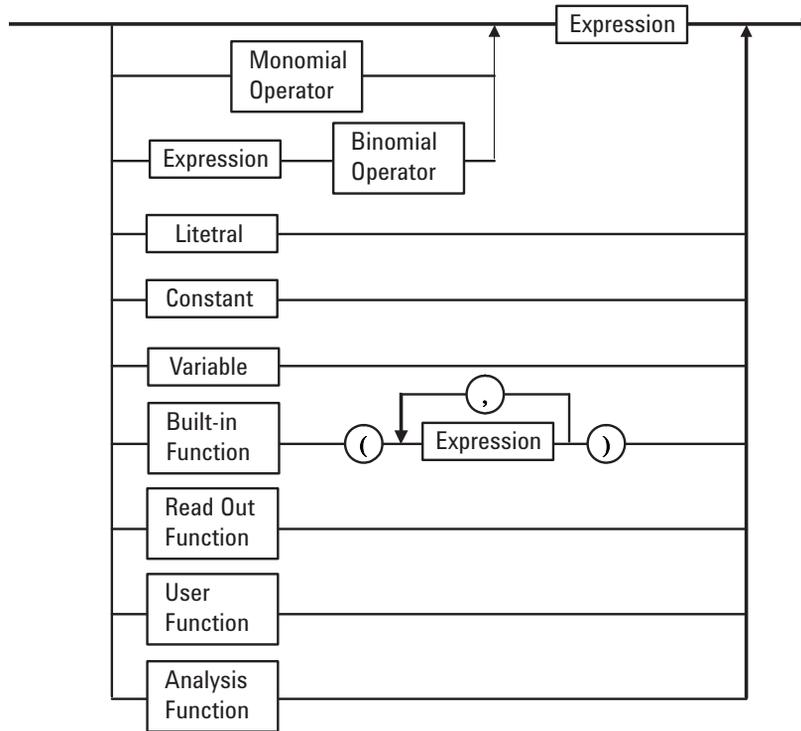
The local variables are defined by using the Local Variable Definition statement in the Test Contents setup displayed on the Test Definition window. The test parameters and the device parameters are defined in the Test Specification setup, and the analysis parameters are defined in the Test Output setup.

Expressions

Figure 8-1 shows the expression effective for variable definition. The elements are explained below.

Figure 8-1

Syntax of Expression



Constants

The following scientific constants are available.

- q: electric charge. 1.602177×10^{-19}
- k: Boltsmann's constant. 1.380658×10^{-23}
- e: space permittivity. 8.854188×10^{-12}

Literals

Numeric type and string type are available.

- Numeric type

To enter a numeric value, type as follows, where [] is optional.

`Dd[.d][E[S]d][s]`

D: Numeric character 0 to 9

d: This means repeating D 0 times or more.

E: Exponent symbol, E or e

S: Sign, + or -

s: Prefix symbol. The subsequent symbols (y, z, a, f, p, n, u, m, k, M, G) separated by the comma mean the value following the colon.

y: 10^{-24} , z: 10^{-21} , a: 10^{-18} , f: 10^{-15} , p: 10^{-12} , n: 10^{-9} , u: 10^{-6} , m: 10^{-3} ,
k: 10^3 , M: 10^6 , G: 10^9

- String type

Enclose the string by using the double quotes. To contain the double quotes into the string, type as shown below. The example string is ABC"DEF.

```
"ABC " "DEF "
```

Monomial Operators and Binomial Operators

Table 8-1 shows monomial operators and binomial operators available for an expression. The table also shows the priority of operators and the type of operand. For the expression that contains the same priority operators, the operations are performed from left to right. Module type variable is one of SMU, HPSMU, MPSMU, HRSMU, HRSMU/ASU, CMH, or CML.

NOTE

Operation between arrays

Operation is performed between data at the same index.

Table 8-1 Monomial Operator and Binomial Operator

| Priority | Operator | Type of operand | | | |
|----------|------------------|-----------------|---------------------|---------------|--------|
| | | Numeric | Vector ^a | String | Module |
| High | () | Yes | Yes | Yes | Yes |
| | NOT | Yes | Yes | No | No |
| | ^ | Yes | Yes | No | No |
| | * or / | Yes | Yes | No | No |
| | + or -, monomial | Yes | Yes | +: Yes, -: No | No |
| | + or -, binomial | Yes | Yes | +: Yes, -: No | No |
| | >, >=, <, <= | Yes | Yes | Yes | No |
| | =, <> | Yes | Yes | Yes | No |
| Low | AND | Yes | Yes | No | No |
| | XOR | Yes | Yes | No | No |
| | OR | Yes | Yes | No | No |

- a. Two-dimensional array. The primary plane is for the primary sweep index, and the secondary plane is for the secondary sweep index.

Built-in Functions

Agilent EasyEXPERT built-in function can be used. See “Built-in Functions” on page 8-7.

Read Out Functions

Agilent EasyEXPERT built-in read out function can be used. Available only for the Analysis Functions. See “Read Out Functions” on page 8-15.

User Functions and Analysis Functions

User functions and analysis functions are the user-defined functions that consist of the variable name, unit, and expression. The functions are effective for numeric or vector type data. To define the functions, see “Function Setup” on page 5-42.

Numeric literal, scientific constants (q, k, e), variable to store the test result data, and a built-in function that returns the numeric or vector type data can be used in the expression.

For an analysis function, the read-out function can also be used.

Built-in Functions

This section describes Agilent EasyEXPERT built-in functions. The functions appear in alphabetical order. In the function name, the character in parentheses is a variable.

abs(A)

Returns the absolute value of the expression A.

Example `B=abs(A)`

Data type A: numeric, B: numeric. Or A: vector, B: vector.

acos(A)

Returns the arccosine value of the expression A. The A value must be between -1 and 1.

Example `B=acos(A)`

Data type A: numeric, B: numeric. Or A: vector, B: vector.

asin(A)

Returns the arcsine value of the expression A. The A value must be between -1 and 1.

Example `B=asin(A)`

Data type A: numeric, B: numeric. Or A: vector, B: vector.

at(A,B)

Finds a data element in the expression A, and returns the value. The data element is specified by index B. The index number starts from 1. If B is not an integer, a linear interpolated A value will be returned.

Example `C=at(A,B)`

Data type A: vector or numeric, B: numeric, C: vector.

at(A,B,C)

Finds a data element in the expression A, and returns the value. The data element is specified by the indices B and C. B is the index for the primary plane of a two-dimensional array and C is the index for the secondary plane. The index number starts from 1.

If B is not an integer, a linear interpolated A value will be returned. The linear interpolation will be executed between $A[n,C]$ and $A[n+1,C]$, where $n < B < n+1$.

If C is not an integer, C will be n, where $n < C < n+1$.

Example `D=at(A,B,C)`

Data type A: vector or numeric, B: numeric, C: numeric, D: numeric.

Built-in Programming Tool

Built-in Functions

- atan(A)** Returns the arctangent value of the expression A.
- Example** `B=atan(A)`
- Data type** A: numeric, B: numeric. Or A: vector, B: vector.
- atan2(A,B)** Returns the radian value of the angle made by the X-axis and the line that passes through the coordinates (0, 0) and (A, B).
- Example** `C=atan2(A,B)`
- Data type** A: numeric, B: numeric, C: numeric. If A and/or B is vector, C: vector.
- avg(A)** Returns the average value of data in the expression A. For subordinate sweep measurement, this function returns the average values for each primary sweep.
- Example** `B=avg(A)`
- Data type** A: vector or numeric, B: vector.
- ceil(A)** Returns the minimum integer value more than or equal to the expression A.
- Example** `B=ceil(A)`
- Data type** A: numeric, B: numeric. Or A: vector, B: vector.
- cond(A,B,C,D)** This function does the following.
- If $A < B$, returns C.
 - If $A \geq B$, returns D.
- If the A or B value is invalid, the value for the previous measurement index number is used for the comparison.
- Example** `E=cond(A,B,C,D)`
- Data type** A, B, C, D: numeric, E: numeric. If A, B, C, and/or D is vector, E: vector.
- cos(A)** Returns the cosine value of the expression A.
- Example** `B=cos(A)`
- Data type** A: numeric, B: numeric. Or A: vector, B: vector.

delta(A)

Returns the difference of the expression A. Calculation is performed as follows.

$$D_n = (A_2 - A_1) \quad \text{when } n = 1$$

$$D_n = (A_{n+1} - A_{n-1}) / 2 \quad \text{when } 1 < n < N$$

$$D_n = (A_N - A_{N-1}) \quad \text{when } n = N$$

where,

- D_n** difference for the index number n
- A_n** A value for the index number n
- N** number of sweep steps or number of samples

For subordinate sweep, the first index number of each primary sweep is always 1.

If A is a data variable for a secondary sweep source, this function returns the sweep step value of the secondary sweep.

For frequency data of C-V sweep, the calculation is performed for all frequencies.

Example `B=delta(A)`

Data type A: vector or numeric, B: vector.

diff(A,B)

Returns the differential coefficient of the expression A by B. Calculation is performed as follows.

$$A'_n = (A_2 - A_1) / (B_2 - B_1) \quad \text{when } n = 1$$

$$A'_n = (A_{n+1} - A_{n-1}) / (B_{n+1} - B_{n-1}) \quad \text{when } 1 < n < N$$

$$A'_n = (A_N - A_{N-1}) / (B_N - B_{N-1}) \quad \text{when } n = N$$

where,

- A'_n**: differential coefficient for the index number n
- A_n**: A value for the index number n
- B_n**: B value for the index number n
- N**: number of sweep steps or number of samples

For subordinate sweep, the first index number of each primary sweep is always 1.

Example `C=diff(A,B)`

Data type A, B: vector or numeric, C: vector.

Built-in Programming Tool

Built-in Functions

- dim1Size(A)** Returns the number of elements in the primary plane of the vector variable A.
Example `B=dim1Size(A)`
Data type A: vector, B: numeric.
- dim2Size(A)** Returns the number of elements in the secondary plane of the vector variable A.
Example `B=dim2Size(A)`
Data type A: vector, B: numeric.
- exp(A)** Raises e (exponential) to the power of the expression A. The following example enters e^A calculation result to the variable B.
Example `B=exp(A)`
Data type A: numeric, B: numeric. Or A: vector, B: vector.
- floor(A)** Returns the maximum integer value less than or equal to the expression A.
Example `B=floor(A)`
Data type A: numeric, B: numeric. Or A: vector, B: vector.
- getNumericData(A)** Returns data of the numeric variable specified by A. This function is effective for the variables defined in the Function Setup or Display Setup of the last Classic Test or the analysis parameters of the last Application Test. The variables are valid in a test definition.
Example `B=getNumericData("A")`
Data type A: string (name of numeric variable), B: numeric.
- getVectorData(A)** Returns data of the vector variable specified by A. This function is effective for the variables defined in the Function Setup or Display Setup of the last Classic Test or the analysis parameters of the last Application Test. The variables are valid in a test definition.
Example `B=getVectorData("A")`
Data type A: string (name of vector variable), B: vector.
- index(A,B)** Finds the string B in the string A, and returns the index number where the string B is first found. The index 0 indicates the first character. The following example returns 3.
Example `C=index("AGILENT", "L")`
Data type C: numeric.

integ(A,B)

Performs numerical integration of the expression A by B. Calculation is performed as follows.

When $n = 1$, $\alpha_n = 0$

When $n > 1$, α_n is defined as follows:

$$\alpha_n = \frac{1}{2} \sum_{i=2}^n (y_i + y_{i-1})(x_i - x_{i-1})$$

where,

α_n : integral of A for the index number n

y_i : A value for the index number i

x_i : B value for the index number i

If A or B contain some invalid values, the invalid values are ignored for the calculation.

For subordinate sweep, the first index number of each primary sweep is always 1.

Example `C=integ(A,B)`

Data type A, B: vector or numeric, C: vector.

isValid(A)

Returns 1 if the expression A is valid and is not double.NaN, or else returns 0.

Example `B=isValid(A)`

Data type A: numeric, B: numeric.

lgt(A)

Returns the logarithm (base 10) of the expression A.

If $A=0$, `-Overflow` is returned with the status “Arithmetic error”.

If A is a negative value, the logarithm of the absolute value is returned with the status “Arithmetic error”.

Example `B=lgt(A)`

Data type A: numeric, B: numeric. Or A: vector, B: vector.

Built-in Programming Tool

Built-in Functions

log(A)

Returns the logarithm (base e) of the expression A.

If A=0, -Overflow is returned with the status “Arithmetic error”.

If A is a negative value, the logarithm of the absolute value is returned with the status “Arithmetic error”.

Example $B = \log(A)$

Data type A: numeric, B: numeric. Or A: vector, B: vector.

mavg(A,B)

Returns the moving average value of data in the expression A. B specifies how many data to use for the average. The moving average at the index number n is defined as follows.

When $n \leq r$

$$\bar{x}_n = \frac{1}{r+n} \sum_{i=1}^{n+r} x_i$$

When $r < n \leq N-r$

$$\bar{x}_n = \frac{1}{2r+1} \sum_{i=n-r}^{n+r} x_i$$

When $N-r < n$

$$\bar{x}_n = \frac{1}{r+N-n+1} \sum_{i=n-r}^N x_i$$

where,

\bar{x}_n : moving average of A for the index number n

x_i : A value for the index number i

r : B value

N : number of sweep steps or number of samples

If A contains some invalid values, the invalid values are ignored for the calculation.

For subordinate sweep, the first index number of each primary sweep is always 1.

Example $C = \text{mavg}(A, B)$

Data type A: vector or numeric, B: numeric, C: vector.

- max(A)** Returns the maximum value of data in the expression A. For subordinate sweep measurement, this function returns the maximum value of the primary sweep for each secondary sweep step.
- If there are invalid values in A, invalid values are ignored.
- Example** `B=max(A)`
- Data type** A: vector or numeric, B: vector.
- min(A)** Returns the minimum value of data in the expression A. For subordinate sweep measurement, this function returns the minimum value of the primary sweep for each secondary sweep step.
- If A contains invalid values, the invalid values are ignored.
- Example** `B=min(A)`
- Data type** A: vector or numeric, B: vector.
- setDeviceId(A)** Sets the value of the string variable A to the Device ID parameter of the test result record. This value is effective for the test result records created after this function call. If the A value is an empty string, this function does nothing.
- Example** `B=setDeviceId(A)`
- Data type** A: string, B: numeric. B (returned value) is always 0.
- sin(A)** Returns the sine value of the expression A.
- Example** `B=sin(A)`
- Data type** A: numeric, B: numeric. Or A: vector, B: vector.
- sqrt(A)** Returns the square root of the expression A.
- Example** `B=sqrt(A)`
- Data type** A: numeric, B: numeric. Or A: vector, B: vector.
- storeAt(A,B,C,D)** Finds a data element in the expression A, and replaces it with the D value, and returns the result vector data. The data element is specified by the indices B and C. B is the index for the primary plane of a two-dimensional array and C is the index for the secondary plane. The index number starts from 1. The following example replaces the A[5, 5] value with the D value and enters the result vector data to the variable E.
- Example** `E=storeAt(A,5,5,D)`
- Data type** A: vector or numeric, B, C, D: numeric, E: vector.

Built-in Programming Tool

Built-in Functions

string(A) Translates the expression A to a string data, and returns it.

Example `B=string(A)`

Data type A: numeric or module, B: string.

NOTE

Translating the variable defined with the numeric-symbol assignment

If the argument of the *string* function is a numeric variable defined with the numeric-symbol assignment, the *string* function execution result will be the symbol assigned to the numeric value, not the string value just translated from the numeric value. The numeric-symbol assignment is defined in the “Test Specification” on page 6-5.

For the following example setup of the numeric-symbol assignment, `string(Mode)` execution result at `Mode=0` is the string OFF, not the string 0.

Parameter Mode, Value=0, Symbol=OFF

substring(A,B,C) Extracts a string from the string A, and returns it. B is the index used to specify the first character to extract, and C is the number of characters to extract. The index number starts from 0. If B or C is not an integer, digits over the decimal point are used as the integer. The following example returns G.

Example `D=substring("AGILENT",1,1)`

Data type A: string, B, C: numeric, D: string.

swmToModule(A) Searches the measurement module connected to Agilent B2200 input port number A. And returns the module name.

Example `B=swmToModule(A)`

Data type A: string (Input port number 1 to 14), B: module.

tan(A) Returns the tangent value of the expression A.

Example `B=tan(A)`

Data type A: numeric, B: numeric. Or A: vector, B: vector.

value(A) Translates the string A to a numeric data, and returns it. If the A value is invalid as numeric literal, 0 is returned.

Example `B=value(A)`

Data type A: string, B: numeric.

Read Out Functions

The read out functions are built-in functions for reading various values related to the marker, cursor, or line. You can use these functions to perform complex analysis of the measurement results. They are available only for the Analysis Functions.

To read the value of the read out function, use a numeric variable. The following example reads the X intercept of the line 1 and enters it to the variable A.

Example `A=@L1X`

NOTE

In this section, *n* of the function name is an integer (1 to 8), and *m* is 1 or 2.

You cannot assign a data variable that includes a read out function to an axis of a graphics plot.

If the marker, cursor, or line that are referred to by the read out function are not displayed, the read out function uses the position at which it was most recently displayed. If the marker, cursor, and line have not been displayed, the read out function returns invalid data.

Functions for Marker

@MI

Returns the index number of measurement data at the marker location.

If interpolation mode is enabled and the marker is located between the measurement data, this function returns a non-integer value.

@MX

Returns the value of the X coordinate at the marker location.

@MY

Returns the value of the Y coordinate at the marker location.

If there are two Y axes, this function returns the value for the selected axis.

@MY n

Returns the value of the Y n coordinate at the marker location (n : 1 to 8, integer).

Functions for Cursor

@CX

Returns the value of the X coordinate at the active cursor position.

@CY

Returns the value of the Y coordinate at the active cursor position. If there are two Y axes, this function returns the value for the selected axis.

Built-in Programming Tool Read Out Functions

@CYn Returns the value of the Y_n coordinate at the active cursor position (n : 1 to 8, integer).

Functions for Line

@LmCO Returns the correlation coefficient of the regression for Line m (m : 1 or 2).
Line m must be in regression mode. If not, this function returns invalid data.

@LmG Returns the slope of Line m (m : 1 or 2).
If there are two Y axes, this function returns the value for the selected axis.
This function calculates the slope by using the following formula:

- If the X and Y axes are both linear scale:
$$\alpha = (y_1 - y_0) / (x_1 - x_0)$$
- If the X axis is log scale, and the Y axis is linear scale:
$$\alpha = (y_1 - y_0) / (\log x_1 - \log x_0)$$
- If the X axis is linear scale, and the Y axis is log scale:
$$\alpha = (\log y_1 - \log y_0) / (x_1 - x_0)$$
- If the X and Y axes are both log scale:
$$\alpha = (\log y_1 - \log y_0) / (\log x_1 - \log x_0)$$

where,

α : Slope of Line m

x_0, y_0, x_1, y_1 : X and Y coordinate values at the two points where Line m intercepts the perimeter of the plotting area.

@LmGn Returns the slope of Line m (m : 1 or 2) for the Y_n axis (n : 1 to 8, integer).
This function calculates the slope by using the following formula:

- If the X and Y_n axes are both linear scale:
$$\alpha = (y_1 - y_0) / (x_1 - x_0)$$
- If the X axis is log scale, and the Y_n axis is linear scale:
$$\alpha = (y_1 - y_0) / (\log x_1 - \log x_0)$$

- If the X axis is linear scale, and the Y_n axis is log scale:

$$\alpha = (\log y_1 - \log y_0) / (x_1 - x_0)$$

- If the X and Y_n axes are both log scale:

$$\alpha = (\log y_1 - \log y_0) / (\log x_1 - \log x_0)$$

where,

α : Slope of Line *m*

x_0, y_0, x_1, y_1 : X and Y coordinate values at the two points where Line *m* intersects the perimeter of the plotting area.

@LmX

Returns the X intercept value (Y=0) of Line *m* (*m*: 1 or 2).

If Line *m* is horizontal, this function returns invalid data.

@LmY

Returns the Y intercept value (X=0) of Line *m* (*m*: 1 or 2).

If there are two Y axes, this function returns the value for the selected axis.

If Line *m* is vertical, this function returns invalid data.

@LmYn

Returns the Y_n (*n*: 1 to 8) intercept value (X=0) of Line *m* (*m*: 1 or 2).

If Line *m* is vertical, this function returns invalid data.

Functions for Two Line Display

@IX

Returns the value of the X coordinate at the intersection of Line 1 and Line 2.

This function calculates the intersection by using the following formula.

$$X = (y_2 - y_1) / (\alpha_2 - \alpha_1)$$

where,

X : Value of the X coordinate at the intersection. If the X axis is log scale, this function returns 10^X .

y_m : Y intercept value of Line *m* (*m*: 1 or 2). If the Y axis is log scale, y_m is the log value of the Y intercept of Line *m*.

α_m : Slope of Line *m*

If Line 1 is parallel to Line 2, this function returns invalid data with the status “Arithmetic error”.

Built-in Programming Tool Read Out Functions

@IY

Returns the value of the Y coordinate at the intersection of Line 1 and Line 2.

If there are two Y axes, this function returns the value for the selected axis.

This function calculates the intersection by using the following formula:

$$Y = y_1 + \alpha_1 \times (y_2 - y_1) / (\alpha_1 - \alpha_2)$$

where,

Y : Value of the Y coordinate at the intersection. If the Y axis is log scale, this function returns 10^Y .

y_m : Y intercept value of Line m (m : 1 or 2). If the Y axis is log scale, y_m is the log value of the Y intercept of Line m .

α_m : Slope of Line m

If Line 1 is parallel to Line 2, this function returns invalid data with the status “Arithmetic error”.

@IYn

Returns the value of the Y_n (n : 1 to 8, integer) coordinate at the intersection of Line 1 and Line 2.

This function calculates the intersection by using the following formula:

$$Y_n = y_1 + \alpha_1 \times (y_2 - y_1) / (\alpha_1 - \alpha_2)$$

where,

Y_n : Value of the Y_n coordinate at the intersection. If the Y_n axis is log scale, this function returns 10^{Y_n} .

y_m : Y_n intercept of Line m (m : 1 or 2). If the Y_n axis is log scale, y_m is the log value of the Y_n intercept of Line m .

α_m : Slope of Line m

If Line 1 is parallel to Line 2, this function returns invalid data with the status “Arithmetic error”.

Script Program Statements

The program statements are used to define the test execution flow on the Test Contents tab screen of the Test Definition window. On the screen, click the Program Component tab. The program statements are listed in the component selection area. See also “Program Component” on page 6-26.

Local Variable Definition

This statement defines the local variables used in the test definition. For the setup editor, see “Local Variable Definition” on page 6-24. For the available names and variable types, see “Variables and Expressions” on page 8-3.

The local variables are effective only for this test definition.

ASSIGN

This statement enters a value or expression to the variable as follows:

<variable> = <definition>

where, <variable> is the variable to define, and <definition> is the value or expression.

BLOCK

Beginning of the BLOCK/END BLOCK block. The statements are added to the program list as a pair. The test execution flow (program) must be defined between the statements. Optionally, the following statements can be used in this block.

- ON ERROR

This statement enables an event-initiated branch performed when an error occurs. The routine to be performed when error occurs must be defined between ON ERROR and END BLOCK or between ON ERROR and FINALLY.

- FINALLY

This statement enables an event-initiated branch performed just before terminating the block. The routine to be performed before terminating the block must be defined between FINALLY and END BLOCK.

The statements or components between the BLOCK and END BLOCK statements are performed from top-down. If no error occurs during program execution, the routine below FINALLY is executed and the block is terminated.

If an error occurs, the error code is stored in the @ERROR system variable, the routine below ON ERROR is executed, and the block is terminated. If FINALLY is used, the routine below FINALLY is executed before the block is terminated.

Built-in Programming Tool

Script Program Statements

| | |
|----------------|---|
| COMMENT | This statement enters a comment in the program line. |
| END | This statement terminates program execution. After the END statement, the routines defined by the FINALLY statement are performed. |
| ERROR | This statement causes an error. However, no error code is stored in the @ERROR system variable because of the fictitious error. |
| FOR | <p>Beginning of the FOR/NEXT loop block. FOR and NEXT are added to the program list as a pair. The statements repeatedly performed when looping must be defined between the statements. The FOR/NEXT statements are entered as follows:</p> <pre>FOR <variable> = <initial value> TO <terminate value> STEP <step value> NEXT <variable></pre> <p>where, <variable> is a variable used for the loop counter. <initial value>, <terminate value>, and <step value> are values for the loop counter start value, stop value, and step value respectively.</p> <p>The EXIT FOR statement is available to exit from the loop before the loop count reaches <terminate value>. After looping, the next line of NEXT is performed.</p> |
| IF | <p>Beginning of the IF/END IF block. The statements are added to the program list as a pair. The IF statement specifies the primary branching condition. The routines performed when the condition is satisfied are defined between the statements. The statements are entered as follows:</p> <pre>IF <expression> END IF</pre> <p>where, <expression> is the condition of branching. Optionally the following statements can be used in this block.</p> <ul style="list-style-type: none">• ELSE IF <expression> This statement specifies the additional branching condition used when the previous condition is not satisfied, and defines the routines performed when this branching condition is satisfied.• ELSE This statement defines the routines performed when no branching condition is satisfied. |

LOOP

Beginning of the LOOP/END LOOP block. LOOP and END LOOP are added to the program list as a pair. The statements repeatedly performed during looping should be defined between the statements.

The EXIT LOOP statement is available to exit from the loop. After looping, the next line of END LOOP is performed.

Example 1

Test definition name: Vth_gmMax

Local Variables Definition

BLOCK

```
!***** Integration Time Setting *****
```

```
IF IntegTime="SHORT"
```

```
    IntegMode = "MANUAL"
```

```
    AdcFactor = 8
```

```
ELSE IF IntegTime="MEDIUM"
```

```
    IntegMode = "PLC"
```

```
    AdcFactor = 1
```

```
ELSE IF IntegTime="LONG"
```

```
    IntegMode = "PLC"
```

```
    AdcFactor = 16
```

```
END IF
```

```
!***** I-V Sweep *****
```

```
Vth_gmmax
```

```
!***** Analysis *****
```

```
Auto Analysis
```

END BLOCK

Line 1: Defines local variables.

Line 2: Beginning of program. Program ends by the END BLOCK statement.

Line 3: Comment line. The COMMENT statement is used.

Lines 4 to 13: Changes the integration time setting by the variable IntegTime value.

Line 14: Comment line. The COMMENT statement is used.

Line 15: Executes Vth_gmmax of the Application Test component to perform Id-Vg measurement.

Line 16: Comment line. The COMMENT statement is used.

Line 17: Executes Auto Analysis of the Analysis component.

Built-in Programming Tool

Script Program Statements

Example 2

Test definition name: NandFlash IV-Write-IV

Local Variables Definition

```
BLOCK
  !***** Integration Time Setting *****
  IF IntegTime="SHORT"
    IntegMode = "MANUAL"
    AdcFactor = 8
  ELSE IF IntegTime="MEDIUM"
    IntegMode = "PLC"
    AdcFactor = 1
  ELSE IF IntegTime="LONG"
    IntegMode = "PLC"
    AdcFactor = 16
  END IF
  !***** I/V Sweep & Analysis Initial Characteristics *****
  ForcePG2
  Id-Vg_Initial
  ResetPG
  Auto Analysis
```

(continues to the next page)

Line 1: Defines local variables.

Line 2: Beginning of program. Program ends by the END BLOCK statement.

Line 3: Comment line. The COMMENT statement is used.

Lines 4 to 13: Changes the integration time setting by the variable IntegTime value.

Line 14: Comment line. The COMMENT statement is used.

Line 15: Executes ForcePG2 of the Application Test component to apply pulse from the Output 2 terminal of Agilent 81110A pulse generator connected to Agilent B1500A.

Line 16: Executes Id-Vg_Initial of the Application Test component to perform Id-Vg measurement.

Line 17: Executes ResetPG of the Application Test component to reset Agilent 81110A.

Line 18: Executes Auto Analysis of the Analysis component.

(continues from the previous page)

```
VthInitial = getNumericData("VthBefore")
VgateList = getVectorData("Vgate")
IdInitialList = getVectorData("Idrain")
!***** Force Pulse *****
ForcePG1
ResetPG
!***** I/V Sweep & Analysis after Write *****
ForcePG2
Id-Vg_Written
ResetPG
Auto Analysis
VthWritten = getNumericData("VthAfter")
IdWrittenList = getVectorData("Idrain")
END BLOCK
```

Lines 19 to 21: Enters the value of the variables (VthBefore, Vgate, Idrain) defined in the Function Setup or Display Setup of the Id-Vg_Initial test into the local variables (VthInitial, VgateList, IdInitialList). The ASSIGN statements are used.

Line 22: Comment line. The COMMENT statement is used.

Line 23: Executes ForcePG1 of the Application Test component to perform the NAND-type flash memory write operation.

Line 24: Executes ResetPG of the Application Test component.

Line 25: Comment line. The COMMENT statement is used.

Line 26: Executes ForcePG2 of the Application Test component.

Line 27: Executes Id-Vg_Written of the Application Test component to perform Id-Vg measurement.

Line 28: Executes ResetPG of the Application Test component.

Line 29: Executes Auto Analysis of the Analysis component.

Lines 30 to 31: Enters the value of the variables (VthAfter, Idrain) defined in the Function Setup or Display Setup of the Id-Vg_Written test into the local variables (VthWritten, IdWrittenList). The ASSIGN statements are used.

Line 32: End of program

Built-in Programming Tool
Script Program Statements

If You Have a Problem

This chapter explains how to solve problems or how to read error codes, if you encounter some problems. This chapter consists of the following sections.

- “When You Operate B1500A”
- “When You Perform Measurement”
- “Before Shipping to Service Center”
- “Data Backup and Recovery”
- “B1500A System Recovery”
- “Updating EasyEXPERT”
- “Error Codes”

If error occurs, find solutions in the following sections and solve problems. However, if problems still remain, perform self-test.

If Agilent B1500A fails self-test, contact Agilent Technologies.

To get the latest firmware/software/electronic manuals/support information, visit Agilent Technologies support site (<http://www.home.agilent.com>), and click Test & Measurement Equipment > Parametric Test, click Semiconductor Parameter/Device Analyzer Series, and click B1500A Semiconductor Device Analyzer. You can reach Agilent B1500A support site.

When You Operate B1500A

This section covers the following basic problems that you may encounter when you install or operate Agilent B1500A, and the solutions. See also “Error Codes” on page 9-23.

- “Power On Trouble”
- “SCUU is not Detected”
- “ASU is not Detected”
- “External GPIB Devices are not Detected”
- “To Simplify the Connections”

To set up the Windows, see “Inspection and Installation” on page 3-6

If you need to reinstall Agilent EasyEXPERT software, see “B1500A System Recovery” on page 9-19

Power On Trouble

- Connect the power cable to the B1500A firmly.
- Connect the power cable to power outlet firmly.
- Open the measurement terminals, and set the Standby switch to the ON position.

NOTE

Open the measurement terminals at the device side when turning the B1500A on. Also disconnect the device from the measurement terminals and open the measurement terminals after the measurement. If you leave the connection with the device, the device may be damaged by unexpected operations or charge-up of measurement cables.

SCUU is not Detected

If Agilent B1500A/EasyEXPERT cannot detect SCUU (SMU CMU unify unit), turn B1500A off, check the cable connection, and reboot B1500A/EasyEXPERT.

For the installation and connection of SCUU, see “To Connect SCUU/GSWU” on page 3-21.

ASU is not Detected

If Agilent B1500A/EasyEXPERT cannot detect ASU (atto sense/switch unit), turn B1500A off, check the cable connection, and reboot B1500A/EasyEXPERT.

For the installation and connection of ASU, see “To Connect ASU” on page 3-17.

NOTE

Connect ASU to dedicated HRSMU

The specifications are satisfied and guaranteed for the exclusive combination of the ASU and the HRSMU. So confirm the serial number of the ASU and connect it to the dedicated HRSMU properly.

External GPIB Devices are not Detected

If Agilent B1500A/EasyEXPERT cannot detect external GPIB devices, do the following troubleshooting.

1. Turn B1500A and external GPIB devices off, check the GPIB cable connection, and reboot the devices and B1500A/EasyEXPERT.
2. If the problem still remains, confirm if B1500A is set to the system controller. See “To Enable System Controller” on page 3-10.
3. If the problem still remains, confirm if B1500A is connected to USB0. Open Agilent Connection Expert, check Instrument I/O on this PC. The USB0 in this area must show the information as shown below.

```
USB0
+ B1500A(USB0:::xxxx::x::xxxx::x:: INSTR)
+ agb1500a
+ UsbDevice1
```

If the problem still remains, perform Agilent B1500 system recovery. To perform recovery, see “B1500A System Recovery” on page 9-19.

To Simplify the Connections

If you want to simplify the measurement connections, use the triaxial cables instead of the kelvin triaxial cables, and connect the triaxial cables between the Force terminals and the test fixture or the connector plate. Then the Sense terminals must be opened.

NOTE

The B1500A has the Force and Sense terminals to make the kelvin connection. And the kelvin triaxial cables are effective to extend the measurement terminals near by the device under test. Connecting the Force and Sense lines together at the device terminals can minimize the measurement error caused by the residual resistance of the connection cables. The kelvin connection is effective for the low resistance measurement and the high current measurement. Also it is one of the conditions to satisfy the measurement specifications of the B1500A.

When You Perform Measurement

This section covers the following basic problems that you may encounter when you making a measurement, and the solutions.

- “Measurement Takes More Time than Specified”
- “Noise Affects the Measured Values”
- “Voltage Measurement Error is Large”
- “SMU Oscillates for High-Frequency Device Measurements”
- “SMU Oscillates for Negative Resistance Measurements”
- “Large Current Causes High Temperature (Thermal Drift)”
- “Measurement Damages the Device under Test”
- “Leaving Connections Damages Devices after Measurement”
- “Unexpected Sampling Measurement Data is Returned”
- “MFCMU Causes Unbalance Condition”

Measurement Takes More Time than Specified

If you set many measurement channels, auto ranging mode, or too long integration time, measurement takes a longer time.

To solve this problem:

Depending on your measurement requirements, perform following:

- Decreases measurement channels.
- Uses limited auto ranging mode.
- Uses fixed range.
- Decreases averaging samples of the high-speed A/D converter.
- Decreases integration time of the high-resolution A/D converter.
- Disables the ADC zero function.

Noise Affects the Measured Values

When you measure low current of a DUT, the measured values may not be stable.

To solve this problem:

- Set the power line frequency correctly. The value affects the integration time. So the wrong value causes the measurement error by the power line noise. You can set the power line frequency by using the Configuration window of the EasyEXPERT.
- Use guarding to reduce the leakage current between your prober and the B1500A. Note that long wires cause oscillation because of their large inductance.
- If some high-power electric machines are operating around the B1500A, turn off the machines, then perform the measurements. The machines affect the power line waveform.
- Shut the lid of test fixture or shield box to prevent effects of light.
- If these are vibrations due to nearby machines or due to air flow, put cushioning material under prober, cable, and the B1500A; install stabilizer on the prober; and make the cables stable by taping.
- Wait several minutes after connecting cables or moving probe needles. Because these operations cause electromotive force.
- If you use only Force terminal and triaxial cables, connect an open cap to Sense terminal.
- Keep constant temperature in the room when you use the B1500A. Shift of 1 °C may shift the measurement values. Temperature change causes the following.
 - Offset current in the B1500A.
 - Thermoelectromotive force in DUT, which causes low current.
 - Expansion and contraction of cables, which causes noise.

Voltage Measurement Error is Large

Voltage measurement error may be large because of the effects of the cable resistance when forcing a large current.

