

**Agilent 4155C
Semiconductor Parameter
Analyzer
Agilent 4156C
Precision Semiconductor
Parameter Analyzer**

User's Guide



Agilent Technologies

Notices

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According to EN ISO/IEC 17050-1:2004



Manufacturer's Name: Agilent Technologies Singapore (International) Pte. Ltd.
Manufacturer's Address: No. 1 Yishun Ave 7
SINGAPORE 768923
Singapore

Declares under sole responsibility that the product as originally delivered

Product Name: Semiconductor Parameter Analyzer
Precision Semiconductor Parameter Analyzer
SMU and PGU Generator Expander
Model Number: Agilent 4155C
Agilent 4156C
Agilent 41501B
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 (2006/95/EC)
EMC Directive (2004/108/EC)

and conforms with the following product standards

EMC	Standard	Limit
	IEC 61326-1:2005 / EN 61326-1:2006	
	CISPR 11:2003 / EN55011:1998+A1:1999+A2 :2002	Group 1 Class A
	IEC 61000-4-2:2001 /EN 61000-4-2:1995+A1:1998+A2:2001	4 kV CD, 8 kV AD
	IEC 61000-4-3:2002+A1:2002/EN 61000-4-3:2002+A1:2002	3 V/m / 80 MHz-1 GHz / 1.4-2 GHz, 1 V/m / 2-2.7 GHz
	IEC 61000-4-4:2004 / EN 61000-4-4:2004	0.5 kV signal lines, 1 kV power lines
	IEC 61000-4-5:2001/EN 61000-4-5:1995+A1:2001	0.5 kV line-line, 1 kV line-ground
	IEC 61000-4-6:2003 / EN 61000-4-6:1996+A1:2001	3 V, 0.15-80 MHz
	IEC 61000-4-11:2004 / EN 61000-4-11:2004	0 % for 1/0.5 cycle, 0 % for 250/300 cycles, 70 % for 25/30 cycles
	Canada: ICES/NMB-001:2004	
	Australia/New Zealand: AS/NZS CISPR 11:2004	

Safety IEC 61010-1:2001 / EN 61010-1:2001
Canada: CAN/CSA-C22.2 No. 1010.1-92, NRTL/C

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

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

March 20, 2010

Date

川路 利行

Toshiyuki Kawaji

QA Manager
Agilent Technologies

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- **Herstellerbescheinigung**

GEÄUSCHEMISSION

Lpa < 70 dB

am Arbeitsplatz

normaler Betrieb

nach DIN 45635 T. 19

- **Manufacturer's Declaration**

ACOUSTIC NOISE EMISSION

Lpa < 70dB

operator position

normal operation

per ISO 7779

NOTE

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme à la 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.

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Safety Summary

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

NOTE

Agilent 4155C/4156C/41501B comply with INSTALLATION CATEGORY II for mains input and INSTALLATION CATEGORY I for measurement input terminals, and POLLUTION DEGREE 2 defined in IEC 61010-1.

Agilent 4155C/4156C/41501B are INDOOR USE products.

- *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.



ON (Supply).



OFF (Supply).



STANDBY (Supply).

CAT 1 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

The Agilent 4155C/4156C/41501B can force dangerous voltages (200 V for HPSMU, and 100 V for MPSMU) at the force, guard, and sense terminals. To prevent electric shock hazard, the following safety precautions must be observed during the use of the Agilent 4155C/4156C/41501B.

- Use a three-conductor AC power cable to connect cabinet (if used) and Agilent 4155C/4156C/41501B to an electric ground (safety ground).
- If you do not use Agilent 16442 Test Fixture, make sure to connect the INTLK terminal to a switch that turns off when the shielding box access door is opened.
- Confirm periodically that INTLK function works normally.
- Before touching the connections of the force, guard, and sense terminals, turn the Agilent 4155C/4156C/41501B off and discharge any capacitors whenever possible. If you do not turn the Agilent 4155C/4156C/41501B off, complete “all” of the following items, regardless of any Agilent 4155C/4156C/41501B settings.
 - Terminate measurement by pressing Output key, confirm that the Output status indicator is not lit.
 - Confirm that the HIGH VOLTAGE indicator is not lit.
 - Open the shielding box access door (open the INTLK terminal).
 - Discharge any capacitors if the capacitance is connected to an SMU.
- Warn workers in the vicinity of the Agilent 4155C/4156C/41501B about dangerous conditions.

高電圧感電注意

Agilent 4155C/4156C/41501B 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 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 4155C/4156C/41501B 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 4155C/4156C/41501B の INTLK 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を確認すること。
- 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。
 - Output キーを押して Output 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（INTLK 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; 100 Vdc) émanant du dispositif Agilent 4155C/4156C/41501B 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 4155C/4156C/41501B au moyen du câble d'alimentation tripolaire.
- En cas de hors service du dispositif d'essai, FIXTURE Agilent 16442, connecter les bornes de verrouillage (INTLK) 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 4155C/4156C/41501B. 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 "Output"; vérifier que l'indicateur "Output" 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 4155C/4156C/41501B 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 4155C/4156C/41501B folgendes zu beachten:

- Erden Sie das Kabinett (falls verwendet) sowie die Geräte Agilent 4155C/4156C/41501B mittels dreiadriger Netzleitungen.
- Wenn die Meßfassung, Agilent 16442, zwar angeschlossen, jedoch nicht verwendet wird, schließen Sie die Verriegelungsklemme (INTLK) 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 4155C/4156C/41501B aus, und entladen Sie alle Kapazitäten bevor Sie die Anschlüsse "Force, Guard und Sense" berühren. Falls Sie die Geräte Agilent 4155C/4156C/41501B nicht ausschalten, führen Sie unabhängig von den Geräteeinstellungen folgende Schritt durch:
 - Beenden Sie die gegenwärtige Messung durch Drücken der Output Taste (die Output Leuchtdiode erlischt).
 - Vergewissern Sie sich daß die Hochspannungswarnlampe erloschen ist.
 - Öffnen Sie den Deckel der Meßfassung Agilent 16442 (die Verriegelungsklemme (INTLK) öffnen).
 - Entladen Sie alle an SMUs angeschlossenen Kondensatoren (falls vorhanden).
- Informieren Sie Personen in unmittelbarer Nähe der Geräte Agilent 4155C/4156C/41501B über die Gefährlichkeit der bestehenden Hochspannung, und sichern Sie den Zugang zum Prüfplatz zum Schutz Dritter.

In This Manual

This manual provides information and instructions for installation, file operation, printer/plotter function, and what unrelated to the measurement and analysis, and consists of the following chapters. For the information about the measurement and analysis, refer to *User's Guide: Measurement and Analysis*.

- **Introducing the 4155C/4156C**
This chapter describes overview of the 4155C/4156C.
- **Installation**
This chapter describes how to install the 4155C/4156C, accessories, and peripherals.
- **Connecting to Network**
This chapter describes how to connect the 4155C/4156C to the network.
- **File Operations**
This chapter describes how to store or load the 4155C/4156C setup and measurement data.
- **Print/Plot Function**
This chapter provides information about the print/plot function.
- **External Keyboard**
This chapter provides softkey maps and information about using an external keyboard (furnished with the 4155C/4156C).
- **Initial Settings**
This chapter provides information about user defined initial settings and default initial settings.
- **Specifications**
- **Accessories and Options**

Other Manuals

The following Agilent 4155C/4156C manuals are also available:

- User's Guide Measurement and Analysis

This manual provides information about measurement and analysis by using the 4155C/4156C, and consists of the following chapters:

- Sweep Measurements
 - Knob Sweep Measurements
 - Sampling Measurements
 - Quasi-static C-V Measurements
 - Stress Force
 - Analyzing Measurement Results
 - Measurement Units and Functions
 - Support Functions
 - Data Variables and Built-in Functions
 - Connecting Measurement Devices
- Setup Screen Reference

This manual is a reference of the setup screens of the 4155C/4156C.

- Programmer's Guide

This manual provides information about controlling the 4155C/4156C by remote control command via GPIB interface and Instrument BASIC, and consists of the following chapters:

- Using Instrument BASIC
- 4155C/4156C SCPI Programming
- 4155C/4156C FLEX Programming
- Running 4145A/B Program Directly on the 4155C/4156C
- ASP-Like IBASIC Programming

- **GPIB Command Reference**

This manual is a complete reference of the 4155C/4156C FLEX Command Set and the 4145B Syntax Command Set.

- **SCPI Command Reference**

This manual is a complete reference of the 4155C/4156C SCPI (Standard Commands for Programmable Instruments) Command Set.

- **Sample Application Programs Guide Book**

This manual introduces application measurement examples using the 4155C/4156C and the sample application program disk furnished with the 4155C/4156C.

- **VXIplug&play Driver User's Guide**




This manual provides information about VXIplug&play driver for the 4155C/4156C. This manual also introduces an application measurement example using the 4155C/4156C and the VXIplug&play driver.

- **If You Have a Problem**



This manual provides problem-solving information that you may encounter when using the 4155C/4156C.

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Introducing the 4155C/4156C

Introducing the 4155C/4156C

Agilent 4155C/4156C is an electronic instrument for measuring and analyzing the characteristics of semiconductor devices. This one instrument allows you to perform *both* measurement *and* analysis of measurement results.

Following is summary of Agilent 4155C/4156C features.

- Measurement Capabilities

The 4155C/4156C has four highly accurate source/monitor units (SMUs), two voltage source units (VSUs), and two voltage measurement units (VMUs). The 4156C is designed for Kelvin connections and has high-resolution SMUs (HRSMUs), so the 4156C is especially suited for low resistance and low current measurements. You can measure voltage values with a resolution of 1 μV by using the differential measurement mode of VMUs.

The 4155C/4156C can perform three types of measurements, sweep measurement, sampling measurement, and quasi-static C-V measurement. The 4155C/4156C also provides knob sweep measurement function for quick sweep measurements executed by rotating the rotary knob on the front panel.

The 4155C/4156C can perform *stress* testing. That is, can force a specified dc voltage or current for the specified duration. Also, you can force ac stress by using pulse generator units (PGUs), which are installed in Agilent 41501A/B SMU/Pulse Generator Expander.

- Analysis Function

The 4155C/4156C provides a marker and two lines for analyzing the measurement results. The 4155C/4156C also provides the automatic analysis function which moves marker and lines at desired location and displays desired calculation results automatically after measurement is completed.

- Data storing

The 4155C/4156C allows you to store measurement setup information, measurement data, and instrument setting information on a 3.5-inch diskette using the built-in flexible disk drive, or on a NFS server via LAN.

The allowable disk formats are MS-DOS and HP LIF.

You can also use internal memory for temporary data storage. You can save up to four files in internal memory. You can quickly move information between the internal memory and the 4155C/4156C working memory.

- Printing and plotting

The 4155C/4156C allows you to print the setup data, measurement results and screen images on a printer or plotter that is connected to the 4155C/4156C via GPIB interface, or parallel I/O interface. The 4155C/4156C can also store a TIFF, PCL, or HP-GL file.

You can also use a remote printer via LAN to make hardcopies.

- Remote control

The 4155C/4156C can be controlled by an external controller via GPIB by using remote control commands. The 4155C/4156C provides the following command sets, so you can select the command set suitable for your application.

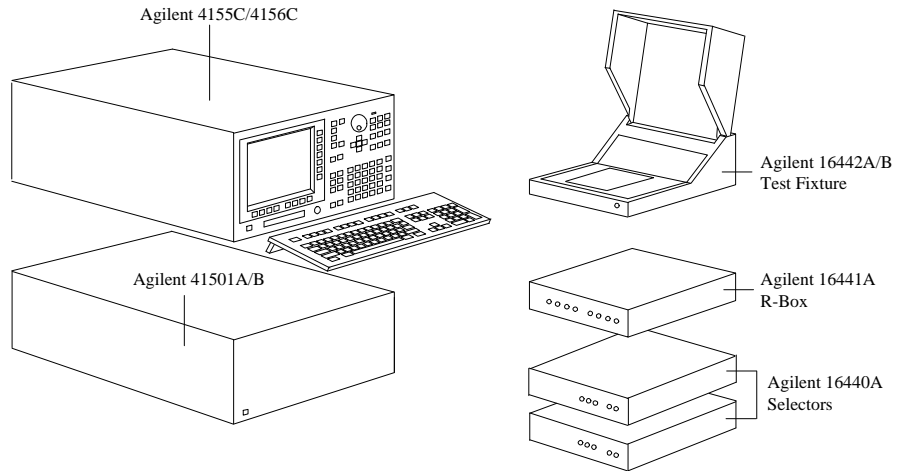
- 4155C/4156C SCPI (Standard Commands for Programmable Instruments) command set
- 4155C/4156C FLEX (Fast Language for Execution) command set
- 4145B syntax command set

Also the 4155C/4156C has internal Instrument BASIC, so you can develop and execute measurement programs by using the 4155C/4156C only, without using an external controller.

- Agilent E5250A control

The 4155C/4156C enables to control the E5250A Low Leakage Switch Mainframe with the E5252A Switching Matrix using the setup screens. You can control the E5250A without an external computer and programs.

Overview



The 4155C/4156C is a box type electronic measurement instrument with LCD display, flexible disk drive, operation keys, and interface connectors.

- Keyboard

You can connect a keyboard to the 4155C/4156C. So, you can operate this instrument by using a keyboard or the front-panel keys.

- Agilent 41501A/B SMU/Pulse Generator Expander

The 41501A/B SMU and Pulse Generator Expander contains pulse generator units (PGUs) and additional SMUs. The 41501A/B is attached to and controlled by the 4155C/4156C.

- Test Fixture

Agilent 16442A/B is the test fixture for the 4155C/4156C. You can mount your device under test (DUT) on the 16442A/B, and measure the device characteristics.

- Resistor Box

Agilent 16441A R-Box contains accurate 10 k Ω , 100 k Ω , and 1 M Ω resistors, and connection of these resistors is controlled by the 4155C/4156C. The 16441A is used to measure negative resistance and to prevent DUT damage when performing breakdown measurements.

- SMU/PGU Selector

Agilent 16440A SMU/Pulse Generator Selector contains two switching circuits to connect the DUT to either an SMU or PGU. You can attach another 16440A to add two more switching circuits.

Measurement Unit Configurations

Agilent 4155C, 4156C, and 41501A/B are frames that contain the measurement units. The measurement units are installed before the product is shipped from factory. User cannot reconfigure the installed units.

- Agilent 4155C configuration:
 - four medium power source monitor units (MPSMUs).
 - two voltage source units (VSUs).
 - two voltage monitor units (VMUs).
- Agilent 4156C configuration:
 - four high resolution source monitor units (HRSMUs).
 - two voltage source units (VSUs).
 - two voltage monitor units (VMUs).

The 4156C has higher measurement resolution. For details about measurement range and resolution, refer to *User's Guide: Measurement and Analysis*.

- Agilent 41501A/B configuration:

The 41501A/B is attached to the 4155C/4156C at your site. See Chapter 2 on how to install the 41501A/B.

The 41501A/B contains a ground unit (GNDU). In addition, you specify an option number according to desired units as follows:

Table 1-1

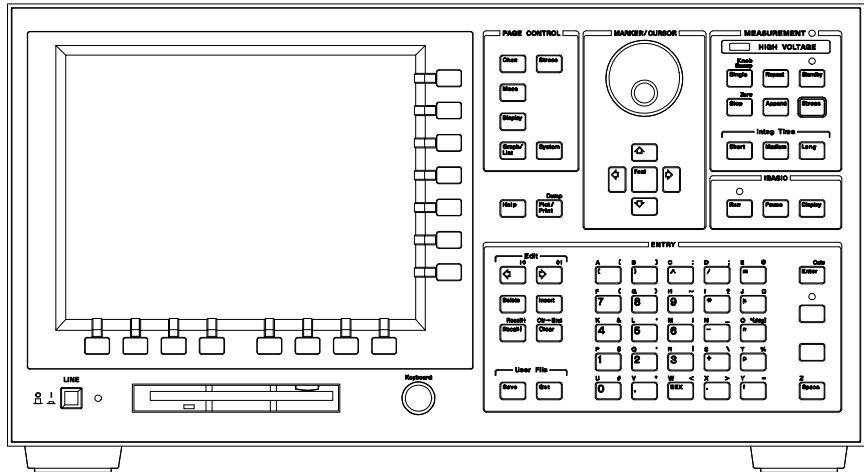
Configuration of the 41501A/B

Unit	Agilent 41501A/B Option Item				
	402	410	412	420	422
One GNDU	yes	yes	yes	yes	yes
Two PGUs	yes		yes		yes
Two MPSMUs				yes	yes
One HPSMU ^a		yes	yes		

a. HPSMU: high power source monitor unit

Front View of the 4155C/4156C

Figure 1-1 Front View of the 4155C/4156C



- **LINE switch**
Use the LINE switch to turn analyzer on and off.
- **Display**
8.4 inch diagonal color active matrix LCD. 640 dot (H) by 480 dot (V).
The flat panel display uses an LCD panel. More than 99.99 % of the pixels in an LCD are active. Inactive pixels less than 0.01 % do not indicate a defect.
- **Flexible disk drive (FDD)**
Use 3.5 inch diskette to load or store the analyzer settings and measurement data.
- **Keyboard connector**
You can use an IBM PC/AT compatible keyboard to operate the 4155C/4156C. See Chapter 6.
- **Help key**
Pressing Help key displays the *help* screens.

Introducing the 4155C/4156C

Front View of the 4155C/4156C

- Plot/Print key

Pressing Print/Plot key prints the setup information and measurement results to your plotter, printer, or file, TIFF, PCL, or HP-GL file.

If you press green key and Print/Plot key, the screen image is dumped to plotter, printer, or file.

- PAGE CONTROL key group

Page Control keys are used to change the display screens.

Chan key Moves to CHANNELS screen group. You define channels, user functions, and user variables.

Meas key Moves to MEASURE screen group. You set the output parameters, measurement parameters, and so on.

Display key Moves to DISPLAY screen group. You set the result display format, auto analysis definitions, and so on.

Graph/List key Moves to GRAPH/LIST screen group. This softkey toggles between GRAPH and LIST screens.

Stress key Moves to STRESS screen group. You define the stress channels, set the stress parameters, and monitor the stress forcing.

System key Moves to SYSTEM screen group. You operate on diskette files, set up plotting and printing environment, define colors of the display, and so on.

- MARKER/CURSOR key group

Rotary knob and arrow keys of the Marker/Cursor key group are used to move the marker and cursor.

Rotary knob Moves the marker, or increases or decreases setup value.

Arrow keys Up, Down, Left, and Right. Moves field pointer or cursor.

Fast key Moves the marker or cursor faster. When you rotate the rotary knob or press the arrow keys with holding Fast key down, the marker or cursor moves faster.

- MEASUREMENT key group

Measurement keys control the measurement, stress, and integration time.