To solve this problem:

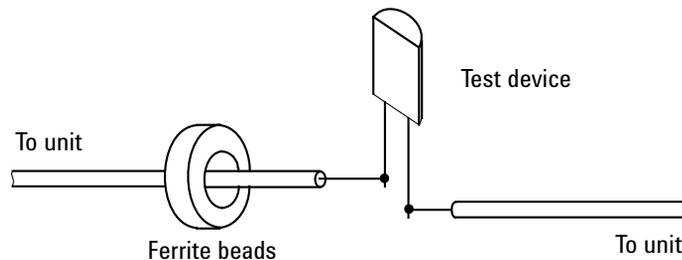
- Use kelvin connections between SMUs and DUT. To cancel the effects of cable resistance, connect the sense line as close as possible to the terminal of the DUT.

SMU Oscillates for High-Frequency Device Measurements

When measuring parameters of high-frequency devices, such as GaAs MESFETs or high-frequency bipolar transistors, oscillation may cause measurement problems. Normal measurement cannot be performed because of oscillation.

To solve this problem:

- For FETs, add resistive ferrite beads as close as possible to the gate.
- For bipolar transistors, add resistive ferrite beads as close as possible to the base or emitter.
- Make connection cables as short as possible. Long wires cause oscillation because of their large inductance.



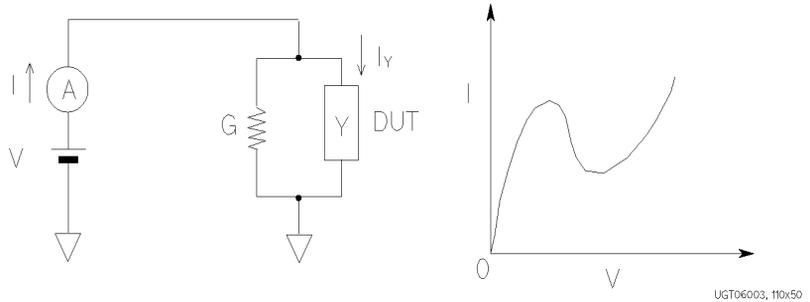
SMU Oscillates for Negative Resistance Measurements

If the DUT has negative resistance characteristics, SMUs may oscillate. Because the positive feedback may be configured by the DUT and the SMUs.

To solve this problem:

- For voltage controlled negative resistance device
 - Connect G in parallel with your DUT to cancel negative resistance. To obtain an output I-V curve, use the following equation.

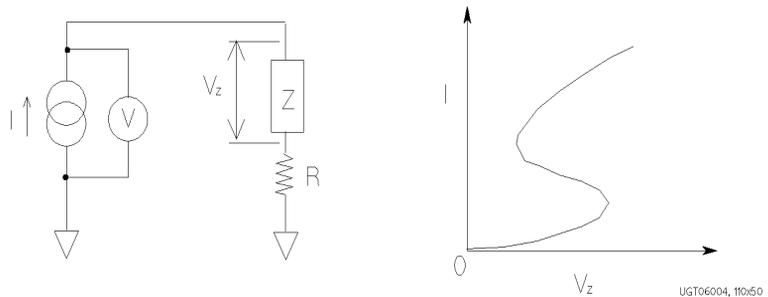
$$IY = I - G \times V$$



- For current controlled negative resistance device
 - Connect R in series with your DUT to cancel negative resistance. To obtain an output I-V curve, use the following equation.

$$VZ = V - R \times I$$

- If the resistance of the DUT is less than 1 M Ω , you can use a series resistor built into the SMU.



Large Current Causes High Temperature (Thermal Drift)

If a large current is forced to a DUT, the temperature of the DUT may increase, which may cause characteristics to drift.

To solve this problem:

- Use the pulse output mode of the SMU.

For large currents, the SMU should be set to pulse output mode. This decreases the average power output to prevent temperature rise of DUT.

Measurement Damages the Device under Test

When performing breakdown measurements, DUTs may be damaged.

When voltage is forced from an SMU, the current is limited by the compliance setting, which prevents the DUT from being damaged by a large current. But when the current rapidly increases, the current limiter in the SMU cannot follow the rapid current increase, so a large amount of current may flow through the DUT for a moment, which may damage the DUT.

To solve this problem:

- Insert a protecting resistor as close as possible to DUT. You can also use a series resistor built into the SMU.

Leaving Connections Damages Devices after Measurement

After the measurements, open the measurement terminals or disconnect the device under test from the measurement terminals. If you leave the connection with the device, the device may be damaged by unexpected operations.

Do not leave the connection over 30 minutes after the measurement if the auto calibration is set to ON. Then, the B1500A performs the self-calibration automatically every 30 minutes after the measurement. The calibration requires to open the measurement terminals.

NOTE

Open the measurement terminals and never connect anything when the calibration is performed.

Unexpected Sampling Measurement Data is Returned

If sampling interval is set to a short time and if FILTER ON is set, you may get unwanted data. FILTER ON causes a slower rise time, so short initial interval will sample during this rise time.

To solve this problem:

- Set FILTER field to OFF if you set initial interval to a short time.

Some data may be skipped because measurement takes a long time. Measurement takes a long time if measurement is performed in a low current range, if many measurement channels are set up, or if analysis, such as moving a marker, is performed during measurements.

To solve this problem:

- Measure current using a fixed range that is more than 10 μA . For measurement ranges 10 μA or less, measurement takes longer than the specified integration time.
- Do not perform analysis operation during measurement state.

MFCMU Causes Unbalance Condition

Extending measurement cables may cause the unbalance condition of the MFCMU.

To solve this problem:

- Perform the phase compensation. See “CMU Calibration” on page 4-37.
- The signal path from MFCMU to DUT must be as short as possible.
- Reduce stray capacitance and guard capacitance on the signal line.

Do not connect the Low (Lcur, Lpot) terminal to the wafer chuck. If the MFCMU must be connected to the wafer chuck, use the High (Hcur, Hpot) terminal to connect to the wafer chuck.

Before Shipping to Service Center

Before shipping Agilent B1500 to the Service Center, you have to do following:

- “To Make Backup”
- “To Check Module Slots”
- “To Check ASU/HRSMU Combination”
- “To Collect Equipment and Accessories”

To Make Backup

If the internal hard disk drive (HDD) is failed, you will lose all data stored in the HDD. So it is important to make backup constantly.

Before shipping the B1500 to the service center, make backup of data in the HDD. And keep the backup media in trust. You may need to perform data recovery of the B1500 returned from the service center.

If the HDD is replaced, the B1500 will be returned with the latest revision of the software, Windows XP, EasyEXPERT, and so on.

To Check Module Slots

Do not remove the plug-in module from the mainframe. The B1500 must be shipped with all modules. The module cannot be repaired without the mainframe. If a module is removed and installed by anyone who is not a service personnel of Agilent Technologies, the specifications are not guaranteed.

To Check ASU/HRSMU Combination

When you ship the B1500 used with the atto sense/switch unit (ASU), disconnect the ASU cable set (triaxial and Dsub) between the ASU and the high resolution source monitor unit (HRSMU), and ship the mainframe, the ASU cable set, and the ASU. The ASU can be used with the exclusive HRSMU. To confirm the ASU/HRSMU combination, check the serial number. See “ASU” on page 4-43.

To Collect Equipment and Accessories

The following equipment and accessories are required for servicing and must be shipped to the Service Center.

- B1500A with all plug-in modules installed
- ASU exclusive to HRSMU
- Connection cable set between ASU and HRSMU
- RSU
- Connection cable set between RSU and WGFMU

For returning ASU or RSU, do not forget to notify the combination of the unit, connection cable, and module channel.

The connection cable set between ASU and HRSMU means one of the following.

- E5288A-001 Triaxial and D-sub cables, 1.5 m
- E5288A-002 Triaxial and D-sub cables, 3 m

The connection cable set between RSU and WGFMU means one of the following.

- 16493R-003 3 m Cable between WGFMU and RSU
- 16493R-004 5 m Cable between WGFMU and RSU
- 16493R-006 1.5 m Cable between WGFMU and RSU
- 16493R-001 and 002 60 cm Cable and 2.4 m Cable between WGFMU and RSU
- 16493R-001 and 005 60 cm Cable and 4.4 m Cable between WGFMU and RSU

WARNING

To prevent electrical shock, turn off Agilent B1500A and remove the power cable before removing the connection cables.

Data Backup and Recovery

Unexpected trouble of HDD (hard disk drive), operation mistake, or malfunction may cause elimination of valuable data. To avoid this kind of risk, make backup of data in the HDD as frequently as possible.

- “Folders to Backup”
- “To Make Database Backup”
- “To Restore Database Backup”
- “To Make Backup of Other Data”
- “To Restore Backup of Other Data”

NOTE

Drive for making backup

Make backup into the storage device that has large free space and can be accessed by the B1500A directly. The device may be the D drive, a USB memory, an external HDD with USB interface and such.

If you make backup into the B1500A internal HDD, C drive or D drive, make a copy of the backup into an external storage device or backup media, CD-ROM, CD-RW, USB memory and such.

Folders to Backup

Backup should be made for the following data areas.

- EasyEXPERT database, below *D:\Agilent\EasyEXPERT*
D:\Agilent\EasyEXPERT\1
- Personal folders, below *C:\Documents and Settings*
Example: C:\Documents and Settings\B1500user
- Desktop EasyEXPERT user folder
Example: C:\Program Files\Agilent\B1500\EasyEXPERT\User
- Desktop EasyEXPERT database
Example:
C:\Program Files\Agilent\B1500\EasyEXPERT\User\1
- Folders that store the data exported by EasyEXPERT or Desktop EasyEXPERT
- Other folders that store the data to be saved

To Make Database Backup

EasyEXPERT database backup can be made by the following procedure.

1. Launch Start EasyEXPERT.
2. Click Option > EasyEXPERT Database > Backup EasyEXPERT Database in the Start EasyEXPERT window.
3. Follow the EasyEXPERT Database Backup Creation wizard, and make backup into the D drive. The extension of the backup file is xdb.
4. Make a copy of the xdb file into an external storage device or backup media.

Example: COPY EasyEXPERT_backup_1.xdb F:\

To Restore Database Backup

EasyEXPERT database can be restored by the following procedure.

1. Make a copy of the database backup file (xdb file) into the D drive.
2. Launch Start EasyEXPERT.
3. Click Option > EasyEXPERT Database > Restore EasyEXPERT Database in the Start EasyEXPERT window.
4. Follow the EasyEXPERT Database Restoration wizard, and restore the backup of EasyEXPERT database.

NOTE

If the backup is not the xdb file

The backup for recovery must be “a copy of the folder that contains the EasyEXPERT database image”. And it must be stored in the location other than the following folders.

- D:\Agilent folder
- EasyEXPERT database folder

For the Windows backup (bkf file) or the compressed backup (zip file or other), uncompress the backup file at the location other than the above folders. And launch the wizard after the uncompression is completed.

Also, for the Backup Type Selection of the wizard, select “A Copy of the folder that contains the EasyEXPERT database image” and follow the wizard.

To Make Backup of Other Data

There are the following three ways to make backup of data other than the EasyEXPERT database. Make backup by using one of the following methods.

- To use Windows backup program:
 1. Click Start > All Programs > Accessories > System Tools > Backup.
 2. Follow the Backup or Restore wizard, and make backup into the D drive. The extension of the backup file is bkf.
 3. Make a copy of the bkf file into an external storage device or backup media.
Example: COPY Mydata_backup_1.bkf F:\
- To make and copy a compressed file:
 1. Make a compressed file for the whole folder to back up.
 2. Make a copy of the compressed file into an external storage device or backup media.
Example: COPY Mydata_backup_1.zip F:\
- To copy a whole folder for backup:
 1. Connect an external storage device, HDD with USB interface and such, to the B1500A.
 2. Make a copy of the folder into the external storage device.
Example: XCOPY Folder_user_1 F:\Backup_user_1

To Restore Backup of Other Data

Backups can be restored as shown below. The recovery method depends on how the backup was made.

- Backup is a bkf file:
 1. Make a copy of the backup file (bkf file) into the D drive.
 2. Click Start > All Programs > Accessories > System Tools > Backup.
 3. Follow the Backup or Restore wizard, and restore the bkf file.
- Backup is a compressed file:
 1. Make a copy of the compressed file into the D drive.
 2. Uncompress the file at the place different from the original folder.
 3. Copy all of the uncompressed files and folders, and paste them to the original folder.
- Backup is a whole folder:
 1. Make a copy of the whole folder into the D drive.
Example: `XCOPY F:\Backup_user_1 Backup_user_1`
 2. Delete the original folder.
Example: `RMDIR /S Folder_user_1`
 3. Change the folder name to the original one.
Example: `RENAME Backup_user_1 Folder_user_1`

B1500A System Recovery

If you find problems in the B1500A system, perform the system recovery.

- “To Perform System Recovery”
- “To Initialize Database”
- “To Restore Database”

NOTE

Before system recovery

After performing B1500A system recovery, the C drive will be returned to the condition when you received the B1500A or when it left the factory. To avoid deleting valuable data, Agilent Technologies strongly recommends to make backup of data in the C drive before starting the system recovery. See “Data Backup and Recovery” on page 9-14 for making the backup.

To Perform System Recovery

B1500A system recovery can be performed by the following procedure.

1. Set the B1500A Standby switch to the OFF position.
2. Disconnect all USB devices from the B1500A.
3. Connect the USB keyboard to a USB port of the B1500A.
4. Set the B1500A Standby switch to the ON position.
5. On the boot system selection menu, select Agilent Recovery System, and press Enter key. To select the system, use arrow keys.

The Command Prompt window is opened. See Figure 9-1.

Where, 2 is not valid now. 3 should be entered for rebooting the B1500A without performing system recovery.

6. For the message “Enter a Choice:”, enter 1 and press the Enter key. Message will be displayed for asking if you allow to overwrite the C drive.
7. For the message, enter 1 and press the Enter key. System recovery starts. After the recovery completes successfully, system boot starts automatically.
8. Perform “To Initialize Database” on page 9-20.
9. Perform “To Restore Database” on page 9-21.

Figure 9-1

Agilent System Recovery Screen

Agilent Technologies System Utilities
Recovery Options

Choose one of the following:

- 1. Recover Factory Backup Image.
- 2. Update System.
- 3. Exit

Enter a Choice:

To Initialize Database

EasyEXPERT database can be initialized by the following procedure. You can use EasyEXPERT after this procedure is completed.

1. Exit Start EasyEXPERT.
2. Rename *D:\Agilent\EasyEXPERT\1* folder (EasyEXPERT database).

Example:

```
CHDIR /D D:\Agilent\EasyEXPERT
RENAME 1 1-backup
```

3. Create *D:\Agilent\EasyEXPERT\1* folder.

Example:

```
MKDIR 1
```

4. Copy all files and folders in the *D:\Agilent\EasyEXPERT\Copy of 1* folder, and paste them to the *D:\Agilent\EasyEXPERT\1* folder.

Example:

```
CHDIR Copy of 1
COPY * ..\1
```

To Restore Database

EasyEXPERT database can be restored by the following procedure.

In the example shown in “To Initialize Database” on page 9-20, the EasyEXPERT database backup is the whole D:\Agilent\EasyEXPERT\1-backup folder. The database can be restored by using the data in this folder.

- For EasyEXPERT revision A.02.10 and earlier

The database reconfiguration tool is required. Obtain it from Agilent Technologies web site. For the execution procedure, see the readme text file included in the package.

- For EasyEXPERT revision A.02.11 and later

1. Launch Start EasyEXPERT.
2. Click Option > EasyEXPERT Database > Restore EasyEXPERT Database in the Start EasyEXPERT window.
3. Follow the EasyEXPERT Database Restoration Wizard and complete the restoration of EasyEXPERT database.

Updating EasyEXPERT

NOTE

The latest version of the EasyEXPERT update package can be obtained from Agilent Technologies web site.

NOTE

The EasyEXPERT revision A.03.20 does not require the administrator privilege which is required by the revision A.03.11 and previous revisions. However, if the software is updated from a previous revision to the revision A.03.20, it still requires the administrator privilege.

Update procedure EasyEXPERT can be updated by the following procedure.

1. Make a backup of EasyEXPERT database. See “To Make Database Backup” on page 9-15.
2. If this is the update from the revision A.03.10 or earlier to the revision A.03.11 or later, install the following software. They are included in the update package.
 - Microsoft .NET Framework Version 2.0 Redistributable Package
 - Microsoft .NET Framework 2.0 Service Pack 1If they are already installed, go to the step 3.
3. Execute the setup program of the update package.
4. Follow the setup wizard and complete the update of EasyEXPERT.
5. After the update is completed, make a backup of EasyEXPERT database.

If update fails

Perform the following procedure.

If EasyEXPERT could recover to the revision before starting the update procedure, skip the following step 1 to 2.

1. Perform system recovery. See “B1500A System Recovery” on page 9-19. This is not required for Desktop EasyEXPERT software.
2. Update EasyEXPERT to the revision before starting the update procedure.
3. Restore the backup made by the update procedure step 1. See “To Restore Database Backup” on page 9-16.
4. Perform the update procedure step 2 to 5.

Error Codes

This section lists Agilent B1500 error codes and messages.

- “Agilent EasyEXPERT Operation Error”
- “Agilent FLEX Execution Error”
- “Agilent B1500A Self-test/Calibration Error”
- “Setup File Converter Execution Error”

Agilent EasyEXPERT Operation Error

When Agilent B1500 causes errors in Agilent EasyEXPERT execution environment, the B1500 returns the following error codes and error messages.

- | | |
|---------------|--|
| 101001 | Log repository operation failed. |
| 101002 | Log file operation failed. |
| 101003 | Log record operation failed. |
| 102001 | Service started successfully. |
| 102002 | Service stopped successfully. |
| 102003 | Service starting process failed. Contact your nearest Agilent Technologies Service Center. |
| 102004 | Service stopping process failed. Contact your nearest Agilent Technologies Service Center. |
| 103001 | USB488 error occurred. Alias: <i>A</i> , Reason: <i>B</i> |
| 103002 | USB488 device was not found. Alias: <i>A</i> , Reason: <i>B</i> |
| 103003 | USB488 timeout occurred. Alias: <i>A</i> , Timeout: <i>B</i> [ms] |
| 103004 | GPIB error occurred. Interface: <i>A</i> , Address: <i>B</i> , Reason: <i>C</i> |
| 103005 | GPIB address must be between 0 and 31. Interface: <i>A</i> , Address: <i>B</i> |
| 103006 | Duplicate GPIB address was found. GPIB address must be unique. Interface: <i>A</i> , Address: <i>B</i> |
| 103007 | GPIB device was not found. Interface: <i>A</i> , Address: <i>B</i> , Reason: <i>C</i> |
| 103008 | GPIB timeout occurred. Interface: <i>A</i> , Address: <i>B</i> , Timeout: <i>C</i> [ms] |

If You Have a Problem

Error Codes

- 104001** Module (*A*) is not available.
- 105001** Generic setup error occurred. Code: *A*, Reason: *B*
- 105002** Duplicate data name was found. Data name must be unique. Data name: *A*
- 105003** Operation is not supported in offline mode.
- 105004** Interlock circuit is open. Interlock circuit must be closed for setting voltage source/compliance absolute value exceeding 42V.
- 105005** Output series resistor cannot be used for HRSMU with ASU.
- 105006** Source wait time coefficient must be between *A* and *B*.
- 105008** Monitor wait time coefficient must be between *A* and *B*.
- 105010** Series resistor is not available for HPSMU using the 1 A range.
- 105011** I/V Staircase Sweep needs at least one monitoring channel.
- 105012** I/V Pulse Sweep needs exactly one monitoring channel.
- 105013** I/V Pulse Biased Sweep needs exactly one monitoring channel.
- 105014** I/V-t Sampling needs at least one monitoring channel.
- 105015** C-V Sweep needs at least one monitoring channel.
- 105016** At least one measurement channel is required for Multi Channel I/V Sweep measurement.
- 105017** Only one measurement channel can be used for I/V-t linear sampling measurement of interval < 2 ms.
- 105018** Base hold time is not available for 4155B/C and 4156B/C. The value must be 0.
- 105020** Interlock circuit is open. Interlock circuit must be closed to set an output or compliance value greater than ± 40 V.
- 105021** Current source value of *A* must be between *B* A and *C* A.
- 105022** Voltage compliance value of *A* must be between *B* V and *C* V.
- 105023** Voltage source value of *A* must be between *B* V and *C* V.
- 105024** Current compliance value of *A* must be between *B* A and *C* A.
- 105025** Power compliance value of *A* must be between *B* W and *C* W.

- 105031** The product of voltage source value and current compliance value of *A* exceeds its output power range. Please set the current compliance value between *B A* and *C A*.
- 105032** The product of current source value and voltage compliance value of *A* exceeds its output power range. Please set the voltage compliance value between *B V* and *C V*.
- 105033** The polarity of peak value(s) and the base value of SMU current pulse must be the same.
- 105034** The start value and stop value of SMU log sweep must be non-zero and have same polarity for primary sweep source (and synchronous sweep source).
- 105035** Invalid value (*A*) was specified for SMU I/V Sweep stop condition.
Valid option(s): *B*
- A* is not available for the setting of the sweep abort condition. Select one from the available choices *B*. If you use a formula, the calculation result must show the available value.
- 105036** The hold time for SMU I/V Sweep must be between *A s* and *B s*.
- 105037** The delay time for SMU I/V Sweep must be between *A s* and *B s*.
- 105041** Invalid value (*B*) was specified for current monitor ranging mode of *A*.
Valid option(s): *C*
- 105042** Invalid value (*B*) was specified for current monitor range of *A*. Valid option(s): *C*
- 105043** Invalid value (*B*) was specified for current monitor ranging rule of *A*.
Valid option(s): *C*
- 105044** Invalid value (*B*) was specified for voltage monitor ranging mode of *A*.
Valid option(s): *C*
- 105045** Invalid value (*B*) was specified for voltage monitor range of *A*. Valid option(s): *C*
- 105046** Invalid value (*A*) was specified for the integral mode of High-Resolution ADC. Valid option(s): *B*
- 105047** The coefficient for High Resolution ADC *A* integral mode must be between *B* and *C*.
- 105048** Invalid value (*A*) was specified for the averaging mode of High-Speed ADC. Valid option(s): *B*

If You Have a Problem

Error Codes

- 105049** The coefficient for High Speed ADC *A* averaging mode must be between *B* and *C*.
- 105050** Invalid value (*A*) was specified for the integral mode of ADC. Valid option(s): *B*
- 105051** Invalid value (*A*) was specified for the sweep direction. Valid option(s): *B*
- 105052** Invalid value (*A*) was specified for the sweep stop condition. Valid option(s): *B*
- 105053** Invalid value (*A*) was specified for the impedance measurement model. Valid option(s): *B*
- 105054** Hold time value must be between *A* s and *B* s.
- 105055** Delay time value must be between *A* s and *B* s.
- 105056** Voltage source value of *A* must be between *B* V and *C* V.
- 105057** Frequency value of *A* must be between *B* Hz and *C* Hz.
- 105058** Coefficient value of *A* integral mode must be between *B* and *C*.
- 105059** AC Level value of *A* must be between *B* mV and *C* mV.
- 105060** Invalid value (*B*) was specified for monitor ranging mode of *A*. Valid option(s): *C*
- 105061** SMU pulse period must be *A* s longer than the pulse width.
- 105062** Primary sweep source step value must be greater than the setup resolution.
- 105063** Synchronous sweep source step value must be greater than the setup resolution. Adjust the offset value and the ratio value, or change the primary sweep source settings.
- 105064** Compliance absolute value must be *A* A or greater if the channel is the SMU pulse source and the output value is *B* V_{pp}.
- 105065** Compliance value must be ± 2 V or less if the channel is the SMU pulse source and the output value is 0 A to 10 μ A.
- 105066** Current compliance must be 100 mA for VSU.
- 105067** Power compliance must be OFF for VSU.
- 105071** Sampling interval for I/V-t sampling must be between *A* s and *B* s.
- 105072** Number of samples for I/V-t *A* sampling must be between *B* and *C*.

- 105073** Hold time for I/V-t sampling must be between *A* s and *B* s.
- 105074** Multiplying the number of monitor channels by No of Samples must be between *A* and *B*.
- 105075** Invalid value *A* specified for I/V-t sampling Lin/Log setting.
Valid option(s): *B*
- 105076** Base hold time for I/V-t sampling must be between *A* s and *B* s.
- 105077** Invalid value *A* specified for I/V-t sampling output sequence.
Valid option(s): *B*
- 105078** Sampling interval for I/V-t *A* sampling must be between *B* s and *C* s.
- 105079** Hold time for I/V-t *A* sampling must be between *B* s and *C* s.
- 105080** Hold time for I/V-t *A* sampling with interval of *B* s or longer must be between *C* s and *D* s.
- 105081** Hold time for I/V-t *A* sampling with interval shorter than *B* s must be between *C* s and *D* s.
- 105083** The number of VAR1 steps multiplied by the number of VAR2 steps must be between *A* and *B* in I/V Sweep, I/V List Sweep and Multi Channel I/V Sweep.
- 105091** List length of VAR1 sweep must be between *A* and *B* for the I/V List Sweep measurement. Length *C* is not applicable.
- 105092** List length of VAR2 sweep must be between *A* and *B* for the I/V List Sweep measurement. Length *C* is not applicable.
- 105093** List length of delay time must be between *A* and *B* for the I/V List Sweep measurement. Length *C* is not applicable.
- 105094** Time until the first step measurement, (hold time + delay time), must be between *A* and *B* s for the I/V List Sweep measurement using SMU pulse.
- 105095** *A* does not support current measurement.
- 105801** Invalid value *A* specified for *Output Value after Measurement* in the Advanced Setup dialog box. Valid option(s): *B*
- 105802** Invalid value *A* specified for *Bias Hold after Measurement* in the Advanced Setup dialog box. Valid option(s): *B*
- 105803** Bias hold function execution error. All channel outputs or voltage compliance must be at ± 42 V or less to control the output switch or the series resistor.

If You Have a Problem

Error Codes

- 105804** Bias hold function execution error. Output voltage or voltage compliance must be ± 40 V or less to control the output switch or the series resistor.
- 105811** Invalid value *A* was specified for Semiconductor Relays (*B*) of Advanced Setup. Valid option(s): *C*
- 105821** Invalid value *A* was specified for Type of SPGU Pulse Setup. Valid option(s): *B*, VName: *C*
- 105822** Invalid value *A* was specified for SW Sync of Pulse Switch Setup. Valid option(s): *B*, VName: *C*
- 105823** Invalid value *A* was specified for Normal of Pulse Switch Setup. Valid option(s): *B*, VName: *C*
- 105824** Width value of Pulse Switch Setup must be between *A* s and *B* s. VName: *C*
- 105825** Width for pulse switch must be between *A* s and *B* s. VName: *C*
- 105826** Sum of Delay and Width of Pulse Switch Setup must be within Period value. VName: *A*
- 105830** Load *Z* value must be between *A* ohm and *B* ohm. VName: *C*
- 105831** Period value of SPGU Pulse Setup must be between *A* s and *B* s.
- 105832** PULSE COUNT value of SPGU Pulse Setup must be between *A* and *B*.
- 105833** DURATION value of SPGU Pulse Setup must be between *A* s and *B* s.
- 105834** Base value of SPGU Pulse Setup must be between *A* V and *B* V. VName: *C*
- 105835** Peak value of SPGU Pulse Setup must be between *A* V and *B* V. VName: *C*
- 105836** Delay value of SPGU Pulse Setup must be between *A* s and *B* s. VName: *C*
- 105837** Width value of SPGU Pulse Setup must be between *A* s and *B* s. VName: *C*
- 105838** Leading value of SPGU Pulse Setup must be between *A* s and *B* s. VName: *C*
- 105839** Trailing value of SPGU Pulse Setup must be between *A* s and *B* s. VName: *C*
- 105840** Leading $\times 1.25$ must be within Width value. VName: *A*

- 105841** Sum of Delay, Width, and Trailing $\times 1.25$ must be within Period value.
VName: *A*
- 105842** Invalid value *A* was specified for PGU output impedance.
Valid option(s): *B*, VName: *C*
- 105843** SPGU cannot be used for bias source of I/V-t linear sampling
measurement of interval < 2 ms.
- 105844** |Peak-Base| value of PGU pulse must be between *A* V and *B* V.
VName: *C*
- 105845** Period, Width, and Delay values of PGU pulse must be in the same
setting range. And Leading and trailing values must be in the same
setting range.
- 105846** SPGU cannot output the specified voltage. Change Load *Z* value or
output voltage.
- 105901** Over voltage was applied to SMU measurement terminal.
- 105902** Over current was applied to SMU measurement terminal.
- 105903** Cannot use the specified module that failed self-test.
- 105904** *A* cannot be set to Additional Data Variables. Only the channels defined
in Channel Definition can be set.
- 105905** Entry is already defined in Additional Data Variables. It is not
necessary to redefine the entry. Unit: *A*, Type: *B*
- 105906** Variable name specified in Additional Data Variables is used for
another variable. Specify a different name. Variable name: *A*
- 105907** FMT command's first argument must be 13.
- 105908** Invalid Type value was found in the Additional Data Variables area. A
test setup cannot contain both the type Re(*Z*) or Im(*Z*) and the type
Re(*Y*) or Im(*Y*).
- 105909** Program memory number is out of range. Valid value: *A* to *B* Entered
value: *C*
- 105910** Program memory variable number is out of range. Valid value: *A* to *B*
Entered value: *C*
- 105911** Empty Command field was found in the Command Setup. A command
must be entered in the Command field.

If You Have a Problem

Error Codes

- 105912** Test execution error was detected. Check the parameter values of the command, and set the Arguments field again. Setup Name=*A*, Line Number=*B*, Command=*C*
- 105913** Incorrect usage of ST and END commands. Use them as a pair to store a command group into the program memory.
- 105914** Improper number of Arguments for the *A* command. Enter the Arguments correctly.
- 106001** Logon request was rejected. The number of Logons already reaches the limit of the software regulation. Restart EasyEXPERT. If this does not solve the problem, restart the B1500.
- 107001** Workspace management error was occurred.
- 107002** Workspace was not found. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 107003** Workspace could not be loaded. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 107004** The request to load or create Workspace was rejected. Workspace is already active. Close the present Workspace and open the Workspace again.
- 107005** The operation cannot be executed because Workspace is in use now. Close the present Workspace and open the Workspace again.
- 107006** The workspace name is conflicting. It must be unique in system. Specify the correct Workspace name.
- 108001** Function Library management error occurred.
- 108002** Function Library function has not been configured correctly or is not running. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 108003** Invalid Function Module assembly file. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 108004** Invalid Function Module. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 108005** Function Module was not found. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.

- 108006** Function Module is inaccessible because it has been removed. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 108007** The same process is running now. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 108008** Profile was not found. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 108009** Profile could not be loaded. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 108010** The request to load or create Profile was rejected. Profile is already active. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 108011** Invalid Function Module for this EasyEXPERT revision. Module ID: *A*, Path: *B*
Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 108020** An I/O error occurred during Function Library operation. Path: *A*
Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 108021** Function Module read error. Path: *A*
Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 108022** Function Module save error. Path: *A*
Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 109001** Auto calibration is in progress.
- 109002** CMU phase compensation failed.
- 109011** CMU open correction failed.
- 109012** The value of standard for CMU open correction must be finite as admittance.
- 109021** CMU short correction failed.

If You Have a Problem

Error Codes

| | |
|---------------|--|
| 109022 | The value of standard for CMU short correction must be finite as impedance. |
| 109031 | CMU load correction failed. |
| 109032 | The value of standard for CMU load correction must be finite in impedance (non-zero as admittance). |
| 109041 | Cannot define multiple standby settings for a SMU. Channel: <i>A</i> |
| 109051 | Direct Control execution status. Sweep measurement was aborted by the automatic abort function or the power compliance. Test setup: <i>A</i> |
| 109052 | Direct Control execution status. Quasi-static CV measurement was aborted by the automatic abort function. Test setup: <i>A</i> |
| 109053 | Direct Control execution status. Search measurement was aborted by the automatic abort function. Test setup: <i>A</i> |
| 109054 | Direct Control execution status. Sampling measurement was aborted by the automatic abort function. Test setup: <i>A</i> |
| 109061 | Duplicate SMU assignment was found. SMU assignment must be unique. SMU: <i>A</i> |
| 110001 | Configuration query completed. |
| 111001 | Data name (<i>A</i>) is invalid. |
| 111002 | Function name (<i>A</i>) is invalid. |
| 111003 | Function name (<i>A</i>) duplicates other data/function name. |
| 111004 | Definition expression of function (<i>A</i>) is invalid. expression: <i>B</i> |
| 111005 | The data (<i>A</i>) assigned with the data (<i>B</i>) is not defined. |
| 111006 | The data (<i>A</i>) assigned to the data (<i>B</i>) is not defined. |
| 111007 | The data (<i>A</i>) cannot be assigned to the data (<i>B</i>) for the mismatch of their types. |
| 111008 | Recursive definition is not allowed for function (<i>A</i>). Expression: <i>B</i> |
| 111011 | Vector data expression is expected. Expression: <i>A</i> |
| 111012 | Numeric expression is expected. Expression: <i>A</i> |
| 111013 | String expression is expected. Expression: <i>A</i> |
| 111014 | Descriptor expression is expected. Expression: <i>A</i> |
| 111015 | Module descriptor expression is expected. Expression: <i>A</i> |

- 111016** ALWaveform type expression must be entered. Expression: *A*
- 111021** Test setup name cannot be an empty string.
- 111022** Test setup name must be *A* characters or less.
- 111031** Assign module parameter for ALWaveform type parameter.
- 111032** ALWG Pattern Name must be entered.
- 111033** Invalid character is included in Name of module parameter assigned for ALWaveform type parameter. Module name: *A*, Invalid character: *B*
- 111034** Invalid character is included in ALWG Pattern Name. ALWG pattern name: *A*, Invalid character: *B*
- 111035** No sequence is defined in the ALWG waveform data. Define one column or more.
- 111036** Pattern is not defined in the ALWG waveform data for the output channel *A*. Specify a pattern.
- 111037** ALWG waveform data contains an invalid pattern.
Name of the invalid pattern: *A*
- 111038** ALWG waveform data memory overflow. Delete unnecessary columns or points in a pattern, and increase free space.
Output channel: *A*, Required space: *B*, Maximum space: *C*
- 112001** Output function must be constant for the unit (*A*) in common mode.
- 112002** Output function (*A*) must be assigned to any unit.
- 112003** Output function (*A*) cannot be assigned to multiple units (*B* and *C*).
- 112004** Pulse mode cannot be assigned to multiple SMUs (*A* and *B*).
- 112005** I/V mode of the primary sweep source and synchronous sweep source must be the same.
- 112006** Duplicate channel data name was found. Channel data name must be unique. Channel data name: *A*
- 112007** Duplicate channel unit assignment was found. Channel unit assignment must be unique. Channel unit: *A*
- 112008** No channel unit was assigned. At least one channel unit must be assigned.
- 112009** Function (*A*) can be used for a maximum of *B* channel(s) in the *C* mode.

If You Have a Problem

Error Codes

- 112010** All SPGU channels must be set to the same output mode, VPULSE or ALWG.
- 112011** SMU descriptor expression is expected. Expression: *A*
- 112012** CMU descriptor expression is expected. Expression: *A*
- 112013** SPGU descriptor expression must be entered. Expression: *A*
- 112014** Mode must be V or COMMON for VSU (*A*).
- 112015** VMU (*A*) must be defined as a constant current source.
- 112016** Mode must be COMMON for GNDU.
- 112022** No CMU was assigned. At least one CMU must be assigned.
- 112023** No SMU was assigned. At least one SMU must be assigned.
- 112024** At least one SPGU must be used for SPGU Control.
- 112051** Auto analysis operation failed.
- 112052** Invalid value *A* specified for the switching matrix input setting. Specify a string, string variable, or module variable defined in the test definition or test setup.
- 112053** Enter a value for numeric variable *A*, used to specify the switching matrix output channel.
- 112054** A switch setup named *A* is already in the preset group *B*. The switch setup name must be unique in a preset group.
- 112055** A preset group named *A* already exists. The preset group name must be unique.
- 112056** Enter a name for the switching matrix setup.
- 112057** Maximum length for a switching matrix setup name is *A* characters.
- 112058** Read Switch Setup operation failed. Set the switching matrix configuration mode to Normal. Could not read the setup for connecting multiple input ports to a output channel.
- 112060** Specified connection pattern is not available for the couple port *A*, *B*.
- 112061** Input port *A* uses a shared path. The path is currently connected to the other input port. The specified connection is not available.
- 112071** Invalid Unit value was entered in the Channel Definition area. A test setup cannot use multiple units connected to the SCUU. Invalid entry:
Unit=SMU *A*

- 112072** Invalid value *A* was specified for Enable/Disable of I/V-t Sampling Stop Condition. Valid option(s): *B*
- 112073** Invalid value *A* was specified for Name of I/V-t Sampling Stop Condition. Valid option(s): *B*
- 112074** Invalid value *A* was specified for Event of I/V-t Sampling Stop Condition. Valid option(s): *B*
- 112075** Invalid function was used in the definition of variable specified by Name of I/V-t Sampling Stop Condition.
- 112100** ALWG waveform data for *A* was not found. Set data of the ALWaveform type parameter properly.
- 112101** Multiple ALWG waveform data are specified for *A*. Set Properties of the ALWaveform type parameter properly.
- 113001** Category name length must be in range of *A* to *B* characters.
- 113002** Application test definition name cannot be an empty string.
- 113003** Application test definition of the same name is already existing. Test definition: *A* Test categories: *B*
- 113011** Duplicate parameter name was found. Parameter name must be unique. Parameter name: *A*
- 113012** Duplicate typical value *A* is assigned. Each typical value must be unique for a numeric parameter.
- 113013** Symbol must not be an empty string.
- 113014** Symbol *A* is duplicated. Symbol must be unique for a numeric parameter.
- 113015** Same value *A* is assigned to symbols *B* and *C*. Each symbol must have unique value for a numeric parameter.
- 113016** Duplicate typical value *A* is assigned. Each typical value must be unique for a string parameter.
- 113017** Empty string is not allowed for the symbol.
- 113018** Symbol *A* is used for another vector parameter. Specify a different symbol.
- 113021** The type of evaluated value does not match the type of parameter *A*.
- 113022** Value for numeric parameter is out of range. Value must be in range. Parameter name: *A* Parameter value: *B* Parameter range: from *C* to *D*

If You Have a Problem

Error Codes

- 113023** Value for string parameter is not contained in the enumeration. Value must be a member of the enumeration. Parameter name: *A*, Parameter value: *B*, Enumeration: *C*
- 113024** Value for module parameter is invalid or is not compliant to the resource type of the parameter. Parameter name: *A*, Parameter value: *B*
- 113025** Improper value specified for the vector parameter. The value must be within the following range.
Restriction: *A*, Specified value: *B*, Effective range: *C* to *D*
- 113031** Test setup *A* depends on an undefined application test *B*. Please import the application test *B* in advance.
- 114001** A preset group named *A* already exists. The preset group name must be unique.
- 114002** Unnamed preset group cannot be exported. Please name the preset group in advance.
- 114011** A test setup named *A* is already in the preset group *B*. The test setup name must be unique in a preset group.
- 114012** A test setup named *A* cannot be retrieved in the preset group *B*. Probably it had already been modified or deleted.
- 114021** Following test result record cannot be retrieved. Probably it had already been deleted. Test result record: *A*
- 114031** Change the file name in the File Name Format dialog box. Following elements can be used in the file name.
A Setup Name
B Date (Time stamp)
C Count
D Device ID
- 114032** Change the file name in the File Name Format dialog box. Specified value contains an invalid character. Specified file name: *A*, Invalid character: *B*
- 114101** File I/O error occurred during automatic data export. Refer to the detail message, and retry after taking necessary measures.
- 114102** Specify the folder path in the Test Results Data Auto Export dialog box.
- 114103** Change the folder path in the Test Results Data Auto Export dialog box. Specified value contains an invalid character. Specified folder path: *A*

- 114104** Folder creation failed during automatic data export. Specify the correct drive letter and folder path in the Test Results Data Auto Export dialog box.
- 114105** Change the file extension in the Test Results Data Auto Export dialog box. Specified value contains an invalid character.
Specified file extension: *A*
- 114106** Data file creation failed during automatic data export. Refer to the detail message, and retry after taking necessary measures.
- 114107** Index file creation failed during automatic data export. Refer to the detail message, and retry after taking necessary measures.
- 114151** Specify the XML Style Sheet File Path in the Test Results Data Auto Export dialog box.
- 114152** Change the XML Style Sheet File Path in the Test Results Data Auto Export dialog box. Specified value contains an invalid character.
Specified path: *A*
- 115001** There is no working test setup. First preset the test setup.
- 115011** The application test *A* depends on an undefined application test *B*. Import the application test *B* in advance.
- 115021** Test setup import operation failed. Probably the imported contents are not a test setup.
- 115022** Test setup conversion failed. Setup *A* is not available for the tests that use the model *B*.
- 115031** Failed to invoke *A*.
- 115032** Repeat execution was aborted.
- 115041** Standby state was changed to OFF due to high voltage related error.
- 116001** Connected model not supported by Desktop EasyEXPERT. Only model *A* is supported. Connected model: *B* (address: *C*)
- 116002** B1500 firmware revision *A* is not supported by Desktop EasyEXPERT. Only revisions *B* and later are supported.
- 116003** Invalid argument specified for /gpib. Specified argument: /gpib:*A*
Example argument (valid): /gpib:gpib0::17
- 116004** Desktop EasyEXPERT does not support 4155/56 firmware revision *A*. Update the firmware to the revision *B* or later.

If You Have a Problem

Error Codes

- 117001** Enter another label for the switching matrix input port. *A* is already used for another port.
- 117002** Do not use a colon (:) in the label for a switching matrix input port.
- 117003** Connect the switching matrix to use this function. To establish the GPIB connection, set the GPIB address on the Configuration window's Switching Matrix tab, and click the Poll button.
- 117004** Invalid value *A* for the switching matrix output channel. Value must be between *B* and *C*.
- 117005** *A* to *B* is not a valid range for the switching matrix output channels. Use positive integers, with the first value no greater than the second.
- 117006** Switching matrix close error. Enter odd numbers to specify output channels connected to couple input port *A*.
- 117007** Switching matrix open error. Enter odd numbers to specify output channels connected to couple input port *A*.
- 117008** Switching matrix input port *A* is a couple input port. Enter *A* - 1 to specify the couple port.
- 117009** swmToModule(*A*) execution failed. Specified port number is out of the valid range (1 to 14). Otherwise, an invalid resource name has been defined in the switching matrix input port configuration. Enter the port number for an input that has a valid resource name.
- 117010** Switching matrix command execution error. B2200 error code: *A*
B2200 error message: *B*
- 117011** Connected model not supported by EasyEXPERT. Only model *A* is supported. Connected model: *B*
- 117012** Capacitance compensation data file read error. Specified file is either corrupt, or is not a compensation data file.
- 117014** Cannot control the switching matrix. It is controlled by the other tool.
- 120000** Script program execution error.
- 120001** Duplicated variable name used. Change the name of the variable. In a script program, the local variable name must be unique.
- 120002** Script program execution is aborted. Program execution paused by clicking the Pause button. This is the status message in normal operation.

- 120003** Script program execution ended abnormally. Program execution stopped by an illegal operation or statement. For more information, click the Detail button.
- 120004** An error forced by ERROR statement. Program execution stopped by the ERROR statement. This is the status message in normal operation.
- 120005** Invalid value detected in flow control statement. Correct the IF, FOR, or other flow control statement. Inappropriate expression used in the statement.
- 120006** Pasting program component failed. Specified program components cannot be pasted to the specified place. Cut or copy the appropriate program components, and paste them to the appropriate place.
- 120007** Variable type mismatch detected for assigning. Enter the appropriate value to the variable. Data type must be the same.
- 120008** Unknown program component imported. Keyword Prefix: *A*, Keyword: *B*

Data import was completed for an application test definition that contains a statement to call a test definition not in this system. Then the statement was automatically commented out. Before importing the test definition, import the test definition to be called.
- 121000** Plug-in execution error.
- 121001** Plug-in execution aborted. Plug-in execution paused by clicking the Pause button. This is the status message in normal operation.
- 121002** Plug-in execution ended abnormally.
- 122000** Script Error.
- 122001** Operator located in wrong place. Operator: *A*

Correct the expression. Put the operator in the correct place.
- 122002** Invalid expression is specified in user function definition.
User function: *A*, Expression: *B*

Correct the expression *B* defined in the user function or analysis function *A*. Click the Detail button for more information.
- 122003** Bracket Mismatch. Add or delete parenthesis. Parentheses must be paired.

If You Have a Problem

Error Codes

- 122004** Invalid expression is specified for function argument. Function: *A*, Argument: *B*
Correct the expression defined for the argument *B* of the function *A*. Click the Detail button for more information.
- 122005** Invalid type of data is specified as function argument. Correct the data type of the variable used for the argument. Or change the variable that is the same data type as the argument.
- 122006** Incorrect data is specified as function argument.
- 122007** Specified argument is out of range. Correct the value of the argument. The value must be within its allowable range.
- 122008** Invalid character is used for system symbol. System symbol: *A*, Invalid character: *B*
- 122009** Invalid character is used for user defined symbol. User defined symbol: *A*, Invalid character: *B*
Use the characters available for the user defined symbol.
- 122010** Missing operator. Index: *A*
Correct the expression. Put the operator on the correct place.
- 122011** Missing operand. Index: *A*
Correct the expression. Number of operands must be one for the monomial operators, and two for the binomial operators.
- 122012** Operand Type Mismatch. Operator: *A*
Correct the expression. The type of operands used in the expression must be the same.
- 122013** Undefined Symbol is used. Symbol: *A*
Correct the expression. Symbols must be defined before using them in the expression.
- 122014** Function failed to call. Function: *A*
Failed to call the function *A*. For more information, click the Detail button.
- 122015** Number of vector data elements must be *A* or less.
- 123000** Only literal value can be specified here. Invalid character is entered in the Variable Inspector. Enter the correct variable name.

- 130001** Transport function error occurred.
- 130002** A target package was not found. Cannot import data because of invalid file format or corrupted file. Specify correct file.
- 130003** The package is unusable because it includes incorrect data. Cannot import data because of invalid file format or corrupted file. Specify correct file.
- 130004** Package data is insufficient for this process. Cannot import data because of invalid file format or corrupted file. Specify correct file.
- 130005** File I/O error. Cannot find or access the package file.
- 130011** Data import failed. Data may be incompatible or corrupt. Data: A
- 131001** Conversion function error occurred.
- 131002** Invalid style sheet. Cannot export data (to CSV or XMLSS) because of invalid file format or corrupted file. Specify correct file.
- 131003** Invalid XML document. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 131004** Conversion process failed. Cannot export data (to CSV or XMLSS) because of invalid file format or corrupted file. Specify correct file.
- 131005** File I/O error. Cannot access the target file.
- 132001** Command interface error occurred.
- 132002** The process failed to execute the specified external command. Confirm that the file is in the system path, and specify the correct file name. Otherwise the file might have a problem.
- 133001** GPIB interface error occurred.
- 133002** Internal error occurred during GPIB operation. GPIB interface might be defective.
- 133003** The GPIB operation failed to complete within the specified timeout period. Set the correct timeout value. GPIB interface might be defective.
- 133004** The specified expression does not match any device, or the GPIB resource was not found. Set GPIB address properly. GPIB interface might be defective.
- 133005** The specified GPIB resources are invalid. Set GPIB address properly.

If You Have a Problem

Error Codes

- 133006** The specified GPIB address value is invalid. Set the correct GPIB address of the GPIB device.
- 133007** The specified GPIB interface number value is invalid. Set the correct GPIB interface number of the GPIB device.
- 133008** The specified timeout value is invalid. Set the proper timeout value.
- 133009** The specified delimiter characters are invalid. Set the proper delimiter value.
- 133010** Install Agilent IO Library.
- 133011** The specified GPIB address *A* is assigned to the B1500A. Specify the value assigned to the other equipment. Cannot control the B1500A.
- 134001** Dialog box interface error occurred.
- 134002** The process failed to activate the message-box window. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 134003** Message-box is already registered in the system. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 134004** Message-box function is not available because it is unregistered. Restart Agilent B1500A. If the problem still occurs, contact your nearest Agilent Technologies Service Center.
- 134005** The message-box configuration with no button information is invalid. Define the message box properly.
- 135001** No value is entered in this field. Enter the appropriate value in this field.
- 140001** Specified value range from *A* to *B* of the axis “*C*” is not valid. Specified value is out of the range for the “*C*” axis. Enter the available value.
- 140002** Specified scale type “*A*” of the axis “*B*” is not valid. Set the scale type to LINEAR or LOG.
- 140003** Data for Auto Analysis is not found. Cannot find the data that satisfy the automatic analysis condition. Specify the analysis condition properly.
- 140004** Data Display Operation has not completed within specified time (*A* seconds). Cannot complete the graph plot, automatic analysis, or data display properly. Internal error.

- 140005** Invalid operation for the stream occurred. Internal error.
- 140006** Duplicate data name was found. Data name must be unique. data name:
A
- 140007** No printers installed.
- 140008** Operation for printing failed. Perform printer setup properly.
- 140009** Failed to evaluate the read out function “*A*”.
- 140010** Enable the X-Y Graph to use this read out function.
- 140011** Define the axis *A* to use this read out function.
- 140012** There is no data for this read out function.
- 140013** Font size must be between *A* and *B*.
- 140014** Number of texts exceeds the limit. Maximum of *A* texts are allowed.
- 140015** Number of pointers exceeds the limit. Maximum of *A* pointers are allowed.
- 140016** Invalid value included in data specified by the marker. Pointer could not be added.
- 140017** Available number of decades for the log scale must be between *A* and *B*.
- 140101** Scalar data *A* is not found. Calculation failed. Scalar data *A* does not exist. Change the test definition so that the data is set before it is called.
- 140102** Vector data *A* is not found. Calculation failed. Vector data *A* does not exist. Change the test definition so that the data is set before it is called.
- 141001** Maximum *A* Data Display windows can be opened other than the base window. Cannot open additional Data Display window because the number of opened windows reaches the limit. Close an unnecessary window to open a new window.
- 141002** Maximum *A* Base Data Display windows can be opened.
- 151001** Maximum *A* Data Display windows can be opened other than the base window.
- 151002** Test execution mode cannot be changed during the test.
- 151003** Up to *A* data traces can be displayed in the Data Display window.
- 151004** Repeat Measurement Setup is not available when Data Record is OFF.
- 161001** Number of test definition windows must be *A* or less.

If You Have a Problem

Error Codes

- 170001** Archive process failed. Reason: *A*
- 171001** Data compression failed. Program error. Contact Agilent Technologies.
- 171002** Specify a correct file for the import. Specified file is either unsupported or corrupt.
- 171003** File I/O failed during compressed data export. Could not access destination file. Specified file is either unsupported or corrupt. Specify a correct file for the export.
- 171004** Compression process or decompression process failed. Specified file is either unsupported or corrupt. Specify a correct file for the export or import. It may also be a program error.
- 200001** Select from the candidates. Specify the value from the choices for this field.
- 200002** Input a numeric value. The value must be numeric. Enter a numeric value.
- 200003** Number of grid data elements must be *A* or less.
- 200004** Data paste failed. Data format is unsupported or incorrect.
- 200005** Data paste failed. Data of size $A \times B$ cannot be pasted to position C, D . It must be pasted to a range of $E \times F$.
- 201001** Failed to load image data. File *A* may not be an image file.
- 202001** The name *A* already exists.
- 300001** SDA daemon is already running.
- 300002** SDA daemon configuration file is corrupt. Check the file `C:\Program Files\Agilent\B1500\EasyEXPERT\Daemon\StaDaemon.exe.config`.
- 300003** Specify a correct folder for the EasyEXPERT database. Specified folder not found.
- 300004** Moving of EasyEXPERT database failed. Refer to the detail message, and retry after taking necessary measures.
- 300011** SDA daemon failed to start FLEX command service.
path: *A*, arguments: *B*, reason: *C*
- 300012** FLEX command service was stopped by SDA daemon. After closing Agilent Connection Expert, launch Start EasyEXPERT or restart B1500A.

- 300021** SDA daemon failed to start SDA service.
path: *A*, arguments: *B*, reason: *C*
- 300031** SDA daemon failed to start SDA shell.
path: *A*, arguments: *B*, reason: *C*
- 300041** SDA daemon failed to start model name inspection process. Path: *A*,
Arguments: *B*, Reason: *C*
- 300042** Model name inspection failed. Set VISA interface ID and GPIB address
correctly, or connect the GPIB cable properly. Reason: *A*
- 300051** SDA daemon failed to start database recovery process.
Path: *A*, Arguments: *B*, Reason: *C*
- 300052** Database recovery failed. Contact Agilent Technologies. Reason: *A*
- 300101** Error occurred during inspection for the specified EasyEXPERT
database. Path: *A*
- See the log file C:\Documents and Settings\All Users\ Application
Data\Agilent Technologies, inc\EasyEXPERT\StaDaemon.log if
needed.
- 300102** The specified EasyEXPERT database is broken. Initialize the database
or restore the normal database backup. Path: *A*, Reason: *B*
- 300103** EasyEXPERT database backup file (.xdb) is broken. Cannot restore this
backup. Path: *A*
- 300104** Insufficient free space of HDD. Drive: *A* Present Free Space: *B* bytes
Required Free Space: *C* bytes
- Retry the operation after increasing free space. Free space can be
increased by deleting unnecessary files, compressing folders, and so on.
- 300105** EasyEXPERT database is not in the specified drive *A*. Specify a folder
on the drive *B* where the EasyEXPERT database exists.
- 300106** The specified backup contains the EasyEXPERT database contents for
another revision. Specify the other backup. Contents: *A*
- 300107** The specified backup does not contain the file or folder needed to
restore the database. Specify the other backup. Contents: *A*
- 300108** The specified backup contains the database that is created by the
EasyEXPERT revision *A*. It cannot be supported by the present
revision. Specify the other backup.

If You Have a Problem

Error Codes

- 300109** EasyEXPERT database backup extraction error. See the log file C:\Documents and Settings\All Users\Application Data\Agilent Technologies, inc\EasyEXPERT\StaDaemon.log if needed. Backup restoration is canceled, and the present EasyEXPERT database remains the same.
- 300110** Folder delete error. Delete the folder in the following path manually.
Path: *A*
- 300111** EasyEXPERT database backup restoration error. Database could not be replaced with the backup. See the log file C:\Documents and Settings\All Users\Application Data\Agilent Technologies, inc\EasyEXPERT\StaDaemon.log if needed. Source: *A*, Destination: *B*

If Source shows the EasyEXPERT database folder name, the database remains the same.

If Destination shows the EasyEXPERT database folder name, the database is broken. Restore the previous database by renaming the temporary database folder named 1.tmp1A and such.
- 300112** Application Library update error. Information: *A*
- 300113** The specified backup is not complete. Evidence of deletion was detected. Specify the other backup.
- 300114** The specified folder is not empty. Specify an empty folder.
- 300115** Folder deletion was canceled. The folder is left to the following path.
Path: *A*
- 300116** EasyEXPERT database backup extraction was canceled. The extracted files were deleted.
- 300117** Folder copy was canceled. The copied files were deleted.
- 400001** Failed to load inf.dat file. Path: *A*, Description: *B*
- 400002** Cannot access EasyEXPERT database. Path: *A*, Description: *B*
- 400003** The specified EasyEXPERT database contains the contents for another revision. Path: *A*, Description: *B*
- 400004** The specified EasyEXPERT database has the incorrect structure. Path: *A*, Description: *B*
- 400005** Failed to load dir file. Path: *A*, Description: *B*
- 400006** Cannot access EasyEXPERT database library directory.
Path: *A*, Description: *B*

- 500011** License device not found. Connect the license device for EasyEXPERT properly. Feature: *A*, Error: *B*
- 500012** License device busy. Try again later. Feature: *A*, Error: *B*
- 500021** License for this feature is locked. Try again later. Feature: *A*, Error: *B*
- 500022** Unlicensed feature found. Feature: *A*
- 500023** Unknown license information for this feature. The software revision may be too old. Feature: *A*
- 500024** You need the license to use this function. Function: *A*, Required Option: *B*
- 500031** License authentication error. Feature: *A*, Reason: *B*
- 500032** License authentication failed. Feature: *A*, Reason: *B*

Agilent FLEX Execution Error

When Agilent B1500 causes errors in Agilent FLEX command execution environment, the B1500 returns the following error code and error message.

- | | |
|------------|---|
| 100 | Undefined GPIB command. Send the correct command. |
| 102 | Incorrect numeric data syntax. Correct the data syntax. |
| 103 | Incorrect terminator position. Correct the command syntax. The number of parameters will be incorrect. |
| 104 | Incorrect serial data syntax. |
| 120 | Incorrect parameter value. Correct the parameter value. |
| 121 | Channel number must be 1 to 10. Correct the channel number. The channel number must be 1 to 10 for Agilent B1500. |
| 122 | Number of channels must be corrected. Check the MM, FL, CN, CL, IN, DZ, or RZ command, and correct the number of channels. |
| 123 | Compliance must be set correctly. Incorrect compliance value was set. Set the compliance value correctly. |
| 124 | Incorrect range value for this channel. Check the range value available for the channel, and correct the range value. |
| 125 | Search goal value must be less than compliance value. |
| 126 | Pulse base and peak must be same polarity. The polarity of the base and peak values must be the same in the PI command. Also the polarity of the base, start, and stop values must be the same in the PWI command. |
| 130 | Start and stop must be same polarity. |

For a log sweep, the polarity of the start and stop values must be the same in the WV, WI, WSV, WSI, or WNX command. Also, 0 is not allowed for the start and stop values.

- 150** Command input buffer is full.
Agilent B1500 can receive 256 characters maximum including the terminator at one time.
- 151** This command is not allowed to this channel.
- 152** Cannot use failed module.
The channel number specifying the module failed the self-test or calibration. Specify another module that passed the self-test or calibration. For the service purpose, execute the RCV command to enable the module.
- 153** No module for the specified channel.
Module is not installed in the slot specified by the channel number.
- 160** Incorrect ST execution.
The internal memory programming can be started by the ST command and completed by the END command. Do not enter the ST command between the ST command and the END command.
- 161** Incorrect END execution.
The internal memory programming can be started by the ST command and completed by the END command. Do not send the END command before starting the programming.
- 162** Incorrect command for program memory.
Specified command cannot be stored in the program memory. For the incorrect commands, see Programming Guide.
- 170** Incorrect usage of internal variable.
The internal variable must be %In for integer data, or %Rn for real data. where *n* is an integer, 0 to 99. Use %In for the integer type command parameters; and use %Rn for the real type command parameters. For the internal variables, see the VAR command of Programming Guide.
- 171** Internal variable is not allowed.

If You Have a Problem

Error Codes

The internal variables %In and %Rn are not available for the ACH, VAR, and VAR? commands. Do not use the internal variables for the commands.

- 200** Channel output switch must be ON.
To enter the specified command, set the channel output switch to ON.
- 201** Compliance must be set.
To change the source output mode (voltage or current), set the compliance value.
- 202** Interlock circuit must be closed.
To set the output voltage or the voltage compliance to more than ± 42 V (high voltage state), close the interlock circuit. If the interlock circuit is opened in the high voltage state, outputs of all units will be set to 0 V.
- 203** Cannot enable channel.
The channel output switch cannot be set to ON in the high voltage state. Set the output voltage or the voltage compliance to ± 42 V or less to set the switch to ON.
- 204** Cannot disable channel.
The channel output switch cannot be set to OFF in the high voltage state. Set the output voltage or the voltage compliance to ± 42 V or less to set the switch to OFF. Or send the CL command with no parameter to set switches of all channels to OFF immediately.
- 205** DZ must be sent before RZ.
The RZ command is effective for the channels set to 0 V output by the DZ command.
- 206** Do not specify the channel recovered by RZ.
Specify the channels that have not been recovered yet by the RZ command after the DZ command. The RZ command cannot be executed if the specified channels include a channel that has already been recovered by the RZ command.
- 210** Ext trigger could not start measurement.
External trigger cannot start measurement because of busy condition.
- 211** TM1 must be sent to use GET.

- Send the TM1 command to use the GPIB GET command (TRIGGER statement in HP BASIC).
- 212** Compliance must be set correctly.
Compliance was not set or an incorrect compliance value was set in the DV, DI, PV, PI, PWV, PWI, TDV, TDI, LSV, LSI, LSSV, LSSI, BSV, BSI, BSSV, or BSSI command. Set the compliance value correctly.
- 213** Cannot perform self-test or calibration.
Self-test and calibration cannot be performed in the high voltage state. Set the output voltage or the voltage compliance to ± 42 V or less to perform the self-test or calibration.
- 214** Send MM before measurement trigger.
Before sending the measurement trigger, the MM command must be sent to set the measurement mode.
- 217** Self-test is not defined for this module.
- 220** Send WV or WI to set primary sweep source.
Before triggering the staircase sweep measurement, triggering the staircase sweep with pulsed bias measurement, or sending the WSV, WSI, or WNX command to set the synchronous sweep source, send the WV or WI command to set the primary sweep source.
- 221** Send PWV or PWI to set pulse sweep source.
Before triggering the pulsed sweep measurement, or sending the WSV or WSI command to set the synchronous sweep source, send the PWV or PWI command to set the pulse sweep source.
- 222** Send PV or PI to set pulse source.
Before triggering the staircase sweep with pulsed bias measurement, send the PV or PI command to set the pulse source.
- 223** Compliance must be set correctly.
Compliance was not set or an incorrect compliance value was set in the WV, WI, WSV, WSI, WNX, or BDV command. Set the compliance value correctly.
- 224** Sweep and sync output modes must be the same.
The primary sweep channel and the synchronous sweep channel must be different, and they must be set to the same output mode (voltage or current).

If You Have a Problem

Error Codes

- 225** Send WSV, WSI, or WNX to get sync sweep data.
If you enable data output of the synchronous sweep source, do not forget to set the synchronous sweep source by the WSV, WSI, or WNX command. For data output, see the FMT command of Programming Guide.
- 226** Set linear sweep for MM4 or MM5.
Only the linear sweep is available for the PWV or PWI command for the pulsed sweep measurement (MM4) or the WV or WI command for the staircase sweep with pulsed bias measurement (MM5).
- 227** Sweep measurement was aborted.
Sweep measurement was aborted by the automatic abort function or the power compliance.
- 228** Pulse period is not set for pulse measurements.
- 230** Pulse source must be set.
To perform the pulsed spot measurement (MM3), send the PV or PI command to set the pulse source.
- 231** Compliance must be set correctly.
Compliance was not set or an incorrect compliance value was set in the PV, PI, PWV, or PWI command. Set the correct compliance value effective for the pulse output.
- 238** Too large pulse width (max. 2 s).
The maximum value of the pulse width is 2 s. And the available value depends on the pulse period value. See the PT command of Programming Guide.
- 239** Pulse width must be 0.5 ms or more.
Set the pulse width to 0.5 ms or more. See the PT command of Programming Guide.
- 240** Enter QSV to set QSCV sweep source.
The QSV command must be entered to set the sweep source of the quasi-static CV measurement.
- 241** QSR range value must be -9 to -14.
The *range* values available for the QSR command are -9 to -14. Set one of the available values.

- 242** QSCV measurement was aborted.
Quasi-static CV measurement was aborted by the automatic abort function.
- 243** Enter MM13 before QSZ.
Before the QSZ command, the MM13 command must be entered to set the measurement mode.
- 244** Set a longer integration time to QST.
The integration time is too short to perform the offset measurement. Set a longer value to the integration time parameter of the QST command.
- 245** Specify a higher measurement range to QSR.
Too large offset current was measured. Specify the next higher measurement range to the QSR command.
- 246** QSV mode value must be 1 or 3.
The *mode* values available for the QSV command are 1 (single linear) and 3 (double linear). Set one of the available values.
- 247** Dedicated channel must be specified by QSO.
Specify the dedicated channel to the QSO command. It must be the channel other than the measurement channel set by the MM13 command or the sweep output channel set by the QSV command.
- 253** Program memory is full.
Maximum of 2000 programs or 40000 commands can be stored in the program memory. See the ST command of Programming Guide.
- 254** Invalid input for a memory program.
The GPIB GET command (TRIGGER statement in HP BASIC) and an external trigger input are not allowed in a memory program (between the ST and END commands).
- 255** Maximum nesting level is eight.
Nesting (one program calling another) of a memory program must be eight levels or less.
- 260** Data output buffer is full.
Maximum 34034 measurement data items can be stored in the data output buffer.

If You Have a Problem

Error Codes

- 270** Search source channel must be set.
Before triggering the search measurement or sending the LSSV, LSSI, BSSV, or BSSI command to set the synchronous search source, send the LSV, LSI, BSV, or BSI command to set the primary search source.
- 271** Search monitor channel must be set.
Before triggering the search measurement, send the LGV, LGI, BGV, or BGI command to set the search monitor channel.
- 273** Search and sync output modes must be the same.
The primary search source channel and the synchronous source channel must be different, and they must be set to the same output mode (voltage or current).
- 274** Search sync source is overflow.
Set the search sources so that the same output range is set to both primary and synchronous search sources.
- 275** Search target must be compliance value or less.
The search target value must be less than or equal to the compliance value of the search monitor channel. Correct the search target value or the compliance value.
- 276** Start and stop must be different.
Set different values for the search start and stop values.
- 277** Step must be output resolution or more.
Set the search step value to the output resolution or more.
- 278** Search and sync channels must be different.
Set the search source and the synchronous source to different channels.
- 279** Search monitor mode must be compliance side.
Send the LGI/BGI command to set the voltage source search monitor channel, or send the LGV/BGV command to set the current source search monitor channel.
- 280** Send WDCV to set CV sweep source.
Before triggering the multi frequency CV measurement, send the WDCV command to set the DC voltage sweep source.
- 281** Send PDCV to set CV pulse source.

- Before triggering the pulsed spot C measurement, send the PDCV command to set the pulsed voltage source.
- 282** Send PWDCV to set CV pulse sweep source.
Before triggering the pulsed CV measurement, send the PWDCV command to set the pulsed voltage sweep source.
- 283** Set linear sweep for MM20.
Only the linear sweep is available for the PWDCV command for the pulsed CV measurement (MM20).
- 284** Improper setting of CMU frequency and pulse width.
Pulse width value is out of the range for the CMU output frequency. Set both frequency value and pulse width value properly.
- 290** Send WFC to set Cf sweep source.
Before triggering the Cf sweep measurement, send the WFC command to set the frequency sweep source (oscillator).
- 301** Line power failure.
- 303** Excess voltage in MPSMU.
Voltage that exceeds maximum voltage at the present current range was detected by a MPSMU. All output switches were set to OFF.
- 304** Ground unit abuse is detected.
- 305** Excess current in HPSMU.
Current that exceeds maximum current at the present voltage range was detected by a HPSMU. All output switches were set to OFF.
- 307** Unsupported module.
This module is not supported by this firmware revision. Until you update the firmware, use Agilent B1500 with this module removed.
- 310** Interlock open operation error. Initialized.
Initialization was automatically performed because the B1500 failed to set its output to 0 V when the interlock circuit was opened in the high voltage condition. Any module may be defective. Perform self-test.
- 311** ASU control cable was connected/disconnected.
The B1500 must be turned off when the Atto Sense and Switch Unit (ASU) is connected/disconnected.

If You Have a Problem

Error Codes

- 312** SCUU control cable was connected/disconnected.
The B1500 must be turned off when the SMU CMU Unify Unit (SCUU) is connected/disconnected.
- 320** Excess current in CMU.
Current that exceeds maximum current at the present voltage range was detected by the CMU. The output switch was set to OFF.
- 321** This command is not available for CMU.
CMU was specified for the SMU dedicated command. Specify SMU.
- 322** This command is not available for SMU.
SMU was specified for the CMU dedicated command. Specify CMU.
- 323** Use SSP instead of CN for SCUU modules.
It is not necessary to specify the modules connected to the SMU CMU Unify Unit (SCUU) in the CN command. The output switches will be controlled by the SSP command.
- 330** Turn on again to detect source channel.
SCUU might be disconnected/connected on the power on condition. Restart the B1500 to detect and enable the channel.
- 331** Turn on again to detect synchronous channel.
SCUU might be disconnected/connected on the power on condition. Restart the B1500 to detect and enable the channel.
- 332** Turn on again to detect measurement channel.
SCUU might be disconnected/connected on the power on condition. Restart the B1500 to detect and enable the channel.
- 333** Turn on again to detect search source.
SCUU might be disconnected/connected on the power on condition. Restart the B1500 to detect and enable the channel.
- 334** Turn on again to detect search sync source.
SCUU might be disconnected/connected on the power on condition. Restart the B1500 to detect and enable the channel.
- 335** Turn on again to detect search monitor channel.
SCUU might be disconnected/connected on the power on condition. Restart the B1500 to detect and enable the channel.

- 603** Sweep and pulse channels must be different.
Set the sweep source and the pulse source to different channels for the staircase sweep with pulsed bias measurement (MM5).
- 610** Quasi-pulse source channel must be set.
Before triggering the quasi-pulsed spot measurement, send the BDV command to set the quasi-pulse source.
- 620** TGP specified incorrect I/O port.
Specify trigger input for the Ext Trig In port, or trigger output for the Ext Trig Out port by the TGP command. See the TGP command of Programming Guide.
- 621** Specify trigger input port for PAX/WSX.
No trigger input port was specified for the PAX or WSX command. Specify the trigger input port, or set the port as the trigger input port. See the TGP command of Programming Guide to set trigger port.
- 622** Specify trigger output port for OSX.
No trigger output port was specified for the OSX command. Specify the trigger output port, or set the port as the trigger output port. See the TGP command of Programming Guide to set trigger port.
- 630** Incorrect polarity of search step value.
For the linear search measurement. The step value must be positive if start<stop, or negative if start>stop.
- 631** Number of search steps must be 1001 or less.
For the linear search measurement. The number of search steps between start and stop must be 1001 or less. This means the |step| value must be |stop-start|/1001 or more.
- 632** Search measurement was aborted.
Search measurement was aborted by the automatic abort function.
- 640** Search limits must be range/20000 or more.
For the binary search measurement. The limit value for the search target must be range/20000 or more. where *range* means the measurement range actually used for the measurement.
- 650** Data format must be ASCII to get time data.

If You Have a Problem

Error Codes

The time stamp function is not available for the binary data output format. To use the time stamp function, set the data output format to ASCII.