Single key	Executes the measurement once, then returns to the idle state (or standby state if standby is enabled for the channel) after the measurement is finished. Measurement data is updated, so data of previous measurement is lost. Pressing the green key, then Single key starts knob sweep measurement.
Repeat key	Starts and repeats the measurement continuously. Measurement data is updated, so data of previous measurement is lost. To stop the measurement, press Stop key.
Append key	Executes the measurement once, then returns to idle state (or standby state if standby is enabled for the channel) after measurement is finished. Measurement data is appended to data of previous measurement.
Stop key	Stops the measurement or stress. Standby enabled channels return to standby state, and other channels return to idle state.
Standby key	Toggles between the standby enabled (Standby indicator is lit) and disabled states. If Standby indicator is lit, then STBY ON channels change to standby state (instead of idle state) when measurement or stress finishes. Stop key has no affect on standby state.
Stress key	Forces the specified stress. The guide around this key prevents you from accidently pressing the Stress key.
Short, Medium, and Long keys	Sets the integration time to SHORT, MEDIUM, or LONG, respectively.

- MEASUREMENT indicator

This indicator lights when the 4155C/4156C is in the measurement state.

- HIGH VOLTAGE indicator

This indicator lights when a unit forces more than 40 V.

Introducing the 4155C/4156C

Front View of the 4155C/4156C

- Standby indicator

This indicator lights when the 4155C/4156C is standby enabled, which means that the channels that are standby enabled (STBY ON) will return to the standby state after the measurement is finished.

- IBASIC key group

IBASIC keys control the IBASIC program execution.

Run key Starts the IBASIC program that is in memory. The indicator is on during program execution.

Pause key Pauses the IBASIC program execution.

Display key Toggles between the IBASIC screen and measurement screen.

- Run indicator

When an IBASIC program is running, this indicator lights.

- ENTRY key group

You enter or modify data such as output values, comments, and variable names.

Character keys Are used to enter alphanumeric and special characters.

Enter key After you enter desired characters into the data entry field, press this key. The characters are entered at the field pointer location. Also, you can use the green key to calculate the value of the data entry field. For example, if you press 4 * 6 green key and Enter key, the result (24) appears.

Blue key Changes entry mode to blue-key shift mode, and lights the indicator. In this mode, you can enter the blue characters that are printed above the keys. Pressing blue key again changes to normal mode. Indicator turns off.

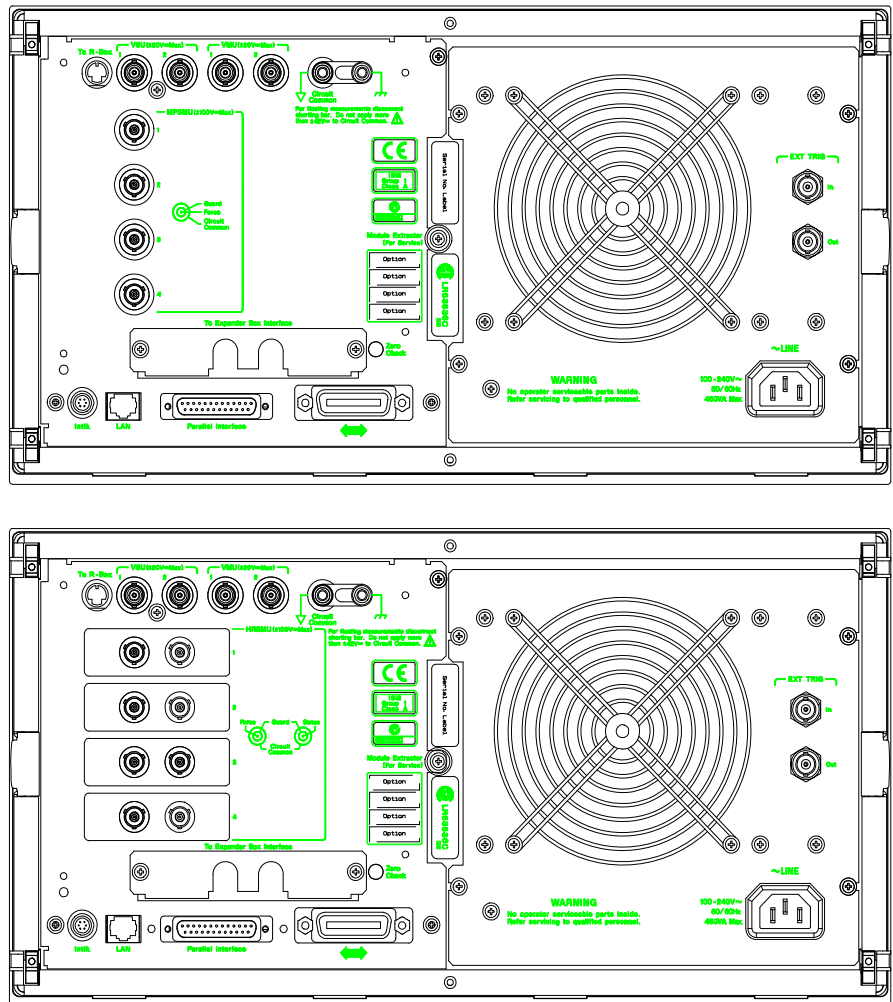
Green key Changes entry mode to green-key shift mode. This mode is effective for the next pressed key, then changes back to normal mode.

Edit keys Are used to edit the characters in the data entry field.

User File keys Are used to operate quickly on a file in diskette, internal memory or a directory on a NFS server. Pressing Save key moves into the filer's SAVE function, and pressing Get key moves into the filer's GET function.

Rear View of the 4155C/4156C

Figure 1-2 Rear View of the 4155C/4156C



Introducing the 4155C/4156C

Rear View of the 4155C/4156C

- To R-Box terminal

"To R-Box" terminal is a 10-pin connector. To use R-Box, connect this terminal to control terminal of Agilent 16441A R-Box.

- VSU terminals

VSU output terminals are BNC connectors. To use VSUs, connect these terminals to VSU terminals of Agilent 16442A/B or connector plate.



- VMU terminals

VMU input terminals are BNC connectors. To use VMUs, connect these terminals to VMU terminals of the 16442A/B or connector plate.

- SMU terminals

The 4155C has four triaxial connectors. The 4156C has eight triaxial connectors, and you can use Kelvin connections. When you use the 16442A/B test fixture and Kelvin connections, up to 3 SMUs can be connected to the 16442A/B test fixture.



- 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 4155C/4156C.

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.

- To Expander Box Interface

When you use Agilent 41501A/B, you insert the board for the 41501A/B into this interface.

- Zero Check terminal

Ground reference point of the 4155C/4156C.

CAUTION

The Zero Check terminal can be used for the service purpose only. For the normal operation, leave this terminal open and do not connect anything to this terminal. Connecting anything can damage the 4155C/4156C.



- Intlk terminal
Used in conjunction with interlock function of the 4155C/4156C. If the Intlk terminal is open, maximum SMU output is limited to 40 V. Be sure to connect this terminal to the 16442A/B test fixture or connector plate before performing measurement. If you use connector plate, you must install interlock circuit. For details on how to install the interlock circuit, see “To Make an Interlock Circuit” in Chapter 2.

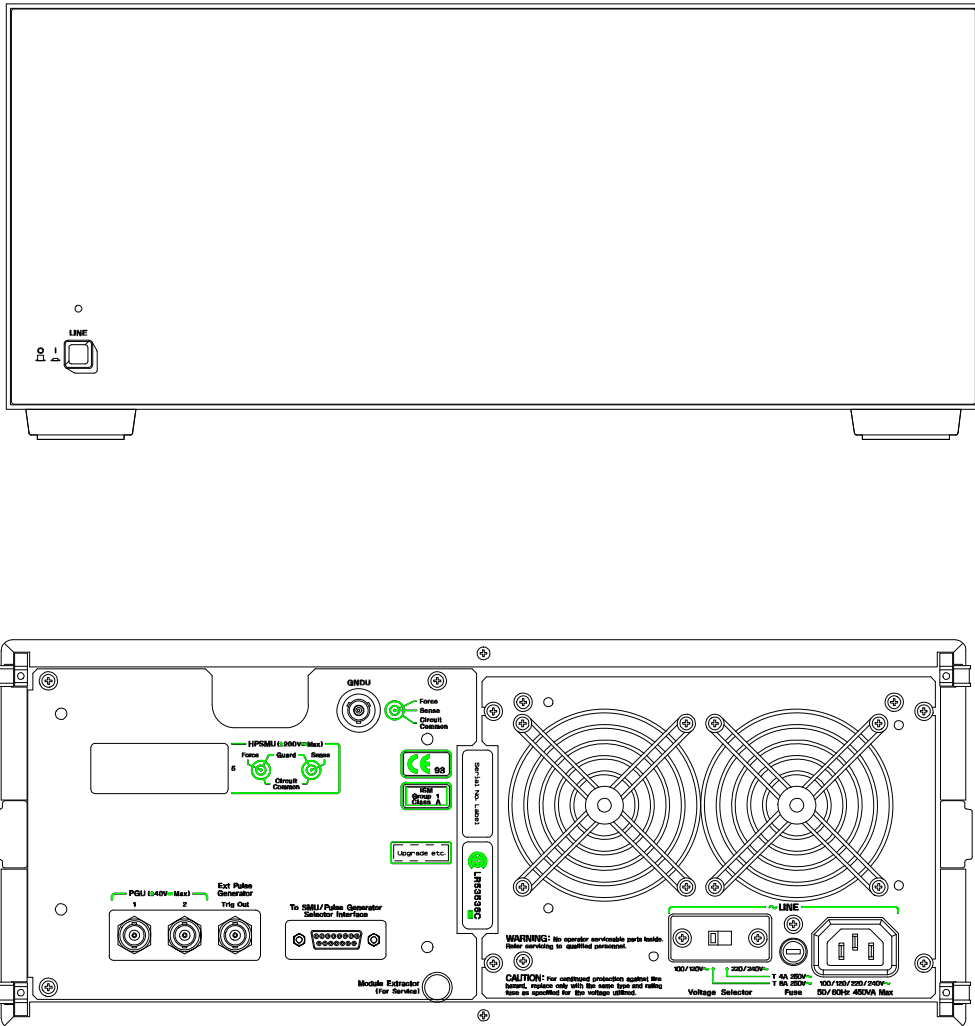
WARNING

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

- LAN interface
RJ45 connector. Ethernet IEEE 802.3 10BASE-T for a 10M bps CSMA/CD local area network.
The 4155C/4156C can be a NFS cluster, and can use a remote printer to make hardcopies.
- Parallel interface
25-pin parallel I/O interface port for connecting peripheral such as a Centronics parallel printer.
- GPIB interface
Use Agilent 10833A/B/C/D GPIB cable.
- Ext Trig terminals
Two BNC connectors: one for trigger input, and one for trigger output.
- LINE input receptacle
AC power cable is connected to this receptacle.
- Serial number
You need this *serial number* when using the telephone assistance program (Agilent Technologies HelpLine).

Front and Rear View of the 41501A/B

Figure 1-3 Front and Rear View of the 41501A





- LINE switch

Use the LINE switch to turn the 41501A/B on and off. *You must turn on the 41501A/B before turning on the 4155C/4156C.*

- Fuse (only for 41501A)

Use the following fuse:

Line	Fuse type	Agilent part number
100/120 Vac	UL/CSA T 8A, 250 Vac	2110-0383
220/240 Vac	UL/CSA T 4A, 250 Vac	2110-0014

- Voltage Selector (only for 41501A)

Voltage selector must be in proper position. Line voltage and position are:

Line Voltage	Position
90 — 132 Vac	left
198 — 264 Vac	right

- LINE input receptacle

AC power cable is connected to this receptacle.

- Serial number

The 41501A/B has its own serial number. You need this *serial number* when using the telephone assistance program (Agilent Technologies HelpLine).

- GNDU connector

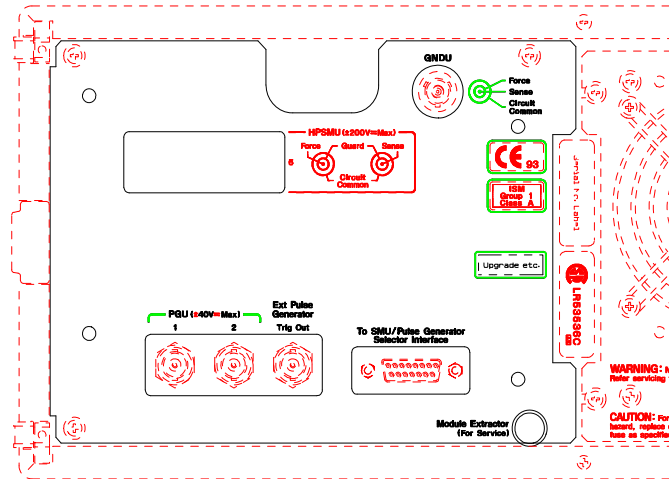
The GNDU connector is a triaxial connector: inner conductor is sense, middle conductor is force, and outer conductor is circuit common.

41501A/B-402

41501A/B-402 has two PGUs.

Figure 1-4

Rear View of 41501A/B-402



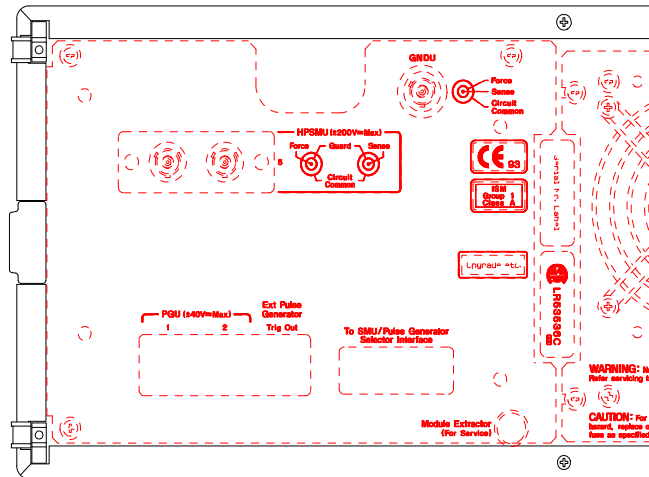
- PGU output terminals
BNC connectors. Inner conductor is force and outer conductor is circuit common.
- Ext Pulse Generator Trig Out terminal
Trigger pulses synchronized with PGU pulses are output. This trigger is used to synchronize the PGU pulse outputs with external pulse generators. You *cannot* change the parameters of this trigger. For details about PGU trigger, see *User's Guide: Measurement and Analysis*.
- To SMU/Pulse Generator Selector Interface
D-SUB 15-pin connector is used to control the 16440A SMU/pulse generator selector.

41501A/B-410

41501A/B-410 has one HPSMU.

Figure 1-5

Rear View of 41501A/B-410



- HPSMU terminals

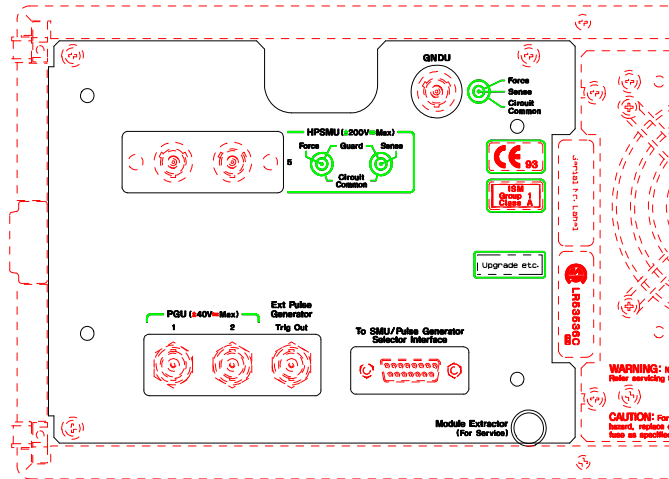
There are two triaxial connectors for Kelvin connections: one is for force and the other is for sense. For SMU5.

41501A/B-412

41501A/B-412 has one HPSMU and two PGUs.

Figure 1-6

Rear View of 41501A/B-412



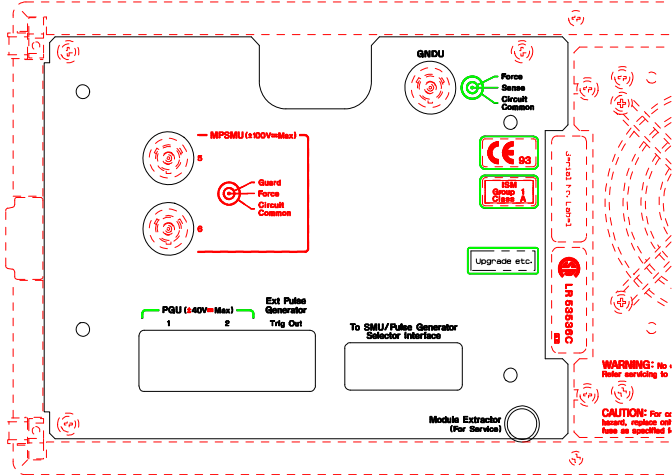
- HPSMU terminals
There are two triaxial connectors for Kelvin connections: one is for force and the other is for sense. For SMU5.
- PGU output terminals
BNC connectors. Inner conductor is force and outer conductor is circuit common.
- Ext Pulse Generator Trig Out terminal
Trigger pulses synchronized with PGU pulses are output. This trigger is used to synchronize the PGU pulse outputs with external pulse generators. You *cannot* change the parameters of this trigger. For details about PGU trigger, see *User's Guide: Measurement and Analysis*.
- To SMU/Pulse Generator Selector Interface
D-SUB 15-pin connector is used to control the 16440A SMU/pulse generator selector.

41501A/B-420

41501A/B-420 has two MPSMUs.

Figure 1-7

Rear View of 41501A/B-420



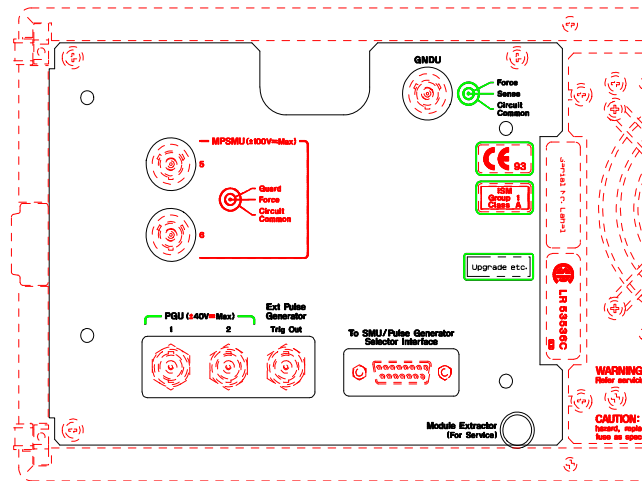
- MPSMU terminals
Two MPSMUs are installed and each MPSMU has a triaxial connector. These connectors are not designed for Kelvin connections. For SMU5 and SMU6.