- 655** Cannot connect/disconnect series resistor.
The series resistor status cannot be changed in the high voltage state. Set the output voltage or the voltage compliance to ± 42 V or less to connect or disconnect the series resistor.
- 656** Series resistor must be OFF for 1 A range.
The series resistor cannot be set to ON for the measurement channels or the output channels that use 1 A range.
- 657** Series resistor cannot be used with ASU.
The series resistor is not available for the channel connected to the Atto Sense and Switch Unit (ASU).
- 660** Sampling measurement was aborted.
Sampling measurement was aborted by the automatic abort function.
- 661** Negative hold time is only valid for I/V-t linear sampling with interval < 2 ms.
- 662** Sampling interval for I/V-t log sampling must be 2 ms or longer.
- 663** Number of samples does not have to exceed 100001.
- 664** Base and bias must be same polarity for I mode.
The *base* and *bias* values of the MI command must be the same polarity.
- 670** Specified channel does not have ASU.
Specify the module that can be used with the ASU.
- 671** SSP is not available for this channel.
SSP command is available only for the CMU. Specify the slot number that the CMU has been installed.
- 680** CMU correction mode must be manual.
To perform the CMU correction by using the ADJ? command, set the CMU correction mode to manual by using the ADJ command.
- 681** CMU correction mode must be off.
- 682** Invalid standard is specified as CMU correction.

| | |
|-------------|---|
| 683 | Frequency index is not available for CMU correction. |
| 684 | AC Voltage is 0 mV. |
| 685 | CMU correction is not complete. |
| 2000 | SPGU module does not exist. The SPGU channel number must be specified correctly. |
| 2001 | SPGU channel does not exist. The SPGU channel number must be specified correctly. |
| 2002 | SPGU signal source does not exist. The SPGU signal source number must be specified correctly. |
| 2003 | SPGU operation mode must be PG. (SIM 0). |
| 2004 | SPGU operation mode must be ALWG (SIM 1). |
| 2051 | Over voltage emergency occurred. All modules stopped their output and opened their output relay. |
| 2052 | Over current emergency occurred. All modules stopped their output and opened their output relay. |
| 2053 | High temperature emergency occurred. All modules stopped their output and opened their output relay. |
| 2054 | Over voltage H/W SRQ detected. Specified module stopped the output and opened the output relay. |
| 2055 | Over current H/W SRQ detected. Specified module stopped the output and opened the output relay. |
| 2056 | High temperature H/W SRQ detected. Specified module stopped the output and opened the output relay. |
| 2101 | Specified load impedance is out of absolute limits. Set the appropriate impedance value to SER. |
| 2103 | Specified period is out of absolute limits. Set the appropriate pulse period value to SPPER. |
| 2104 | Specified trigger count is out of absolute limits. |

If You Have a Problem

Error Codes

- Set the appropriate count value to SPRM.
- 2105** Specified load voltage is out of range.
Set the appropriate voltage to SPV or ALW.
- 2106** Specified load voltage of added amplitude is out of range.
Set the appropriate voltage to SPV for setting the 3-level pulse output.
- 2107** Specified voltage is out of absolute limits (can't achieve amplitude).
Set the appropriate voltage to SPV. It must be the voltage which can be applied under the present load impedance condition.
- 2108** Specified transition time is out of absolute limits.
Set the appropriate value of leading time or trailing time to SPT.
- 2111** Leading/0.8 must be within Width value.
Set the appropriate value to SPT. The pulse width value must be more than *leading time*/0.8 value.
- 2112** Delay + Width + Trail/0.8 must be within Period value.
Set the appropriate value to SPT. The pulse period value must be more than *delay time+pulse width+trailing time*/0.8 value.
- 2113** Specified pulse delay is out of absolute limits.
Set the appropriate delay time value to SPT.
- 2114** Specified pulse width is out of absolute limits.
Set the appropriate pulse width value to SPT.
- 2115** Specified duration is out of absolute limits.
Set the appropriate duration value to SPRM.
- 2121** Delay + Width must be within Period value (ODSW Timing).
Set the appropriate value to ODSW. The period value must be more than *delay+width* value.
- 2122** Specified ODSW delay timing parameter out of absolute limits.
Set the appropriate *delay* value to ODSW.
- 2123** Specified ODSW width timing parameter out of absolute limits.
Set the appropriate *width* value to ODSW.
- 2131** Delay + Interval * N must be within Period value (ADC Timing).

- Set the appropriate value to CORRSER?. The period value must be more than $delay+interval\times count$ value.
- 2132** Specified delay for DUT impedance measurement out of absolute limits.
Set the appropriate *delay* time value to CORRSER?.
- 2133** Specified interval for DUT impedance measurement out of absolute limits.
Set the appropriate *interval* value to CORRSER?.
- 2134** Specified count for DUT impedance measurement out of absolute limits.
Set the appropriate *count* value to CORRSER?.
- 2151** ALWG Sequence Data is not ready.
Sequence data must be set by using ALS before starting the output.
- 2152** Specified ALWG Sequence Data size is out of absolute limits.
Set the appropriate sequence data to ALS. Too large data was specified.
- 2153** Specified pattern index of ALWG Sequence Data is out of absolute limits.
Set the appropriate sequence data to ALS. The pattern index in the sequence data must be the index of a pattern defined in the pattern data.
- 2154** Specified repeat count of ALWG Sequence Data is out of absolute limits.
Set the appropriate sequence data to ALS. The repeat count in the sequence data must be 1 to 1048576.
- 2155** ALWG Pattern Data is not ready.
Pattern data must be set by using ALW before starting the output.
- 2156** Specified ALWG Pattern Data size is out of absolute limits.
Set the appropriate pattern data to ALW. Too large data was specified.
- 2157** Specified interval time of ALWG Pattern is out of absolute limits.
Set the appropriate pattern data to ALW. The incremental time value in the pattern data must be 10 ns to 671.088630 ms in 10 ns resolution.
- 2158** Specified output voltage of ALWG Pattern Data is out of absolute limits.

If You Have a Problem

Error Codes

Set the appropriate pattern data to ALW. The output level value in the pattern data must be 0 to ± 40 V in 1 mV resolution.

- 2204** Load voltage is too small for DUT impedance measurement.
Failed to perform the terminal voltage measurement and the load impedance calculation by the CORRSER? command. Set the SPGU output voltage more than 1 V. Set high voltage for high impedance.
- 2206** Auto correction of load impedance failed.
Cannot perform the SPGU automatic level adjustment. Load impedance exceeds the acceptable range. Change the SPGU output voltage or the DUT.
- 3000** WGF MU module does not exist.
Check the channel number of the WGF MU module and set the correct value.
- 3001** RSU is not connected.
Check the channel number of the WGF MU module connected to the RSU and set the correct value.
- 3015** Measurement data corrupted.
Cannot get the measurement data. Correct measurement result is not stored in the memory.
- 3050** Measurement data memory overflow error.
ALWG sequencer run time error. WGF MU module memory overflow occurred. Data exceeds memory size could not be stored.
- 3051** Measurement data FIFO overflow error.
ALWG sequencer run time error. WGF MU module FIFO overflow occurred because the averaging count was frequently changed.
- 3052** Measurement range change request error.
ALWG sequencer run time error. Measurement range cannot be changed because the range change interval is too short.
- 3201** ALWG Sequence Data is not ready.
Sequence data must be set to the specified WGF MU channel.
- 3202** ALWG Waveform Data is not ready.
Waveform data must be set to the specified WGF MU channel.

- 3301** Specified output voltage is out of absolute limits.
Check the output voltage and set the correct value. The value must be -3 V to +3 V for the 3 V range, -5 V to +5 V for the 5 V range, -10 V to 0 V for the -10 V range, or 0 V to +10 V for the + 10 V range.
- 3302** Specified voltage output range is invalid.
Check the voltage output range and set the correct value.
- 3303** Invalid measurement mode for current operation mode.
Operation mode must be Fast IV or DC to perform current measurement.
- 3304** Specified ALWG Vector Data size is out of absolute limits.
ALWG data cannot be read because of too large data size.
- 3305** Specified ALWG Sequence Data size is out of absolute limits.
ALWG data cannot be read because of too large sequence data size.
- 3306** ALWG Waveform Data is empty.
ALWG data must not be empty.
- 3307** Specified ALWG Waveform Data size is out of absolute limits.
ALWG data cannot be read because of too large waveform data size.
- 3308** Specified waveform index of ALWG Sequence Data is out of absolute limits.
Check the index value of the sequence data and set the correct value.
- 3309** Specified loop number of ALWG Sequence Data is out of absolute limits.
Check the loop value of the sequence data and set the correct value.
- 3310** Specified output voltage of ALWG Waveform Data is out of absolute limits.
Check the output voltage and set the correct value. The value must be -3 V to +3 V for the 3 V range, -5 V to +5 V for the 5 V range, -10 V to 0 V for the -10 V range, or 0 V to +10 V for the + 10 V range.
- 3311** Specified interval time of ALWG Waveform is out of absolute limits.
Check the incremental time (interval time) and set the correct value. The value must be 10 ns to 10995.11627775 s, in 10 ns resolution.

If You Have a Problem

Error Codes

- 3312** Specified ALWG measurement interval time is out of absolute limits.
Check the measurement interval time and set the correct value. The value must be 10 ns to 1.34217728 s, in 10 ns resolution.
- 3313** Specified ALWG measurement instruction code is invalid.
Check the measurement event setting and set the correct values.
- 3314** Specified ALWG range change instruction code is invalid.
Check the range event setting and set the correct values.
- 3315** Specified ALWG measurement count is out of absolute limits.
Check the measurement averaging time and set the correct value. The value must be 0, or 10 ns to 0.020971512 s, in 10 ns resolution.
- 3316** Specified ALWG measurement count is greater than measurement interval.
Check the measurement averaging time and set the correct value. The value must less than or equal to the measurement interval time.
- 3317** Specified slot is invalid.
Check the slot number and set the correct value. The slot number must be 1 to 10.
- 3318** Specified module channel is invalid.
Check the channel number and set the correct value.
- 3319** Output delay is out of absolute limits.
Check the output delay and set the correct value. The value must be -50 ns to 50 ns, in 625 ps resolution.
- 3320** Measurement delay is out of absolute limits.
Check the measurement delay and set the correct value. The value must be -50 ns to 50 ns, in 625 ps resolution.
- 3321** VM/IM measurement mode is invalid.
Check the measurement mode and set the correct value.
- 3322** Voltage measurement range is invalid.
Check the voltage measurement range and set the correct value.
- 3323** Current measurement range is invalid.

- 3324 Check the current measurement range and set the correct value.
WGMA?,WGMB? command query size is out of absolute limits.
Check the data size for WGMA? or WGMB? and set the correct value.
- 3325 Specified count for spot measurement is out of absolute limits.
Check the count value for WGMS? and set the correct value.
- 3326 Specified interval for spot measurement is out of absolute limits.
Check the interval value for WGMS? and set the correct value.
- 3327 Specified operation mode is invalid for spot measurement.
Operation mode must be DC to perform spot measurement.

Agilent B1500A Self-test/Calibration Error

When Agilent B1500 fails the self-test or self-calibration, the B1500 returns the following error code and error message.

In the error code, N indicates the slot number. If the module is installed in slot 1, and it fails the function test, the error code will be 1760.

| | |
|------------|--|
| 700 | CPU failed NVRAM read/write test. |
| 701 | CPU failed FPGA read/write test. |
| 702 | CPU failed H-RESOLN ADC end signal test. |
| 703 | CPU failed H-RESOLN ADC start signal test. |
| 704 | CPU failed emergency status signal test. |
| 705 | CPU failed SRQ status signal test. |
| 706 | CPU failed high voltage status signal test. |
| 707 | CPU failed low voltage status signal test. |
| 708 | CPU failed DAC settling status signal test. |
| 709 | CPU failed measure ready status signal test. |
| 710 | CPU failed set ready status signal test. |
| 711 | CPU failed measure end status signal test. |
| 712 | CPU failed measure trigger signal test. |
| 713 | CPU failed pulse trigger signal test. |
| 714 | CPU failed abort trigger signal test. |
| 715 | CPU failed DAC set trigger signal test. |
| 720 | H-RESOLN ADC is not installed. |
| 721 | H-RESOLN ADC failed ROM/RAM test. |
| 722 | H-RESOLN ADC failed B-COM offset DAC test. |
| 723 | H-RESOLN ADC failed sampling ADC test. |
| 724 | H-RESOLN ADC failed integrating ADC test. |
| 725 | H-RESOLN ADC failed bus function test. |
| 740 | GNDU failed calibration. |
| 935 | CMU FPGA version mismatch. |

| | |
|-------------|---|
| 2400 | SPGU module is in TEST FAIL state. |
| 2401 | Digital H/W function test failed. |
| 2402 | CPLD access function test failed. |
| 2403 | CPLD version check test failed. |
| 2404 | CPLD revision check test failed. |
| 2405 | FPGA configuration test failed. |
| 2406 | FPGA access function test failed. |
| 2407 | FPGA version check test failed. |
| 2408 | FPGA revision check test failed. |
| 2409 | DCM function test failed. |
| 2410 | CONVEND interrupt function test failed. |
| 2411 | EMG interrupt function test failed. |
| 2412 | 10 MHz clock test failed. |
| 2413 | FPGA SYNC SEL pin control function test failed. |
| 2414 | FPGA SYNC FB pin control function test failed. |
| 2415 | FPGA SYNC IN pin control function test failed. |
| 2416 | IDELAY function test failed. |
| 2417 | NVRAM access function test failed. |
| 2418 | ADC function test failed. |
| 2419 | SDRAM access function test failed. |
| 2430 | Module EEPROM CRC data is invalid. |
| 2431 | Module EEPROM CRC data of module data ID is invalid. |
| 2432 | Module EEPROM CRC data of format revision data is invalid. |
| 2433 | Module EEPROM CRC data of analog reference data is invalid. |
| 2434 | Module EEPROM CRC data of timing calibration data is invalid. |
| 2435 | Module EEPROM CRC data is skew calibration data invalid. |
| 2450 | Internal ADC function test failed. |
| 2451 | 0.5 Vref Internal ADC function test failed. |

If You Have a Problem

Error Codes

| | |
|-------------|---|
| 2452 | 4.5 Vref Internal ADC function test failed. |
| 2453 | Power Amp initial test failed. |
| 2454 | Filter & Amp test failed. |
| 2455 | Internal temperature test failed. |
| 2456 | Internal output resistance test failed. |
| 2481 | Invalid frame configuration. |
| 2482 | Frame has no modules. |
| 2483 | PLL not locked in slave module. |
| 2484 | Reference line is not connected. |
| 2485 | Sync line is not connected. |
| 2486 | Interrupt line is not available. |
| 2487 | Module service request assertion test failed. |
| 2488 | Module service request detection test failed. |
| 2489 | Emergency interrupt is not available. |
| 2500 | SPGU calibration failed. |
| 2501 | Power Amp idling calibration failed. |
| 2502 | DAC output level calibration failed. |
| 3002 | WGFMU initialization failure. |
| 3003 | WGFMU FPGA is not configured. |
| 3004 | EEPROM CRC data of system timing data is invalid. |
| 3005 | EEPROM CRC data of DAC DCM PS data is invalid. |
| 3006 | EEPROM CRC data of ADC DCM PS data is invalid. |
| 3007 | EEPROM CRC data of DAC clock edge data is invalid. |
| 3008 | EEPROM CRC data of ADC clock edge data is invalid. |
| 3009 | EEPROM CRC data of DAC level calibration data is invalid. |
| 3010 | EEPROM CRC data of ADC level calibration data is invalid. |
| 3011 | EEPROM CRC data of DAC skew calibration data is invalid. |
| 3012 | EEPROM CRC data of ADC skew calibration data is invalid. |

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|-------------|---|
| 3013 | EEPROM CRC data of RSU calibration data is invalid. |
| 3014 | Invalid EEPROM type. |
| 3400 | WGFMU module is in TEST FAIL state. |
| 3401 | Digital H/W function test failed. |
| 3402 | CPLD access function test failed. |
| 3403 | FPGA configuration test failed. |
| 3404 | FPGA1 access function test failed. |
| 3405 | FPGA2 access function test failed. |
| 3406 | FPGA1 System Clock DCM function test failed. |
| 3407 | FPGA1 DAC Clock DCM function test failed. |
| 3408 | FPGA1 ADC Clock DCM function test failed. |
| 3409 | FPGA1 Memory Clock DCM function test failed. |
| 3410 | FPGA2 System Clock DCM function test failed. |
| 3411 | FPGA2 DAC Clock DCM function test failed. |
| 3412 | FPGA2 ADC Clock DCM function test failed. |
| 3413 | FPGA2 Memory Clock DCM function test failed. |
| 3414 | FPGA1, 2 communication I/F test failed. |
| 3415 | CONVEND interrupt function test failed. |
| 3416 | 10 MHz clock test failed. |
| 3417 | FPGA SYNC SEL pin control function test failed. |
| 3418 | FPGA SYNC FB pin control function test failed. |
| 3419 | FPGA SYNC IN pin control function test failed. |
| 3420 | IDELAY function test failed. |
| 3421 | Channel 1 SDRAM access function test failed. |
| 3422 | Channel 2 SDRAM access function test failed. |
| 3423 | WGFMU EEPROM access function test failed. |
| 3424 | Channel 1 RSU EEPROM access function test failed. |
| 3425 | Channel 2 RSU EEPROM access function test failed. |

If You Have a Problem

Error Codes

| | |
|-------------|---|
| 3426 | WGFMU EEPROM CRC data is invalid. |
| 3427 | WGFMU EEPROM CRC data of format revision data is invalid. |
| 3428 | WGFMU EEPROM CRC data of serial number data is invalid. |
| 3429 | WGFMU EEPROM CRC data of system timing data is invalid. |
| 3430 | WGFMU EEPROM CRC data of DAC DCM PS data is invalid. |
| 3431 | WGFMU EEPROM CRC data of ADC DCM PS data is invalid. |
| 3432 | WGFMU EEPROM CRC data of DAC clock edge data is invalid. |
| 3433 | WGFMU EEPROM CRC data of ADC clock edge data is invalid. |
| 3434 | WGFMU EEPROM CRC data of DAC level calibration data is invalid. |
| 3435 | WGFMU EEPROM CRC data of ADC level calibration data is invalid. |
| 3436 | WGFMU EEPROM CRC data of DAC skew calibration data is invalid. |
| 3437 | WGFMU EEPROM CRC data of ADC skew calibration data is invalid. |
| 3438 | RSU EEPROM CRC data of format revision data is invalid. |
| 3439 | RSU EEPROM CRC data of serial number data is invalid. |
| 3440 | RSU EEPROM CRC data of type id data is invalid. |
| 3441 | RSU EEPROM CRC data of calibration data is invalid. |
| 3450 | WGFMU EEPROM data is invalid. |
| 3451 | WGFMU EEPROM data of RSU type is invalid. |
| 3452 | WGFMU EEPROM data of RSU cable type is invalid. |
| 3460 | Main DAC, Main ADC test failed. |
| 3461 | Bias DAC, Main ADC test failed. |
| 3462 | Main DAC, Reference ADC test failed. |
| 3463 | VM function test failed. |
| 3464 | IM offset test failed. |
| 3465 | IM short test failed. |
| 3480 | Invalid frame configuration. |
| 3481 | Invalid frame configuration. |
| 3482 | Frame has no modules. |

| | |
|-------------|---|
| 3483 | PLL not locked in slave module. |
| 3484 | Reference line is not connected. |
| 3485 | Sync line is not connected. |
| 3486 | Sync Reserve line is not connected. |
| 3487 | Interrupt line is not available. |
| 3488 | Module service request assertion test failed. |
| 3489 | Module service request detection test failed. |
| 3490 | Emergency interrupt is not available. |
| 3500 | WGFMU calibration failed. |
| 3501 | ADC gain calibration failed. |
| 3502 | CMR calibration failed. |
| 3503 | IM offset calibration failed. |
| 3504 | VM offset calibration failed. |
| 3505 | VF gain calibration failed. |
| 3506 | VF offset calibration failed. |
| 3507 | Reference ADC does not exist. Cannot perform WGFMU calibration. |
| 3508 | WGFMU, RSU cable length calibration failed. |
| N760 | SMU failed function test. |
| N761 | SMU failed VF/VM function test. |
| N762 | SMU failed IF/IM function test. |
| N763 | SMU failed loop status test. |
| N764 | SMU failed temperature sensor test. |
| N765 | SMU failed CMR amplifier calibration. |
| N766 | SMU failed CMR amplifier adjustment. |
| N767 | SMU failed CMR 100 V range full output test. |
| N768 | SMU failed VF/VM calibration. |
| N769 | SMU failed VM offset calibration. |
| N770 | SMU failed VM gain calibration. |

If You Have a Problem

Error Codes

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|-------------|---|
| N771 | SMU failed VF offset calibration. |
| N772 | SMU failed VF gain calibration. |
| N773 | SMU failed VF gain calibration at 20 V range. |
| N774 | SMU failed VF filter offset calibration. |
| N775 | SMU failed H-SPEED ADC self-calibration. |
| N776 | SMU failed H-SPEED ADC VM offset calibration. |
| N777 | SMU failed H-SPEED ADC VM gain calibration. |
| N778 | SMU failed IF/IM calibration. |
| N779 | SMU failed calibration bus test. |
| N780 | SMU failed IM offset calibration. |
| N781 | SMU failed IM gain calibration. |
| N782 | SMU failed IF offset calibration. |
| N783 | SMU failed IF gain calibration. |
| N784 | SMU failed IDAC filter offset calibration. |
| N785 | SMU failed oscillation detector test. |
| N786 | SMU failed I bias test. |
| N787 | SMU failed common mode rejection test. |
| N789 | SMU failed high voltage detector test. |
| N790 | SMU failed zero voltage detector test. |
| N791 | SMU failed V hold test. |
| N792 | SMU failed V switch test. |
| N800 | CMU failed NULL DC offset adjustment. |
| N801 | CMU failed NULL DC offset measurement. |
| N802 | CMU failed VRD DC offset adjustment. |
| N803 | CMU failed VRD heterodyne offset adjustment. |
| N804 | CMU failed NULL gain/phase adjustment. |
| N805 | CMU failed MODEM offset adjustment. |
| N806 | CMU failed relative Z adjustment. |

| | |
|-------------|---|
| N807 | CMU failed Vch full scale measurement. |
| N808 | CMU failed nominal gain measurement |
| N809 | CMU failed extent range X3 adjustment. |
| N810 | CMU failed range resistor 50ohm adjustment. |
| N811 | CMU failed range resistor 1kohm adjustment. |
| N812 | CMU failed range resistor 10kohm adjustment. |
| N813 | CMU failed range resistor 100kohm adjustment. |
| N814 | CMU failed relative Z calculation. |
| N820 | CMU failed correction. |
| N830 | CMU failed configuration test. |
| N831 | SCUU failed SCUU configuration test. |
| N832 | SCUU failed SMU configuration test. |
| N833 | SCUU failed CMU configuration test. |
| N834 | CMU failed digital function test. |
| N835 | CMU failed CPLD test. |
| N836 | CMU failed FPGA test. |
| N837 | CMU failed EEPROM test. |
| N838 | CMU failed PLL1/PLL2 test. |
| N839 | CMU failed PLL DET low state test. |
| N840 | CMU failed PLL DET high state test. |
| N841 | CMU failed PLL1 lock test |
| N842 | CMU failed PLL2 lock test. |
| N843 | CMU failed PLL2 lock test. |
| N844 | CMU failed Hcur DC and VRD ADC test. |
| N845 | CMU failed DC offset test. |
| N846 | CMU failed DC bias 0V test. |
| N847 | CMU failed DC bias -25V test. |
| N848 | CMU failed DC bias +25V test. |

If You Have a Problem

Error Codes

| | |
|-------------|---------------------------------|
| N849 | CMU failed PLL0 test. |
| N850 | CMU failed PLL0 lock test. |
| N851 | CMU failed PLL0 lock test. |
| N852 | CMU failed DDS test. |
| N853 | CMU failed DDS1 test. |
| N854 | CMU failed DDS2 test. |
| N855 | CMU failed VRD normalizer test. |
| N856 | CMU failed RA1 test. |
| N857 | CMU failed RA2 test. |
| N858 | CMU failed ExR test. |
| N859 | CMU failed R_LPF2 f1 test. |
| N860 | CMU failed MODEM DAC test. |
| N861 | CMU failed N_II_DAC test. |
| N862 | CMU failed N_QI_DAC test. |
| N863 | CMU failed N_IQ_DAC test. |
| N864 | CMU failed N_QQ_DAC test. |
| N865 | CMU failed TRD normalizer test. |
| N866 | CMU failed NA1 test. |
| N867 | CMU failed NA2 test. |
| N868 | CMU failed NA3 test. |
| N869 | CMU failed N_LPF1 f2 test. |
| N870 | CMU failed N_LPF1 f3 test. |
| N871 | CMU failed N_LPF1 f4 test. |
| N872 | CMU failed N_LPF1 f5 test. |
| N873 | SCUU failed EEPROM test. |
| N874 | SCUU failed output relay test. |
| N875 | SCUU failed control test. |
| N876 | SCUU failed CG2 test. |

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|-------------|-------------------------------------|
| N877 | SCUU failed LRL test. |
| N880 | CMU failed Hcur AC and VRD Fm test. |
| N881 | CMU failed SA/RA 32mV test. |
| N882 | CMU failed SA/RA 64mV test. |
| N883 | CMU failed SA/RA 125mV test. |
| N884 | CMU failed SA/RA 250mV test. |
| N885 | CMU failed ExR test. |
| N886 | CMU failed Bias_chg test. |
| N887 | CMU failed R_LPF2/R_HPFP_vs test. |
| N888 | CMU failed VRD IF test. |
| N889 | CMU failed IRM local 0deg test. |
| N890 | CMU failed IRM local 90deg test. |
| N891 | CMU failed S_LPF1 f1 120kHz test. |
| N892 | CMU failed S_LPF1 f2 500kHz test. |
| N893 | CMU failed S_LPF1 f3 2MHz test. |
| N894 | CMU failed S_LPF1 f4 5MHz test. |
| N895 | CMU failed TRD MODEM test. |
| N896 | CMU failed VG local 90deg test. |
| N897 | CMU failed VG local 0deg test. |
| N898 | CMU failed NA4 test. |
| N899 | CMU failed NA5 X1/4 test. |
| N900 | CMU failed NA5 X1/8 test. |
| N901 | CMU failed N_LPF2 f2 500kHz test. |
| N902 | CMU failed N_LPF2 f3 5MHz test. |
| N903 | CMU failed MODEM PSD test. |
| N904 | CMU failed PSD 0deg test. |
| N905 | CMU failed PSD 90deg test. |
| N906 | CMU failed Rr/Rf 100ohm test. |

If You Have a Problem

Error Codes

| | |
|-------------|---|
| N907 | CMU failed Rr/Rf 1kohm test. |
| N908 | CMU failed Rr/Rf 10kohm test. |
| N909 | CMU failed Rr/Rf 100kohm test. |
| N910 | CMU failed TRD IVamp test. |
| N911 | CMU failed N_HPFI/N_LPF1 10kHz test. |
| N912 | CMU failed N_HPFI/N_LPF1 200kHz test. |
| N913 | CMU failed N_HPFI/N_LPF1 1MHz test. |
| N914 | CMU failed N_HPFI/N_LPF1 2MHz test. |
| N915 | CMU failed N_HPFI/N_LPF1 5MHz test. |
| N916 | CMU failed NA1 test. |
| N917 | CMU failed NA2 test. |
| N918 | CMU failed NA3 test. |
| N919 | CMU failed IV saturation detector test. |
| N920 | CMU failed normal status test. |
| N921 | CMU failed normal status test. |
| N922 | CMU failed IV saturation status test. |
| N923 | CMU failed IV saturation status test. |
| N924 | CMU failed unbalance detector test. |
| N925 | CMU failed normal status test. |
| N926 | CMU failed normal status test. |
| N927 | CMU failed unbalance status test. |
| N928 | CMU failed unbalance status test. |
| N929 | CMU failed over current detector test. |
| N930 | CMU failed normal status test. |
| N931 | CMU failed normal status test. |
| N932 | CMU failed over current status test. |
| N933 | CMU failed over current status test. |

Setup File Converter Execution Error

The followings are the error code for the setup file converter (SetupFileConverter.exe). See “SetupFileConverter.exe” on page 10-53.

- #01** Maximum length for the file path is 256 characters.
- #02** fopen failure. Could not open source file.
- #03** Specify a proper source file. The specified file is unsupported.
- #04** Specify a proper source file. The specified file is corrupt.
- #05** fopen failure. Could not open destination file.

If You Have a Problem
Error Codes

Application Library and Utilities

This chapter introduces the application library and utility programs included in the Agilent B1500A/EasyEXPERT software.

- “Application Test Definitions”
- “QSCV Measurement Supplemental Data”
- “License Management Tool”
- “Setup File Converter”
- “Utility Programs”
- “Desktop EasyEXPERT”

Application Test Definitions

Agilent EasyEXPERT software contains the application library which supports the characteristic measurements of CMOS devices, TFT, BJT, diode, resistor, capacitor, varactor, memory, nanotechnology devices such as CNT FET, and so on. The application library includes more than one hundred test definitions. And they are classified into the following categories. Table 10-1 lists all test definitions belonging to the category. Each test definition requires the modules and instruments shown in the table.

1. BJT
2. CMOS
3. Discrete
4. Generic Test
5. Memory
6. Mixed Signal
7. Nano Tech
8. Power Device
9. Reliability
10. Structure
11. TFT
12. Utility
13. WGF MU

NOTE

Application Library

The application library is a set of test definitions effective for the EasyEXPERT application test execution mode. The application test can be performed by selecting a test definition and setting the test condition for the actual DUT (device under test). And the setup can be saved as the dedicated test setup for the DUT.

All test definitions are just sample. If the samples damage your devices, Agilent Technologies is NOT LIABLE for the damage.

Application Library and Utilities
Application Test Definitions

Table 10-1 Application Test Definitions

| Category | Test definition name | Supported analyzer | Required equipment and quantity |
|----------|--------------------------|------------------------|---------------------------------|
| BJT | BC Diode Fwd | B1500A,4155B/C,4156B/C | SMU 2 |
| | BC Diode Rev | B1500A,4155B/C,4156B/C | SMU 2 |
| | BVcbo | B1500A,4155B/C,4156B/C | SMU 2 |
| | BVcei | B1500A,4155B/C,4156B/C | SMU 3 |
| | BVceo | B1500A,4155B/C,4156B/C | SMU 2 |
| | BVebo | B1500A,4155B/C,4156B/C | SMU 2 |
| | CS Diode Fwd | B1500A,4155B/C,4156B/C | SMU 2 |
| | CS Diode Rev | B1500A,4155B/C,4156B/C | SMU 2 |
| | Ctc-Freq Log | B1500A | MFCMU 1 |
| | Ctc-Vc | B1500A | MFCMU 1 |
| | Cte-Ve | B1500A | MFCMU 1 |
| | Cts | B1500A | MFCMU 1 |
| | EB Diode Fwd | B1500A,4155B/C,4156B/C | SMU 2 |
| | EB Diode Rev | B1500A,4155B/C,4156B/C | SMU 2 |
| | G-Plot ConstVce Pulse | B1500A,4155B/C,4156B/C | SMU 4 |
| | G-Plot ConstVce Pulse[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | G-Plot ConstVce | B1500A,4155B/C,4156B/C | SMU 4 |
| | G-Plot ConstVce[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | G-Plot Vbc=0V Pulse | B1500A,4155B/C,4156B/C | SMU 4 |
| | G-Plot Vbc=0V Pulse[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | G-Plot Vbc=0V | B1500A,4155B/C,4156B/C | SMU 4 |
| | G-Plot Vbc=0V[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | hfe-Vbe ConstVce | B1500A,4155B/C,4156B/C | SMU 4 |
| | hfe-Vbe Vbc=0V | B1500A,4155B/C,4156B/C | SMU 4 |
| | Ic-Vc Ib | B1500A,4155B/C,4156B/C | SMU 4 |
| | Ic-Vc Ib[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | Ic-Vc Pulse Ib | B1500A,4155B/C,4156B/C | SMU 4 |

| Category | Test definition name | Supported analyzer | Required equipment and quantity |
|----------|----------------------|------------------------|---------------------------------|
| BJT | Ic-Vc Pulse Ib[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | Ic-Vc Pulse Vb | B1500A,4155B/C,4156B/C | SMU 4 |
| | Ic-Vc Pulse Vb[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | Ic-Vc Vb | B1500A,4155B/C,4156B/C | SMU 4 |
| | Ic-Vc Vb[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | Rb | B1500A,4155B/C,4156B/C | SMU 4 |
| | Re+Rc | B1500A,4155B/C,4156B/C | SMU 4 |
| | Re | B1500A,4155B/C,4156B/C | SMU 4 |
| | Simple Gummel Plot | B1500A,4155B/C,4156B/C | SMU 3 |
| | Vbe-Le | B1500A | SMU 4, B2200A/B2201A 1 |
| | Vbe-We | B1500A | SMU 4, B2200A/B2201A 1 |
| CMOS | BVdss | B1500A,4155B/C,4156B/C | SMU 4 |
| | BVgso | B1500A,4155B/C,4156B/C | SMU 3 |
| | Cgb-AC Level | B1500A | MFCMU 1, SMU 1 |
| | Cgb-Freq Log | B1500A | MFCMU 1, SMU 1 |
| | Cgb-Vg HighVoltage | B1500A | MFCMU 1, SMU 3, SCUU 1, GSWU 1 |
| | Cgb-Vg | B1500A | MFCMU 1, SMU 1 |
| | Cgc-Freq Log | B1500A | MFCMU 1, SMU 1 |
| | Cgc-Vg | B1500A | MFCMU 1, SMU 1 |
| | Cgg-Freq Linear | B1500A | MFCMU 1 |
| | Cgg-Freq Log | B1500A | MFCMU 1 |
| | Cgg-Vg 2Freq | B1500A | MFCMU 1 |
| | Cgg-Vg | B1500A | MFCMU 1 |
| | IdRdsGds | B1500A,4155B/C,4156B/C | SMU 4 |
| | Id-Vd pulse | B1500A,4155B/C,4156B/C | SMU 4 |
| | Id-Vd pulse[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | Id-Vd | B1500A,4155B/C,4156B/C | SMU 4 |
| | Id-Vd[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | Id-Vg pulse | B1500A,4155B/C,4156B/C | SMU 4 |
| | Id-Vg Vpulse[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | Id-Vg | B1500A,4155B/C,4156B/C | SMU 4 |

Application Library and Utilities
Application Test Definitions

| Category | Test definition name | Supported analyzer | Required equipment and quantity |
|-------------|----------------------------------|------------------------|--|
| CMOS | Id-Vg[3] | B1500A,4155B/C,4156B/C | SMU 3 |
| | IonIoffSlope | B1500A,4155B/C,4156B/C | SMU 4 |
| | Isub-Vg | B1500A,4155B/C,4156B/C | SMU 4 |
| | QSCV[4] | B1500A | SMU 5 |
| | QSCV C Offset Meas | B1500A | SMU 2 |
| | Simple Cgb | B1500A | MFCMU 1 |
| | Simple Vth | B1500A,4155B/C,4156B/C | SMU 4 |
| | Vth Const Id | B1500A,4155B/C,4156B/C | SMU 4 |
| | Vth gmMax | B1500A,4155B/C,4156B/C | SMU 4 |
| | VthAndCgg-Vg ASU | B1500A | MFCMU 1, SMU 1, HRSMU/ASU 2 |
| | VthAndCgg-Vg SCUU | B1500A | MFCMU 1, SMU 3, SCUU 1, GSWU 1 |
| | Vth-Lg | B1500A | SMU 4, B2200A/B2201A 1 |
| | Vth-Wg | B1500A | SMU 4, B2200A/B2201A 1 |
| Discrete | BJT GummelPlot | B1500A,4155B/C,4156B/C | SMU 3 |
| | BJT Ic-Vc Ib | B1500A,4155B/C,4156B/C | SMU 3 |
| | Diode IV Fwd | B1500A,4155B/C,4156B/C | SMU 2 |
| | Diode IV Rev | B1500A,4155B/C,4156B/C | SMU 2 |
| | FET Id-Vd | B1500A,4155B/C,4156B/C | SMU 3 |
| | FET Id-Vg | B1500A,4155B/C,4156B/C | SMU 3 |
| GenericTest | Generic C-f | B1500A | MFCMU 1 |
| | Generic C-t | B1500A | MFCMU 1 |
| Memory | Flash Ccf-V | B1500A | MFCMU 1 |
| | Flash Cfb-V | B1500A | MFCMU 1 |
| | Flash Cgg-Vcg | B1500A | MFCMU 1 |
| | NandFlash2 Endurance 3devices | B1500A | SMU 3, B2200A/B2201A 1, 81110A (2 outputs) 1 |
| | NandFlash2 Endurance | B1500A | HRSMU/ASU 3, 81110A (2 outputs) 1 |
| | NandFlash2 IV-Erase-IV | B1500A | SMU 1, HRSMU/ASU 2, 81110A (2 outputs) 1 |
| | NandFlash2 IV-Write-IV | B1500A | SMU 2, HRSMU/ASU 1, 81110A (2 outputs) 1 |
| | NandFlash2 Retention(ErasedCell) | B1500A | SMU 1, HRSMU/ASU 2, 81110A (2 outputs) 1 |

| Category | Test definition name | Supported analyzer | Required equipment and quantity |
|----------|---------------------------------------|--------------------|--|
| Memory | NandFlash2 Retention(WrittenCell) | B1500A | SMU 2, HRSMU/ASU 1, 81110A (2 outputs) 1 |
| | NandFlash2 Vth(ErasingTimeDependence) | B1500A | SMU 1, HRSMU/ASU 2, 81110A (2 outputs) 1 |
| | NandFlash2 Vth(WritingTimeDependence) | B1500A | SMU 2, HRSMU/ASU 1, 81110A (2 outputs) 1 |
| | NandFlash2 WordDisturb(ErasedCell) | B1500A | HRSMU/ASU 3, 81110A (2 outputs) 1 |
| | NandFlash2 WordDisturb(WrittenCell) | B1500A | SMU 2, HRSMU/ASU 1, 81110A (2 outputs) 1 |
| | NandFlash3 Endurance | B1500A | [SPGU 1, HRSMU/ASU 3] or [SPGU 1, SMU 3, 16440A/16445A 2] |
| | NandFlash3 IV-Erase-IV | B1500A | [SPGU 1, SMU 1, HRSMU/ASU 2] or [SPGU 1, SMU 3, 16440A/16445A 1] |
| | NandFlash3 IV-Write-IV | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 1] or [SPGU 1, SMU 3, 16440A/16445A 1] |
| | NandFlash3 Retention(ErasedCell) | B1500A | [SPGU 1, SMU 1, HRSMU/ASU 2] or [SPGU 1, SMU 3, 16440A/16445A 1] |
| | NandFlash3 Retention(WrittenCell) | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 1] or [SPGU 1, SMU 3, 16440A/16445A 1] |
| | NandFlash3 Vth(ErasingTimeDependence) | B1500A | [SPGU 1, SMU 1, HRSMU/ASU 2] or [SPGU 1, SMU 3, 16440A/16445A 1] |
| | NandFlash3 Vth(WritingTimeDependence) | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 1] or [SPGU 1, SMU 3, 16440A/16445A 1] |
| | NandFlash3 WordDisturb(ErasedCell) | B1500A | [SPGU 1, HRSMU/ASU 3] or [SPGU 1, SMU 3, 16440A/16445A 2] |
| | NandFlash3 WordDisturb(WrittenCell) | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 1] or [SPGU 1, SMU 3, 16440A/16445A 1] |
| | NorFlash Endurance | B1500A | [SPGU 2, SMU 1, HRSMU/ASU 3] or [SPGU 2, SMU 4, 16440A/16445A 2] |
| | NorFlash IV-Erase-IV | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 2] or [SPGU 1, SMU 4, 16440A/16445A 1] |
| | NorFlash IV-Write-IV | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 2] or [SPGU 1, SMU 4, 16440A/16445A 1] |
| | NorFlash Retention(ErasedCell) | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 2] or [SPGU 1, SMU 4, 16440A/16445A 1] |
| | NorFlash Retention(WrittenCell) | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 2] or [SPGU 1, SMU 4, 16440A/16445A 1] |

Application Library and Utilities
Application Test Definitions

| Category | Test definition name | Supported analyzer | Required equipment and quantity |
|---------------|-------------------------------------|------------------------|--|
| Memory | NorFlash Vth(ErasingTimeDependence) | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 2] or [SPGU 1, SMU 4, 16440A/16445A 1] |
| | NorFlash Vth(WritingTimeDependence) | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 2] or [SPGU 1, SMU 4, 16440A/16445A 1] |
| | NorFlash WordDisturb(ErasedCell) | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 2] or [SPGU 1, SMU 4, 16440A/16445A 1] |
| | NorFlash WordDisturb(WrittenCell) | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 2] or [SPGU 1, SMU 4, 16440A/16445A 1] |
| | NorFlash DataDisturb(ErasedCell) | B1500A | [SPGU 2, SMU 1, HRSMU/ASU 3] or [SPGU 2, SMU 4, 16440A/16445A 2] |
| | NorFlash DataDisturb(WrittenCell) | B1500A | [SPGU 1, SMU 2, HRSMU/ASU 2] or [SPGU 1, SMU 4, 16440A/16445A 1] |
| MixedSignal | BJT Varactor CV Mismatch | B1500A | MFCMU 1 |
| | Diff-R Mismatch | B1500A | SMU 8 |
| | Diode IV Fwd Mismatch | B1500A | SMU 3 |
| | Diode IV Rev Mismatch | B1500A | SMU 3 |
| | G-Plot ConstVce Mismatch | B1500A | SMU 6 |
| | G-Plot ConstVce Mismatch[3] | B1500A | SMU 5 |
| | G-Plot Vbc=0V Mismatch | B1500A | SMU 6 |
| | G-Plot Vbc=0V Mismatch[3] | B1500A | SMU 5 |
| | Ic-Vc Ib Mismatch | B1500A | SMU 6 |
| | Ic-Vc Ib Mismatch[3] | B1500A | SMU 5 |
| | Ic-Vc Vb Mismatch | B1500A | SMU 6 |
| | Ic-Vc Vb Mismatch[3] | B1500A | SMU 5 |
| | Id-Vd Mismatch | B1500A | SMU 5 |
| | Id-Vd Mismatch[3] | B1500A | SMU 4 |
| | Id-Vg Mismatch | B1500A | SMU 5 |
| | Id-Vd Mismatch[3] | B1500A | SMU 4 |
| | MIM CV Mismatch | B1500A | MFCMU 1 |
| | MOS Varactor CV Mismatch | B1500A | MFCMU 1 |
| | Poly-R Mismatch | B1500A | SMU 7 |
| | NanoTech | CNT Differential R[AC] | B1500A |
| CNT Gate Leak | | B1500A,4155B/C,4156B/C | SMU 2 |
| CNT Id-Time | | B1500A,4156B/C | SMU 4 |

| Category | Test definition name | Supported analyzer | Required equipment and quantity |
|-------------|------------------------------|------------------------|---------------------------------|
| NanoTech | CNT Id-Vd | B1500A,4155B/C,4156B/C | SMU 4 |
| | CNT Id-Vg | B1500A,4155B/C,4156B/C | SMU 4 |
| | CNT Id-Vg-Time | B1500A,4156B/C | SMU 4 |
| | CNT IV Sweep | B1500A,4155B/C,4156B/C | SMU 2 |
| | CNT R-I Kelvin 2SMU | B1500A,4155B/C,4156B/C | SMU 2 |
| | CNT R-V Kelvin 2SMU | B1500A,4155B/C,4156B/C | SMU 2 |
| | CNT Vth gmMax | B1500A,4155B/C,4156B/C | SMU 4 |
| PwrDevice | BVdss[3] PwrDevice | B1500A | SMU 3 |
| | BVgso[3] PwrDevice | B1500A | SMU 2 |
| | Id-Vd pulse[3] PwrDevice | B1500A | SMU 3 |
| | Id-Vd[3] PwrDevice | B1500A | SMU 3 |
| | Id-Vg pulse[3] PwrDevice | B1500A | SMU 3 |
| | Id-Vg[3] PwrDevice | B1500A | SMU 3 |
| | Vth Const Id[3] PwrDevice | B1500A | SMU 3 |
| | Vth gmMax[3] PwrDevice | B1500A | SMU 3 |
| Reliability | BJT EB RevStress 3devices | B1500A | SMU 6, B2200A/B2201A 1 |
| | BJT EB RevStress 3devices[3] | B1500A | SMU 5, B2200A/B2201A 1 |
| | BJT EB RevStress | B1500A | SMU 4 |
| | BJT EB RevStress2 | B1500A | SMU 4 |
| | BJT EB RevStress[3] | B1500A | SMU 3 |
| | BJT EB RevStress2[3] | B1500A | SMU 3 |
| | BTI 3devices | B1500A | SMU 5, B2200A/B2201A 1 |
| | BTI 3devices[3] | B1500A | SMU 5, B2200A/B2201A 1 |
| | BTI | B1500A | SMU 4 |
| | BTI2 | B1500A | SMU 4 |
| | BTI[3] | B1500A | SMU 3 |
| | BTI2[3] | B1500A | SMU 3 |
| | Charge Pumping | B1500A | SMU 2, 81110A (2 outputs) 1 |
| | Charge Pumping2 | B1500A | SMU 2, SPGU 1 |
| | EM Istress | B1500A | SMU 4 |
| | EM Istress2 | B1500A | SMU 4 |

Application Library and Utilities
Application Test Definitions

| Category | Test definition name | Supported analyzer | Required equipment and quantity |
|-------------|------------------------|------------------------|---------------------------------|
| Reliability | EM Istress[2] | B1500A | SMU 2 |
| | EM Istress2[2] | B1500A | SMU 2 |
| | EM Istress[6] | B1500A | SMU 6 |
| | EM Istress2[6] | B1500A | SMU 6 |
| | EM Vstress | B1500A | SMU 4 |
| | EM Vstress2 | B1500A | SMU 4 |
| | EM Vstress[2] | B1500A | SMU 2 |
| | EM Vstress2[2] | B1500A | SMU 2 |
| | EM Vstress[6] | B1500A | SMU 6 |
| | EM Vstress2[6] | B1500A | SMU 6 |
| | HCI 3devices | B1500A | SMU 8 |
| | HCI | B1500A | SMU 4 |
| | HCI2 | B1500A | SMU 4 |
| | J-Ramp | B1500A | SMU 2 |
| | TDDB Istress 3devices | B1500A | SMU 4 |
| | TDDB Istress2 3devices | B1500A | SMU 4 |
| | TDDB Istress | B1500A | SMU 2 |
| | TDDB Istress2 | B1500A | SMU 2 |
| | TDDB Vstress 3devices | B1500A | SMU 4 |
| | TDDB Vstress2 3devices | B1500A | SMU 4 |
| | TDDB Vstress | B1500A | SMU 2 |
| | TDDB Vstress2 | B1500A | SMU 2 |
| | Timing On-the-fly NBTI | B1500A | SMU 4 |
| | TZDB | B1500A | SMU 2 |
| V-Ramp | B1500A | SMU 2 | |
| Structure | BVgb ThinOx | B1500A,4155B/C,4156B/C | SMU 2 |
| | BVgb | B1500A,4155B/C,4156B/C | SMU 2 |
| | Cgb-Freq[2] Log | B1500A | MFCMU 1 |
| | Cgb-Vg 2Freq | B1500A | MFCMU 1 |
| | Cgb-Vg[2] | B1500A | MFCMU 1 |
| | Cj-Freq Log | B1500A | MFCMU 1 |
| | Cj-V | B1500A | MFCMU 1 |

| Category | Test definition name | Supported analyzer | Required equipment and quantity |
|-----------|--------------------------|------------------------|---------------------------------|
| Structure | Diode BVAndCj-V ASU | B1500A | MFCMU 1, HRSMU/ASU 2 |
| | Diode BVAndCj-V SCUU | B1500A | MFCMU 1, SMU 2, SCUU 1, GSWU 1 |
| | Ig-Vg Iforce | B1500A,4155B/C,4156B/C | SMU 2 |
| | Ig-Vg Vforce | B1500A,4155B/C,4156B/C | SMU 2 |
| | Interconnect CouplingCap | B1500A | MFCMU 1 |
| | Interconnect OverlapCap | B1500A | MFCMU 1 |
| | Junction BV | B1500A,4155B/C,4156B/C | SMU 2 |
| | Junction DcParam | B1500A,4155B/C,4156B/C | SMU 2 |
| | Junction IV Fwd | B1500A,4155B/C,4156B/C | SMU 2 |
| | Junction IV Rev | B1500A,4155B/C,4156B/C | SMU 2 |
| | QSCV[2] | B1500A | SMU 3 |
| | QSCV C Offset Meas | B1500A | SMU 2 |
| | Rdiff-I kelvin | B1500A | SMU 5 |
| | Rdiff-I | B1500A,4155B/C,4156B/C | SMU 3 |
| | Rdiff-V kelvin | B1500A | SMU 5 |
| | Rdiff-V | B1500A,4155B/C,4156B/C | SMU 3 |
| | R-I DVM | B1500A | SMU 2, 3458A 1 |
| | R-I kelvin | B1500A,4155B/C,4156B/C | SMU 4 |
| | R-I | B1500A,4155B/C,4156B/C | SMU 2 |
| | R-V DVM | B1500A | SMU 2, 3458A 1 |
| | R-V kelvin | B1500A,4155B/C,4156B/C | SMU 4 |
| | R-V | B1500A,4155B/C,4156B/C | SMU 2 |
| | VanDerPauw Square | B1500A,4155B/C,4156B/C | SMU 4 |
| TFT | TFT Id-Vd | B1500A,4155B/C,4156B/C | SMU 3 |
| | TFT Id-Vg | B1500A,4155B/C,4156B/C | SMU 3 |
| Utility | ForcePG1 | B1500A,4155B/C,4156B/C | 81110A (2 outputs) 1 |
| | ForcePG2 | B1500A,4155B/C,4156B/C | 81110A (2 outputs) 1 |
| | ForcePG2P | B1500A,4155B/C,4156B/C | 81110A (2 outputs) 1 |
| | ForcePG12 | B1500A,4155B/C,4156B/C | 81110A (2 outputs) 1 |
| | ForcePG | B1500A,4155B/C,4156B/C | 81110A (2 outputs) 1 |
| | ForcePGC | B1500A,4155B/C,4156B/C | 81110A (2 outputs) 1 |

Application Library and Utilities
Application Test Definitions

| Category | Test definition name | Supported analyzer | Required equipment and quantity |
|--|---|------------------------|---------------------------------|
| Utility | Measure Diff-V | B1500A,4155B/C,4156B/C | 3458A 1 |
| | QSCV C Offset Meas | B1500A | SMU 2 |
| | ResetPG | B1500A,4155B/C,4156B/C | 81110A (2 outputs) 1 |
| | Subsite move | B1500A,4155B/C,4156B/C | Wafer prober 1 |
| | CVSweep4284_a | B1500A,4155B/C,4156B/C | 4284A 1 or E4980A 1 |
| WGFMU (needs test definitions of WGFMU Utility) | Fast BTI(ACstress Id-Sampling) | B1500A | WGFMU 1, RSU 2 |
| | Fast BTI(DCstress Id-Sampling) | B1500A | WGFMU 1, RSU 2 |
| | Fast BTI(ACstress Id-Vg) | B1500A | WGFMU 1, RSU 2 |
| | Fast BTI(DCstress Id-Vg) | B1500A | WGFMU 1, RSU 2 |
| | TRANSIV DC IdVd | B1500A | SMU 2, WGFMU 1, RSU 2 |
| | TRANSIV DC IdVg | B1500A | SMU 2, WGFMU 1, RSU 2 |
| | WGFMU Pattern Editor | B1500A | WGFMU 1, RSU 2 |
| WGFMU Utility (cannot be executed directly) | Fast BTI Id-Sampling child | B1500A | WGFMU 1, RSU 2 |
| | Fast BTI Id-Sampling child2 | B1500A | WGFMU 1, RSU 2 |
| | Fast BTI Id-Vg child | B1500A | WGFMU 1, RSU 2 |
| | Fast BTI Id-Vg child2 | B1500A | WGFMU 1, RSU 2 |
| | Fast BTI Pattern Editor Child DataDisplay | B1500A | WGFMU 1, RSU 2 |

NOTE

If you delete a test definition

Application library should be recovered. Import the test definition by using the Import Test Definition... function of the Library button. The original test definitions are stored in the following folder.

C:\Program Files\Agilent\B1500\EasyEXPERT\Application Tests

QSCV Measurement Supplemental Data

This section provides the following supplemental data of the QSCV measurement. You can perform the QSCV measurement by using the QSCV[2] application test.

- “Maximum Measurement Value”
- “Considering Measurement Accuracy”

NOTE

To obtain stable QSCV measurement results, use two source monitor units (SMU). Assign the current meter and the voltage sweep source to the individual SMU.

Maximum Measurement Value

NOTE

The maximum measurement value is not the specifications but the reference data.

Even if the capacitance is within this range, measurement may not be completed due to influences on the measurement path such as extension cables, etc. The maximum measurement value will be smaller depending on the leakage current.

The maximum measurement value depends on the settings of the current measurement range, the QSCV measurement voltage, and the integration time. See Figure 10-1 to Figure 10-5. Each figure shows the characteristics of the capacitance value vs. the QSCV measurement voltage by the integration time setting. Each line in the graph specifies the maximum measurement value for each integration time setting.

The graph data is applied to the measurement when the QSCV integration time is set to the same value as the LEAK integration time.

Figure 10-1

Maximum Measurement Value Using 10 pA and 100 pA Range: HRSMU/ASU

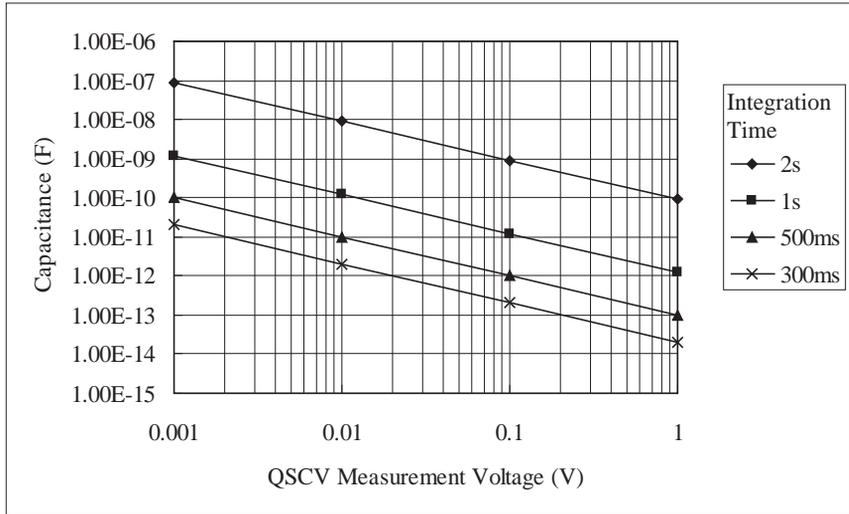


Figure 10-2

Maximum Measurement Value Using 1 nA Range: HPSMU/MPSMU/HRSMU/ASU

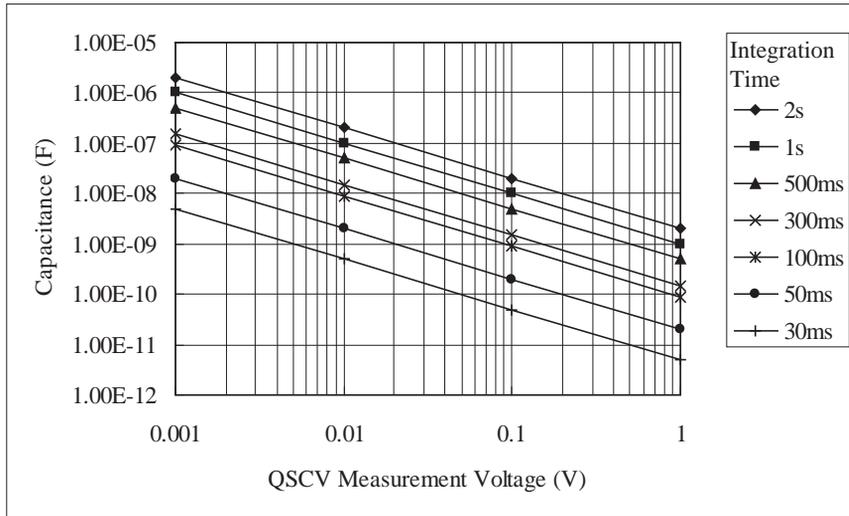


Figure 10-3

Maximum Measurement Value Using 10 nA Range:
 HPSMU/MPSMU/HRSMU/ASU

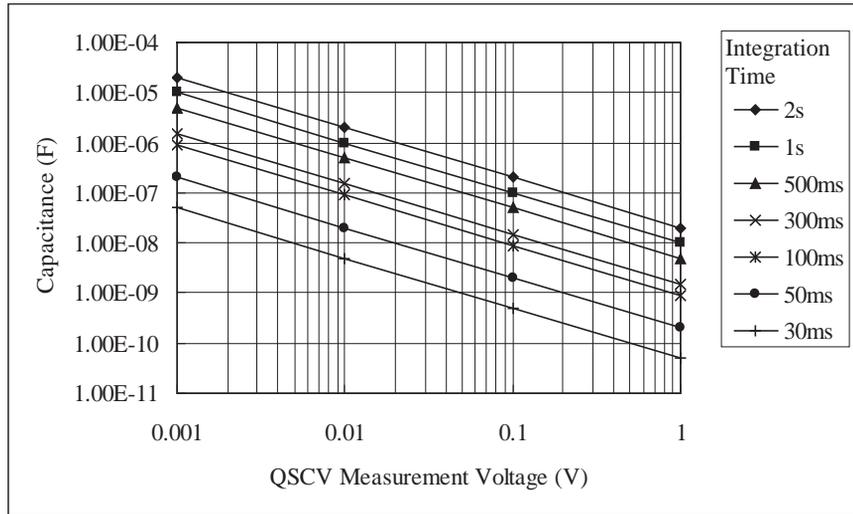


Figure 10-4

Maximum Measurement Value Using 100 nA Range:
 HPSMU/MPSMU/HRSMU/ASU

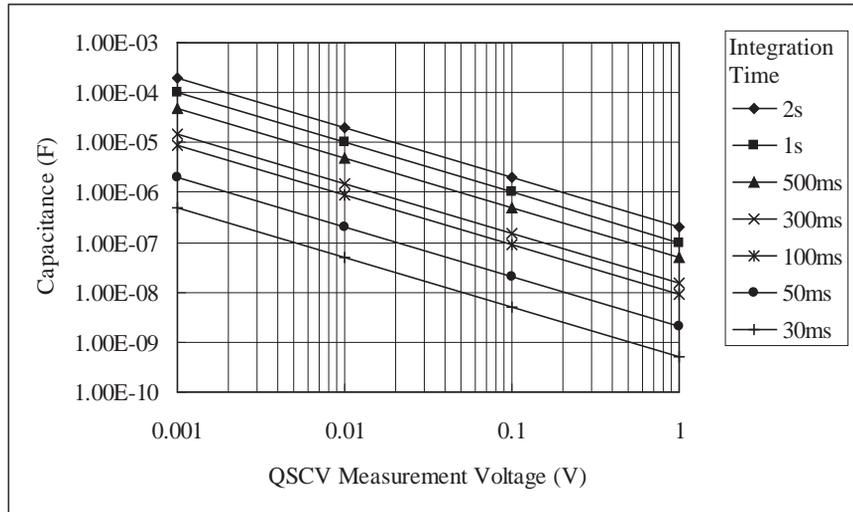
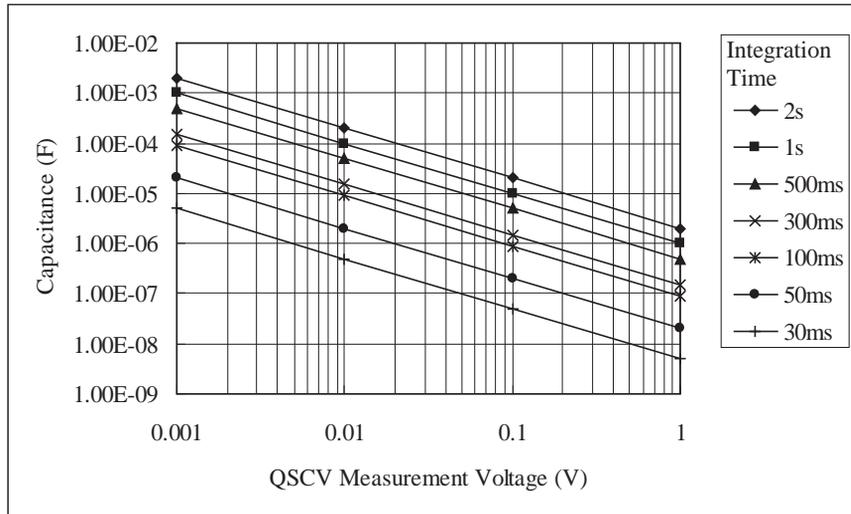


Figure 10-5

Maximum Measurement Value Using 1 μ A Range:
HPSMU/MPSMU/HRSMU/ASU



Considering Measurement Accuracy

NOTE

The measurement accuracy is not the specifications but the reference data. Applicable conditions for supplemental data: Leak current compensation function ON, Offset cancel function ON, QSO mode OFF

The capacitance measurement accuracy can be calculated by the following formula:

Measurement accuracy = A (%) + B (F)

A : Reading accuracy. % accuracy of the measured value.

B : Offset accuracy.

$$A = A_p + \frac{B_p + C_p \times T_{integ} + D_p \times \frac{T_{integ}}{T_{leak}}}{V_{step}}$$

$$B = \frac{A_o}{R_{dut}} + \frac{B_o + B_{oc} \times C_g + (C_o + C_{oc} \times C_g) \times T_{integ} + (D_o + D_{oc} \times C_g) \times \frac{T_{integ}}{T_{leak}}}{V_{step}}$$

where,

T_{integ} : Integration time for the capacitance measurement, in seconds

T_{leak} : Integration time for the leakage current measurement, in seconds

V_{step} : QSCV measurement voltage, in V

R_{dut} : Equivalent parallel resistance of DUT, in Ω

C_g : Guard capacitance of the measurement path, in F

A_x , B_x , C_x , and D_x values are the constant. For the values, see Table 10-2 for the high resolution SMU (HRSMU), and Table 10-3 for the medium power/high power SMU (MPSMU and HPSMU).

Calculation examples of the measurement accuracy are shown in Figure 10-6 through Figure 10-30. Conditions of the calculation are shown in Table 10-5.

NOTE

Settings for the QSCV Measurement Mode

The measurement mode should be selected based on the measurement conditions. Normal mode is effective for large leakage currents. The 4155C/4156C compatible mode is effective if the leakage current is low, or the QSCV measurement voltage is low.

Table 10-2 Constant Value for Calculating the Measurement Accuracy: HRSMU/ASU

| Measurement Range | Constant | Voltage Output Range | | | | | | QSCV Operating Mode |
|-------------------|----------|----------------------|-------|-------|-------|-------|-------|------------------------|
| | | 0.5 V | 2 V | 5 V | 20 V | 40 V | 100 V | |
| 10 pA | Ap | 0.47 | 0.47 | 0.47 | 0.47 | 0.48 | 0.48 | |
| | Bp | 0.014 | 0.029 | 0.051 | 0.15 | 0.30 | 0.72 | Normal |
| | | 0.009 | 0.011 | 0.015 | 0.03 | 0.06 | 0.13 | 4155C/4156C compatible |
| | Cp | 0.013 | | | | | | |
| | Dp | 0.001 | | | | | | |
| | Ao | 0.04 | | | | | | Normal |
| | | 0.07 | | | | | | 4155C/4156C compatible |
| | Bo | 1.3E-16 | | | | | | |
| | Boc | 1.1E-05 | | | | | | |
| | Co | 5.4E-15 | | | | | | |
| | Coc | 2.4E-05 | | | | | | |
| | Do | 1.3E-16 | | | | | | |
| | Doc | 1.1E-05 | | | | | | |
| 100 pA | Ap | 0.31 | 0.31 | 0.31 | 0.31 | 0.32 | 0.32 | |
| | Bp | 0.014 | 0.029 | 0.051 | 0.153 | 0.298 | 0.720 | Normal |
| | | 0.009 | 0.011 | 0.015 | 0.033 | 0.056 | 0.131 | 4155C/4156C compatible |
| | Cp | 0.009 | | | | | | |
| | Dp | 0.002 | | | | | | |
| | Ao | 0.03 | | | | | | Normal |
| | | 0.071 | | | | | | 4155C/4156C compatible |
| | Bo | 4.7E-16 | | | | | | |
| | Boc | 3.5E-05 | | | | | | |
| | Co | 1.3E-14 | | | | | | |
| | Coc | 9.8E-05 | | | | | | |
| | Do | 4.7E-16 | | | | | | |
| | Doc | 3.5E-05 | | | | | | |

**Table 10-3 Constant Value for Calculating the Measurement Accuracy:
 MPSMU/HRSMU/ASU**

| Measurement Range | Constant | Voltage Output Range | | | | | | QSCV Operating Mode |
|-------------------|----------|----------------------|-------|-------|-------|-------|-------|------------------------|
| | | 0.5 V | 2 V | 20 V | 40 V | 100 V | 200 V | |
| 1 nA | Ap | 0.11 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 | |
| | Bp | 0.014 | 0.029 | 0.051 | 0.153 | 0.298 | 0.720 | Normal |
| | | 0.009 | 0.011 | 0.015 | 0.033 | 0.056 | 0.131 | 4155C/4156C compatible |
| | Cp | 0.026 | | | | | | |
| | Dp | 0.014 | | | | | | |
| | Ao | 0.03 | | | | | | Normal |
| | | 0.04 | | | | | | 4155C/4156C compatible |
| | Bo | 1.7E-15 | | | | | | |
| | Boc | 1.3E-04 | | | | | | |
| | Co | 5.9E-14 | | | | | | |
| | Coc | 4.5E-04 | | | | | | |
| | Do | 1.7E-15 | | | | | | |
| | Doc | 1.3E-04 | | | | | | |
| 10 nA | Ap | 0.11 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 | |
| | Bp | 0.014 | 0.029 | 0.051 | 0.153 | 0.298 | 0.720 | Normal |
| | | 0.009 | 0.011 | 0.015 | 0.033 | 0.056 | 0.131 | 4155C/4156C compatible |
| | Cp | 0.031 | | | | | | |
| | Dp | 0.015 | | | | | | |
| | Ao | 0.03 | | | | | | Normal |
| | | 0.04 | | | | | | 4155C/4156C compatible |
| | Bo | 1.7E-15 | | | | | | |
| | Boc | 7.3E-05 | | | | | | |
| | Co | 3.9E-14 | | | | | | |
| | Coc | 1.9E-04 | | | | | | |
| | Do | 1.7E-15 | | | | | | |
| | Doc | 7.3E-05 | | | | | | |

Application Library and Utilities
 QSCV Measurement Supplemental Data

| Measurement Range | Constant | Voltage Output Range | | | | | | QSCV Operating Mode |
|-------------------|-----------|----------------------|-------|-------|-------|-------|-------|------------------------|
| | | 0.5 V | 2 V | 20 V | 40 V | 100 V | 200 V | |
| 100 nA | Ap | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | |
| | Bp | 0.014 | 0.029 | 0.051 | 0.153 | 0.298 | 0.720 | Normal |
| | | 0.009 | 0.011 | 0.015 | 0.033 | 0.056 | 0.131 | 4155C/4156C compatible |
| | Cp | 0.209 | | | | | | |
| | Dp | 0.023 | | | | | | |
| | Ao | 0.03 | | | | | | Normal |
| | | 0.04 | | | | | | 4155C/4156C compatible |
| | Bo | 2.4E-15 | | | | | | |
| | Boc | 2.0E-04 | | | | | | |
| | Co | 8.7E-12 | | | | | | |
| | Coc | 4.6.0E-04 | | | | | | |
| | Do | 2.4E-15 | | | | | | |
| | Doc | 2.0E-04 | | | | | | |
| | 1 μ A | Ap | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 |
| Bp | | 0.014 | 0.029 | 0.051 | 0.153 | 0.298 | 0.720 | Normal |
| | | 0.009 | 0.011 | 0.015 | 0.033 | 0.056 | 0.131 | 4155C/4156C compatible |
| Cp | | 0.125 | | | | | | |
| Dp | | 0.021 | | | | | | |
| Ao | | 0.03 | | | | | | Normal |
| | | 0.04 | | | | | | 4155C/4156C compatible |
| Bo | | 1.1E-14 | | | | | | |
| Boc | | 4.0E-05 | | | | | | |
| Co | | 3.1E-12 | | | | | | |
| Coc | | 3.5.0E-04 | | | | | | |
| Do | | 1.1E-14 | | | | | | |
| Doc | | 4.0E-05 | | | | | | |

Table 10-4 Constant Value for Calculating the Measurement Accuracy: HPSMU

| Measurement Range | Constant | Voltage Output Range | | | | | QSCV Operating Mode |
|-------------------|----------|----------------------|-------|-------|-------|--------|------------------------|
| | | 2 V | 20 V | 40 V | 100 V | 200 V | |
| 1 nA | Ap | 0.11 | 0.11 | 0.12 | 0.12 | 0.14 | |
| | Bp | 0.033 | 0.149 | 0.293 | 0.717 | 1.459 | Normal |
| | | 0.0100 | 0.03 | 0.05 | 0.12 | 0.2347 | 4155C/4156C compatible |
| | Cp | 0.026 | | | | | |
| | Dp | 0.014 | | | | | |
| | Ao | 0.03 | | | | | Normal |
| | | 0.04 | | | | | 4155C/4156C compatible |
| | Bo | 1.7E-15 | | | | | |
| | Boc | 1.3.0E-04 | | | | | |
| | Co | 5.9E-14 | | | | | |
| | Coc | 4.5.0E-04 | | | | | |
| | Do | 1.7E-15 | | | | | |
| | Doc | 1.3.0E-04 | | | | | |
| | 10 nA | Ap | 0.11 | 0.11 | 0.12 | 0.12 | 0.14 |
| Bp | | 0.033 | 0.149 | 0.293 | 0.717 | 1.459 | Normal |
| | | 0.0100 | 0.03 | 0.05 | 0.12 | 0.2347 | 4155C/4156C compatible |
| Cp | | 0.031 | | | | | |
| Dp | | 0.015 | | | | | |
| Ao | | 0.03 | | | | | Normal |
| | | 0.04 | | | | | 4155C/4156C compatible |
| Bo | | 1.7E-15 | | | | | |
| Boc | | 7.3E-05 | | | | | |
| Co | | 3.9E-14 | | | | | |
| Coc | | 1.9.0E-04 | | | | | |
| Do | | 1.7E-15 | | | | | |
| Doc | | 7.3E-05 | | | | | |

Application Library and Utilities
 QSCV Measurement Supplemental Data

| Measurement Range | Constant | Voltage Output Range | | | | | QSCV Operating Mode |
|-------------------|----------|----------------------|-------|-------|-------|--------|------------------------|
| | | 2 V | 20 V | 40 V | 100 V | 200 V | |
| 100 nA | Ap | 0.06 | 0.06 | 0.07 | 0.07 | 0.09 | |
| | Bp | 0.033 | 0.149 | 0.293 | 0.717 | 1.459 | Normal |
| | | 0.0100 | 0.03 | 0.05 | 0.12 | 0.2347 | 4155C/4156C compatible |
| | Cp | 0.209 | | | | | |
| | Dp | 0.023 | | | | | |
| | Ao | 0.01 | | | | | Normal |
| | | 0.04 | | | | | 4155C/4156C compatible |
| | Bo | 2.4E-15 | | | | | |
| | Boc | 2.0E-04 | | | | | |
| | Co | 8.7E-12 | | | | | |
| | Coc | 4.6.0E-04 | | | | | |
| | Do | 2.4E-15 | | | | | |
| | Doc | 2.0E-04 | | | | | |
| 1 μ A | Ap | 0.06 | 0.06 | 0.07 | 0.07 | 0.09 | |
| | Bp | 0.033 | 0.149 | 0.293 | 0.717 | 1.459 | Normal |
| | | 0.0100 | 0.03 | 0.05 | 0.12 | 0.2347 | 4155C/4156C compatible |
| | Cp | 0.125 | | | | | |
| | Dp | 0.021 | | | | | |
| | Ao | 0.01 | | | | | Normal |
| | | 0.04 | | | | | 4155C/4156C compatible |
| | Bo | 1.1E-14 | | | | | |
| | Boc | 4.0E-05 | | | | | |
| | Co | 3.1E-12 | | | | | |
| | Coc | 3.5.0E-04 | | | | | |
| | Do | 1.1E-14 | | | | | |
| | Doc | 4.0E-05 | | | | | |

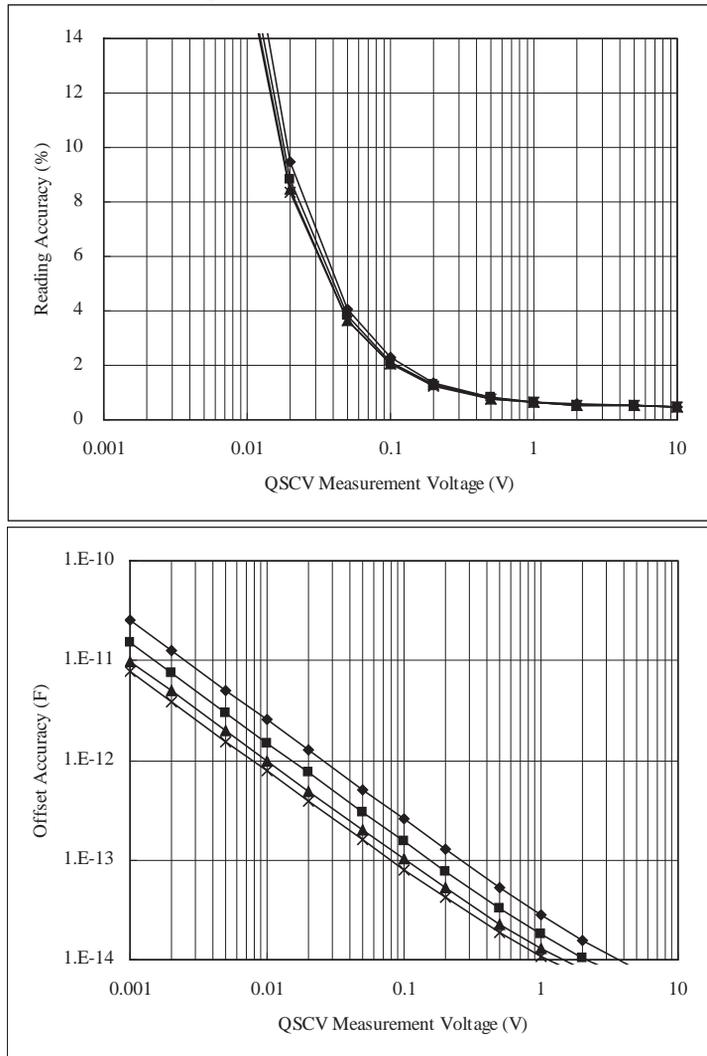
Table 10-5 Conditions for Calculating Measurement Accuracy

| Conditions | | | | | Measurement unit: HRSMU/ASU |
|-------------------|------------------------|--------------|---------------------------------------|---------------------------------------|--------------------------------|
| Measurement range | QSCV operating mode | Output range | Equivalent parallel resistance of DUT | Guard capacitance of measurement path | |
| 10 pA | Normal | 20 V | 10 T ohm | 200 pF | Figure 10-6 |
| 100 pA | Normal | 20 V | 10 T ohm | 200 pF | Figure 10-7 |
| | Normal | 20 V | 10 T ohm | 1 nF | Figure 10-8 |
| | Normal | 20 V | 100 G ohm | 200 pF | Figure 10-9 |
| 1 nA | Normal | 20 V | 10 T ohm | 200 pF | Figure 10-10 |
| | Normal | 20 V | 10 T ohm | 1 nF | Figure 10-11 |
| | Normal | 20 V | 10 G ohm | 200 pF | Figure 10-12 |
| | Normal | 20 V | 1 G ohm | 200 pF | Figure 10-13 |
| 10 nA | Normal | 20 V | 10 T ohm | 200 pF | Figure 10-14 |
| | Normal | 20 V | 10 G ohm | 200 pF | Figure 10-15 |
| | Normal | 20 V | 1 G ohm | 200 pF | Figure 10-16 |
| 100 nA | Normal | 20 V | 10 T ohm | 200 pF | Figure 10-17 |
| | Normal | 20 V | 1 G ohm | 200 pF | Figure 10-18 |
| | Normal | 20 V | 100 M ohm | 200 pF | Figure 10-19 |
| | Normal | 20 V | 10 M ohm | 200 pF | Figure 10-20 |
| 1 μA | Normal | 20 V | 10 T ohm | 200 pF | Figure 10-21 |
| | Normal | 20 V | 1 G ohm | 200 pF | Figure 10-22 |
| | Normal | 20 V | 100 M ohm | 200 pF | Figure 10-23 |
| | Normal | 20 V | 10 M ohm | 200 pF | Figure 10-24 |
| 10 pA | 4155C/4156C compatible | 20 V | 10 T ohm | 200 pF | Figure 10-25 |
| 100 pA | | 20 V | 10 T ohm | 200 pF | Figure 10-26 |
| 1 nA | | 20 V | 10 T ohm | 200 pF | Figure 10-27 |
| 10 nA | | 20 V | 10 T ohm | 200 pF | Figure 10-28 |
| 100 nA | | 20 V | 10 T ohm | 200 pF | Figure 10-29 |
| 1 μA | | 20 V | 10 T ohm | 200 pF | Figure 10-30 |

Calculation example data shown in Figure 10-6 through Figure 10-30 is applied to the measurement data when the QSCV integration time is set to the same value as the LEAK integration time.