41501A/B-422

41501A/B-422 has two MPSMUs and two PGUs.

Figure 1-8

Rear View of 41501A/B-422



- **MPSMU terminals**

Two MPSMUs are installed and each MPSMU has a triaxial connector. These connectors are not designed for Kelvin connections. For SMU5 and SMU6.
- **PGU output terminals**

BNC connectors. Inner conductor is force and outer conductor is circuit common.
- **Ext Pulse Generator Trig Out terminal**

Trigger pulses synchronized with PGU pulses are output. This trigger is used to synchronize the PGU pulse outputs with external pulse generators. You *cannot* change the parameters of this trigger. For details about PGU trigger, see *User's Guide: Measurement and Analysis*.
- **To SMU/Pulse Generator Selector Interface**

D-SUB 15-pin connector is used to control the 16440A SMU/pulse generator selector.

2

Installation

Installation

This chapter describes how to install Agilent 4155C/4156C and accessories.

- Requirements
- Inspection
- Connecting the 41501A/B
- Installing accessories
- Mounting connectors
- Connecting peripherals
- Maintenance



WARNING

There are potentially hazardous voltages (200 V for HPSMU, and 100 V for HRSMU and MPSMU) present at the Force, Guard, and Sense terminals of the 4155C/4156C. To prevent electrical shock, the following safety precautions must be observed during the use of the 4155C/4156C.

- Use a three-conductor ac power cable to connect the cabinet (if used) and the 4155C/4156C to an electrical ground (safety ground).
- If you do *not* use the 16442A/B test fixture, you must connect the Intlk terminal to a switch that turns off 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 4155C/4156C off and discharge any capacitors. If you do *not* turn the 4155C/4156C off, complete *all* of the following items, regardless of the 4155C/4156C settings.
 - Terminate measurement by pressing Stop key, confirm that the MEASUREMENT indicator is not lit.
 - Deactivate standby mode (if used) by pressing Standby key, confirm that the Standby indicator is not lit.
 - Confirm that the HIGH VOLTAGE indicator is not lit.
 - Open the shielding box access door (open the Intlk terminal).
 - Discharge any capacitors connected to an SMU.
- Warn persons working around the 4155C/4156C about dangerous conditions.

Requirements

This section contains information on:

- power requirements
- power cables
- line fuse and line voltage selectors (for the 41501A)
- ventilation requirements
- operating environment
- storing/shipping environment

Power Requirements

The 4155C/4156C can operate from any single-phase ac power source supplying 90 to 264 V at 47 to 63 Hz. The maximum power consumption is 450 VA for the 4155C/4156C/41501A, and 350 VA for the 41501B. For details, see Chapter 8.

Power Cable

CAUTION

Before applying ac line power to the 4155C/4156C or the 41501A/B, ensure that the correct power cable is used.




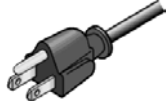




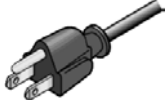
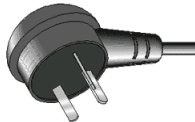




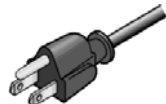

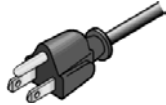
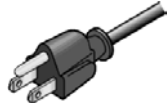
In accordance with international safety standards, this instrument is equipped with a three-prong power cable. When connected to an appropriate ac power outlet, this cable grounds the instrument frame. The type of power cable shipped with each instrument depends on the country of destination. Refer to the following table for the 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 Chapter 8)
- ground connection
- cable clamp

Installation Requirements

 <ul style="list-style-type: none"> • Plug: BS 1363/A, 250 V, 10 A • PN: 8120-4420 	 <ul style="list-style-type: none"> • Plug: AS 3112, 250 V, 10 A • PN: 8120-4419 	 <ul style="list-style-type: none"> • Plug: CEE 7 sheet VII, 250 V, 10 A • PN: 8120-4519 	 <ul style="list-style-type: none"> • Plug: NEMA 5-15P, 125 V, 10 A • PN: 8120-6825
 <ul style="list-style-type: none"> • Plug: NEMA 6-15P, 250 V, 10 A • PN: 8120-3996, 8120-0698 	 <ul style="list-style-type: none"> • Plug: SEV 1011, 250 V, 10 A • PN: 8120-2104 	 <ul style="list-style-type: none"> • Plug: SR 107-2-D1, 250 V, 10 A • PN: 8120-2956 	 <ul style="list-style-type: none"> • Plug: IS 1293 and IS 6538, 250 V, 10 A • PN: 8120-4211
 <ul style="list-style-type: none"> • Plug: JIS C 8303, 125 V, 12 A • PN: 8121-0743 	 <ul style="list-style-type: none"> • Plug: Israel SI 32, 250 V, 10 A • PN: 8120-5182 	 <ul style="list-style-type: none"> • Plug: IRAM 2073-10A, 250 V, 10 A • PN: 8120-6870 	 <ul style="list-style-type: none"> • Plug: CEI 23-16, 250 V, 10 A • PN: 8120-6978
 <ul style="list-style-type: none"> • Plug: GB 1002 figure 3, 250 V, 10 A • PN: 8120-8376 	 <ul style="list-style-type: none"> • Plug: SANS 164-1, 250 V, 10 A • PN: 8120-4211, 8121-0564 	 <ul style="list-style-type: none"> • Plug: TISI 166, 250 V, 10 A • PN: 8121-1866 	 <ul style="list-style-type: none"> • Plug: NBR 14136, 250 V, 10 A • PN: 8121-1809
 <ul style="list-style-type: none"> • Plug: CNS 10917-2, 125 V, 10 A • PN: 8120-6825, 8121-1635 	 <ul style="list-style-type: none"> • Plug: CS 0017:2003, 250 V, 10 A • PN: 8120-8871, 8121-1638 		

WARNING

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



Line Fuse and Line Voltage Selector for the 41501A

Before applying ac line power to the 41501A, verify that the correct line fuse is installed in the fuse holder and the line voltage selector is set correctly.

Line	Fuse Type	Agilent Part Number
100/120 Vac	UL/CSA T 8A, 250 Vac	2110-0383
220/240 Vac	UL/CSA T 4A, 250 Vac	2110-0014

WARNING

Replace the line fuse only with the same type and rating. Do *not* use repaired fuses, and do *not* short circuit the fuse holder.

The line voltage selector switch is set at the factory. Verify the voltage selector setting before applying ac line power to the 41501A. The line voltage selector switch is located on the rear panel of the 41501A

Line Voltage	Position
90 — 132 Vac	left
198 — 264 Vac	right

Ventilation Requirements

The 4155C/4156C has one cooling fan, and the 41501A/B has two 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.

Operating Environment

The 4155C/4156C and the 41501A/B are specified to operate within the following environmental conditions:

Temperature:	10 °C to 40 °C (with using flexible disk drive) 5 °C to 40 °C (without using flexible disk drive)
Humidity:	20 % to 80 % RH (with using flexible disk drive) 15 % to 80 % RH (without using flexible disk drive) non-condensing and wet bulb temperature 29 °C or below
Altitude:	0 to 2000 m

Storaging/Shipping Environment

The 4155C/4156C and the 41501A/B are specified to store/ship within the following environmental conditions:

Temperature:	-22 °C to 60 °C
Humidity:	5 % to 90 % RH, non-condensing and wet bulb temperature 39 °C or below
Altitude:	0 to 4600 m

Inspection

This section describes what to do when you receive the 4155C/4156C and accessories.

1. Inspect the shipment.
2. Verify the 4155C/4156C operation.

To maintain the 4155C/4156C and 41501A/B measurement accuracy specifications, perform calibration and adjustments once a year.

To Inspect the 4155C/4156C and Accessories

Perform the following inspections when the 4155C/4156C and accessories arrive at your site.

- 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.

- When you open the boxes that contain the 4155C/4156C 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 Check the 4155C/4156C Operation

1. Make sure that the LINE button is set to off.
2. If the 41501A/B will be used with the 4155C/4156C, connect the 41501A/B as shown in “Connecting the 41501A/B SMU/Pulse Generator Expander” on page 2-11.
3. On the 4155C/4156C rear panel, connect the Circuit Common terminal to the frame ground terminal by using a shorting-bar.

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.

4. Connect the power cable from the 4155C/4156C to an ac power outlet. If the 41501A/B will be used, connect the power cable from the 41501A/B to the outlet.
5. If the 41501A/B is installed, press the LINE button of the 41501A/B before pressing the LINE button of the 4155C/4156C.
6. Press the LINE button to turn on the 4155C/4156C.

The initialization screen will appear on the display of the 4155C/4156C. And the power-on self-test is automatically executed.

If no error message is displayed on the screen, the 4155C/4156C is operating correctly, and displays the CHANNELS: CHANNEL DEFINITION screen as shown in Figure 2-1.

If a problem occurs, see *If You Have a Problem* manual.

7. Make sure that the units displayed in the UNIT column match the units installed. Refer to Table 2-1 for the available units.

Table 2-1

Available Units of 4155C/4156C and 41501 Expander

4155C	4156C	Additional units by 41501A/B option item				
		402	410	412	420	422
SMU1:MP	SMU1:HR	PGU1	SMU5:HP	SMU5:HP	SMU5:MP	SMU5:MP
SMU2:MP	SMU2:HR	PGU2	GNDU	PGU1	SMU6:MP	SMU6:MP
SMU3:MP	SMU3:HR	GNDU		PGU2	GNDU	PGU1
SMU4:MP	SMU4:HR			GNDU		PGU2
VSU1	VSU1					GNDU
VSU2	VSU2					
VMU1	VMU1					
VMU2	VMU2					

Figure 2-1

CHANNELS: CHANNEL DEFINITION Screen

CHANNELS: CHANNEL DEFINITION 01JAN10 07:05PM

*MEASUREMENT MODE

*CHANNELS

UNIT	MEASURE				STBY	SERIES RESISTANCE
	VNAME	INAME	MODE	FCTN		
SMU1:HR	V1	I1	COMMON	CONST		0 ohm
SMU2:HR	V2	I2	I	VAR2		
SMU3:HR	V3	I3	V	VAR1		
SMU4:HR	V4	I4	V	CONST		
SMU5:HP						0 ohm
VSU1	VSU1	-----	V	CONST		
VSU2	VSU2	-----	V	CONST		
VMU1	VMU1	-----	V	-----	----	DISCHARGE
VMU2	VMU2	-----	V	-----	----	ON
PGU1		-----				
PGU2		-----				
GNDU		-----				

SWEEP
 Select Measurement Mode with softkey or rotary knob. B

CHANNEL	USER	USER		S	E5250A				
DEF	FCTN	VAR			PROP				

To Set the Power Line Frequency

When the 4155C/4156C is shipped from the factory, the power line frequency is set to 60 Hz. To set the power line frequency correctly for your site, do following:

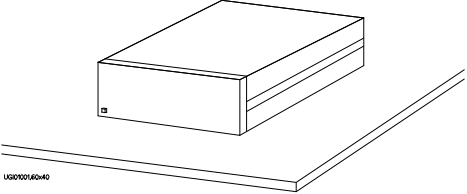
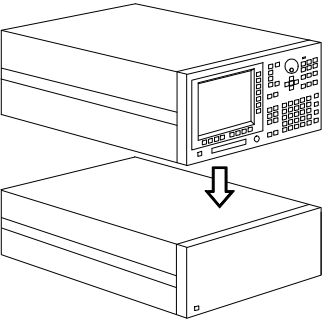
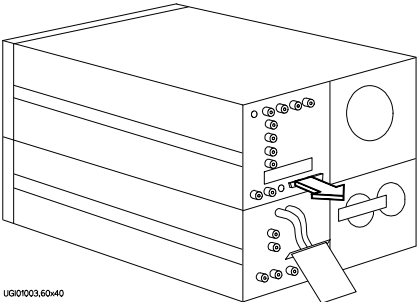
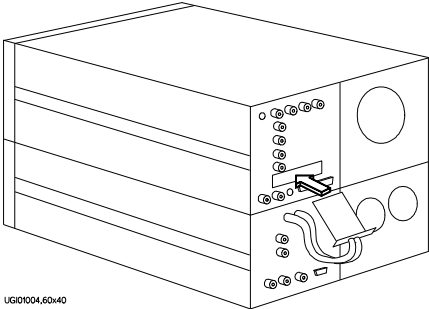
1. Turn on the 4155C/4156C. And wait until the CHANNELS: CHANNEL DEFINITION screen is appeared.
2. Press the **System** front-panel key, then select the MISCELLANEOUS primary softkey. The SYSTEM: MISCELLANEOUS screen is displayed.
3. Move the pointer to the POWER LINE FREQUENCY field, then select the 50 Hz or 60 Hz secondary softkey corresponding to the line frequency of your site.

To Execute Diagnostics and Self-calibration

You can execute diagnostics and/or self-calibration to verify the operation of the 4155C/4156C.

1. Disconnect all cables from the measurement terminals on the 4155C/4156C rear panel.
2. Press System key, then CALIB/DIAG softkey.
The SYSTEM: SELF-CALIBRATION/DIAGNOSTICS screen is displayed.
3. If you want to execute both diagnostics and self-calibration, select DIAG SELFTST ALL softkey.
4. If you want to execute self-calibration only, select CALIB ALL softkey.
5. To stop the diagnostics or self-calibration, select STOP softkey.

Connecting the 41501A/B SMU/Pulse Generator Expander

<p>1. Place the 41501A/B on your workbench.</p>	<p>2. Place the 4155C/4156C on top of the 41501A/B.</p>
 <p>UG010021,60v40</p>	 <p>UG010022,60v40</p>
<p>3. Remove the blank panel labeled "To Expander Box Interface" from the rear panel of the 4155C/4156C.</p>	<p>4. Insert the 41501A/B interface board into the 4155C/4156C, then attach it with the thumbscrews.</p>
 <p>UG010003,60v40</p>	 <p>UG010004,60v40</p>

WARNING

The 4155C/4156C, together with the 41501A/B, weights about 37 kg (81.8 lb). The 4155C/4156C is not anchored to the 41501A/B. Use caution when handling.

Installing Accessories

This section describes how to install the 4155C/4156C and accessories. Additional information regarding airflow can be found in the “Ventilation Requirements” on page 2-5.

This section describes how to:

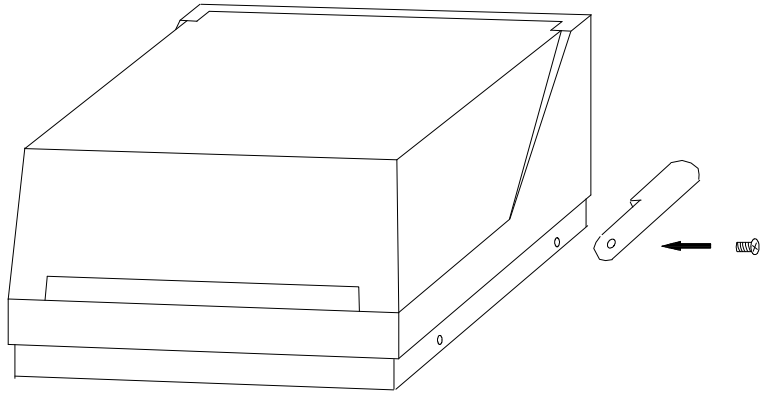
- install the 16442A/B test fixture
- install the 16441A R-box
- install the 16440A SMU/pulse generator selector
- connect the 16440A to the 4155C/4156C
- connect a measurement cable to a connector plate

When you install a keyboard, connect the keyboard to the keyboard interface on the front-panel *before* switching on the 4155C/4156C. The 4155C/4156C recognizes the keyboard during the power-on self-test.

To Install the 16442A/B Test Fixture

Before performing this procedure, turn off the 4155C/4156C and 41501A/B.

When you use the 16442A/B test fixture without the 16441A R-box or the 16440A selector, you can stabilize the 16442A/B as shown in the figure below.



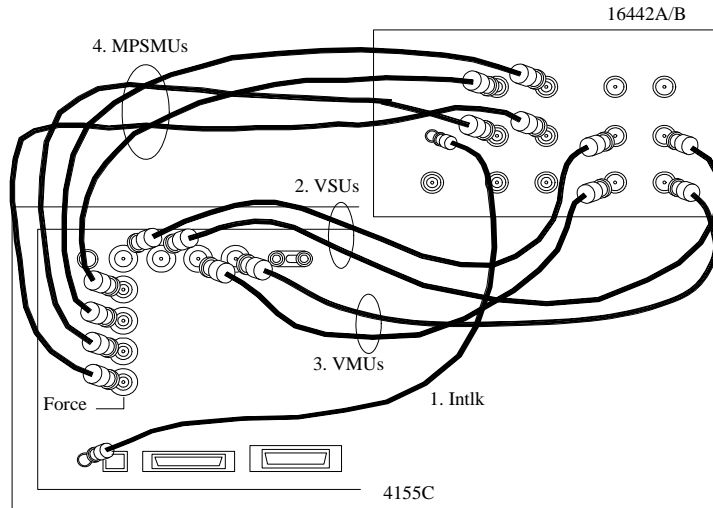
1. Put a stabilizer on both sides of the test fixture.
2. Attach each stabilizer to the unit with a flathead screw.

Connecting the 4155C and the 16442A/B test fixture

Connect the 4155C and the 16442A/B as shown below.

CAUTION

To prevent electrical shock during use, be sure to connect the interlock cable.



4155C Terminals	16442A/B Terminals	Cable
Intlk	Intlk	3 m or 1.5 m Interlock Cable
VSU	VSU	3 m or 1.5 m Coaxial Cable
VMU	VMU	3 m or 1.5 m Coaxial Cable
MPSMU	SMU	3 m or 1.5 m Triaxial Cable

WARNING

There are potentially hazardous voltages of up to ± 100 V at the Force and Guard terminals. To prevent electrical shock, do *not* expose these lines.

CAUTION

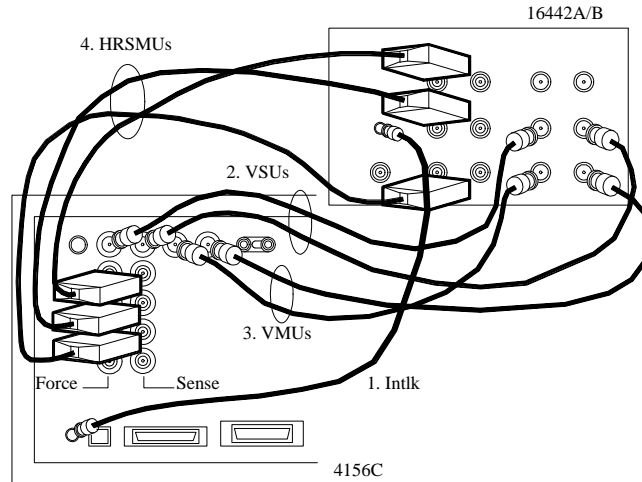
Never connect the Guard terminal to any output, including circuit common, frame ground, or any other guard terminal. Doing so will damage the SMU.