Figure 10-6

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 10 pA

Output Range: 20 V

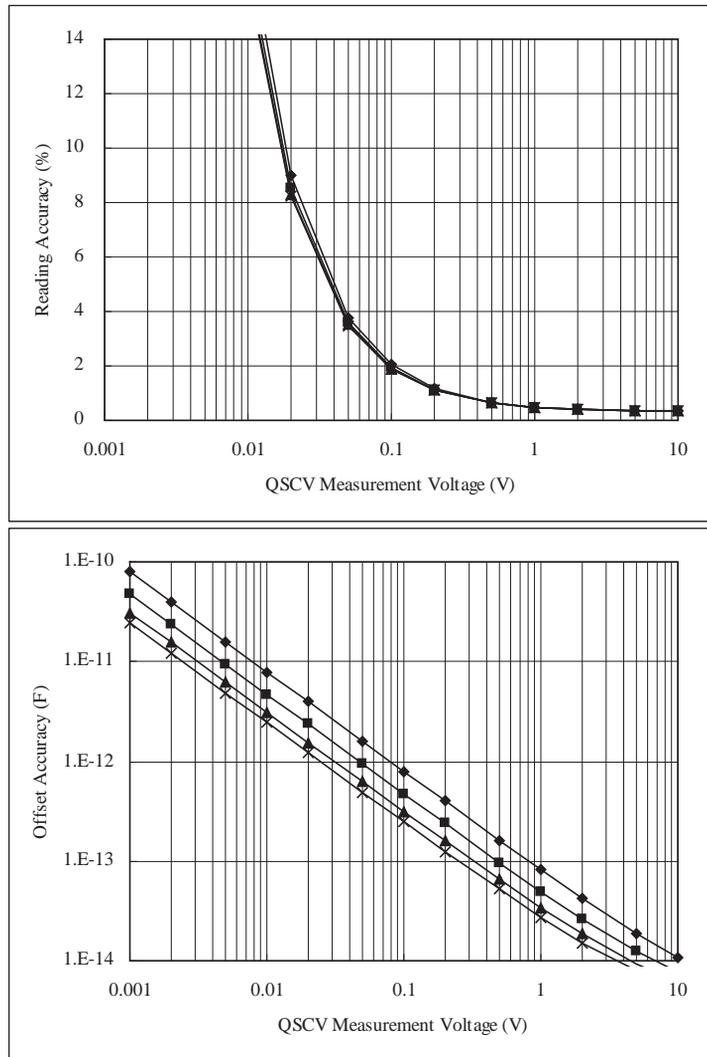
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-7

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 100 pA

Output Range: 20 V

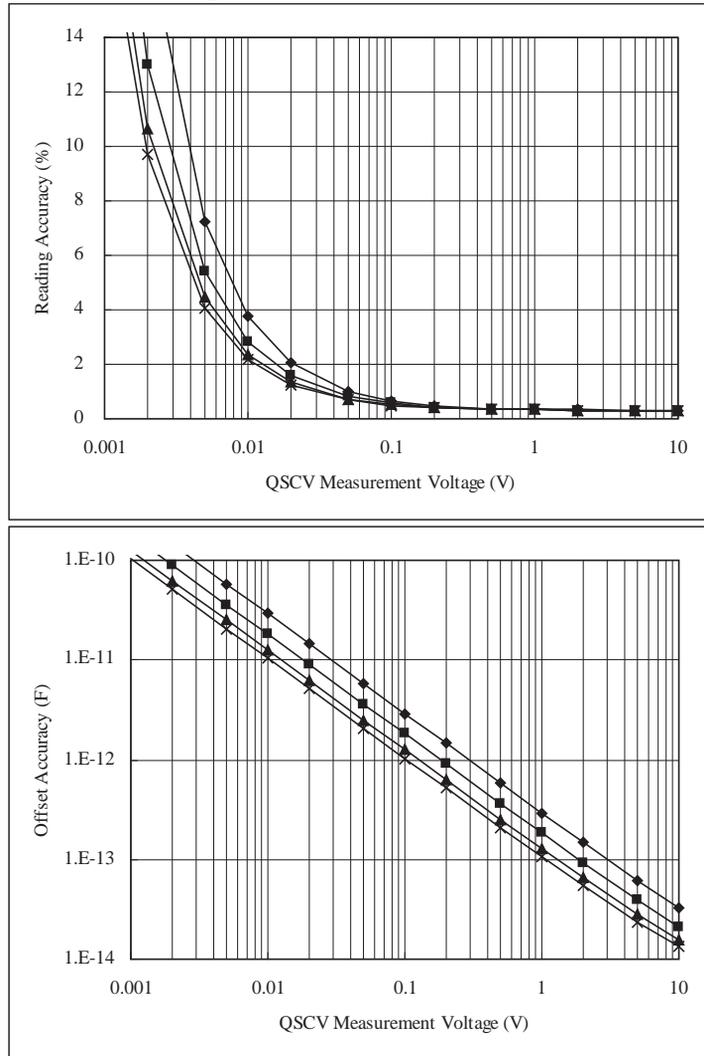
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-8

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 100 pA

Output Range: 20 V

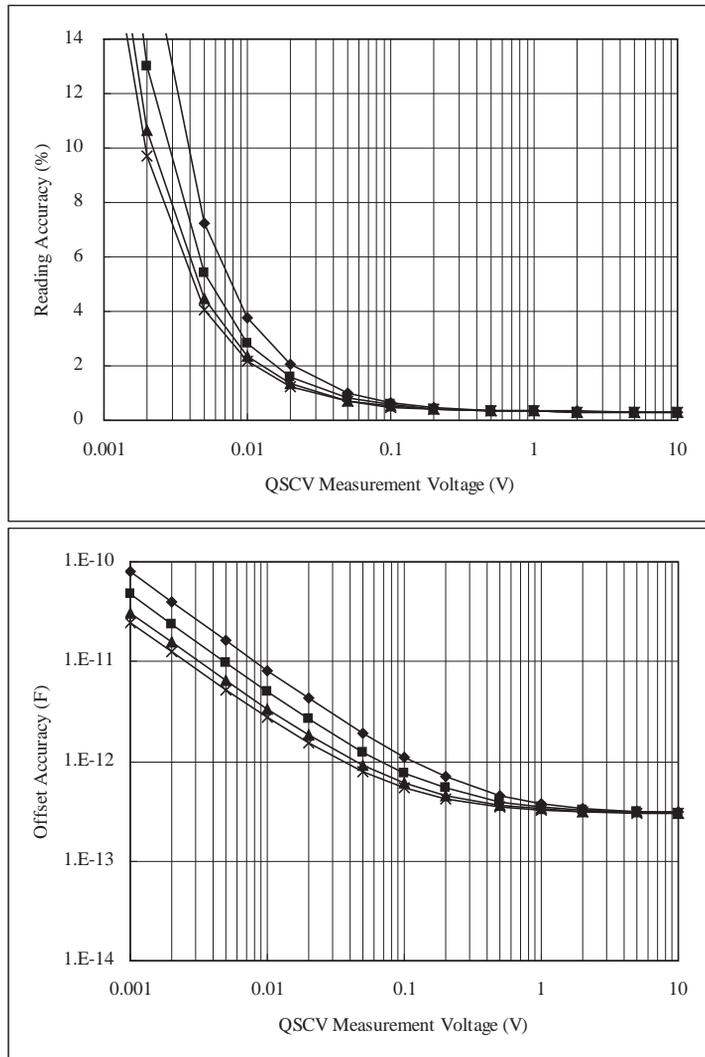
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 1 nF

Figure 10-9

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 100 pA

Output Range: 20 V

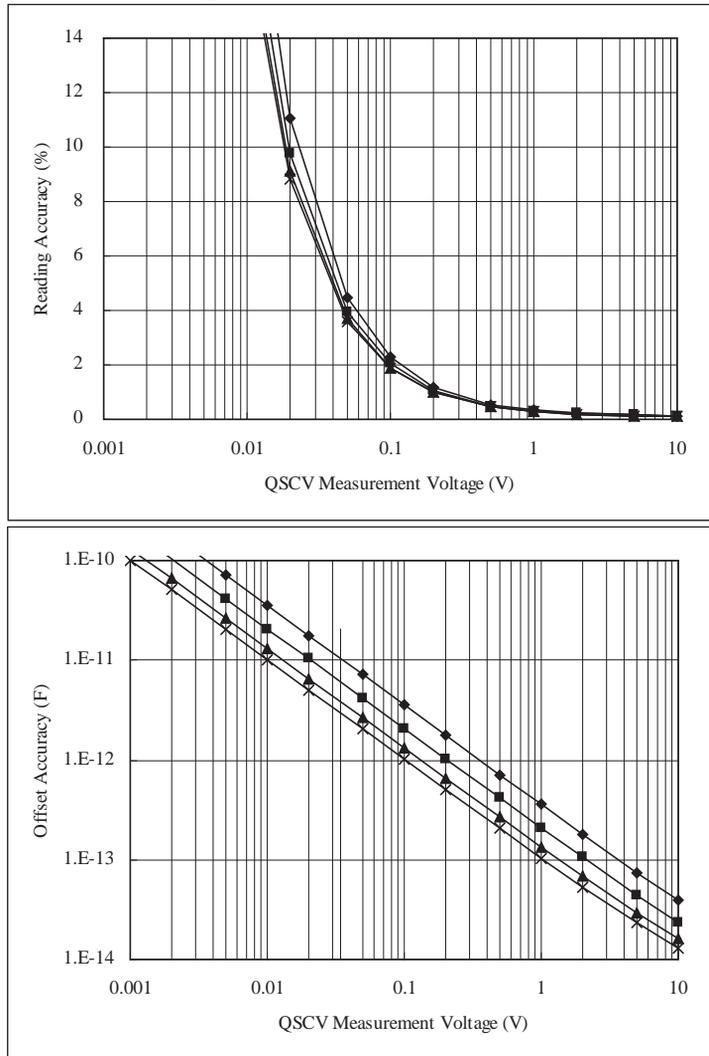
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 100 G ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-10

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 1 nA

Output Range: 20 V

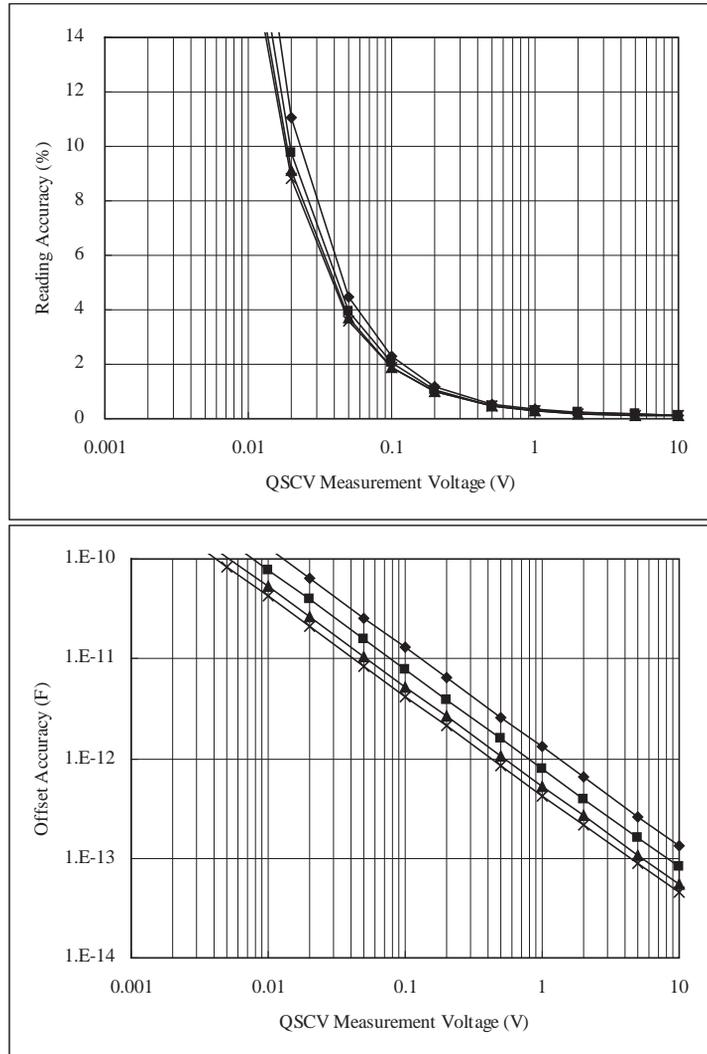
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-11

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 1 nA

Output Range: 20 V

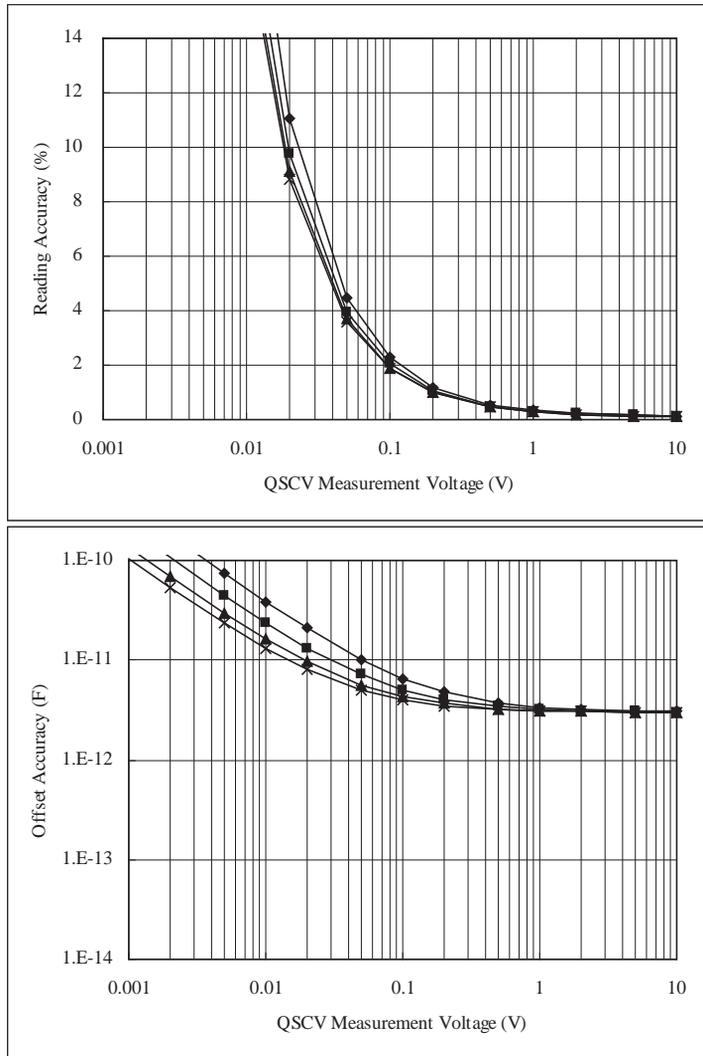
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 1 nF

Figure 10-12

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 1 nA

Output Range: 20 V

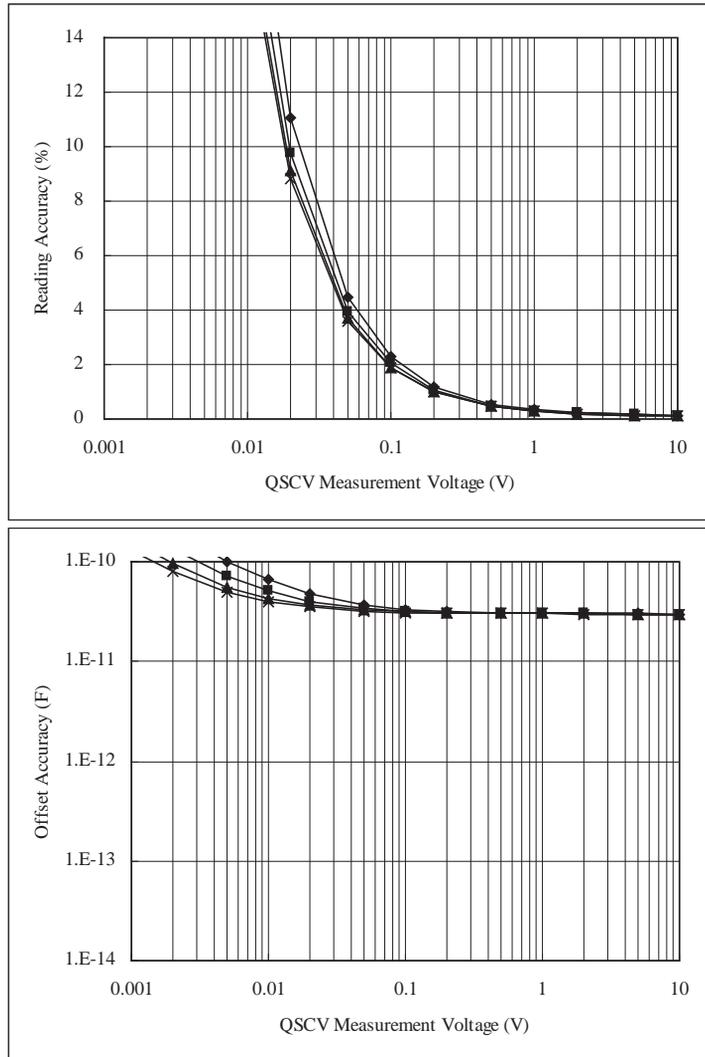
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 G ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-13

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 1 nA

Output Range: 20 V

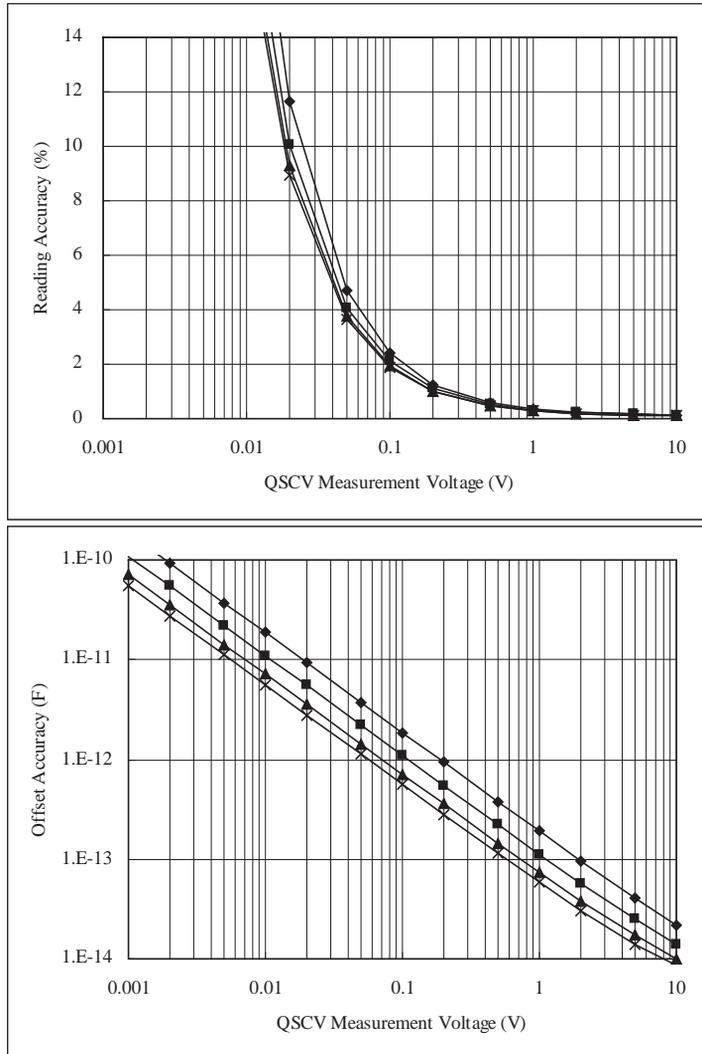
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 1 G ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-14

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 10 nA

Output Range: 20 V

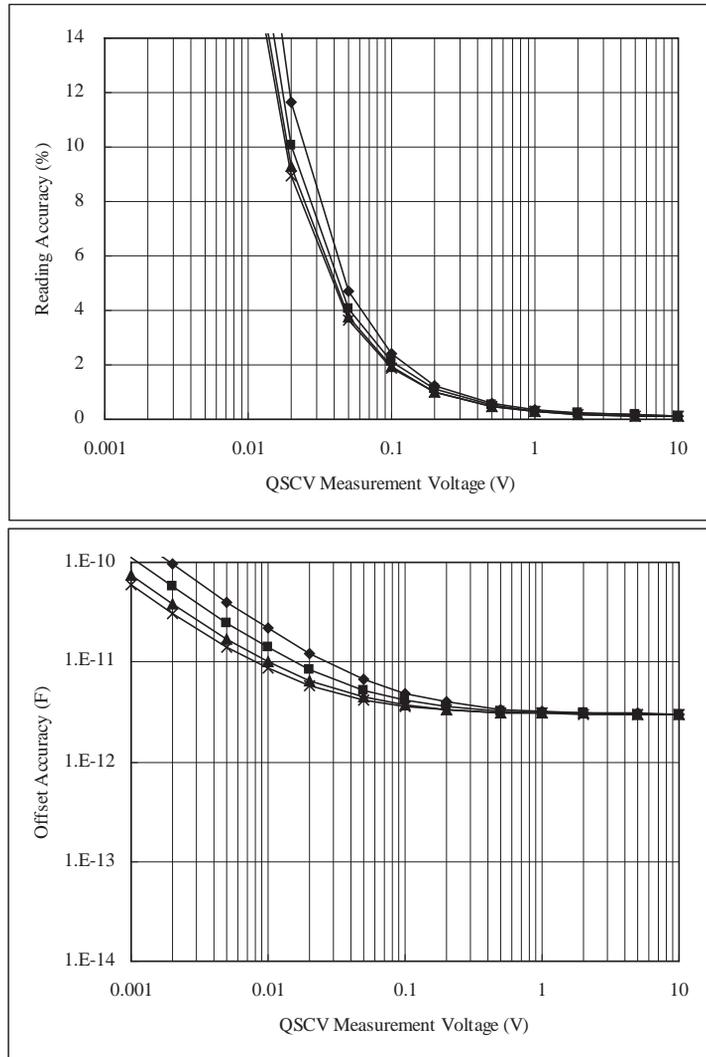
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-15

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 10 nA

Output Range: 20 V

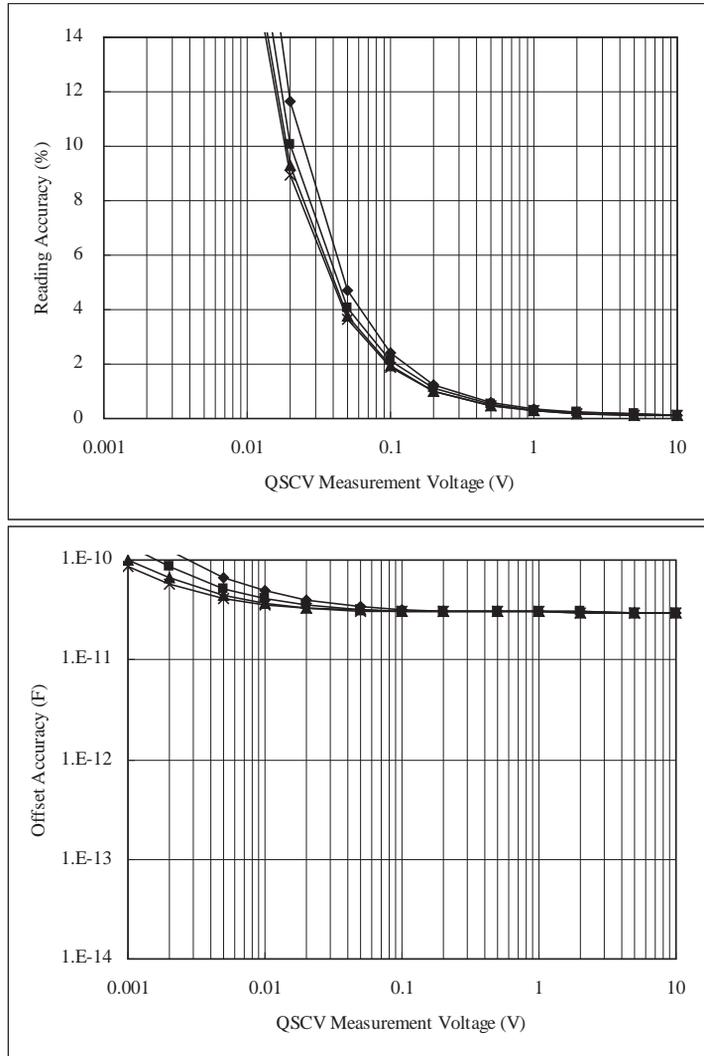
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 G ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-16

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 10 nA

Output Range: 20 V

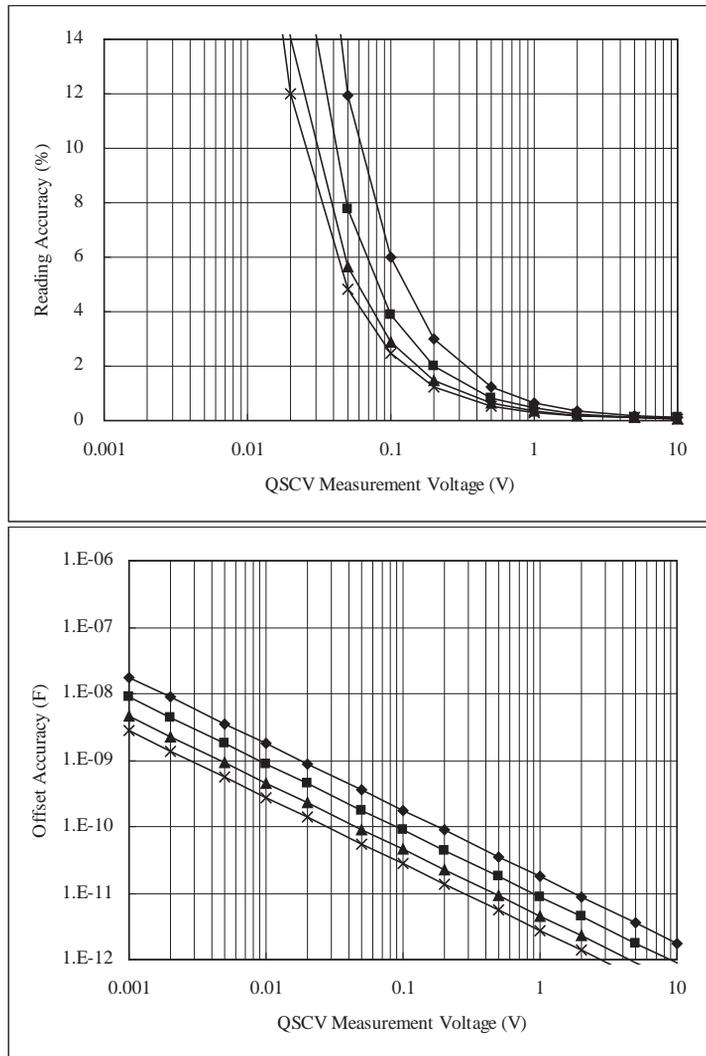
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 1 G ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-17

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 100 nA

Output Range: 20 V

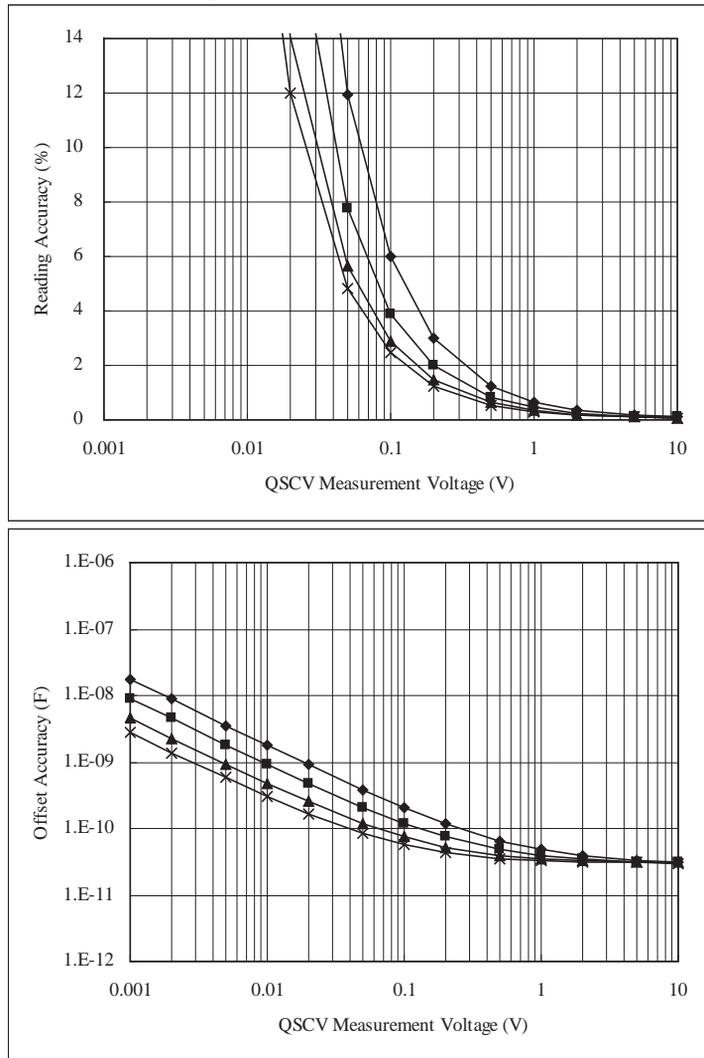
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-18

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 100 nA

Output Range: 20 V

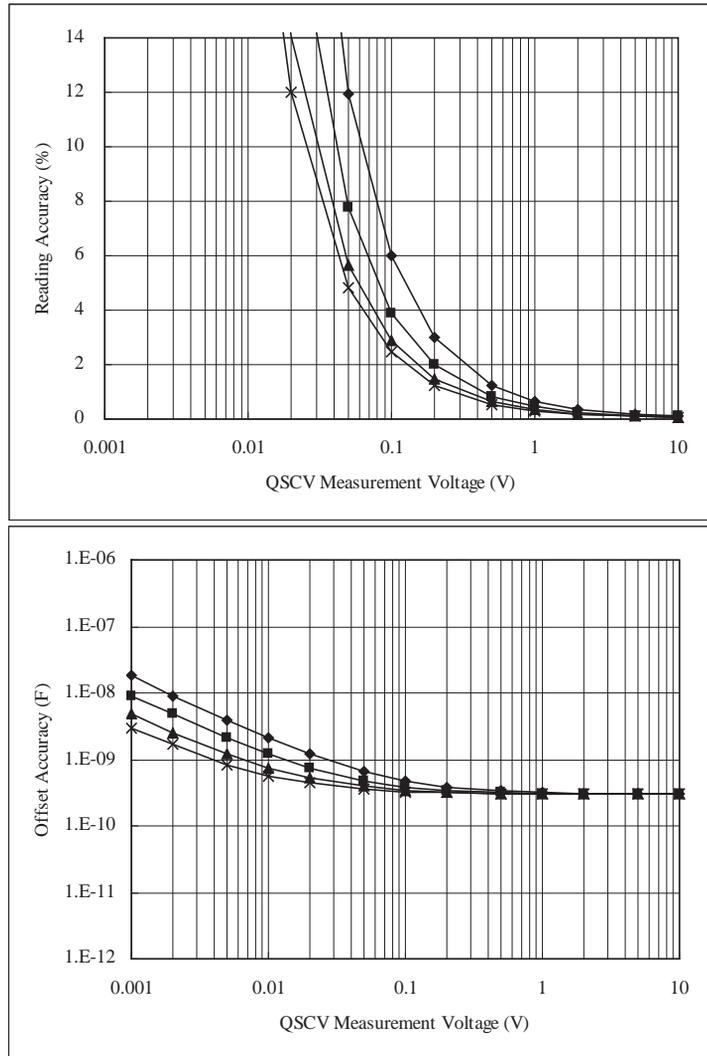
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 1 G ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-19

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 100 nA

Output Range: 20 V

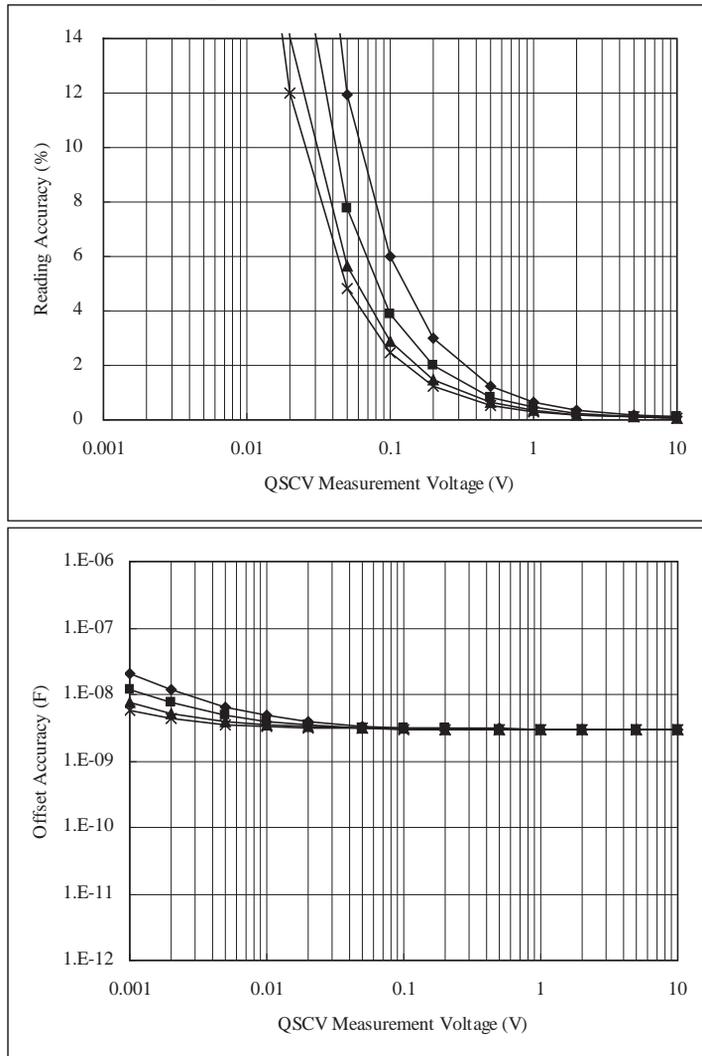
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 100 M ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-20

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 100 nA

Output Range: 20 V

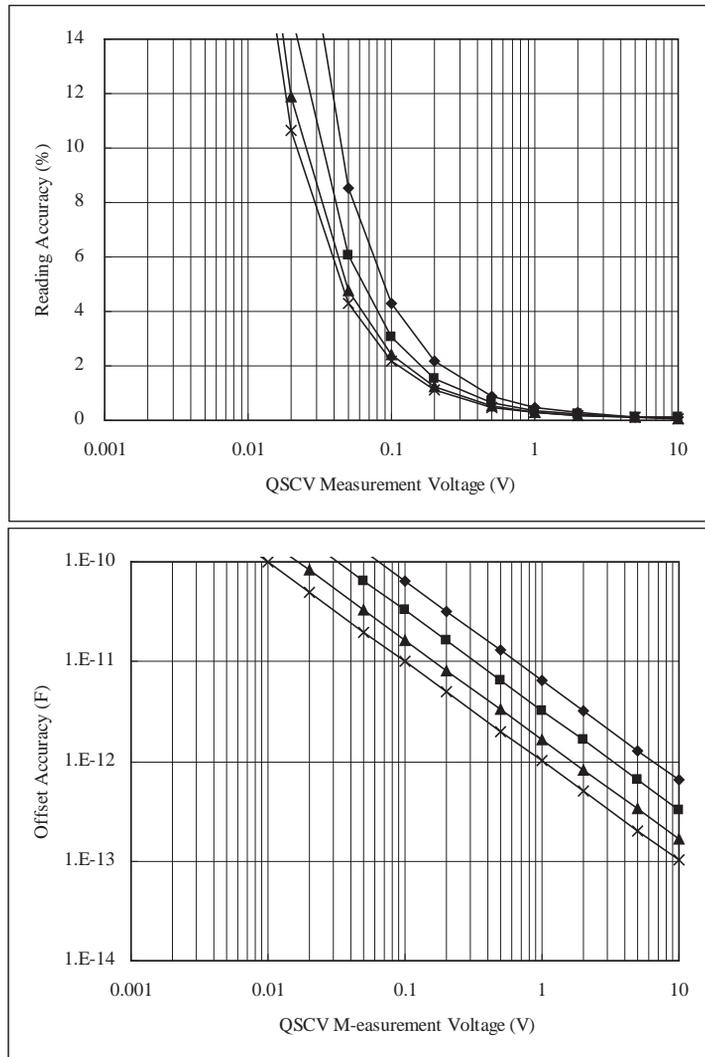
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 M ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-21

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 1 μ A

Output Range: 20 V

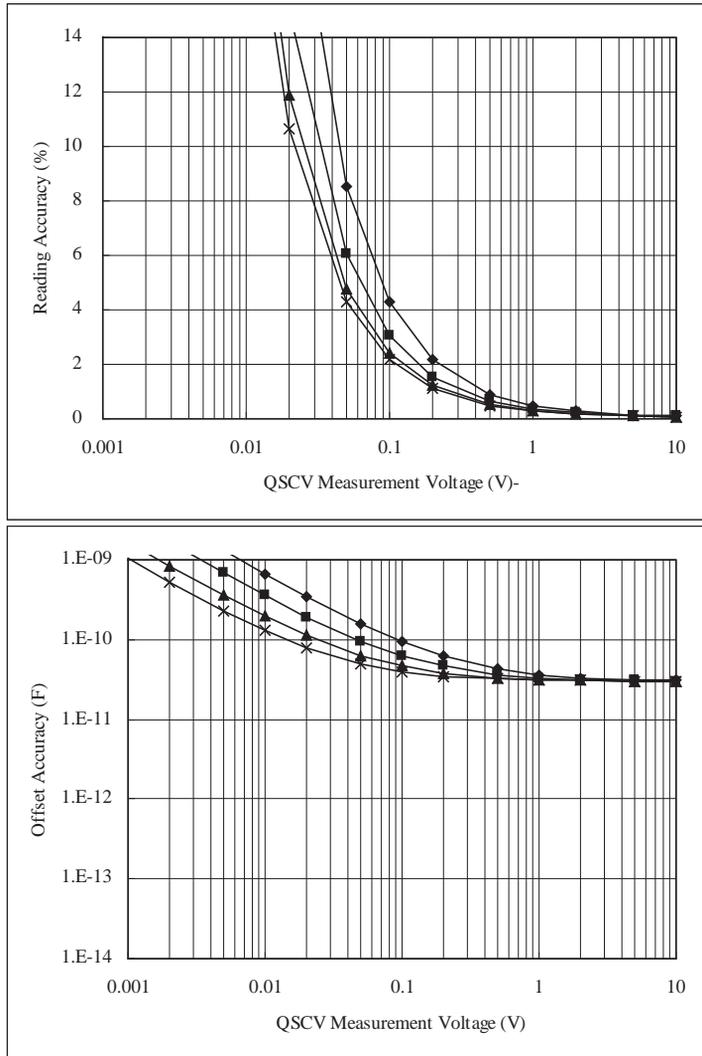
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-22

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 1 μ A

Output Range: 20 V

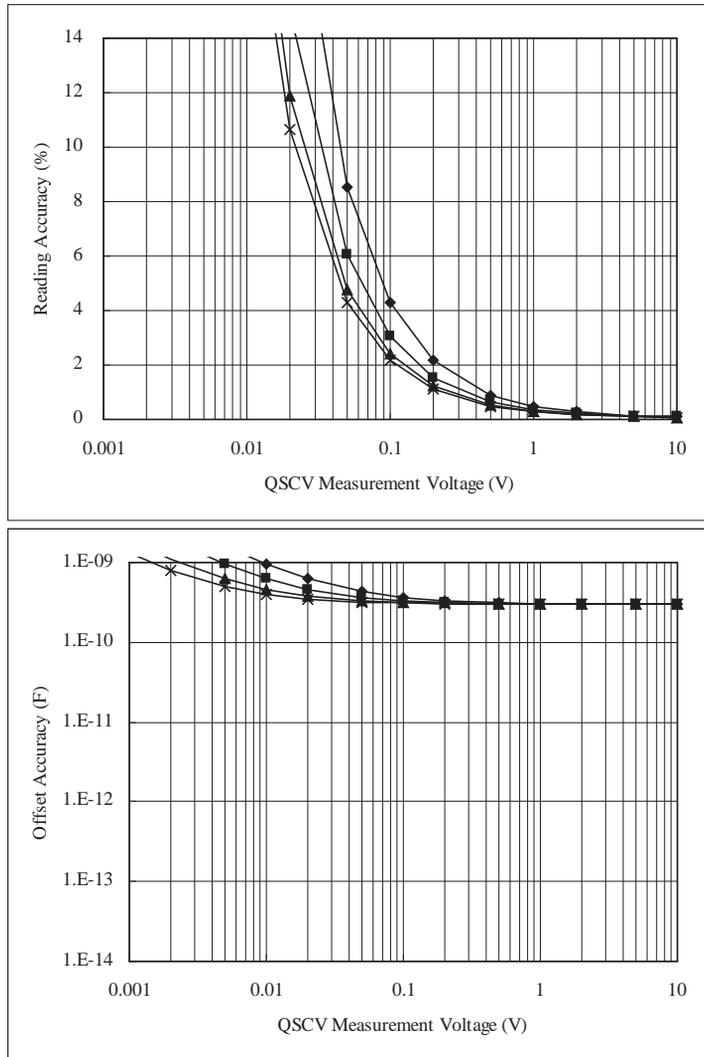
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 1 G ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-23

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 1 μ A

Output Range: 20 V

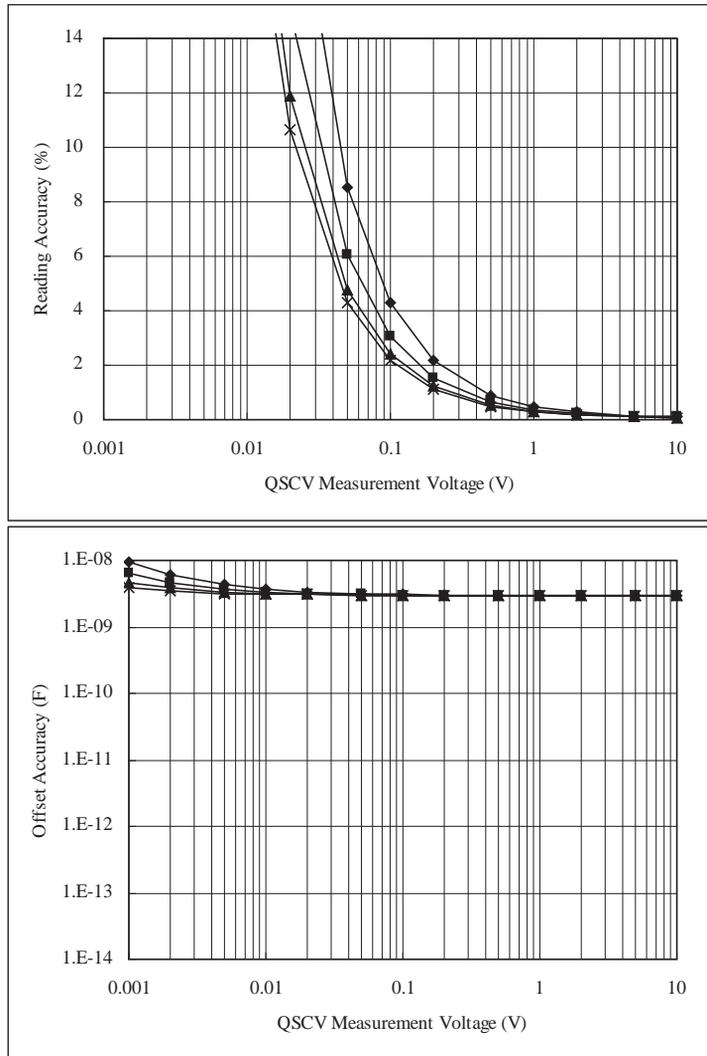
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 100 M ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-24

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: Normal

Measurement Range: 1 μ A

Output Range: 20 V

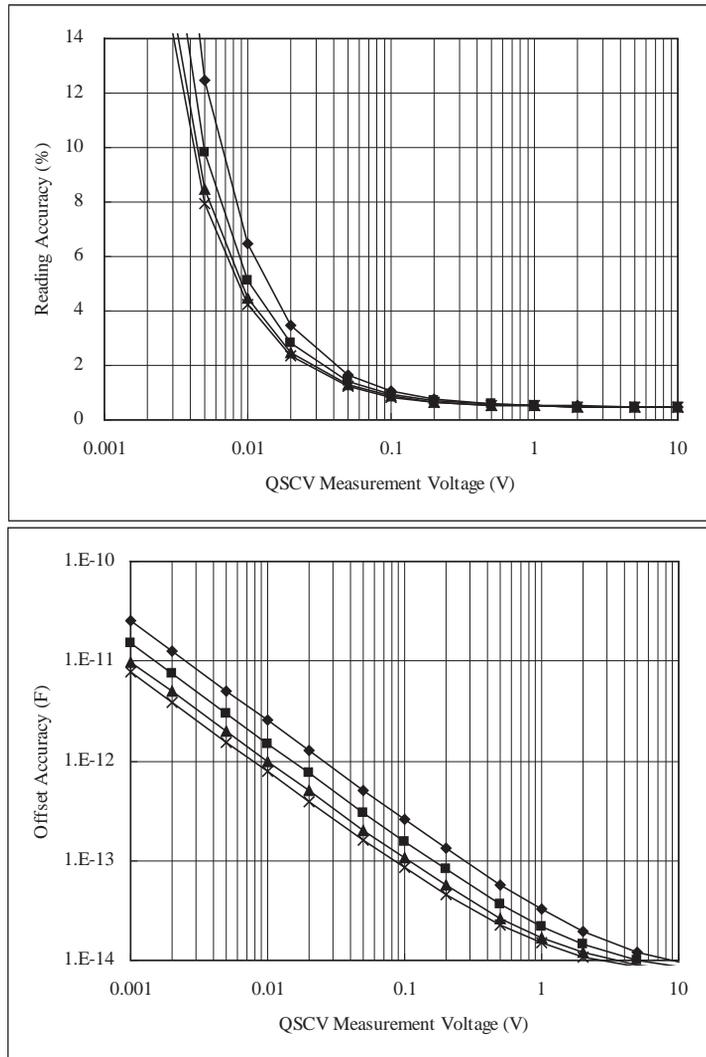
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 M ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-25

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: 4155C/4156C compatible

Measurement Range: 10 pA

Output Range: 20 V

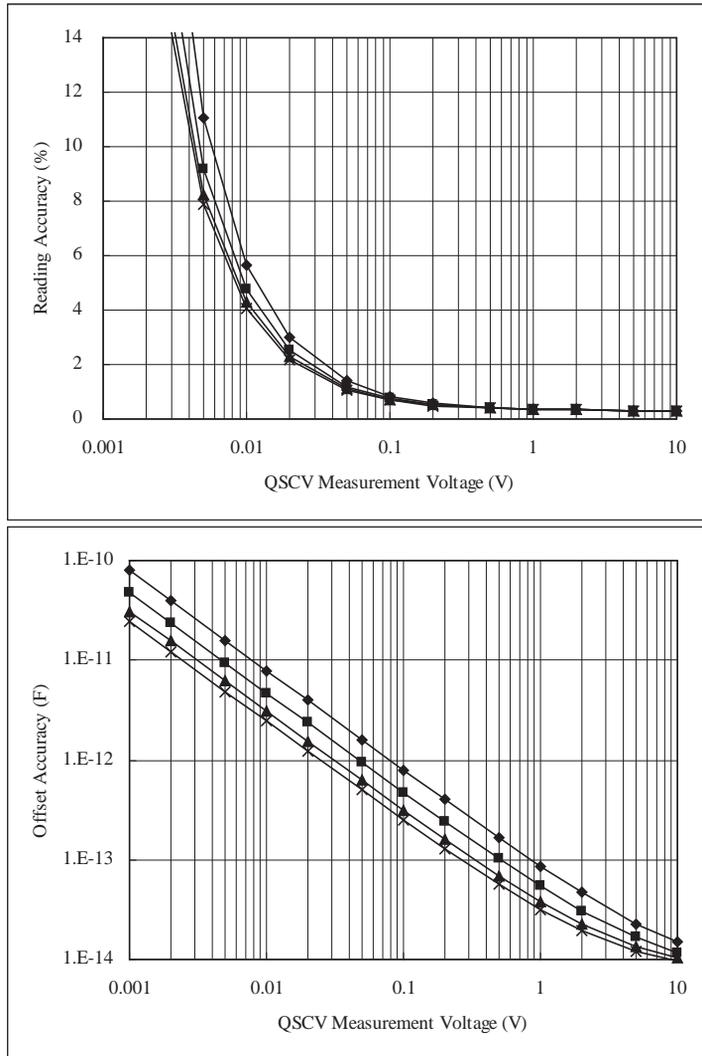
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-26

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: 4155C/4156C compatible

Measurement Range: 100 pA

Output Range: 20 V

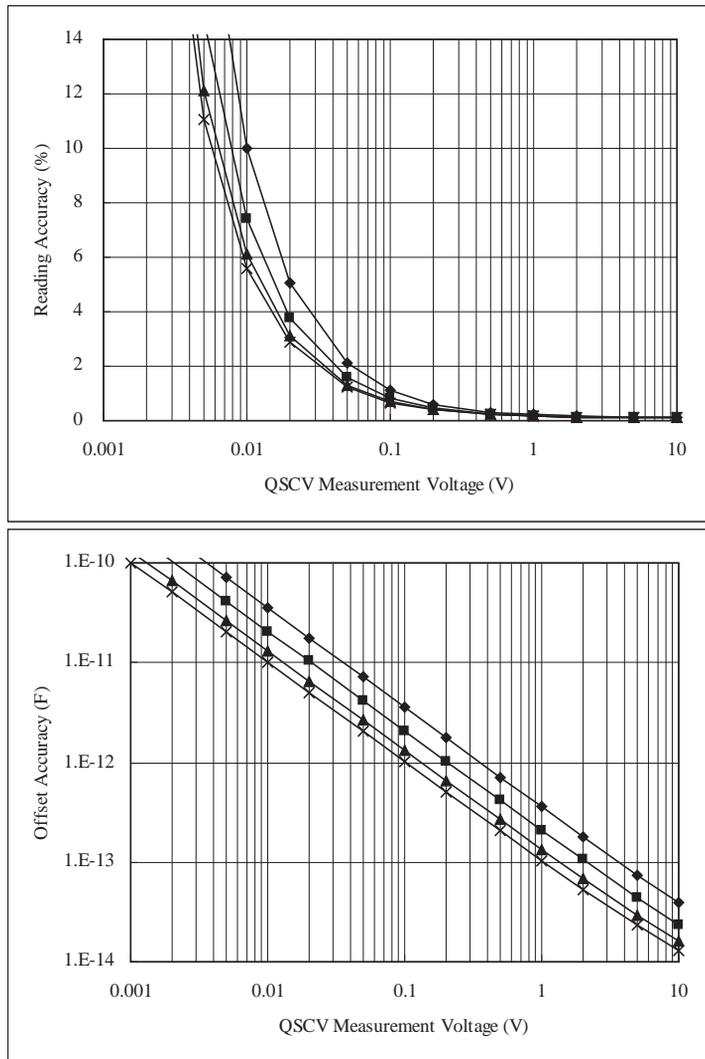
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-27

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: 4155C/4156C compatible

Measurement Range: 1 nA

Output Range: 20 V

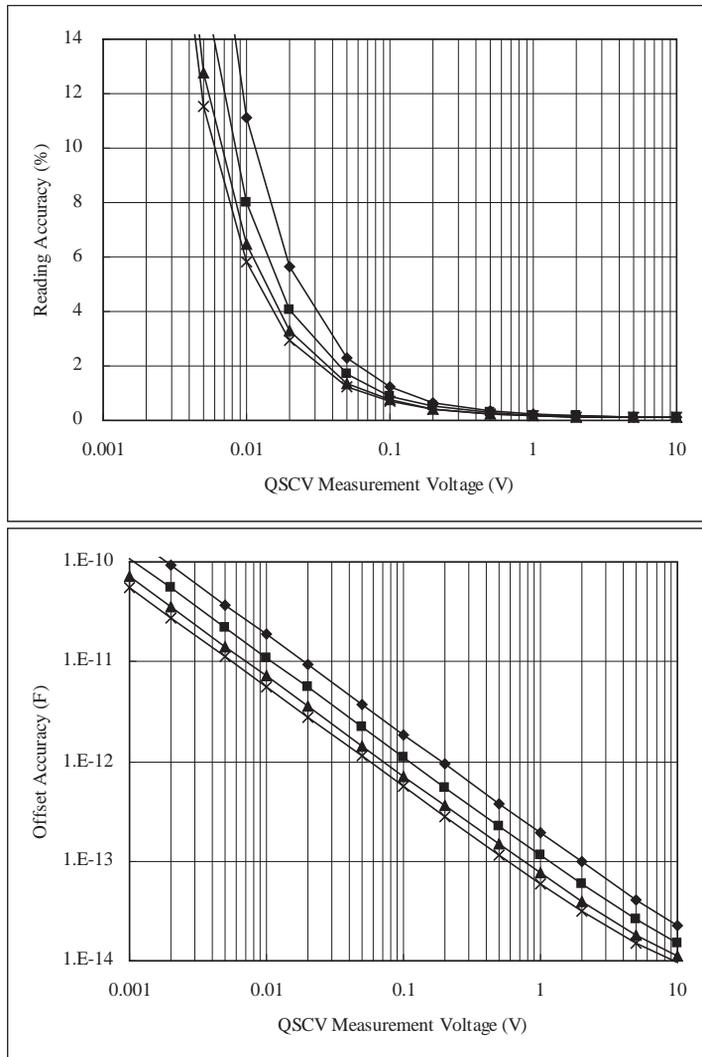
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-28

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: 4155C/4156C compatible

Measurement Range: 10 nA

Output Range: 20 V

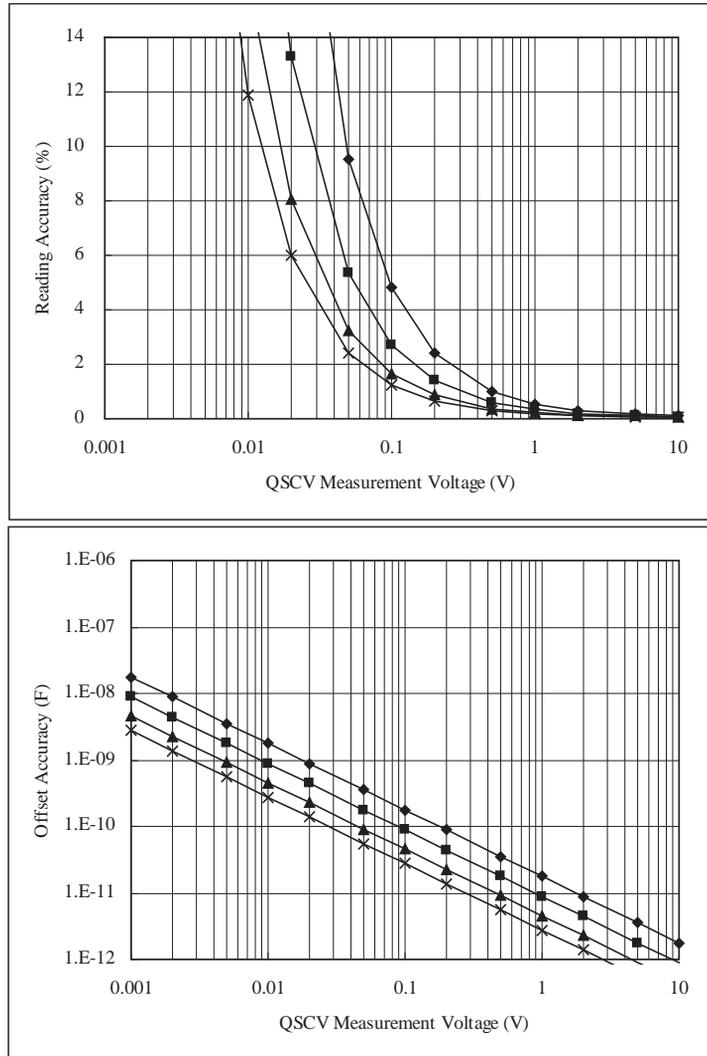
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-29

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: 4155C/4156C compatible

Measurement Range: 100 nA

Output Range: 20 V

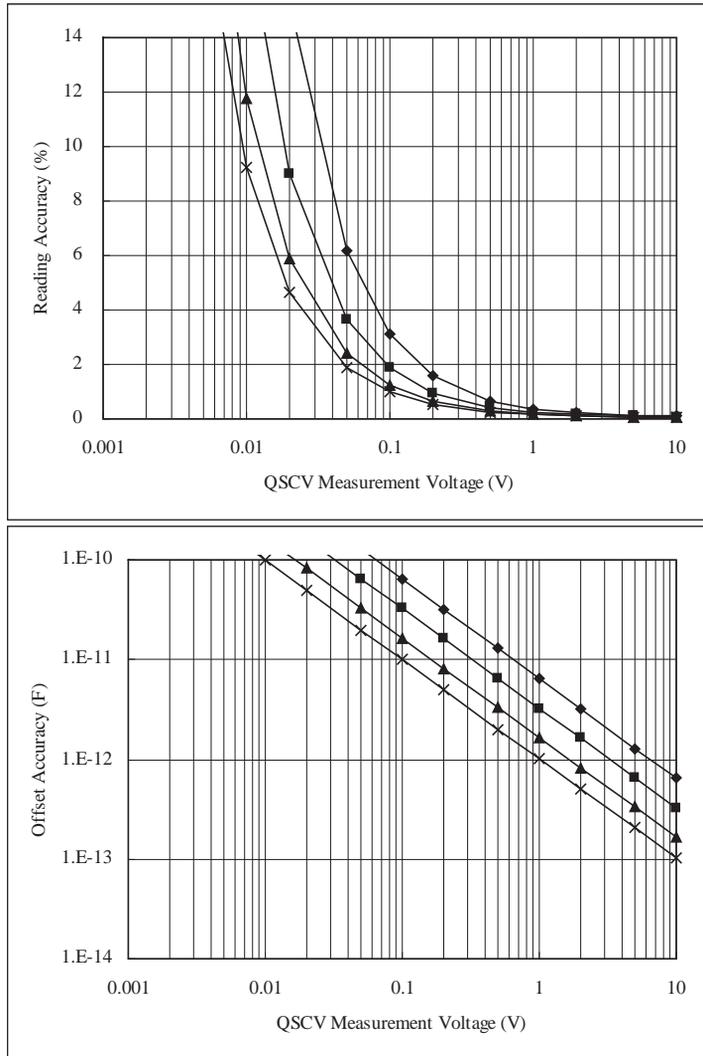
Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

Figure 10-30

Calculation Example of Measurement Accuracy: HRSMU/ASU



Conditions:

QSCV Operating Mode: 4155C/4156C compatible

Measurement Range: 1 μ A

Output Range: 20 V

Integration Time: 2, 1, 0.5, 0.3 s corresponding to the lines from top to bottom

Equivalent Parallel Resistance of DUT: 10 T ohm

Guard Capacitance of Measurement Path: 200 pF

License Management Tool

The licence management tool is the program used to install the license of the Agilent B1540A-002 EasyEXPERT Plus edition or the Agilent B1541A-002 Desktop EasyEXPERT Plus edition. This program is also used to confirm the licenses already installed and the host ID of the B1500A or the controller for Desktop EasyEXPERT.

- To launch program** Click Start > All Programs > Agilent B1500A EasyEXPERT > Licence Management Tool.
- To check licenses already installed** Click Installed Licenses tab on the Licence Management Tool. The installed licenses will be displayed.
- To check host ID** Click Information tab on the Licence Management Tool. The host ID will be displayed.
- To install license** The following procedure installs the license.
1. Click Install icon, or click File > Install License File to open a dialog box.
 2. Specify the license file (.lic file) of the B1540A-002 or the B1541A-002.
 3. Click Open.

License Management Tool GUI

- File menu**
- Install License File** Opens a dialog box used to specify the license file.
 - Exit** Closes the Licence Management Tool.
- Help menu**
- About** Opens the About dialog box.
- Install icon** Opens a dialog box used to specify the license file.
- Installed Licenses tab screen** Displays the license already installed.
- Information tab screen** Displays the host ID of the B1500A or the controller for Desktop EasyEXPERT.

Setup File Converter

The setup file converter is the program which converts the Agilent 4155A/4156A/4155B/4156B/4155C/4156C setup file (extension: DAT or MES) and creates the EasyEXPERT setup file (extension: XTS). This program can convert the setup information but cannot convert the test result data.

To launch setup file converter

Click Start > All Programs > Agilent B1500A EasyEXPERT > 4155,4156 Setup File Converter. This executes SetupFileConverterW.exe in the following folder.

C:\Program Files\Agilent\B1500\EasyEXPERT\415xC\Conversion\

This program can be executed on a PC installed with Windows XP Professional SP2 (Microsoft .NET Framework 2.0 runtime library is required) or Windows Vista Business SP1.

To execute this program, the SetupFileConverter.exe, SetupFileConverterW.exe, and SetupFileConverterW.exe.config files must be stored in the same folder.

To create XTS file

The following procedure converts the 4155/4156 setup file (.DAT or .MES) and creates the .XTS file in the folder the setup file is stored.

1. Click Select icon, or click File > Select Files to open the Select 4155/4156 MES Files or DAT Files dialog box.
2. Specify the 4155/4156 setup files to convert. Multiple files can be selected.
3. Click Open on the Select 4155/4156 MES Files or DAT Files dialog box.
4. Click Convert icon, or click File > Convert Files.

Instead of the step 1 to 3, you can use the drag and drop operation from Explorer to the Selected Files area on the Setup File Converter.

To read XTS file

Use the import function to read the created .XTS file on the EasyEXPERT.

Open the Import Test Setup window by clicking File > Import Test Setup... on the Classic Test screen. Specify the .XTS file to be imported, and click Open.

Conversion results

For details about the conversion results, see “SetupFileConverter.exe” on page 10-53.

Setup File Converter GUI

The setup file converter provides the following GUI.

| | | |
|-----------------------|---------------------------|--|
| File menu | Select Files | Opens the Select 4155/4156 MES Files or DAT Files dialog box used to specify the 4155/4156 setup files to convert. |
| | Convert Files | Performs conversion and creates XTS file. This program overwrites the file of the same name. |
| | Clear | Clears the Selected Files area and the Log area. |
| | Quit | Closes the setup file converter. |
| Help menu | About | Opens the About dialog box. |
| Icons | Select | Opens the Select 4155/4156 MES Files or DAT Files dialog box used to specify the 4155/4156 setup files to convert. |
| | Convert | Performs conversion and creates XTS file. This program overwrites the file of the same name. |
| | Clear | Clears the Selected Files area and the Log area. |
| Create XTS for | | Specifies the type of the XTS file to create. |
| | B1500A | XTS file for the B1500A |
| | 4155B/C | XTS file for the 4155A/B/C |
| | 4155B/C with HPSMU | XTS file for the 4155A/B/C. The HPSMU in the MES/DAT file is converted to SMU5: HP. |
| | 4156B/C | XTS file for the 4156A/B/C |
| | 4156B/C with HPSMU | XTS file for the 4155A/B/C. The HPSMU in the MES/DAT file is converted to SMU5: HP. |
| Selected Files | | Lists the 4155/4156 setup files to convert. Drag and drop operation is allowed. |
| Log | | Displays the execution log. |

Utility Programs

The following useful programs are stored in the following folder on the Agilent B1500A internal hard disk drive. Remember that they are just sample programs.

C:\Program Files\Agilent\B1500\EasyEXPERT\Utilities\

- “Prober Control”
- “SetupFileConverter.exe”
- “sleep.exe”
- “XSLT”

Prober Control

The C:\Program Files\Agilent\B1500\EasyEXPERT\Utilities\ProberControl folder stores the execution files used to control the following probers.

- Cascade Microtech Summit 12K or S300
- SUSS MicroTec PA200 or PA300
- Vector Semiconductor VX-2000 or VX-3000

You can use the execution files when you perform a repeat measurement by using Agilent B1500A/EasyEXPERT and a prober listed above. The execution files control the prober chuck movement (down, move, and up) by defining them in the Repeat Measurement Setup window. See “Repeat Measurement Setup” on page 4-31. Also see the readme.mht file in the ProberControl folder to use the prober control script.

This folder also stores the source files and the document files. See the pdf files in the ProberControl\xxxx\doc folder for more details or if you create your own prober control script by referring to the source code; xxxx is cascade, suss, or vector.

SetupFileConverter.exe

This program is the script version of the setup file converter. This program converts the 4155A/4156A/4155B/4156B/4155C/4156C setup file (.DAT or .MES) and creates the EasyEXPERT setup file (.XTS). This program can convert the setup information but cannot convert the test result data.

Execution environment

Windows 2000 Professional, Windows XP Professional or Home edition

Syntax

SetupFileConverter.exe [*option*] [*file*]

Parameter

option : Execution options. See Table 10-6. Multiple options can be set. Both /4155 and /4156 cannot be set for one execution.

file : 4155/4156 setup file name

You can specify multiple files by using a space as the separator. Wildcard can be used.

If no parameter is specified, the Usage message is displayed.

Execution examples

```
C:\415xConvert>SetupFileConverter.exe MOS1.MES
```

```
C:\415xConvert>SetupFileConverter.exe MOS*.DAT MOS*.MES
```

```
C:\415xConvert>SetupFileConverter.exe /4156 /HP *.MES
```

Table 10-6

Option Parameter

| Option | Description |
|-------------|---|
| (no option) | Performs normal operation. |
| /4155 | Creates the XTS file for the 4155, not for the B1500A. |
| /4156 | Creates the XTS file for the 4156, not for the B1500A. |
| /HP | Converts HPSMU in the MES/DAT file to SMU5: HP. For creating the XTS file for the 4155/4156. |
| /S | Leaves <i>Command Prompt</i> open after execution. For the XTS file creation example 2. See NOTE below. |

Application Library and Utilities

Utility Programs

XTS file creation example 1

The .XTS file can be created by using *Command Prompt* as shown below.

1. Create your working folder (for example, C:\415xConvert\).
2. Copy the 4155/4156 setup files to be converted and the SetupFileConverter.exe file, and paste them to the working folder.
3. Open *Command Prompt*.
4. On *Command Prompt*, execute SetupFileConverter.exe as shown below. This creates the .XTS file in the working folder and displays the message as follows.

```
C:\415xConvert>SetupFileConverter.exe IDVG.MES  
SetupFileConverter.exe : Version A.02.10  
Start Conversion : IDVG.MES  
ExportFile       : IDVG.xts  
SetupVersion    : HP4155_C03.06  
Conversion successfully completed.
```

XTS file creation example 2

The .XTS file can be created by using the shortcut on the Desktop as shown below. Before the procedure, create the following shortcut on the Desktop.