Connecting the 4156C and the 16442A/B test fixture

Connect the 4156C and the 16442A/B as shown below.

CAUTION

To prevent electrical shock during use, be sure to connect the interlock cable.



4156C Terminals	16442A/B Terminals	Cable
Intlk	Intlk	3 m or 1.5 m Interlock Cable
VSU	VSU	3 m or 1.5 m Coaxial Cable
VMU	VMU	3 m or 1.5 m Coaxial Cable
HRSMU	SMU1 and SMU2	3 m or 1.5 m Kelvin Triaxial Cable (for Kelvin connection) or 3 m or 1.5 m Triaxial Cable (for non-Kelvin connection)
	SMU3 and SMU4	
	SMU5 and SMU6	

WARNING

There are potentially hazardous voltages of up to ± 100 V at the Force, Sense, and Guard terminals. To prevent electrical shock, do *not* expose these lines.

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**Making non-Kelvin connection**

As same as the 4155C, 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.

Connecting the 41501A/B and the 16442A/B test fixture

Connect the 41501A/B measurement terminals to the 16442A/B input as follows:

41501A/B Terminals	16442A/B Terminals	Cable
GNDU	GNDU	3 m or 1.5 m GNDU Cable
PGU	PGU	3 m or 1.5 m Coaxial Cable
MPSMU	SMU	3 m or 1.5 m Triaxial Cable
HPSMU	SMU1 and SMU2	3 m or 1.5 m Kelvin Triaxial Cable (for Kelvin connection) or 3 m or 1.5 m Triaxial Cable (for non-Kelvin connection)
	SMU3 and SMU4	
	SMU5 and SMU6	

WARNING

Use Agilent 16493H GNDU cable to connect the GNDU to a test fixture or a connector plate. Do *not* use the triaxial cable. The GNDU cable is rated for up to 1.6 A, but the maximum current rating of the triaxial cable is 1 A.

WARNING

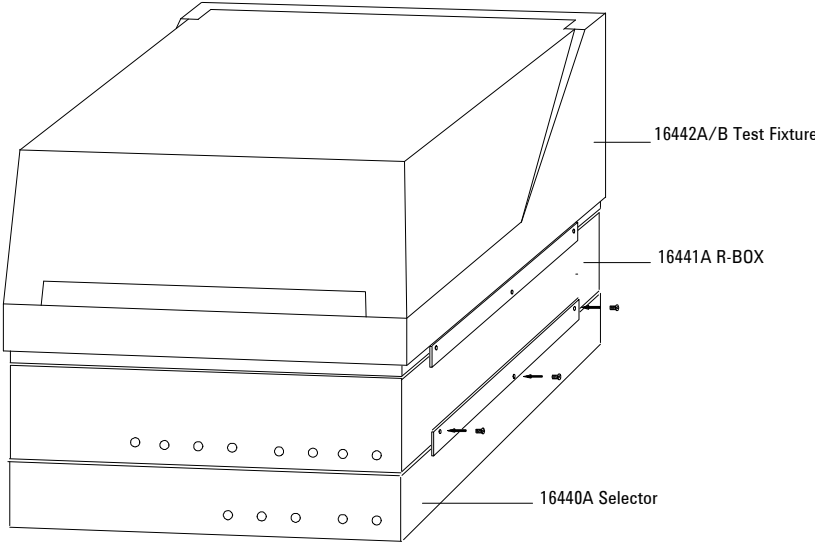
There are potentially hazardous voltages of up to ± 200 V at the Force, Sense, and Guard terminals. To prevent electrical shock, do *not* expose these lines.

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.

Installing the 16442A/B test fixture with other accessories

The 16442A/B test fixture can be installed with an 16441A R-box, 16440A selector, or both. The following figure shows how to attach the 16442A/B to other accessories.



To Install the 16441A R-Box

Before installing the 16441A R-box, turn off the 4155C/4156C and 41501A/B.

1. Connect the To R-Box terminal on the 4155C/4156C to the Control terminal on the 16441A rear panel using a 3.0 m or 1.5 m control cable.
2. Connect the instrument measurement terminals to the 16441A input terminals as follows:

Instrument terminals	16441A Input	Cable
4155C MPSMU	Input Force	3 m or 1.5 m Triaxial Cable
4156C HRSMU	Input (Force/Sense)	3 m or 1.5 m Kelvin Triaxial Cable
41501A/B MPSMU	Input Force	3 m or 1.5 m Triaxial Cable
41501A/B HPSMU	Input (Force/Sense)	3 m or 1.5 m Kelvin Triaxial Cable

3. Connect the 16441A output terminals to the 16442A/B input terminals, or to the connector plate input terminals, using 40 cm triaxial cables as shown below:

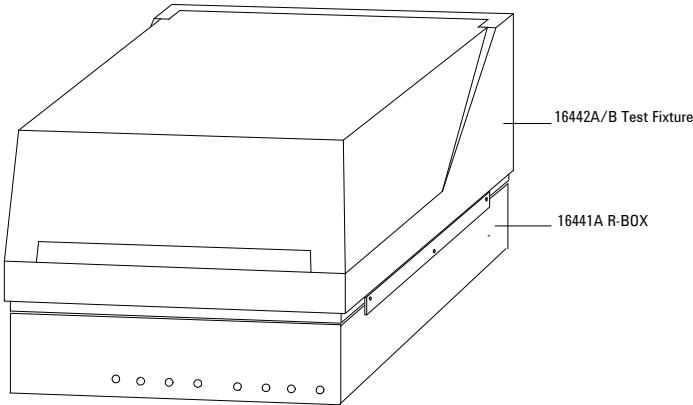
16441A Output	16442A/B Input or Connector Plate Input		
Output Force ^a	SMU1, 2, 3, 4, 5, or 6		
Output Force ^b	SMU1	SMU3	SMU5
Output Sense ^b	SMU2	SMU4	SMU6

- a. For non-Kelvin connection.
- b. For the Kelvin connection, two triaxial cables must be used to connect the 16441A and the 16442A/B, instead of a Kelvin triaxial cable.

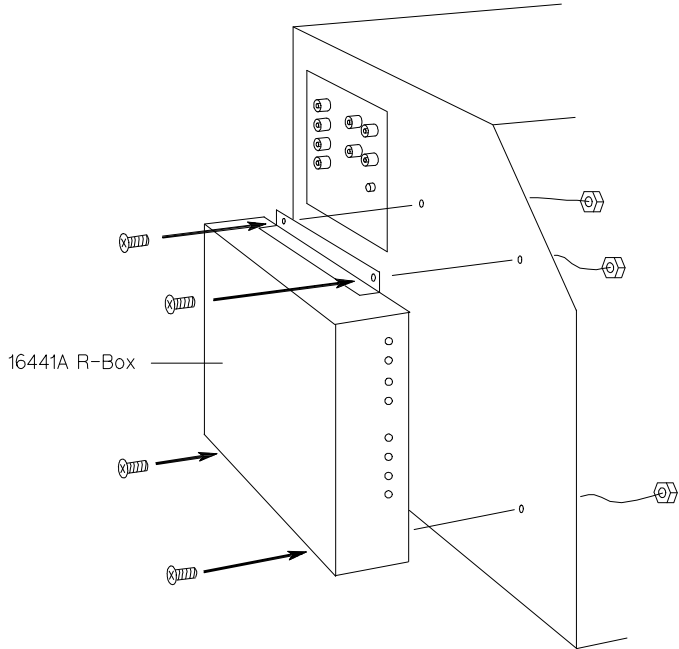
Installing the 16441A R-box with other accessories

You can attach the 16441A R-box to the 16442A/B test fixture or to your shielding box, as shown in the following figures.

Attaching the 16441A R-Box to the 16442A/B Test Fixture



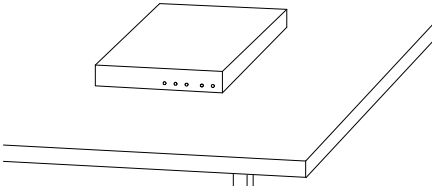
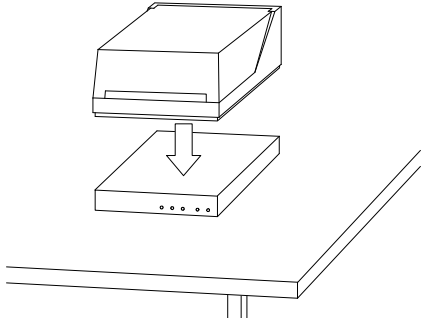
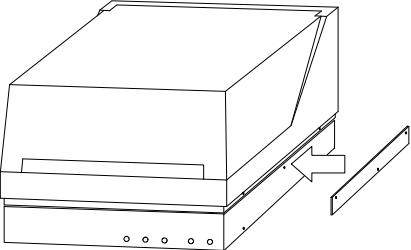
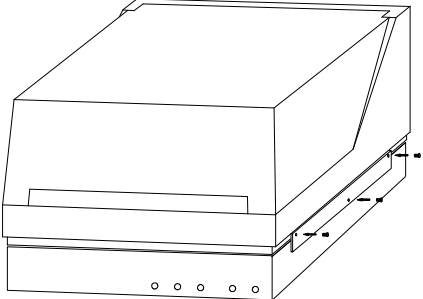
Attaching the 16441A R-Box to the Shielding Box



To Install the 16440A SMU/Pulse Generator Selector

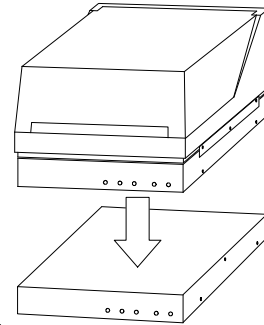
To use the 16440A, the 4155C/4156C must be equipped with an 41501A/B SMU/pulse generator expander with two PGUs.

- To attach the 16440A selector to the 16442A/B test fixture:

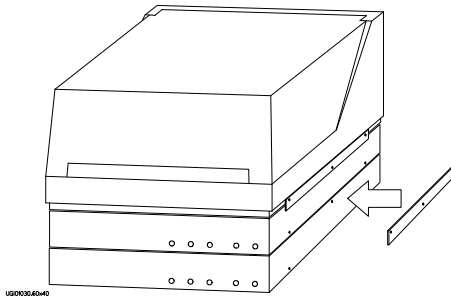
<p>1. Place the 16440A selector on your workbench.</p>	<p>2. Place the 16442A/B test fixture on top of the 16440A selector.</p>
	
<p>3. Position a plate on both sides.</p>	<p>4. Attach each plate using the three flathead screws supplied with the instrument.</p>
	 <p>UG01028,60040</p>

- The following steps apply when using two 16440A SMU/pulse generator selectors:

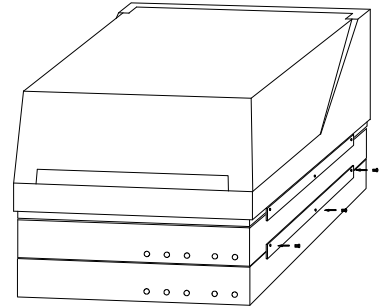
5. Place the second 16440A on your workbench. Place the 16440A selector and the 16442A/B test fixture on top of the second 16440A.



6. Position a plate on both sides.



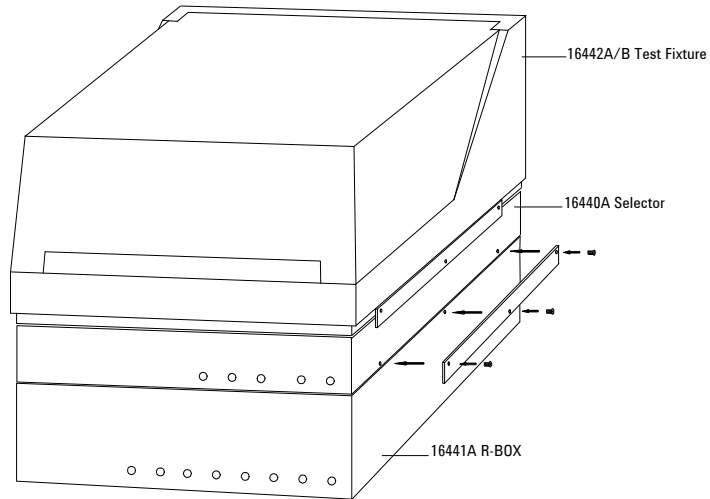
7. Attach each plate using the three flathead screws supplied with the instrument.



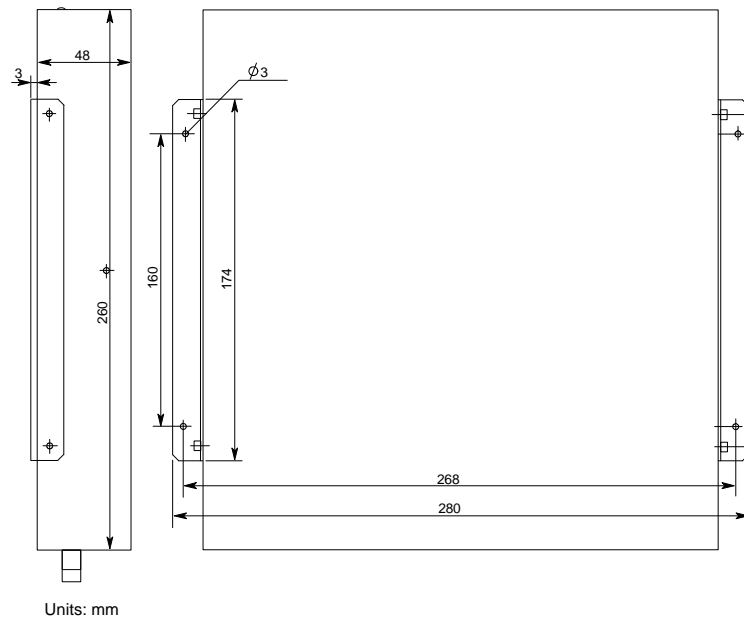
Installation

Installing Accessories

- To attach an 16441A R-box to the 16442A/B test fixture and the 16440A selector:

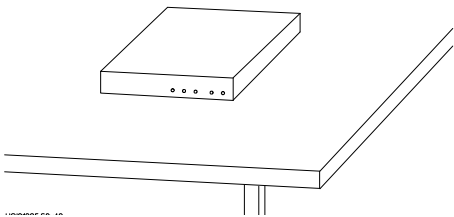
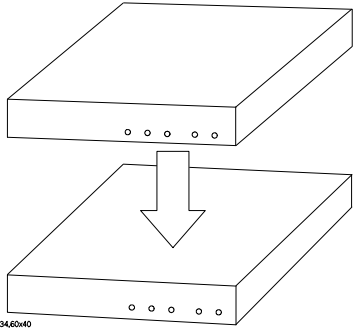
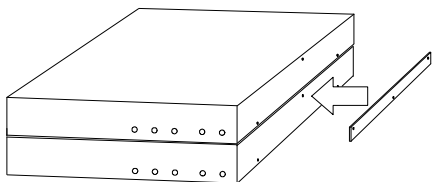
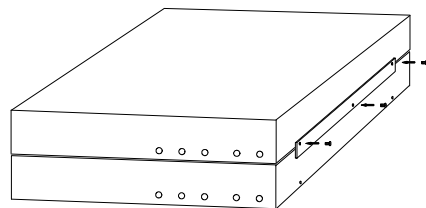


- To attach the 16440A selector to a shielding box:



The figure above shows the spacing of the 16440A screw holes. You need to prepare four screws and nuts to match the screw holes.

- If you use two 16440As, connect the 16440As before connecting to the shielding box, as shown below:

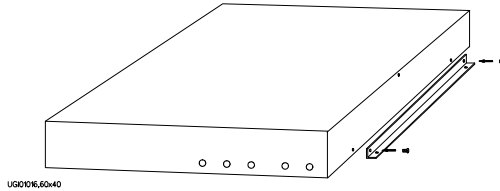
1. Place the 16440A on your workbench.	2. Place the second 16440A on top of the 16440A.
 <p>A line drawing of a rectangular 16440A unit with four small circles on its front face, being placed on a workbench. The workbench is shown as a flat surface supported by two legs.</p>	 <p>UG01034,60040</p> <p>A line drawing showing a second 16440A unit being lowered onto the first unit. A large downward-pointing arrow indicates the direction of movement. The front faces of both units are visible, showing the four circles on each.</p>
3. Position a plate on both sides.	4. Attach each plate using the three flathead screws supplied with the instrument.
 <p>UG01035,60040</p> <p>A line drawing of the 16440A unit with a plate being slid into its side. An arrow points from the plate towards the unit. The front face of the unit is visible, showing the four circles on each of the two stacked units.</p>	 <p>UG01036,60040</p> <p>A line drawing of the 16440A unit with the plate fully attached to its side. Three screws are shown being inserted into the plate. The front face of the unit is visible, showing the four circles on each of the two stacked units.</p>

Installation

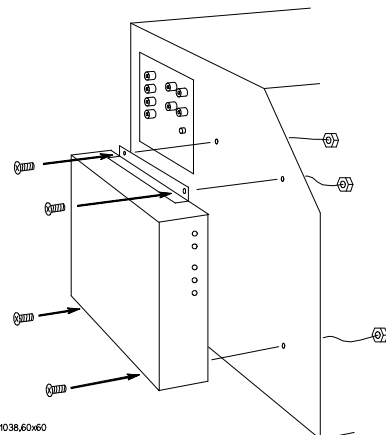
Installing Accessories

- To connect the selector to the shielding box:

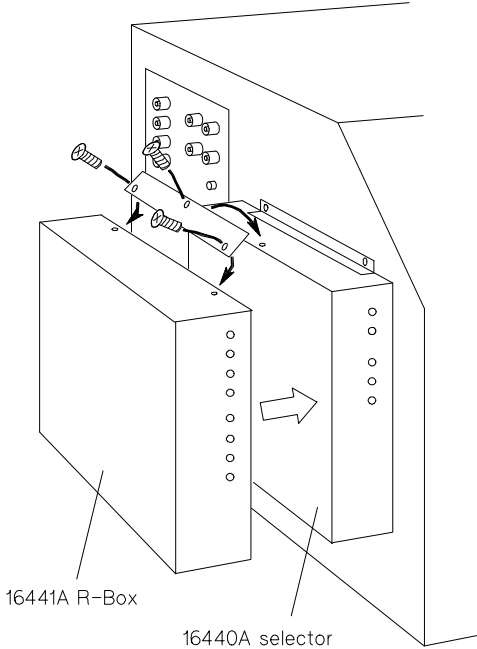
1. Attach an angle bracket to each side of the 16440A, using the screws supplied.



- Place the 16440A(s) on the side panel of the shielding box.
- Position four nuts on the inside panel of the shielding box.
- Attach the angle bracket to the shielding box using four flathead screws.