Target file:

C:\Program Files\Agilent\B1500\EasyEXPERT\Utilities\SetupFileConverter.exe

Shortcut name: SetupFileConverter

1. Copy the 4155/4156 setup files to be converted, and paste them on the Desktop.
2. Drag the icon of the setup file and drop it on the SetupFileConverter icon. This creates the .XTS file and its icon on the Desktop, and opens *Command Prompt* for displaying the status message one moment.

NOTE

To set options to the SetupFileConverter shortcut

If you want to leave *Command Prompt* open, add the /S option as shown below.

1. Right-click on the SetupFileConverter icon and select Properties to open the Properties window.
2. On the Shortcut tab screen, add /S to the end of the string in the Target field as follows.

```
"C:\Program Files\Agilent\B1500\EasyEXPERT\Utilities\SetupFile  
Converter.exe" /S
```

3. Click OK.

If you want to make the .XTS file for the 4155/4156, insert /4155 or /4156 before /S.

If you want to add /HP option, insert /HP before /S.

- To read XTS file** Use the import function to read the created .XTS file on the EasyEXPERT.
- Open the Import Test Setup window by clicking File > Import Test Setup... on the Classic Test screen. Specify the .XTS file to be imported, and click Open.
- About conversion results** The setup file conversion is not complete. The following are the expected differences. When you use the .XTS file, you will see differences in the operation, performance, measurement result data, and so on.
- Channel number may be changed. For example, the HPSMU channel number is 5 for the 4155/4156 but 1 for the B1500A.
 - Setup value is changed to the value available for the B1500A and EasyEXPERT.
 - Voltage Source and Monitor Unit (two channels of VSU and two channels of VMU) is converted to four channels of MPSMU.
 - Pulse Generator Unit (PGU) setup is deleted.
 - Unused module information is deleted.
 - Functions only for the 4155/4156 are deleted.
 - For converting the setup data which satisfies the following two conditions, SMU5 is converted to HPSMU. Else, SMU5 is converted to MPSMU.
 1. SMU6 information is not included in the setup data.
 2. SMU5 information contains the value available only for the HPSMU.
- If an inconvertible setup parameter is found during the setup file conversion, a message will be displayed. If an inconvertible setup file is specified, the file conversion is not performed for the file and a message will be displayed.
- About conversion results with option /4155 or /4156** If the /4155 or /4156 option is specified, there are the following differences between the conversion results.
- Channel number is not changed.
 - Setup value will be changed to the value available for the 4155/4156 and Desktop EasyEXPERT.
 - VSU/VMU is converted to VSU/VMU respectively.

sleep.exe

This execution file is used to put a wait time in the test execution flow of an application test.

Execution environment

Agilent EasyEXPERT application test execution environment

File Name

C:\Program Files\Agilent\B1500\EasyEXPERT\Utilities\sleep.exe

Parameters

The following parameters are available for this file. To use sleep.exe, the parameters must be defined in the Local Variables Definition statement of the Test Contents tab in the Test Definition window.

WAIT : List input parameter. Vector variable (1 × 1) to store the data passed to sleep.exe. Enter a wait time in ms.

PassFail : Value output parameter. Numeric variable to store the execution result. 0 is always returned.

Return Value : Value output parameter. Numeric variable to store the data returned by executing sleep.exe. 1 is returned after execution.

Setup examples

To execute sleep.exe, the following setup should be done in the Command Execution element, Miscellaneous component, Test Contents tab in the Test Definition window.

| Windows Command Execution | | | | | | | |
|---------------------------|---|--------|---|--------|--------------|------|------|
| Command Filename: | C:\Program Files\Agilent\B1500\EasyEXPERT\Utilities\sleep.exe | | | | | | |
| Argument: | | | | | | | |
| Write Type: | | String | x | List | | | |
| Read Type: | | String | x | Value | | List | None |
| Write List | | | | | | | |
| Values: | WAIT | | | | | | |
| Format: | | | | | | | |
| Read Value | | | | | | | |
| Result: | PassFail | | | Value: | Return Value | | |

XSLT

The XSLT (XSL-Transformation, eXtensible Stylesheet Language Transformation) filter files are used to export test records. The fifteen filter files listed below are stored in the C:\Program Files\Agilent\B1500\EasyEXPERT\Utilities\XSLT folder. See Table 10-7.

Filter files that contain *csv* in the file name export test record in the format that uses a comma (,) as data separator.

Filter files that contain *tab-sv* in the file name export test record in the format that uses a tab as data separator.

Filter files that contain *xmlss* in the file name export test record in the XML Spread Sheet format.

To export test record

Test record can be exported by the following procedure.

1. Open the Export in My Format (p. 4-22) dialog box by clicking Results > Transport Data > Export in My Format....
2. Enter the XSLT filter file name, and click the Export As... button.
3. On the Export As dialog box, specify the file name and file type for the export data, and click Save.

To read export result

The exported data file can be opened and read with a spreadsheet software. The procedure for opening the export data with a spreadsheet software is as follows.

- For data separated by a comma
Specify the data separated by a comma for the original data format.
- For data separated by a tab
Specify the data separated by a tab for the original data format.
- For data in the XML Spread Sheet format
Specify the XML file for the file type.

After reading the file, all data in the file will be entered into independent cells on the spreadsheet software.

Table 10-7 XSLT Filter Files

| Group | File name | Description |
|-------|---|--|
| 1 | <ul style="list-style-type: none"> • meas-csv.xml • meas-tab-sv.xml • meas-xmlss.xml | <p>Filter files for exporting the measurement data only</p> <p>Classic test record export example is shown in Table 10-8.</p> |
| 2 | <ul style="list-style-type: none"> • meas-index-csv.xml • meas-index-tab-sv.xml • meas-index-xmlss.xml | <p>Filter files for exporting the measurement data with the index</p> <p>Classic test record export example is shown in Table 10-9.</p> |
| 3 | <ul style="list-style-type: none"> • meas-meta-csv.xml • meas-meta-tab-sv.xml • meas-meta-xmlss.xml | <p>Filter Files for exporting the measurement data with the meta data</p> <p>The meta data contains the test name, the setup name, the record time of the test results, the device ID, the counter number, the flag of the test results, and the remarks on the test results.</p> <p>Classic test record export example is shown in Table 10-10.</p> |
| 4 | <ul style="list-style-type: none"> • meas-index-meta-csv.xml • meas-index-meta-tab-sv.xml • meas-index-meta-xmlss.xml | <p>Filter files for exporting the measurement data with the index and the meta data</p> <p>The meta data contains the test name, the setup name, the record time of the test results, the device ID, the counter number, the flag of the test results, and the remarks on the test results.</p> <p>Classic test record export example is shown in Table 10-11.</p> |
| 5 | <ul style="list-style-type: none"> • csv.xml (used by the Export As CSV... (p. 4-16) function) • tab-sv.xml • xmlss.xml (used by the Export As XML Spread Sheet... (p. 4-16) function) | <p>Filter files for exporting all data including the test setup</p> <p>Application test record export example is shown in Table 10-12. Data in the first cell is the label for the data components in that row. The following cells are the data corresponding to the label. Table 10-15 and Table 10-16 list the components available for the exported data file.</p> |

Table 10-8 Example of the data exported by using the XSLT Filter File Group 1

| Vd | Vg | Index | Time | Id | ABS_ID | Slope |
|------|----|-------|---------|----------|----------|----------|
| 0 | 1 | 1 | 0.00264 | -0.00012 | 0.00012 | 0.004346 |
| 0.06 | 1 | 2 | 0.01265 | 0.000398 | 0.000398 | 0.004346 |
| 0.12 | 1 | 3 | 0.02265 | 0.000902 | 0.000902 | 0.004346 |
| : | : | : | : | : | : | : |

Table 10-9 Example of the data exported by using the XSLT Filter File Group 2

| No. | Vd | Vg | Index | Time | Id | ABS_ID | Slope |
|-----|------|----|-------|---------|----------|----------|----------|
| 1 | 0 | 1 | 1 | 0.00264 | -0.00012 | 0.00012 | 0.004346 |
| 2 | 0.06 | 1 | 2 | 0.01265 | 0.000398 | 0.000398 | 0.004346 |
| 3 | 0.12 | 1 | 3 | 0.02265 | 0.000902 | 0.000902 | 0.004346 |
| : | : | : | : | : | : | : | : |

Table 10-10 Example of the data exported by using the XSLT Filter File Group 3

| I/V Sweep | Trng Id-Vd | | | | | |
|-------------|------------------------|-------|---------|----------|----------|----------|
| Record Time | 04/04/2007 08:36:42 | | | | | |
| Device ID | | | | | | |
| Count | 2 | | | | | |
| Flag | | | | | | |
| Remarks | | | | | | |
| Vd | Vg | Index | Time | Id | ABS_ID | Slope |
| 0 | 1 | 1 | 0.00264 | -0.00012 | 0.00012 | 0.004346 |
| 0.06 | 1 | 2 | 0.01265 | 0.000398 | 0.000398 | 0.004346 |
| 0.12 | 1 | 3 | 0.02265 | 0.000902 | 0.000902 | 0.004346 |
| : | : | : | : | : | : | : |

Application Library and Utilities
Utility Programs

Table 10-11 Example of the data exported by using the XSLT Filter File Group 4

| | | | | | | | |
|-------------|------------------------|----|-------|---------|----------|----------|----------|
| I/V Sweep | Trng Id-Vd | | | | | | |
| Record Time | 04/04/2007 08:36:42 | | | | | | |
| Device ID | | | | | | | |
| Count | 2 | | | | | | |
| Flag | | | | | | | |
| Remarks | | | | | | | |
| No. | Vd | Vg | Index | Time | Id | ABS_ID | Slope |
| 1 | 0 | 1 | 1 | 0.00264 | -0.00012 | 0.00012 | 0.004346 |
| 2 | 0.06 | 1 | 2 | 0.01265 | 0.000398 | 0.000398 | 0.004346 |
| 3 | 0.12 | 1 | 3 | 0.02265 | 0.000902 | 0.000902 | 0.004346 |
| : | : | : | : | : | : | : | : |

Filter File Modification Example

This section explains the modification example of a filter file. In this example, a filter file of group 5 is used.

The group 5 filter files will export the data that contains the test setup information. To obtain the data without the setup information, modify the filter file as shown below, also see Figure 10-31, and export data by using the filter file after modification.

The data will not contain the *TestParameter*, *DutParameter*, *MetaData*, and *AnalysisSetup* of the Application test result record, and the *TestParameter*, *MetaData*, and *AnalysisSetup* of the Classic test result record.

1. Modify the following *template* elements for *sta:TestParameterList* to *sta:TerminalList* as shown below.

```
<xsl:template match="sta:TestParameterList">
</xsl:template>

<xsl:template match="sta:DutParameterList">
</xsl:template>

<xsl:template match="sta:AnalysisParameterList">
</xsl:template>

<xsl:template match="sta:MetaData/sta:ParameterList">
</xsl:template>

<xsl:template match="sta:TerminalList">
  <xsl:apply-templates />
</xsl:template>
```

2. Comment out the whole of the following *template* element.

```
<!--
<xsl:template match="sta:Parameter">
  : : : : : : : :
</xsl:template>
-->
```

Exported data examples of Classic test result record are shown in Table 10-12 and Table 10-13.

Table 10-14 explains the reference name used in the filter file and shows the relation to the parameter name used in the data file exported by using the filter file.

Figure 10-31

Modification Example

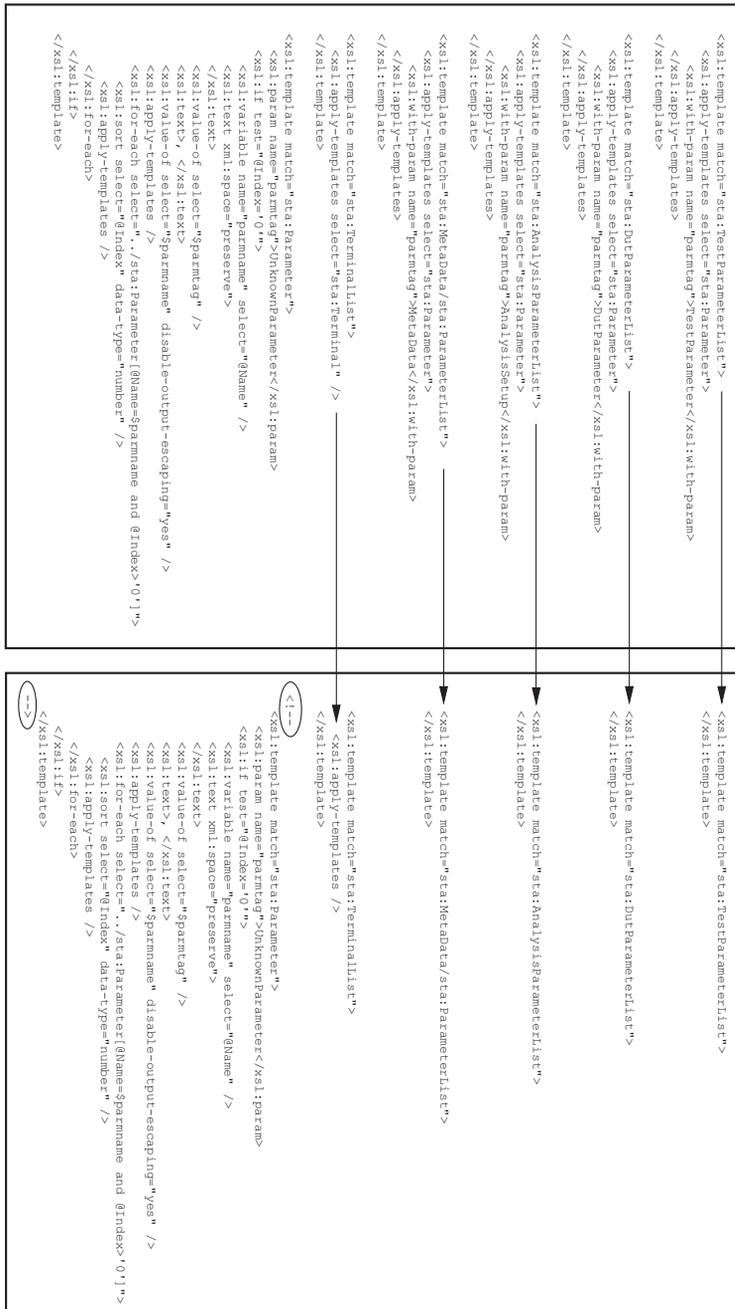


Table 10-12 Example of the data exported by using the filter file before modification

| | | | | | |
|---------------|-----------------|---------|---------|---------|----------|
| SetupTitle | Trng Id-Vd | | | | |
| PrimitiveTest | I/V Sweep | | | | |
| TestParameter | Channel.Unit | SMU1:HP | SMU2:HP | SMU3:HR | SMU4:HR |
| TestParameter | Channel.IName | Id | Ig | Is | Sub |
| TestParameter | Channel.VName | Vd | Vg | Vs | Vsub |
| : | : | : | : | : | : |
| MetaData | TestRecord.Entr | true | | | |
| : | : | : | : | : | : |
| AnalysisSetup | Analysis.Setup. | true | | | |
| : | : | : | : | : | : |
| Dimension1 | 51 | 51 | 51 | 51 | 51 |
| Dimension2 | 3 | 3 | 3 | 3 | 3 |
| DataName | Vd | Vg | Index | Time | Id |
| DataValue | 0 | 1 | 1 | 0.00251 | 0 |
| DataValue | 0.06 | 1 | 2 | 0.01251 | 3.35E-05 |
| : | : | : | : | : | : |

Table 10-13 Example of the data exported by using the filter file after modification

| | | | | | |
|---------------|------------|----|-------|---------|----------|
| SetupTitle | Trng Id-Vd | | | | |
| PrimitiveTest | I/V Sweep | | | | |
| Dimension1 | 51 | 51 | 51 | 51 | 51 |
| Dimension2 | 3 | 3 | 3 | 3 | 3 |
| DataName | Vd | Vg | Index | Time | Id |
| DataValue | 0 | 1 | 1 | 0.00251 | 0 |
| DataValue | 0.06 | 1 | 2 | 0.01251 | 3.35E-05 |
| : | : | : | : | : | : |

Table 10-14 Filter File Reference Name

| Reference name | Description |
|--------------------------------|--|
| sta:TestData | Indicates a test result data saved in an EasyEXPERT test result record |
| sta:MeasurementData | Indicates a measurement result data saved in a test result data |
| sta:DataVectorSet | Indicates a set of vector data saved in a measurement result data |
| sta:TestSetup | Indicates a test setup data saved in a test result data |
| sta:Title | Indicates test setup name, <i>SetupTitle</i> in export data |
| sta:PrimitiveTest | Indicates a classic test data set, <i>PrimitiveTest</i> in export data |
| sta:ApplicationTest | Indicates an application test data set, <i>ApplicationTest</i> in export data |
| sta:TestParameterList | Indicates a set of Test Parameters definitions, <i>TestParameter</i> in export data |
| sta:DutParameterList | Indicates a set of Device Parameters definitions, <i>DutParameter</i> in export data |
| sta:AnalysisParameterList | Indicates a set of display and analysis data, <i>AnalysisSetup</i> in export data |
| sta:MetaData/sta:ParameterList | Indicates a set of system data, <i>MetaData</i> in export data |
| sta:TerminalList | Indicates a set of terminal information |
| sta:Parameter | Indicates a parameter |
| sta:Number | Indicates an integer data |
| sta:Double | Indicates a real data |
| sta:String | Indicates a string data |
| sta:Boolean | Indicates a boolean data |
| sta:DateTime | Indicates a date time data |
| sta:Binary | Indicates a binary data |
| sta:Channel | Indicates a channel information |
| sta:Terminal | Indicates a terminal information |
| sta:Port | Indicates a port information |

Table 10-15 Export Data Components for Classic Test Result

| Label | Description | Example (csv output) |
|---------------|--|--|
| SetupTitle | Title of this test setup | Trng_Id_Vd |
| PrimitiveTest | Setup name of this classic test | I/V Sweep |
| TestParameter | Parameter name and setup value of Channel Setup, Measurement Setup, Function Setup, Auto Analysis Setup, and Display Setup. Data file contains a lot of rows for TestParameter. One setup item per row. | Channel.Unit, SMU1:HP, SMU2:HP, SMU3:HR, SMU4:HR |
| MetaData | Data for system use. Test record entry point, record time, test target, iteration index, preservation, flag, remarks, and link key. | TestRecord.EntryPoint, true |
| AnalysisSetup | Parameter name and setup value of the data display and analysis setup. Data file contains a lot of rows for AnalysisParameter. One setup item per row. | Analysis.Setup.Vector.Graph.Enabled, true |
| Dimension1 | Size of data variable. For dimension 1. Order sensitive. 51 for all data variables in Example. | 51, 51, 51, 51, 51 |
| Dimension2 | Size of data variable. For dimension 2. Order sensitive. 1 for all data variables in Example. | 3, 3, 3, 3, 3 |
| DataName | Measurement parameter names or data variable names. Order sensitive. For example, Vgate=-0.5 in Example. | Vd, Vg, Index, Time, Id |
| DataValue | Measurement result data. Order sensitive. For example, Vgate=-0.5 in Example. Data file contains a lot of rows for DataValue. One data set per row. | 0, 1, 1, 0.00251, 0 |

Table 10-16 Export Data Components for Application Test Result

| Label | Description | Example (csv output) |
|-----------------|---|--|
| SetupTitle | Title of this test setup | Trng_Id_Vd |
| ApplicationTest | Setup name of this application test | Trng_Id_Vd, Public |
| TestParameter | Two rows. The upside is for the test parameter names. The downside is for the test parameter values. Order sensitive. For example, Vd=0.1 in Example. | Name, VdStart, VdStop, VdStep, VgStart, VgStop, VgStep, Vs |
| | | Value, 0, 3, 0.06, 1, 2, 0.5, 0 |
| DutParameter | Two rows. The upside is for the device parameter names. The downside is for the device parameter values. Order sensitive. For example, Temp=25 in Example. | Name, Polarity, Lg, Wg, Temp, IdMax |
| | | Value, 1, 1.00E-07, 1.00E-05, 25, 0.005 |
| MetaData | Data for system use. Test record entry point, record time, test target, iteration index, preservation, flag, remarks, and link key. | TestRecord.EntryPoint, true |
| AnalysisSetup | Parameter name and setup value of the data display and analysis setup. Data file contains a lot of rows for AnalysisParameter. One setup item per row. | Analysis.Setup.Vector.Graph.Enabled, true |
| Dimension1 | Size of data variable. For dimension 1. Order sensitive. 51 for all data variables in Example. | 51, 51, 51, 51, 51 |
| Dimension2 | Size of data variable. For dimension 2. Order sensitive. 1 for all data variables in Example. | 3, 3, 3, 3, 3 |
| DataName | Measurement parameter names or data variable names. Order sensitive. For example, Vgate=-0.5 in Example. | Vd, Vg, Index, Time, Id |
| DataValue | Measurement result data. Order sensitive. For example, Vgate=-0.5 in Example. | 0, 1, 1, 0.00251, 0 |
| | Data file contains a lot of rows for DataValue. One data set per row. | |

Desktop EasyEXPERT

The Desktop EasyEXPERT software CD-ROM is included with Agilent B1500A. This section describes the following topics.

- “About Desktop EasyEXPERT”
- “System Requirements”
- “To Install Desktop EasyEXPERT”
- “Before Starting Desktop EasyEXPERT”
- “To Start Desktop EasyEXPERT”
- “Execution Mode dialog box”
- “Start EasyEXPERT window”
- “To Change Execution Mode and GPIB Settings”
- “To Move the EasyEXPERT Database”
- “Using 4155B/4156B/4155C/4156C”

NOTE

Desktop EasyEXPERT Standard Edition

There are two editions Plus and Standard for Desktop EasyEXPERT. The Standard edition does not support the Agilent E5250A Switching Matrix.

NOTE

Software Update and Database Backup

To perform software update of Desktop EasyEXPERT, see “Updating EasyEXPERT” on page 9-22.

To make and restore EasyEXPERT database, see “Data Backup and Recovery” on page 9-14.

NOTE

About privilege to use Desktop EasyEXPERT

The Desktop EasyEXPERT revision A.03.20 does not require the administrator privilege which is required by the revision A.03.11 and previous revisions. However, if the software is updated from a previous revision to the revision A.03.20, it still requires the administrator privilege.

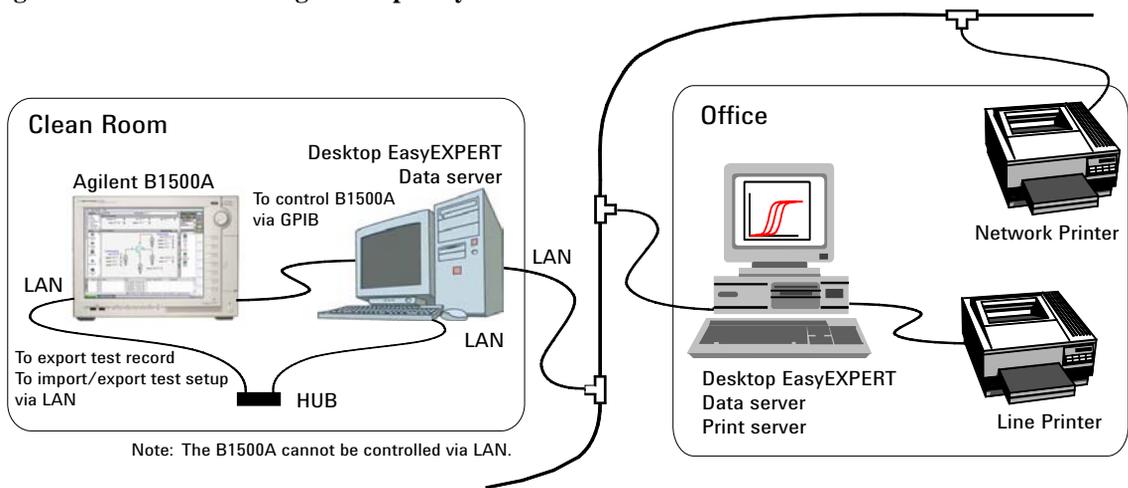
About Desktop EasyEXPERT

The Desktop EasyEXPERT software provides the following additional advantages to the B1500A, allowing you to minimize the amount of offline tasks performed on B1500A and increase the working ratio for measurements.

- Allows B1500A to be controlled from an external computer via GPIB while online.
- Allows test setup to be created on an external computer while offline.
- Allows data analysis to be performed on an external computer while offline.

The Desktop EasyEXPERT can use the 4155B, 4156B, 4155C, or 4156C instead of the B1500A. Then, there are some differences in the functions and operations compared with when the B1500A is used. See “Using 4155B/4156B/4155C/4156C” on page 10-74.

Figure 10-32 Using Desktop EasyEXPERT



NOTE

Desktop EasyEXPERT supports most B1500A/EasyEXPERT functions. However, some functions are not supported on an external computer due to differences in hardware and so on.

System Requirements

The following are the minimum requirement for executing Desktop EasyEXPERT revision A.03.20 or later.

| | | |
|-----------------------------------|---|--------------------------------------|
| Operating system and service pack | Microsoft Windows XP Professional SP2 | Microsoft Windows Vista Business SP1 |
| Processor | Intel Celeron 2 GHz | Vista certified PC with 1 GB memory |
| Memory | 512 Megabytes DDR266 | |
| Display | XGA 1024×768 (SXGA 1280×1024 recommended) | |
| HDD | 1 GB free space on the C drive, 10 GB (30 GB recommended) free space on a drive for test setup/result data storage. | |
| .NET Framework | Microsoft .NET Framework Ver 2.0 Redistributable Package Microsoft .NET Framework 2.0 SP1 | Microsoft .NET Framework Ver 3.0 |
| GPIB interface | Agilent 82350B GPIB interface, for Online execution | |
| IO libraries | Agilent IO Libraries Suite 15.0, for Online execution | |

NOTE

If your computer does not install a software, install the software in the above order. For example, if your computer does not install Microsoft .NET Framework 2.0 SP1, install it and Agilent IO Libraries in this order. If you do not use the Online execution mode, you do not need to install the IO Libraries.

Prepare the Agilent IO Libraries software CD-ROM provided with Agilent GPIB interface to install the IO Libraries.

Open the Desktop EasyEXPERT Prerequisites folder to get installation packages for the other required software.

To Install Desktop EasyEXPERT

To install Desktop EasyEXPERT onto your computer, follow the procedure below.

1. Insert the Desktop EasyEXPERT software CD-ROM into the CD-ROM drive.
2. Execute Setup.exe and follow the instructions of the setup wizard.
3. Wait for installation to complete, and remove the CD-ROM from the CD-ROM drive.

NOTE

To set the same module configuration as B1500A

The module configuration of the B1500A can be set to the Desktop EasyEXPERT in the offline mode. Copy the following file on the B1500A internal HDD to the same location on the PC which the Desktop EasyEXPERT runs.

```
\Documents and Settings\All Users\Application Data\Agilent  
Technologies, Inc\EasyEXPERT\UnitConfigB1500A.xml
```

Before Starting Desktop EasyEXPERT

Note the following when you use Desktop EasyEXPERT.

- When using the Offline mode, use the data import/export function to transfer your test setup data files and test result records.
- When using the Online mode, do not send a control command to the analyzer (B1500A, 4155B, 4156B, 4155C, or 4156C) by using a programming environment except for Desktop EasyEXPERT.
- Do not send a control command to the analyzer by using the GPIB IO statement in the application test definitions.
- To control the B1500A by using Desktop EasyEXPERT, exit EasyEXPERT on B1500A. The Start EasyEXPERT window (button) must be displayed or be minimized to the Windows task bar on the B1500A screen.

To Start Desktop EasyEXPERT

To launch Desktop EasyEXPERT, follow the procedure below.

1. Double click the Start EasyEXPERT icon or click Start > All Programs > Start EasyEXPERT. The Execution Mode dialog box is displayed.
2. Select the execution mode, Online or Offline.
If you select the Online mode, set the GPIB configuration. See “Execution Mode dialog box” on page 10-71.
3. Click the OK button. The Start EasyEXPERT window is displayed.
4. Click the Start EasyEXPERT button to launch Desktop EasyEXPERT.

Execution Mode dialog box

The Execution Mode dialog box provides the following graphical user interface.

Online

Click the Online radio button to select the online execution mode. Then the following fields are available.

| | |
|--------------------------|---|
| VISA interface ID | VISA interface ID of the GPIB interface installed in your computer. Select one from the pop-up menu. |
| GPIB address | GPIB address of the analyzer (B1500A, 4155B, 4156B, 4155C, or 4156C). Select one from the pop-up menu. 0 to 30 are available. |

Offline

Click the Offline radio button to select the offline execution mode. And select the analyzer assumed by the Desktop EasyEXPERT in the offline mode.

| | |
|--------------|---|
| Model | Select B1500A, 4155B, 4156B, 4155C, or 4156C. |
|--------------|---|

NOTE

@ANALYZER Function

This function returns the present Model setting. It can be used in the application test definitions. The return value can be read by using a string variable (e.g. String1) as shown below.

Example: String1=@ANALYZER

The return value is B1500A, 4155B, 4156B, 4155C, or 4156C.

Start EasyEXPERT window

The Start EasyEXPERT window provides the following graphical user interface.

Start EasyEXPERT This button launches Desktop EasyEXPERT.

File menu *Exit* closes the Start EasyEXPERT window.

Option menu *Execution Mode* opens the Execution Mode dialog box.

EasyEXPERT Database provides the following three functions.

- *Backup EasyEXPERT Database*

Opens the EasyEXPERT Database Backup Creation Wizard used to make backup of the EasyEXPERT database. You can make backup easily by following the wizard. Required time depends on the database size.

- *Restore EasyEXPERT Database*

Opens the EasyEXPERT Database Restoration Wizard used to restore the EasyEXPERT database backup. You can restore the backup easily by following the wizard. Required time depends on the database size.

- *Move EasyEXPERT Database*

Opens the EasyEXPERT Database dialog box used to move the EasyEXPERT database. To move the database, enter the destination folder name into the Move To field. For example, enter C:\EasyEXPERT_user_1\database.

EasyEXPERT Database is the folder used to store your test setup data and such.

To Change Execution Mode and GPIB Settings

To change the Desktop EasyEXPERT execution mode or the GPIB configuration, follow the procedure below.

1. Launch Start EasyEXPERT.

If the Execution Mode dialog box is not opened, click Option > Execution Mode.

If Desktop EasyEXPERT is running, exit it. And in the Start EasyEXPERT window, click Option > Execution Mode.

2. Select the execution mode, Online or Offline.

If you select the Online mode, set the GPIB configuration. See “Execution Mode dialog box” on page 10-71.

3. Click the OK button to set the changes.

Click the Cancel button to cancel the setup changes.

To Move the EasyEXPERT Database

When the HDD (hard disk drive) is full, add a humongous HDD and move the EasyEXPERT database to it. To move the database, follow the procedure below. Required time depends on the database size.

1. Launch Start EasyEXPERT.

If the Execution Mode dialog box is opened, click the Cancel button.

If Desktop EasyEXPERT is running, exit it to open the Start EasyEXPERT window.

2. Click Option > EasyEXPERT Database > Move EasyEXPERT Database. The EasyEXPERT Database dialog box is displayed.

3. Enter the destination folder name into the Move To field. For example, enter C:\EasyEXPERT_user_1\database.

4. Click the OK button to start the database move operation.

Click the Cancel button to cancel the move operation.

Using 4155B/4156B/4155C/4156C

This section describes the notices when using Desktop EasyEXPERT and 4155/4156.

4155/4156 Firmware Revision

4155/4156 firmware revision supported by Desktop EasyEXPERT

- HOSTC: 03.08 or later
- SMUC: 04.08 or later

4155/4156 Functions

4155/4156 functions unsupported by Desktop EasyEXPERT

- Log sampling measurement and Thinned out sampling measurement
- Functions using R Box
- Differential voltage measurement using VMU (Voltage Monitor Unit)
- DC bias output using PGU (Pulse Generator Unit)
- Other functions unavailable for the B1500A

Desktop EasyEXPERT

Classic tests available for 4155/4156

- I/V Sweep, I/V-t Sampling, and Switching Matrix Control for 4155C/4156C
- I/V Sweep and Switching Matrix Control for 4155B/4156B

Desktop EasyEXPERT functions unavailable for 4155/4156

- Functions using SMU Series Resistor
- Functions using ASU (Atto Sense Unit)
- Functions using SCUU (SMU CMU Unify Unit)
- Functions using CMU (Capacitance Measurement Unit)
- Functions using SPGU (Semiconductor Pulse Generator Unit)

PGU can be used instead of SPGU for the I/V Sweep and I/V-t Sampling classic tests. The Load Z function and the ALWG output are not supported. The Output Impedance dialog box is available to set the output impedance of the PGU.

- Functions using WGFMU (Waveform Generator/Fast Measurement Unit) and RSU (Remote-sense and Switch Unit)

| | |
|----------------------------------|--|
| Calibration | Differences on Calibration window <ul style="list-style-type: none">• Calibration window provides Module Self Calibration screen only.• Module Self Calibration screen provides Enable Auto Calibration only. |
| Configuration, Main Frame | Differences on Configuration window Main Frame screen <ul style="list-style-type: none">• Line Frequency just displays the setting of 4155/4156.• Firmware Rev. displays as follows. [HOSTC Rev.]:[SMUC Rev.]:[ADC Rev.]• Main Frame Diagnosis is not supplied. |
| Configuration, Module | Differences on Configuration window Module screen <ul style="list-style-type: none">• Self-test cannot be performed.• Status, SCUU, and Notes columns are not supplied.• Start Self Test and Recover Module buttons are not supplied.• Accessory Configuration is not supplied. |
| I/V Sweep | Differences on I/V Sweep Classic Test <ul style="list-style-type: none">• Time Stamp Name field is not supplied for 4155B/4156B.• SMU Pulse Period and Width value must satisfy $\text{Period} \geq \text{Width} + 4 \text{ ms}$. |
| I/V-t Sampling | Differences on I/V-t Sampling Classic Test <ul style="list-style-type: none">• Log sampling is not supported.• Sampling interval must be 60 μs to 65.535 s.• Number of samples must be 1 to 10001.• Base hold time must be 0 sec. |
| ADC and Integration Time | Differences on A/D Converter & Integration Time Setup <ul style="list-style-type: none">• ADC always shows HR ADC.• High Resolution ADC is set as shown in Table 10-17. <p>For the sampling measurement of Interval < 2 ms, the Integration Time setting is ignored.</p> |

- Advanced Setup** Differences on Advanced Setup
- Series R always shows NONE.
 - Wait Time Control is not supplied.

- Restrictions for Standard Edition** There are the following restrictions for the Desktop EasyEXPERT Standard edition.
- I/V-t Sampling classic test is not supported.
 - VSU, VMU, and PGU are not supported.
 - Agilent E5250A Switching Matrix is not supported.

Table 10-17 Setting of High Resolution ADC

| Mode | Factor | Setting of 4155/4156 |
|--------|---------------------|-----------------------------------|
| AUTO | - | MEDIUM |
| MANUAL | $1 \leq N \leq 127$ | SHORT, TIME=80 μ s \times N |
| PLC | 1 | MEDIUM |
| | $N \geq 2$ | LONG, NPLC=N |

NOTE

To reuse the test setup for B1500A

Perform the following procedure to reuse the test setup created for the B1500A.

1. Launch Desktop EasyEXPERT with the condition *Set Analyzer=B1500A*.
2. Export the test setups to be reused. And exit Desktop EasyEXPERT.
3. Launch Desktop EasyEXPERT with the condition *Set Analyzer=4155B, 4156B, 4155C, or 4156C*.
4. Import the test setups exported at the step 2.
5. Set the channel for the analyzer to use.

Also, the procedure made by replacing the step 1 with the step 3 can be used to reuse the test setup created for the 4155/4156.