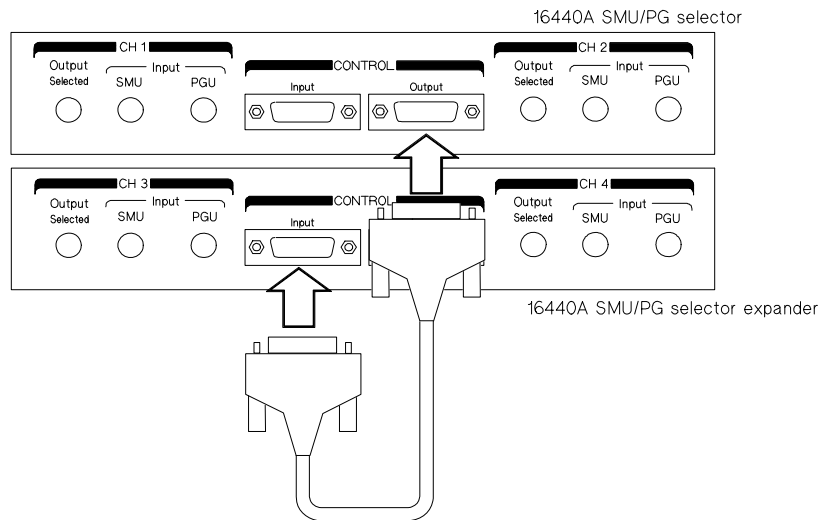
- To attach an 16441A R-box to the 16440A selector on the shielding box:



To Connect the 16440A Selector to the 4155C/4156C

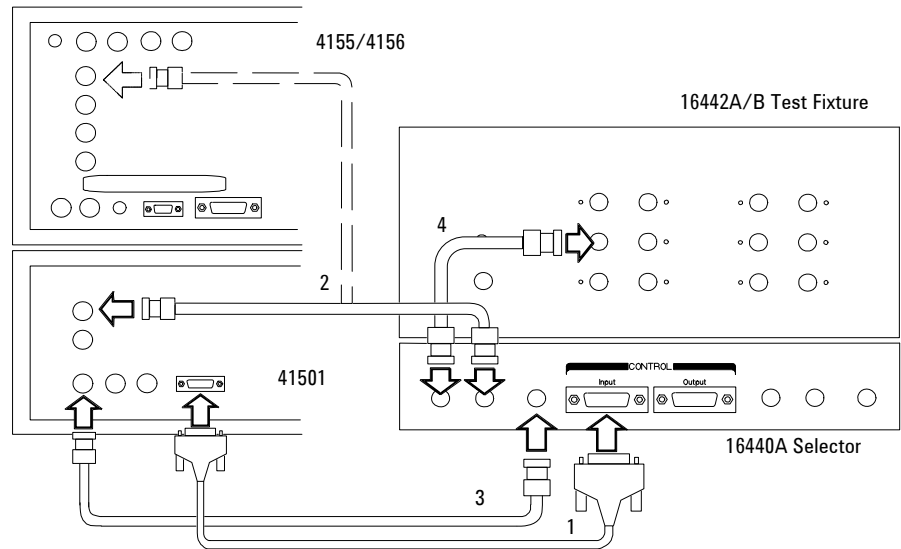
- Connecting two 16440A selectors

If you use two 16440A, connect the Control Output terminal of the selector to the Control Input terminal of the second selector using a 40 cm control cable as shown below.



- Connecting the 16440A selector to the 4155C/4156C

Turn off the 4155C/4156C and 41501A/B before connecting the instruments.
Then connect as shown below.



Instrument	Terminal	16440A Terminal	Cable
41501A/B	To SMU/Pulse Generator Selector Interface	CONTROL Input	3.0 m or 1.5 m Control Cable
	PGU	Input PGU ^a	3.0 m or 1.5 m Coaxial Cable
	MPSMU or HPSMU	Input SMU	3.0 m or 1.5 m Triaxial Cable
4155C	MPSMU	Output Selected ^b	40 cm Triaxial Cable
4156C	HRSMU		
16442A/B	SMU		
Connector Plate	SMU		

- You can use two inputs for one selector, and four inputs for two selectors.
- You can use two outputs for one selector and four outputs for two selectors. Selector output is either one of the PGU outputs or the SMU output.

To Connect the Measurement Cable to the Connector Plate

This section provides instructions for connecting the measurement cables from the 4155C/4156C to the connector plate. For connector plate installation information, refer to the *16495 Installation Guide*.

The following connector plates are available for the 4155C/4156C:

Agilent 16495H Connector Plate with 6 Triaxial Connectors

16495H-001 has 6 triaxial through connectors (female to female), 6 BNC through connectors (female to female), an Intlk connector, and a GNDU connector (triaxial through, female to female). The back of the Intlk connector is designed for soldering.

16495H-002 has 6 triaxial connectors, 6 BNC connectors, an Intlk connector, and a GNDU connector. The back of each connector is designed for soldering.

Agilent 16495J Connector Plate with 8 Triaxial Connectors

16495J-001 has 8 triaxial through connectors (female to female), 4 BNC through connectors (female to female), an Intlk connector, and a GNDU connector (triaxial through, female to female). The back of the Intlk connector is designed for soldering.

16495J-002 has 8 triaxial connectors, 4 BNC connectors, an Intlk connector, and a GNDU connector. The back of each connector is designed for soldering.

NOTE

Making non-Kelvin connection (4156C)

As same as the 4155C, the Force terminals of the 4156C 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.

Connecting the measurement cables

Connect the measurement cables as shown below.

Instrument		Connector Plate		Cable
Model No.	Connector	Model No.	Connector	
4155C	Intlk	16495H/J	Intlk	16493J Interlock Cable
	MPSMU	16495H	INPUT 1 to 6	Triaxial Cable
		16495J	INPUT 1 to 8	
	VSU	16495H	INPUT 7 to 12	BNC Cable
		16495J	INPUT 9 to 12	
	VMU	16495H	INPUT 7 to 12	BNC Cable
16495J		INPUT 9 to 12		
4156C	Intlk	16495H/J	Intlk	16493J Interlock Cable
	HRSMU	16495H	INPUT 1 to 6	Kelvin Triaxial Cable (for Kelvin) or Triaxial Cable (for non-Kelvin)
		16495J	INPUT 1 to 8	
	VSU	16495H	INPUT 7 to 12	BNC Cable
		16495J	INPUT 9 to 12	
	VMU	16495H	INPUT 7 to 12	BNC Cable
16495J		INPUT 9 to 12		
41501A/B	GNDU	16495H/J	GNDU	16493H GNDU Cable
	HPSMU	16495H	INPUT 1 to 6	Kelvin Triaxial Cable (for Kelvin) or Triaxial Cable (for non-Kelvin)
		16495J	INPUT 1 to 8	
	MPSMU	16495H	INPUT 1 to 6	Triaxial Cable
		16495J	INPUT 1 to 8	
	PGU	16495H	INPUT 7 to 12	BNC Cable
16495J		INPUT 9 to 12		



Connecting the interlock terminal

The 4155C/4156C provides an interlock connector to prevent you from receiving an electrical shock from high voltage (more than ± 40 V). If the interlock terminal is open, the 4155C/4156C *cannot* force high voltage more than ± 40 V.

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

If you use the 16495H/16495J 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 2-33. Then connect the 4155C/4156C Intlk connector to the external interlock connector by using the 16493J interlock cable.

Mounting Connectors

Previous sections described how to install the available accessories, and the *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 2-2.
2. Make the holes and mount the connectors. See Table 2-3.

For Kelvin connections using the 4156C SMU, use Agilent 16493K Kelvin cable. A Kelvin 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 2-33.
4. Attach cables from the connectors to the DUT (device under test). Refer to “To Connect the GNDU Output”, “To Connect the SMU Output”, and “To Connect the VSU/VMU/PGU Outputs” later in this chapter.

Table 2-2 lists the parts required to mount connectors on your shielding box. The type and quantity of parts needed will depend on your application.

Table 2-2

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

Installation
Mounting Connectors

Usage	Agilent Part No.	Description
Connecting VSU/VMU to DUT	1250-0118	BNC Connector (female)
	8150-0447	Wire
Connecting PGU to DUT	1250-0118	BNC Connector (female)
	8120-0102 or 8121-1191	Low Noise Coaxial Cable

Table 2-3 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 four mounting holes. The distance between the first and second hole is 14 mm, between the second and third is 11 mm, between the third and fourth is 11 mm, and between the fourth and the center is 14 mm. The diameter of the base is 10.3 mm. The diameter of the mounting holes is 2 - Ø11.3 mm. The diameter of the central hole is Ø3.2 mm. The depth of the mounting holes is 2 - M3 x 0.5 mm. The thickness of the base is 2.8 mm.</p>	<p>Technical drawing of a Triaxial Connector. It shows a circular base with a diameter of 10.3 mm and a diameter of Ø11.3 mm for the central hole.</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 12.1 mm and a diameter of Ø 12.8 mm for the central hole.</p>	<p>Technical drawing of an Interlock Connector. It shows a circular base with a diameter of 5.1 mm and a diameter of Ø 8.2 mm for the central hole. The distance from the top of the base to the center of the hole 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.

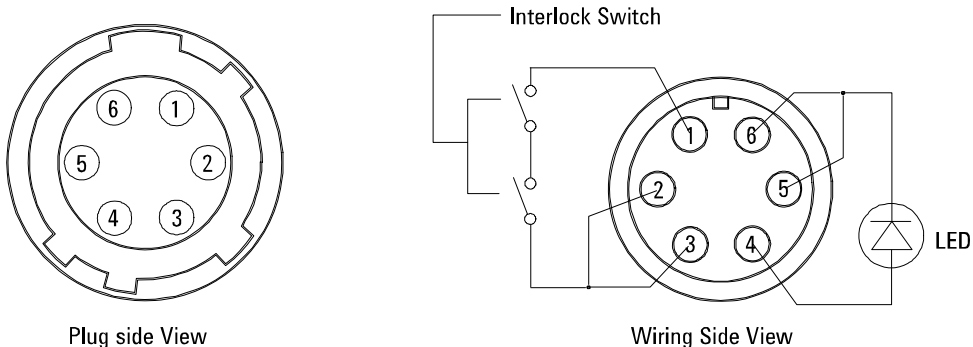
CAUTION

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

Figure 2-2 shows the pin assignments of the interlock connector mounted on a connector plate or test fixture.

Figure 2-2

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 2-3 and Figure 2-4 below.
2. Mount an LED on your shielding box. For the dimensions of the LED, see Figure 2-5.
3. Use wire to connect the two switches in series between pin number 1 and 2 (or 3) of the interlock connector. See Figure 2-2.
4. Use wire to connect the LED between pin number 4 and 5 (or 6) of the interlock connector. See Figure 2-2.

If the 4155C/4156C Intlk connector is connected to the interlock circuit, the 4155C/4156C SMU *cannot* force more than ± 40 V when the door is open. When the door is closed, it can force more than ± 40 V.

When more than ± 40 V is forced from an SMU, the LED lights to indicate *high voltage output*.

Figure 2-3

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

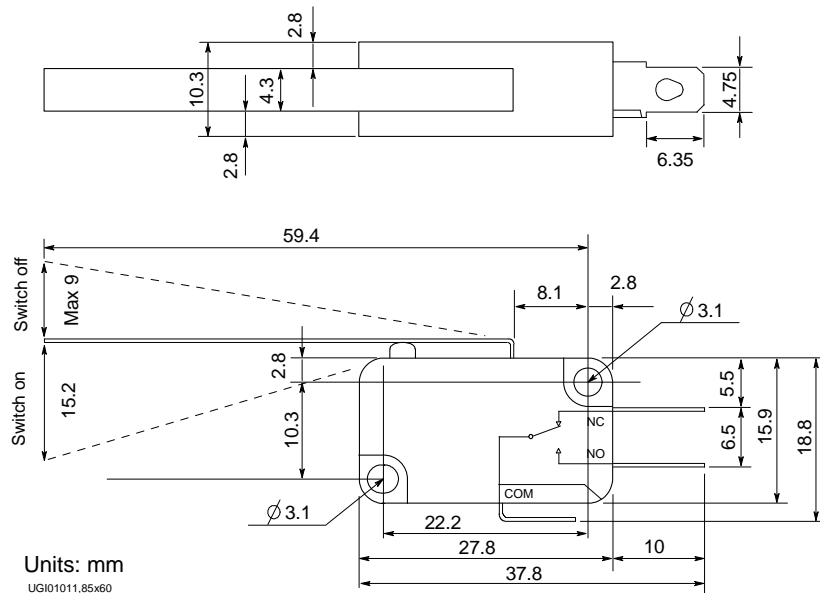


Figure 2-4 **Dimensions of the Interlock Switch (Agilent part number 3101-3241)**

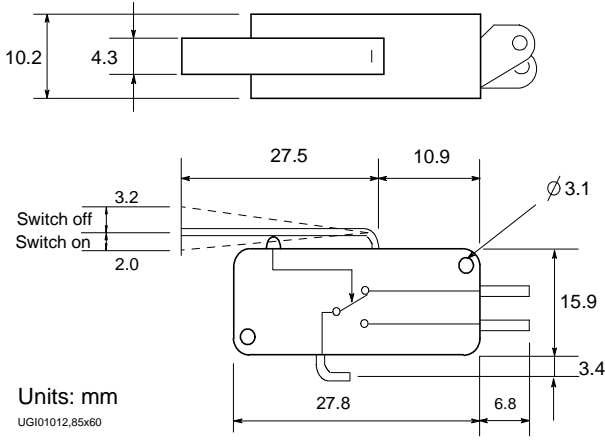
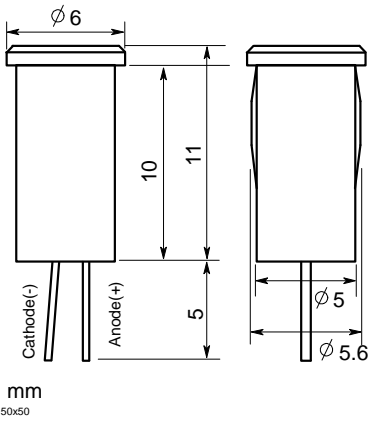


Figure 2-5 **Dimensions of the LED (Agilent part number 1450-0641)**



NOTE

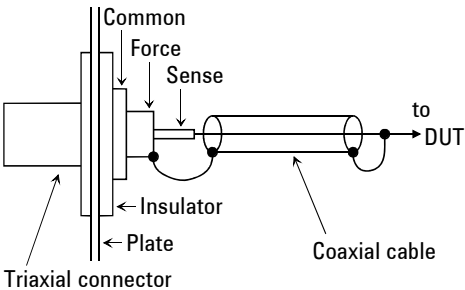
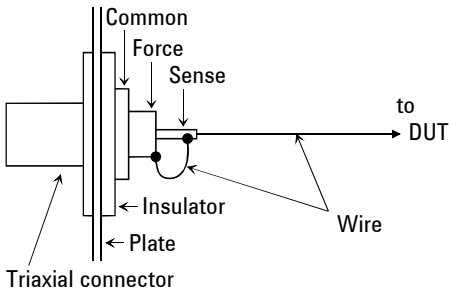
To Perform an Interlock Circuit Test

To confirm that the interlock circuit is operating properly, perform the following test.

1. Connect the Intlk terminal of the 4155C/4156C to your interlock circuit.
 2. Press System key, then select CALIB/DIAG softkey to display the SYSTEM: SELF-CALIBRATION/DIAGNOSTICS screen.
 3. In the CALIB/DIAG field, select DIAG softkey.
 4. In the CATEGORY field, select I/O PERIPH softkey.
 5. Move the pointer to 403 (INT.) Interlock LED.
 6. Select EXECUTE softkey.
 7. Confirm the following:
 - the LED turns on within 1 second when the interlock circuit is shorted.
 - the LED turns off within 1 second when the interlock circuit is opened.
 8. To stop the interlock test, select STOP softkey.
-

To Connect the GNDU Output

The following figures show connection examples for the GNDU output.

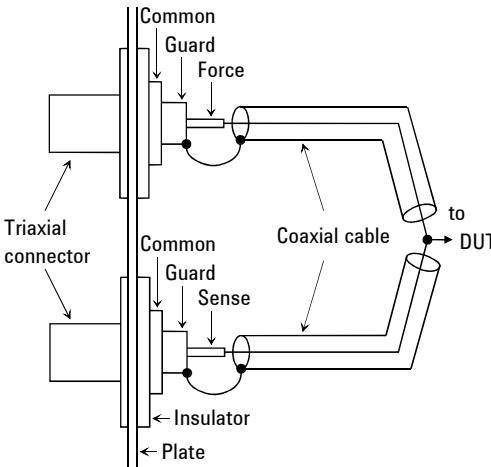
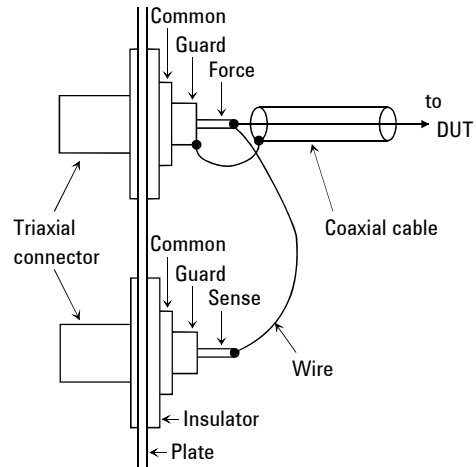
Kelvin connections	non-Kelvin connections
<p>Use a low-noise coaxial cable (Agilent part number 8121-1189) from the connector to the prober, socket, or DUT as shown.</p> <p>To cancel the effects of cable resistance, connect the Sense line and Force line as close as possible to the terminal of the DUT.</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 16493H 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 1.6 A, while the maximum current rating of the triaxial cable is 1 A.

To Connect the SMU Output

The following figures show connection examples for the SMU output.

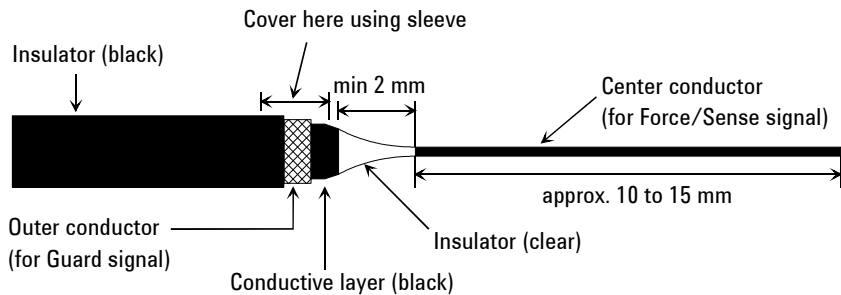
Kelvin connections	non-Kelvin connections
<p>This connection is for the 4156C HRSMU or the 41501A/B HPSMU.</p> <p>Use low-noise coaxial cable (Agilent part number 8121-1191) from the connector to the prober, socket, or DUT as shown.</p> <p>To cancel the effects of cable resistance, connect the Sense line and Force line as close as possible to the DUT terminal.</p> <p>To prevent oscillations, do not use cables longer than 1.5 m.</p> <p>To make accurate measurements when applying high currents, extend the guard as far as possible from the front panel connector to the DUT. Physically stabilize the cables with tape.</p>	<p>The following figure is for the HRSMU/HPSMU connection using Kelvin triaxial cable. For the MPSMU connection, and for the HRSMU/HPSMU connection using triaxial cable, connect the cable to the Force terminal only. Measurement data will include residual resistance from the connection cable.</p> <p>Use low-noise coaxial cable (Agilent part number 8121-1191).</p> <p>To make accurate measurements when applying high currents, extend the guard as far as possible from the front panel connector to the DUT.</p>
	

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.

Following figure 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.



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.

WARNING

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

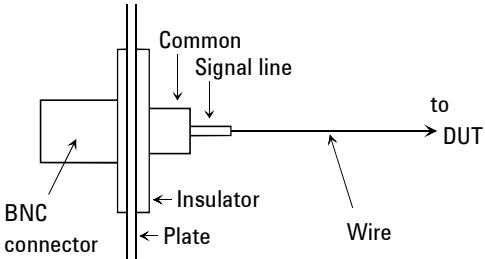
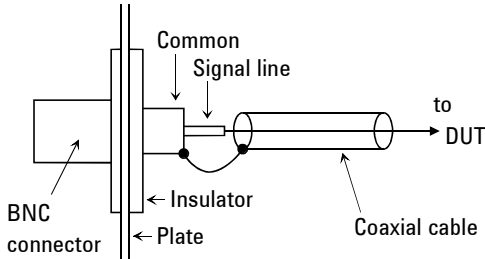
To prevent electrical shock, do not expose these lines.

Before turning the 4155C/4156C on, connect the Intlk terminal to a switch that turns off when the shielding box access door is opened.

Before you touch any connections to these terminals, turn the 4155C/4156C off, disconnect the power cable, and discharge any capacitors.

To Connect the VSU/VMU/PGU Outputs

The following figures show connection examples for VSU/VMU and PGU output.

VSU/VMU connector	PGU connector
<p>Use AWG 24 single-strand insulated wire (Agilent part number 8150-0447) to connect to a prober, socket, or DUT.</p>	<p>Regardless of the output impedance setting, use a low-noise coaxial cable (Agilent part number 8120-0102) from the connector to a prober, socket, or DUT.</p> <p>If you use an 16440A selector, use a low-noise coaxial cable (Agilent part number 8121-1191).</p>
 <p>The diagram shows a cross-section of a VSU/VMU connector. On the left, a BNC connector is attached to a vertical plate. A common signal line passes through an insulator in the center of the plate. A wire is connected to the end of this signal line, which is labeled 'to DUT'.</p>	 <p>The diagram shows a cross-section of a PGU connector. On the left, a BNC connector is attached to a vertical plate. A common signal line passes through an insulator in the center of the plate. A coaxial cable is connected to the end of this signal line, which is labeled 'to DUT'.</p>

Connecting Instruments or Peripherals

The 4155C/4156C provides an GPIB interface and parallel I/O interface for connection with other instruments or peripherals. This section contains information required to connect instruments or peripherals.

To Connect GPIB Instruments or Peripherals

The 4155C/4156C has an GPIB interface for instrument, printer, or plotter control.

- If you use an external controller with the 4155C/4156C, connect an GPIB cable between the controller and the 4155C/4156C.
- If you control instruments using the 4155C/4156C built-in IBASIC capability, connect an GPIB cable between the instrument and the 4155C/4156C.
- If you use an GPIB printer or plotter to make hard copies, connect an GPIB cable between the printer or plotter and the 4155C/4156C.

To use the GPIB interface, you will need to fill in the following entry fields on the SYSTEM: MISCELLANEOUS screen. For details of this setup screen, see *Setup Screen Reference* manual.

**4155C is
(4156C is)**

Selects SYSTEM CONTROLLER or NOT SYSTEM CONTROLLER.

Select NOT SYSTEM CONTROLLER if the 4155C/4156C will be used with an external controller.

Select SYSTEM CONTROLLER if the 4155C/4156C will be used to control other instruments or peripherals.

**GPIB
ADDRESS**

Sets the GPIB addresses of the 4155C/4156C and peripheral (printer or plotter).

Enter the GPIB address in the 4155C or the 4156C field.

Enter the GPIB address of the printer or plotter in the HARD COPY field.

Installation

Connecting Instruments or Peripherals

REMOTE CONTROL

Selects the 4155C/4156C Control Command Set used to control the unit with an external controller or built-in IBASIC.

Select "4155/4156" to use the 4155C/4156C command set (SCPI or FLEX commands).

Select "4145" to use the 4145 syntax command set. You will also need to set the DELIMITER and EOI fields.

To Connect Parallel Peripherals

The 4155C/4156C has a 25 pin parallel I/O interface port for connecting peripherals, such as a Centronics parallel printer.

To use a parallel printer, connect a parallel cable from the 4155C/4156C to the peripheral. You do *not* need to define any fields on the setup screen.

To make hard copies, refer to Chapter 5.

Maintenance

Maintenance should be performed periodically to keep the 4155C/4156C and 41501A/B in good condition.

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 your nearest Agilent Technologies Service Center. Trained service personnel will perform the calibration and adjustments.

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.

Installation
Maintenance

3

Connecting to Network

Connecting to Network

This chapter explains how to connect to a network, and contains the following sections:

- “Introduction”
This section explains what the 4155C/4156C can do by connecting it to a network.
- “Executing LAN Interface Test”
This section explains how to execute the LAN interface test of the 4155C/4156C.
- “Network Setup Parameters”
This section explains the network setup parameters of the 4155C/4156C.
- “Setting Up 4155C/4156C”
This section explains how to set up the network of the 4155C/4156C.
- “Using Network”
This section explains the network functions of the 4155C/4156C, and describes examples of using a NFS server and a print server on a network.
- “If You Use a HP-UX System”
This section describes information required to use a HP-UX system as a server.
- “If You Use a Windows PC”
This section describes examples of setting up a NFS server and print server using a Windows PC.

NOTE

Setting Up Server

The server should be set up by someone who is familiar with the operating system and networking.

If you use a HP-UX system, refer to “If You Use a HP-UX System”, and ask the HP-UX system administrator of your site to set up the server.

If you use a Windows PC, ask the administrator of the computer or do the setup yourself to configure the server. Setup example is described in “If You Use a Windows PC”. It uses the software package “Microsoft Windows Services for UNIX” to set up the NFS server. For the software package, visit the following URL:

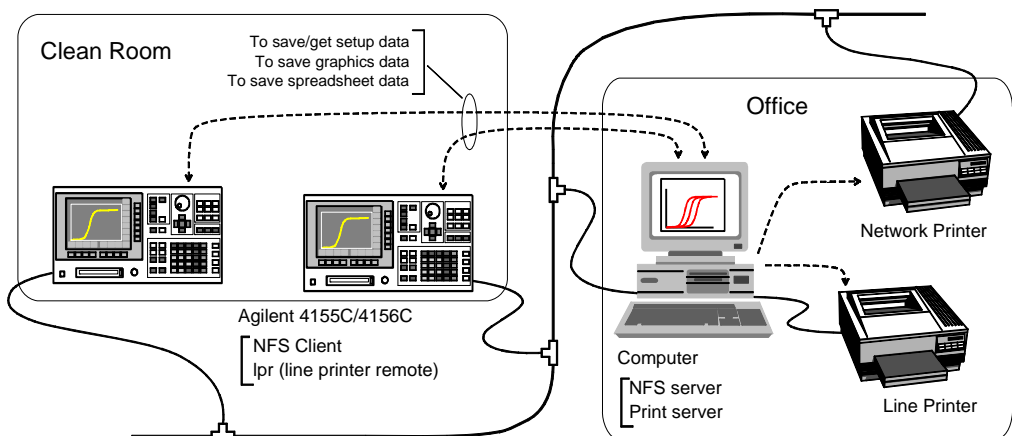
<http://www.microsoft.com/windows/sfu/>

Introduction

The 4155C/4156C supports the NFS (network file system) client and lpr (line printer remote) capability. This feature provides the following advantages.

- You can manage the 4155C/4156C setup data files (*.DAT, *.MES, *.STR, *.MAT, or *.CST) on a network file system, instead of diskettes.
- You can share those files with more than one 4155C/4156C.
- You can access files faster than using the built-in disk drive.
- You can transfer spreadsheet data files (*.TXT) and graphics data files (TIFF, PCL, or HP-GL) to your PC using the network file system. You can analyze data by using spreadsheet software, and can import the graphics files into your technical report by using a word-processing software.
- You can store files that are too large to store on a diskette. This is useful for automatic measurements that store large amounts of data.
- You can share a remote printer with other users. You do not need to connect a printer to the 4155C/4156C.
- You can use a remote printer outside the clean room. This is good to keep the clean room free of normal printer dust.

Figure 3-1 Network Connection Example



Note: The 4155C/4156C cannot be controlled via the LAN interface.
 Note: The network file system cannot be mass-storage of the IBASIC of the 4155C/4156C.
 You cannot save IBASIC programs, BASIC binary and ASCII data to the network file system.

Executing LAN Interface Test

Before connecting the 4155C/4156C to the network, you should check the operation of the LAN interface installed in the 4155C/4156C. Do this by executing the LAN interface test as shown below.

1. Turn the 4155C/4156C on.
2. Attach the LAN I/F test adapter (Agilent part number 04155-61631, furnished with the 4155C/4156C) to the LAN connector on the rear panel.
3. Press the System key, then select the CALIB/DIAG softkey to display the SYSTEM: SELF-CALIBRATION/DIAGNOSTICS screen.
4. In the CALIB/DIAG field, select the DIAG softkey.
5. In the CATEGORY field, select the CPU softkey.
6. Move the pointer to 312 (INT.) LAN Interface using the down-arrow key.
7. Select the EXECUTE softkey to execute the LAN interface test.

If the 4155C/4156C fails the test, contact the Agilent Technologies service office.

Network Setup Parameters

The 4155C/4156C needs the following parameters to connect to a network. Acquire the parameters from the administrators shown in the following table. If you are not connecting the 4155C/4156C to the network but to the server directly, you can assign the parameter values by yourself.

	Parameter	Description	Assigned by	Example
To connect to network	HOST NAME	Host name of 4155C/4156C. Maximum 15 alphanumeric characters.	Network administrator or User	ANALYZER
	IP ADDRESS	IP address of 4155C/4156C	Network administrator	192.168.1.2
	SUBNET MASK ^a	Subnet mask	Network administrator	255.255.255.0
	GATEWAY ^a	IP address of gateway	Network administrator	192.168.1.3
	USER ID ^b	Your user ID. Numeric value from 1 to 32767.	System administrator or User	1234
	GROUP ID	Your group ID. Numeric value from 1 to 32767.	System administrator	20
To use remote printer	PRINTER ^c	Name of remote printer you use. Maximum 15 alphanumeric characters.	System administrator	PRN01
	IP ADDRESS	IP address of print server you use	Network administrator	192.168.1.1
	TEXT OUT	lpr command option for text output.	User	-h
	GRAPH OUT	lpr command option for graphics output.	User	-h -l
	SERVER TYPE	Server type. BSD or System V. Set System V for HP-UX.	User	System V or BSD
To use network file system	LABEL ^c	Label. Max. 15 alphanumeric chars.	User	DATA
	IP ADDRESS	IP address of NFS server you use	Network administrator	192.168.1.1
	DIRECTORY	Full path name of directory for HP-UX, or share name of folder for Windows. Maximum 58 alphanumeric characters.	System administrator or User	/D4156 or DATA4156

- a. If you access only a network within the subnet, set to 0.0.0.0.
- b. User ID must be unique for each user. After using the 4155C/4156C, set a meaningless value. If you do not change the value, any user can access the network file system using your user ID.
- c. The value is used as a softkey label to specify a printer or a directory.

Setting Up 4155C/4156C

This section explains how to set up the 4155C/4156C network. The procedure supposes that the server has already been set up.

1. Turn off the 4155C/4156C.
2. Connect the 4155C/4156C to the network by using the straight LAN cable. If you are not connecting the 4155C/4156C to the network but to the server directly, use the cross LAN cable.
3. Turn on the 4155C/4156C.
4. Press the **System** key and the MISCELLANEOUS softkey to display the SYSTEM: MISCELLANEOUS screen.
5. Complete the 4155C/4156C NETWORK SETUP table. See Figure 3-2 and Table 3-1.
6. Press the **System** key to enable the setup.
7. Enter the following command using the server to check the network connection of the 4155C/4156C.

If you use HP-UX \$ /usr/sbin/ping 192.168.1.2

If you use Windows C:\> ping 192.168.1.2

This is the example for the 4155C/4156C with IP address 192.168.1.2. If no response is returned, perform these instructions again.

8. Select the MISCELLANEOUS softkey of the 4155C/4156C.
9. Complete the NETWORK PRINTER SETUP, and select ADD or UPDATE. Skip this step if you are going to use a network file system only.
10. Complete the NETWORK DRIVE SETUP, and select ADD or UPDATE. Skip this step if you are going to use a remote printer only.
11. Press the **System** key to save and enable the setup.

NOTE

If you use Windows for the server, and if you use a DHCP server to obtain an IP address automatically, enter the ipconfig command to know the network parameters of your server. The values are displayed on the computer screen.

Figure 3-2

Setting Up 4155C/4156C

SYSTEM: MISCELLANEOUS

*4156C is *POWER LINE FREQUENCY ANALYZE R

*GPIB ADDRESS

*4156C NETWORK SETUP

HOST NAME ← 5

*REMOTE CONTROL

*CLOCK

Y	M	D	H	M
2001	1	23	13	42

*NETWORK PRINTER SETUP

PRINTER ← 9

*SYSTEM SETUP

BEEP	ON
SCREEN SAVE	0 min
LP TIMEOUT	300 sec

*NETWORK DRIVE SETUP

LABEL ← 10

ANALYZER

Enter Host Name of 4155/4156 (max 15 chars)

FILEL	MISCEL- LANEOUS	CONFIG	CALIB/ DIAG	PRINT SETUP	COLOR SETUP				
-------	--------------------	--------	----------------	----------------	----------------	--	--	--	--

Table 3-1 4155C/4156C Setup Parameters

	Field Name	Description	Example
5	HOST NAME	Host name assigned to the 4155C/4156C.	ANALYZER
	IP ADDRESS	IP address assigned to the 4155C/4156C.	192.168.1.2
	SUBNET MASK	Subnet mask. For the default value, enter 0.0.0.0.	255.255.255.0
	GATEWAY	IP address of the gateway. For the network access within the subnet, enter 0.0.0.0.	192.168.1.3
	USER ID ^a	Your user ID ^b registered in the NFS server.	1234
	GROUP ID	Your group ID ^b registered in the NFS server.	20
9	PRINTER	Share name of a printer registered in the print server.	PRN01
	IP ADDRESS	IP address of the print server.	192.168.1.1
10	LABEL	Softkey label used to specify a directory to mount.	DATA
	IP ADDRESS	IP address of the NFS server.	192.168.1.1
	DIRECTORY	Full path name for HP-UX, or NFS sharing name for Windows.	/D4156 or DATA4156

a. User ID must be unique for each user. After using the 4155C/4156C, set a meaningless value. If you do not change the value, any user can access the network file system using your user ID.

b. For Windows, use the values defined in the password file. See “Setting Up NFS Server” on page 3-35.

Using Network

This section explains the network function of the 4155C/4156C, and describes the following examples of using the NFS server and the print server.

- “Functions”
- “Saving 4155C/4156C Setup Data”
- “Using Remote Printer”
- “Saving Graphics Data”
- “Saving Spreadsheet Data”

Functions

Connecting to a network, the 4155C/4156C can use a remote printer and a NFS server on the network.

- To use a remote printer
- To mount a NFS server

To use a remote printer

1. Press the **System** key and PRINT SETUP softkey.
2. Select a softkey for the DESTINATION field. For the setup shown in Figure 3-2, the PRN01 softkey will be enabled.
3. Use the print/plot function to do printing.

If the network printing fails, check the 4155C/4156C setup parameters, setup of the print server, and operation of the remote printer.

To mount a NFS server

1. Press the **System** key.
2. Select a softkey for the DISK field. For the setup shown in Figure 3-2, the DATA softkey will be enabled.
3. Use the filer function to do the file operation.

If the 4155C/4156C cannot mount the network file system, check the 4155C/4156C setup parameters, setup of the NFS server, or permission of the file system.

Note that the FLOPPY softkey unmounts the network file system, and enables the built-in flexible disk drive.

Files and directories created by the 4155C/4156C

The 4155C/4156C creates a file or a directory upon the following permission. After creating it, change the permission as you wish by using the NFS server. The 4155C/4156C cannot change the permission.

- If you use HP-UX system:

Permission of a file -rw-rw-rw-

Permission of a directory drwxrwxrwx

To change the permission, enter the `chmod` command. For details of the command, enter *man chmod* to display the on-line manual.

The following example changes the permission to *read only* for group and others.

```
$ chmod 644 /D4156/FILE1.DAT
```

- If you use Windows PC:

	Permission of a file	Permission of a folder
a creator	Read and Write	Full Control
a group	Read and Write	Change, or Modify
Everyone	Read and Write	Change, or Modify

To change the permission, enter the `CACLS` command. For details of the command, enter *HELP CACLS* to display the help message.

The following example changes the permission to *Full Control* for the creator `USER01`, and to *Read* for users except for the creator.

```
C:\D4156> CACLS FILE1.DAT /P USER01:F Users:R Everyone:R
```

NOTE

For Windows PC, be careful about permission of a file. The file can be deleted by a user even if the file is saved into the folder with the following permission.

	Permission of a folder
a creator	Full Control
a group	Read
Everyone	Read

To avoid the trouble, change the permission to Read for group and Everyone.

Saving 4155C/4156C Setup Data

This example saves a setup data file to a network file system. Figure 3-3 shows the 4155C/4156C setup screen for saving measurement setup data with result data to the IDVG.DAT file in the C:\D4156 directory of the NFS server.

Figure 3-3

Saving 4155C/4156C Setup Data

SYSTEM: FILER

2

*DISK DATA CC:\D4156 Mounting directory

FILE CATALOG

FORMAT:	DIR: /
FILE NAME	SIZE(byte) DATE TIME [COMMENT]

3

FUNCTION :SAVE 0/0

4

NAME	TYPE	COMMENT
IDVG	DAT	

5

6

DAT

7

Select File Type with softkey or rotary knob.

EXECUTE [] s [] B EXIT

1. Press the System key to display the SYSTEM: FILER screen.
2. Move the field pointer to the DISK field, and select a softkey to mount the network file system.
3. Move the pointer to the FUNCTION field, and select the SAVE softkey.
4. Move the pointer to the NAME field, and enter the file name.
5. Move the pointer to the TYPE field, and select a softkey to specify the data type.
6. (optional) Move the pointer to the COMMENT field, and enter a comment for the file.
7. Select the EXECUTE softkey to start saving.

Using Remote Printer

The following example prints a measurement result graph by using a remote printer.

1. Press the Graph/List key to display the GRAPH/LIST: GRAPHICS screen.
2. If you print the result graph, press the Plot/Print key. The GRAPH PLOT dialog box appears.

If you print the screen image, press the green key and Plot/Print key. The SCREEN DUMP dialog box appears.

3. Complete the dialog box. See Figure 3-4 for the example setup.

Note that the DESTINATION field must be PRINTER/PLOTTER for printing.

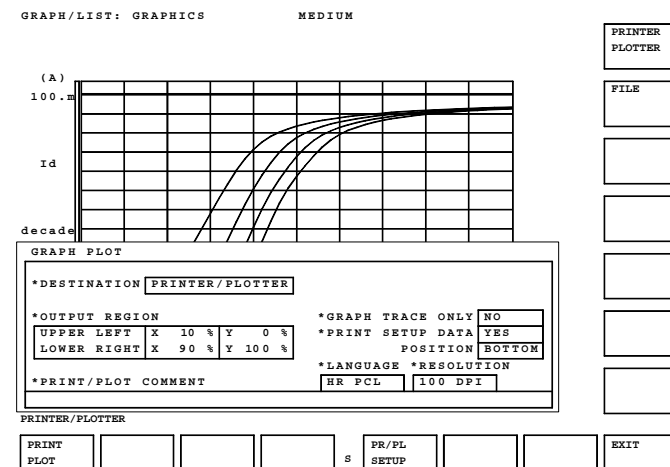
4. Press the PR/PL SETUP softkey to display the PRINT/PLOT SETUP screen.
5. Complete the PRINT/PLOT SETUP screen. See Figure 3-6 for the example setup.

Select one of the softkeys in the DESTINATION field to specify a remote printer. Do not select the GPIB softkey or PARALLEL softkey that specify a printer connected to the 4155C/4156C directly.

6. Select the EXIT softkey to close the PRINT/PLOT SETUP screen.
7. Select the PRINT PLOT softkey to start printing. The hardcopy will be almost the same as in Figure 3-7.

Figure 3-4

Printing Result Graph

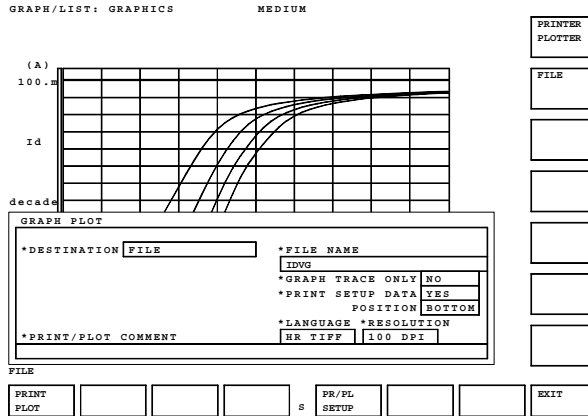


Saving Graphics Data

This example saves a graphics data file to a network file system. Figure 3-5 shows the 4155C/4156C setup screen to save a measurement result graph to the IDVG.TIF file in the network file system.

Figure 3-5

Saving Graphics Data



1. Press the System key to display the SYSTEM: FILER screen.
2. Move the field pointer to the DISK field, and select a softkey to mount the network file system.
3. Press the Graph/List key to display the GRAPH/LIST: GRAPHICS screen.
4. If you save the graph data, press the Plot/Print key. The GRAPH PLOT dialog box appears.

If you save the screen image, press the green key and Plot/Print key. The SCREEN DUMP dialog box appears.

5. Complete the dialog box. See Figure 3-5 for the example setup.

Note that the DESTINATION field must be FILE to save graphics data.

Specify the data format by selecting one of the softkeys in the LANGUAGE field. Select the HR TIFF softkey for the tiff format.

6. Press the PR/PL SETUP softkey to display the PRINT/PLOT SETUP screen.
7. Complete the PRINT/PLOT SETUP screen. See Figure 3-6 for the example setup. In Figure 3-6, ignore the DESTINATION field for saving to a file.
8. Select the EXIT softkey to close the PRINT/PLOT SETUP screen.

9. Select the PRINT PLOT softkey to start saving.

You can import the graphics file to a document such as a technical report by using word-processing software. Figure 3-7 shows the actual example of importing the tiff file to the document.

Figure 3-6

SYSTEM: PRINT/PLOT SETUP Screen

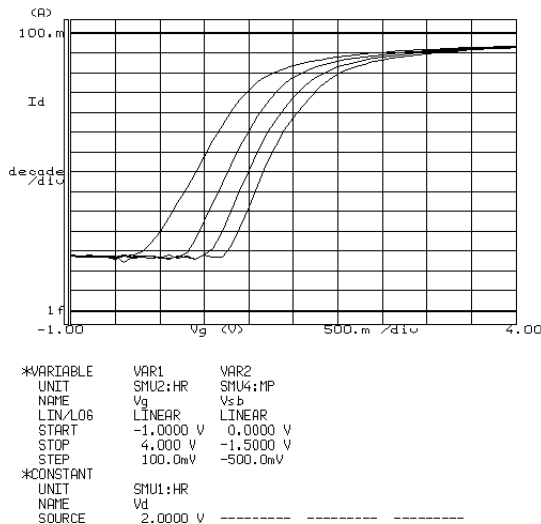
```

SYSTEM: PRINT/PLOT SETUP
*DESTINATION PRN01
*FORM FEED DISABLE *LINE 60 *COLUMN 80
*COLOR/ B/W B/W
*PAPER
SIZE A4
FEED DIR SHORT SIDE
LENGTH -----
WIDTH -----
UNIT -----
*OUTPUT ITEM
TITLE ENABLE
DATE&TIME ENABLE
PAGE NO. ENABLE
USER COMMENT ENABLE
PRINT/PLOT COMMENT ENABLE
GRAPH TRACE ENABLE
GRAPH FRAME & GRID ENABLE
GRAPH AXIS TEXT ENABLE
GRAPH TEXT ENABLE
*INIT STRING
*TRAILER STRING
PRN01
Select one of the secondary softkeys.
[ ] [ ] [ ] [ ] s [ ] [ ] [ ] [ ] B EXIT
    
```

Figure 3-7

Importing Graphics Data

*** Agilent 4156C GRAPH PLOT *** Feb 8 12:17:05 2001 PAGE 1



Saving Spreadsheet Data

This example saves measurement result data to a file in the spreadsheet format. Figure 3-8 shows an example setup to save spreadsheet data to the L-IDVG.TXT file in the C:\D4156 directory of the NFS server.

1. Press the System key to display the SYSTEM: FILER screen.
2. Move the field pointer to the DISK field, and select a softkey to mount the network file system.
3. Press the Graph/List key twice to display the GRAPH/LIST: LIST screen.
4. Select the SPREAD SHEET softkey.
5. Complete the ASCII SAVE function menu.

Example setup shown in Figure 3-8 defines the file name L-IDVG, enables output of the unit with data, sets the delimiter to comma, sets the string mark to double quotation mark, and enables output of all data (from index 1 to maximum).

6. Select the EXECUTE softkey to start saving.

You can read the file using spreadsheet software such as Lotus 1-2-3, as shown in Figure 3-9.

Figure 3-8

Saving Spreadsheet Data

*DISK DATA Mounting directory
FILE CATALOG

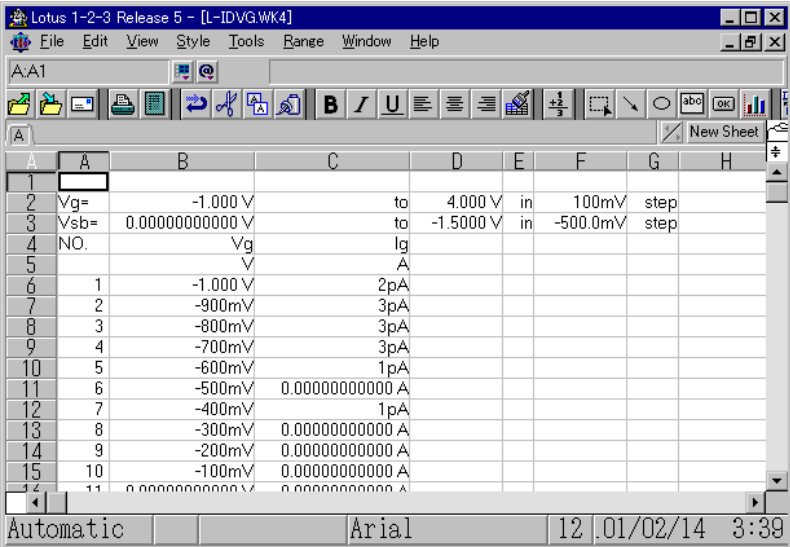
FORMAT:	DIR:/PRNOTE
FILE NAME	SIZE[byte] DATE TIME [COMMENT]
IDVG	DAT 13488 01-02-08 00:12 []
IDVG	TIF 47078 01-02-08 00:17 -----

0 / 2

FUNCTION :ASCII SAVE

NAME	L-IDVG		
UNIT	ON		
OUTPUT DATA (INDEX NO)	DELIMITER	COMMA	
1 <- -> MAX	STRING MARK	" "	

Figure 3-9 Reading Spreadsheet Data



If You Use a HP-UX System

This section describes the information required for using a network file system and a remote printer on a HP-UX system via the network of your site.

- “Defining Network Parameters”
- “Setting Up HP-UX System”

Defining Network Parameters

To connect the 4155C/4156C to the network of your site, the following network parameters are required. These parameters are usually assigned and managed by the network administrator. Contact the network administrator of your site, and acquire the parameter values.

- Host name of the 4155C/4156C
(A maximum 15 alphanumeric characters for the 4155C/4156C)
- IP address of the 4155C/4156C
- Subnet mask
- IP address of gateway

The subnet mask and the IP address of the gateway are required to access a network outside the subnet.

Setting Up HP-UX System

To use a network file system and a remote printer on the HP-UX system, contact the HP-UX system administrator of your site, and request the following setup. The setup should be performed by the system administrator.

- To register your user account in the system (if you have not had an account)
For the user ID and group ID, a numeric value from 1 to 32767 is available.
- To add a printer (if no printer has been registered)
For the printer name, a maximum 15 alphanumeric characters is available. The first character must be a letter of the alphabet.
- To enable NFS server and export a directory to the 4155C/4156C
Host name and IP address of the 4155C/4156C are required. Previously acquire them from the network administrator.

Previously decide the name, owner, and permission of the directory to export.
For the name, a maximum 58 alphanumeric characters including / is available.

Also, acquire the following parameters from the system administrator. They are required to set up the 4155C/4156C.

- User ID and group ID registered in the system
- IP address of the print server
- Name of the printer registered in the system
- IP address of the NFS server
- Full path name of the directory exported to the 4155C/4156C

If You Use a Windows PC

This section describes examples of setting up a NFS server and print server using a computer installed with Windows XP, Windows 2000, or Windows NT.

- “Hardware/Software Required”
- “Network Parameters Required”
- “Setting Up Network for Windows XP”
- “Setting Up Print Server for Windows XP”
- “Setting Up Network for Windows 2000”
- “Setting Up Print Server for Windows 2000”
- “Setting Up Network for Windows NT”
- “Setting Up Print Server for Windows NT”
- “Setting Up NFS Server”

NOTE

Setting up of network and servers must be performed by a member of the Windows *Administrators* group.

Hardware/Software Required

You need the hardware and software listed below:

- Computer with the following specifications
 - Available hard disk space: 19 MB to 275 MB. Depends on the components installed from the Services for UNIX software package.
 - Memory: 16 MB or more.
 - Network adapter: Ethernet IEEE 802.3, 10BASE-T.
 - Operating system:
 - For use of Services for UNIX 3.5:
Windows Server 2003, Windows 2000 Server with SP3 or SP4,
Windows 2000 Professional SP3 or SP4, or Windows XP Professional with SP1 (SP2 can be used under a condition of “personal firewall off”).
 - For use of Services for UNIX 3.0:
Windows XP Professional SP1 (with Internet Explorer 6.0 or later) or
Windows 2000 Professional SP3 (with Internet Explorer 6.0 or later).
 - For use of Services for UNIX 2.0:
Windows 2000 Professional (with Internet Explorer 4.01 or later) or
Windows NT 4.0 SP4 or later (with Internet Explorer 4.01 or later).
- LAN cable (1 ea., straight or cross)
 - Use straight cable for connecting the computer to a network.
 - Use cross cable for connecting the computer to the 4155C/4156C directly.
- CD-ROM drive
- Operating system CD-ROM
- Services for UNIX 2.0, 3.0, or 3.5
 - Services for UNIX 3.5 supports the NTFS file system only. And the FAT file system is not supported.

NOTE

For the requirements and details about *Services for UNIX*, visit the following URL:

<http://www.microsoft.com/windows/sfu/>

Services for UNIX is required to set up the NFS server. If you set up the print server only, you do not need *Services for UNIX*.

Network Parameters Required

To set up a server, the following network parameters are required. These parameters are usually assigned and managed by the network administrator. Contact the network administrator of your site to acquire the parameter values.

Table 3-2 Network Parameters

Parameter	Example value used in this section
Computer name ^a	PC001
Workgroup or Domain	DOMAIN1
IP address of computer	192.168.1.1
Subnet mask	255.255.255.0
IP address of Gateway	192.168.1.3

a. A maximum 15 alphanumeric characters is available for the 4155C/4156C.

NOTE

If you are going to use the DHCP server, you need only the computer name and the domain name. The DHCP server assigns the IP address automatically, and changes it dynamically.

NOTE

If you connect the computer to the 4155C/4156C directly and *never* connect to a local area network, assign the computer name and IP address by yourself.

For the workgroup name, set WORKGROUP.

Do not set the subnet mask and the IP address of gateway.

Setting Up Network for Windows XP

NOTE

If your computer has already been on the network, ignore this section. Just check the following network parameters.

- Computer name
- IP address of the computer
- IP address of the gateway (optional)
- Subnet mask (optional)

You can check these values by executing the `hostname` command and the `ipconfig` command using the Command Prompt.

This section describes how to set up the network of the computer.

Table 3-3 Check List of Network Setup

Steps	Summary
Step 1. Preparation	You set up the computer.
Step 2. Network Identification	You check the network identification.
Step 3. Network Protocols	You set the network protocol.
Step 4. TCP/IP Properties	You set up the TCP/IP properties.
Step 5. Network Connection Check	You check the network connection.

Step 1.

Preparation

1. Set up the computer, and connect the CD-ROM drive to the computer.
2. Connect the computer to the network of your site using the straight LAN cable.
If you are not going to connect the computer to the network but to the 4155C/4156C directly, use the cross LAN cable.
3. Turn on the computer and CD-ROM drive. Then wait until Windows boots up.

Step 2.

Network Identification

1. Log on to Windows.
2. Click *Start* and *Control Panel* to open the Control Panel.

Connecting to Network If You Use a Windows PC

3. Click *Performance and Maintenance*, then *System* to open the System Properties dialog box.
4. Click the *Computer Name* tab.
5. Check Full computer name and Workgroup or Domain. Or set them properly.

Step 3.

Network Protocols

1. In the Control Panel, click *Network and Internet Connections*, then *Network Connections*.
2. Double-click *Local Area Connection* to open the Local Area Connection Status dialog box.
3. Click *Properties* to open the Local Area Connection Properties dialog box.
If Internet Protocol (TCP/IP) is not installed, click *Install*. After that, step through the setup instruction to install the TCP/IP.
4. Highlight *Internet Protocol (TCP/IP)*.

Step 4.

TCP/IP Properties

1. Click *Properties* to open the Internet Protocol (TCP/IP) Properties dialog box.
2. If you are going to use the DHCP server, click “*Obtain an IP address automatically*”. You do not need to set the network parameters.
Otherwise, click “*Use the following IP address*” and set the network parameters.
3. Click *OK*.
4. Click *OK*.
5. Click *Close*.

Step 5.

Network Connection Check

1. Click *Start, All Programs, Accessories*, and *Command Prompt* to open the Command Prompt window.
2. Ping a computer or a device on the network. If, for example, the IP address of the device is 192.168.1.99, execute C:\> ping 192.168.1.99.
If any error occurs, perform these instructions again.

Setting Up Print Server for Windows XP

This section describes how to set up a print server using the computer installed with Windows XP. Before starting the procedure, set up the network of the computer as described in “Setting Up Network for Windows XP” on page 3-21.

Table 3-4 Check List of Setting up Print Server

Steps	Summary
Step 1. Preparation	You open Control Panel.
Step 2. Add/Remove Programs	You check print services.
Step 3. Services	You enable TCP/IP Print Server.
Step 4. Add Printer	You register a printer in the print server.

Step 1. Preparation

1. Log on to Windows.
2. Click *Start* and *Control Panel* to open the Control Panel.

Step 2. Add/Remove Programs

1. Click *Add or Remove Programs* to open the Add or Remote Programs window.
2. Click the *Add/Remove Windows Components* icon to open the Windows Components Wizard.
3. In the Components list box, highlight *Other Network File and Print Services* (but do not select or clear its check box).
4. Click *Details* to open the Other Network File and Print Services window.
5. Confirm the *Print Services for Unix* check box.

If the check box has been selected (checked), click *Cancel* of the window, and click *Cancel* of the wizard.

If the check box has not been selected, select the check box, click *OK* of the window, click *Next* of the wizard. After that, step through the setup instruction to install the Print Services for Unix.

6. Click *Close* of the Add or Remote Programs window.

Connecting to Network If You Use a Windows PC

Step 3.

Services

1. In the Control Panel, click *Performance and Maintenance*, then *Administrative Tools* to open the Administrative Tools window.
2. Double-click *Services* to open the Services window.
3. Check Status and Startup Type of the TCP/IP Print Server.

If they are not set as shown below, double-click *TCP/IP Print Server*, and set as shown below:

Name	Status	Startup Type
TCP/IP Print Server	Started	Automatic

4. Close the Services window.

Step 4.

Add Printer

If a remote printer is not defined in the computer, or you want to add a new printer, use the Add Printer Wizard. This wizard will guide you in adding a new printer. Step through the Add Printer Wizard. You will not need special instruction. Here is how to open the Add Printer Wizard.

1. Click *Start, Printers and Faxes*.
2. Click *Add a printer*. The Add Printer Wizard opens.

NOTE

Do not forget sharing the printer, and its share name used to specify the printer. For the share name, a maximum 15 alphanumeric characters is available. The first character must be a letter of the alphabet.

Setting Up Network for Windows 2000

NOTE

If your computer has already been on the network, ignore this section. Just check the following network parameters.

- Computer name
- IP address of the computer
- IP address of the gateway (optional)
- Subnet mask (optional)

You can check these values by executing the hostname command and the ipconfig command using the Command Prompt.

This section describes how to set up the network of the computer.

Table 3-5

Check List of Network Setup

Steps	Summary
Step 1. Preparation	You set up the computer.
Step 2. Network Identification	You check the network identification.
Step 3. Network Protocols	You set the network protocol.
Step 4. TCP/IP Properties	You set up the TCP/IP properties.
Step 5. Network Connection Check	You check the network connection.

Step 1.

Preparation

1. Set up the computer, and connect the CD-ROM drive to the computer.
2. Connect the computer to the network of your site using the straight LAN cable.
If you are not going to connect the computer to the network but to the 4155C/4156C directly, use the cross LAN cable.
3. Turn on the computer and CD-ROM drive. Then wait until Windows boots up.

Connecting to Network If You Use a Windows PC

Step 2.

Network Identification

1. Log on to Windows.
2. Click Start, Settings, and Control Panel to open the Control Panel.
3. Double-click the System icon to open the System Properties dialog box.
4. Click the Network Identification tab.
5. Check Full computer name and Workgroup or Domain. Or set them properly.

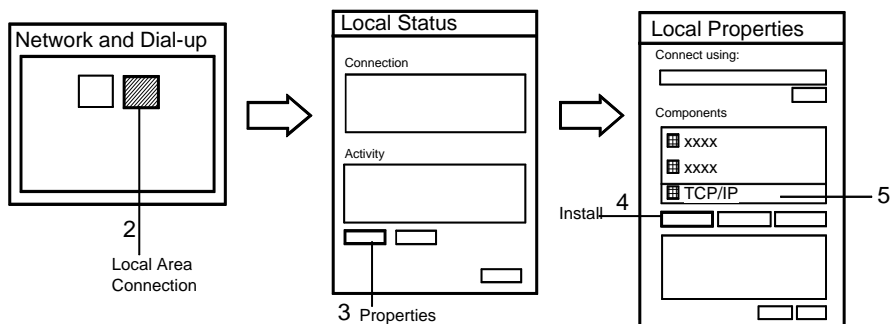
Step 3.

Network Protocols

1. Double-click the Network and Dial-up Connections icon in the Control Panel.
2. Double-click the Local Area Connection icon to open the Local Area Connection Status dialog box. See Figure 3-10.
3. Click Properties to open the Local Area Connection Properties dialog box.
4. If Internet Protocol (TCP/IP) is not installed, click Install. After that, step through the setup instruction to install the TCP/IP.
5. Highlight Internet Protocol (TCP/IP).

Figure 3-10

Selecting Network Protocol



Step 4.

TCP/IP Properties

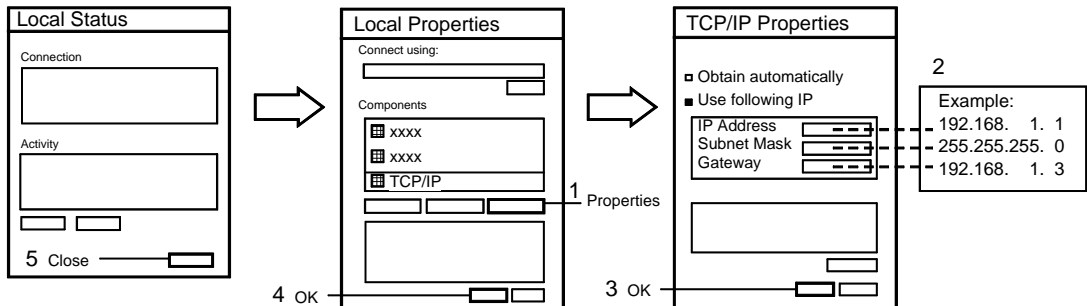
1. Click Properties to open the Internet Protocol (TCP/IP) Properties dialog box. See Figure 3-11.
2. If you are going to use the DHCP server, click “Obtain an IP address automatically”. You do not need to set the network parameters. Otherwise, click “Use the following IP address” and set the network parameters.
3. Click OK.
4. Click OK.
5. Click Close.

Step 5.

Network Connection Check

1. Click Start, Programs, Accessories, and Command Prompt to open the Command Prompt window.
 2. Ping a computer or a device on the network. If, for example, the IP address of the device is 192.168.1.99, execute C:\> ping 192.168.1.99.
- If any error occurs, perform these instructions again.

Figure 3-11 **Setting up TCP/IP Properties**



Setting Up Print Server for Windows 2000

This section describes how to set up a print server using the computer installed with Windows 2000. Before starting the procedure, set up the network of the computer as described in “Setting Up Network for Windows 2000” on page 3-25.

Table 3-6 Check List of Setting up Print Server

Steps	Summary
Step 1. Preparation	You open Control Panel.
Step 2. Add/Remove Programs	You check print services.
Step 3. Services	You enable TCP/IP Print Server.
Step 4. Add Printer	You register a printer in the print server.

Step 1.

Preparation

1. Log on to Windows.
2. Click Start, Settings, and Control Panel to open the Control Panel.

Step 2.

Add/Remove Programs

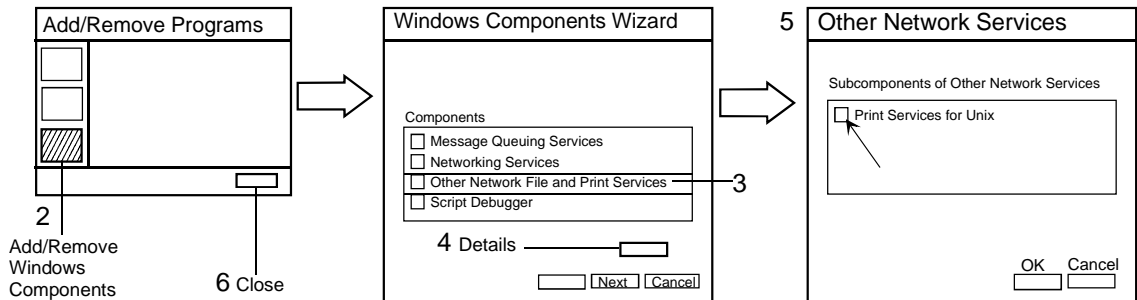
1. Double-click the Add/Remove Programs icon to open the Add/Remote Programs window.
2. Click Add/Remove Windows Components to open the Windows Components Wizard. See Figure 3-12.
3. In the Components list box, highlight Other Network File and Print Services (but do not select or clear its check box).
4. Click Details to open the Other Network File and Print Services window.
5. Confirm the *Print Services for Unix* check box.

If the check box has been selected (checked), click Cancel of the window, and click Cancel of the wizard.

If the check box has not been selected, select the check box, click OK of the window, click Next of the wizard. After that, step through the setup instruction to install the *Print Services for Unix*.

6. Click Close of the Add/Remote Programs window.

Figure 3-12 **Confirming Print Services**



Step 3. Services

1. Double-click the Administrative Tools icon to open the Administrative Tools window.
2. Double-click the Services icon to open the Services window.
3. Check Status and Startup Type of the TCP/IP Print Server.

If they are not set as shown below, double-click TCP/IP Print Server, and set as shown below:

Name	Status	Startup Type
TCP/IP Print Server	Started	Automatic

4. Close the Services window.

Step 4. Add Printer

If a remote printer is not defined in the computer, or you want to add a new printer, use the Add Printer Wizard. This wizard will guide you in adding a new printer. Step through the Add Printer Wizard. You will not need special instruction. Here is how to open the Add Printer Wizard.

1. Click Start, Settings, and Printers to open the Printers folder.
2. Double-click the Add Printer icon. The Add Printer Wizard opens.

NOTE

Do not forget sharing the printer, and its share name used to specify the printer. For the share name, a maximum 15 alphanumeric characters is available. The first character must be a letter of the alphabet.

Setting Up Network for Windows NT

NOTE

If your computer has already been on the network, ignore this section. Just check the following network parameters.

- Computer name
- IP address of the computer
- IP address of the gateway (optional)
- Subnet mask (optional)

You can check these values by executing the hostname command and the ipconfig command using the Command Prompt.

This section describes how to set up the network of the computer.

Table 3-7

Check List of Network Setup

Steps	Summary
Step 1. Preparation	You set up the computer.
Step 2. Network Identification	You check the network identification.
Step 3. Network Protocols	You set the network protocol.
Step 4. TCP/IP Properties	You set up the TCP/IP properties.
Step 5. Network Connection Check	You check the network connection.

Step 1.

Preparation

1. Set up the computer, and connect the CD-ROM drive to the computer.
2. Connect the computer to the network of your site using the straight LAN cable.
If you are not going to connect the computer to the network but to the 4155C/4156C directly, use the cross LAN cable.
3. Turn on the computer and CD-ROM drive. Then wait until Windows boots up.

Step 2.

Network Identification

1. Log on to Windows.
2. Click Start, Settings, and Control Panel to open the Control Panel.
3. Double-click the Network icon to open the Network dialog box.
4. Check Computer Name and Workgroup or Domain. Or set them properly.

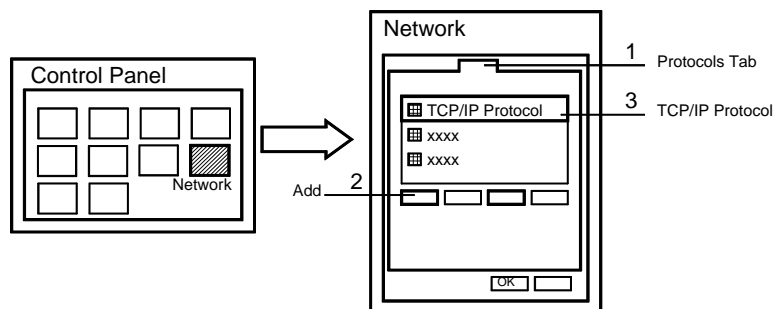
Step 3.

Network Protocols

1. Click the Protocols tab of the Network dialog box. See Figure 3-13.
2. If TCP/IP Protocol is not installed, click Add. After that, step through the setup instruction to install the TCP/IP.
3. Highlight TCP/IP Protocol.

Figure 3-13

Selecting Network Protocol



Connecting to Network If You Use a Windows PC

Step 4.

TCP/IP Properties

1. Click Properties to open the TCP/IP Properties dialog box. See Figure 3-14.
2. If the computer is installed with multiple network adapters, select one to use.
3. If you are going to use the DHCP server, click “Obtain an IP address from a DHCP server”. You do not need to set the network parameters.

Otherwise, click “Specify an IP address” and set the network parameters.

4. Click OK.
5. Click OK.
6. Restart the computer.

Step 5.

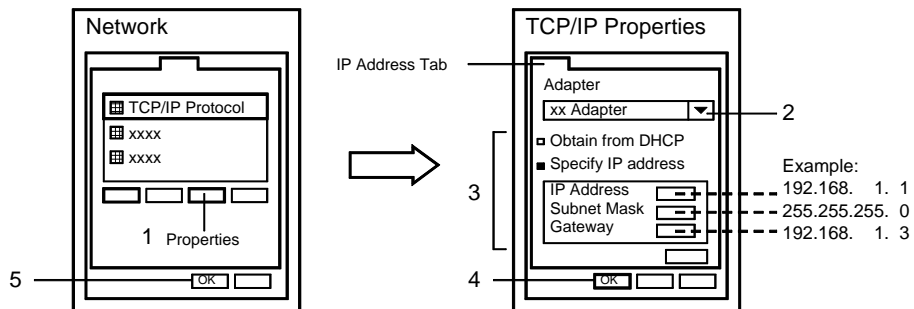
Network Connection Check

1. Log on to Windows.
2. Click Start, Programs, and Command Prompt to open the Command Prompt window.
3. Ping a computer or a device on the network. If, for example, the IP address of the device is 192.168.1.99, execute C:\> ping 192.168.1.99.

If any error occurs, perform these instructions again.

Figure 3-14

Setting up TCP/IP Properties



Setting Up Print Server for Windows NT

This section describes how to set up a print server using the computer installed with Windows NT. Before starting the procedure, set up the network of the computer as described in “Setting Up Network for Windows NT” on page 3-30.

Table 3-8 Check List of Setting up Print Server

Steps	Summary
Step 1. Preparation	You open Control Panel.
Step 2. Network Services	You check network services.
Step 3. Services	You enable TCP/IP Print Server.
Step 4. Add Printer	You register a printer in the print server.

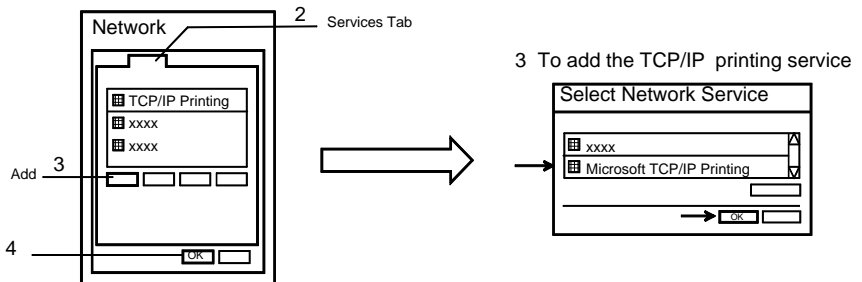
Step 1. Preparation

1. Log on to Windows.
2. Click Start, Settings, and Control Panel to open the Control Panel.

Step 2. Network Services

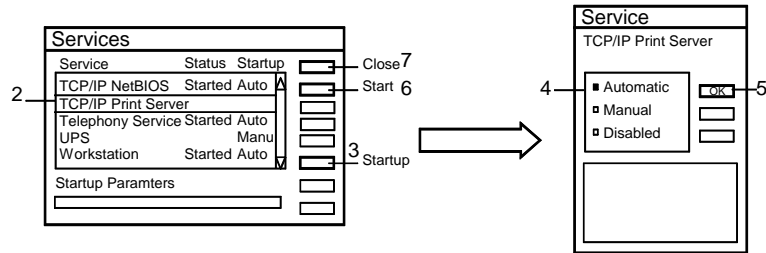
1. Double-click the Network icon to open the Network dialog box.
2. Click the Services tab of the Network dialog box. See Figure 3-15.
3. If Microsoft TCP/IP Printing is not installed, click Add. After that, follow the setup instructions to install the TCP/IP Printing service.
4. Click OK.

Figure 3-15 Confirming Network Services



Connecting to Network If You Use a Windows PC

Figure 3-16 **Enabling Print Server**



Step 3.

Services

1. Double-click the Services icon to open the Services dialog box. See Figure 3-16.
2. Click TCP/IP Print Server.
3. Click Startup to open the TCP/IP Print Server dialog box.
4. Set Automatic.
5. Click OK.
6. Click Start.
7. Click Close.

Step 4.

Add Printer

If a remote printer is not defined in the computer, or you want to add a new printer, use the Add Printer Wizard. This wizard will guide you in adding a new printer. Step through the Add Printer Wizard. You will not need special instruction. Here is how to open the Add Printer Wizard.

1. Click Start, Settings, and Printers to open the Printers folder.
2. Double-click the Add Printer icon. The Add Printer Wizard opens.

NOTE

Do not forget sharing the printer, and its share name used to specify the printer. For the share name, a maximum 15 alphanumeric characters is available. The first character must be a letter of the alphabet.

Setting Up NFS Server

This section describes how to set up the NFS server using the Microsoft Windows Services for UNIX software. Before starting the procedure, set up the network of the computer as described in “Setting Up Network for Windows XP” on page 3-21, “Setting Up Network for Windows 2000” on page 3-25, or “Setting Up Network for Windows NT” on page 3-30.

This section provides setup procedures using the Services for UNIX 3.5 software.

Perform step 1 to step 9 to set up the NFS server.

Perform step 10 to export a network file system.

Table 3-9

Check List of Setting up NFS Server

Steps	Summary
Step 1. Preparation	You add Windows logon accounts, and create password file and group file. ^a
Step 2. Installation	You install Services for UNIX.
Step 3. Server for NFS	You set up Server for NFS menu.
Step 4. Group Registration	You register groups.
Step 5. User Registration	You register users.
Step 6. User Mapping Configuration	You specify password file and group file.
Step 7. User Name Mapping	You set user mapping.
Step 8. Group Name Mapping	You set group mapping.
Step 9. Map Maintenance	You save user name mapping data.
Step 10. Export (Windows Explorer)	You export a network file system.

- a. The password file and group file are used for the user mapping between a NFS server and a NFS client.

Connecting to Network If You Use a Windows PC

Step 1.

Preparation

1. Add Windows logon accounts and groups you want to register.

For Windows XP, use User Accounts opened from the Control Panel.

For Windows 2000, use Users and Passwords opened from the Control Panel.

For Windows NT, use User Manager opened by clicking Start, Programs, Administrative Tools, and User Manager.

2. Create and save a password file (for example, C:\test\passwd).

The file must contain the user name (first element), user ID (third element), and group ID (fourth element) separated by a colon in each line. The second, fifth, sixth, and seventh elements are not required for the 4155C/4156C dedicated NFS server.

Example:

```
user01::1234:20:::  
user02::1235:20:::
```

3. Create and save a group file (for example, C:\test\group).

The file must contain the group name (first element), group ID (third element), and group members (fourth element) separated by a colon in each line. The second element is not required for the 4155C/4156C dedicated NFS server.

Example:

```
users::20:user01,user02
```

Example shown in 2 and 3 defines the following user information:

User Name	User ID	Group Name	Group ID
user01	1234	users	20
user02	1235	users	20

NOTE

User ID and group ID defined in the password file and group file are important. They must be set to the 4155C/4156C when it mounts to a network file system on the NFS server. A numeric value from 1 to 32767 is available for the 4155C/4156C.

NOTE

If the computer is going to be a NFS server of an Unix system, copy the password file and group file from the Unix system. You do not need to create the password file and group file shown in 2 and 3.

Step 2.

Installation

Insert the software CD-ROM into the CD-ROM drive, and wait for the starting of the setup program. Step through the setup program. Here are the points to watch when executing the setup program.

1. Select Custom mode for the installation mode.
2. Select the following components:
 - NFS**
 - Server for NFS
 - Authentication tools for NFS**
 - User Name Mapping
 - Server for NFS Authentication
 - Server for PCNFS
3. When installation is completed, you may need to restart the computer. Then restart the computer, and log on to Windows again.

NOTE

If the computer is going to be a client of a NFS server, a software component “Client for NFS” must be additionally selected in 2 shown above.

Step 3.

Server for NFS

1. Click Start, Programs, *Windows Services for UNIX*, and *Services for UNIX Administration* to open the *Services for UNIX Administration* window.
2. Click *Services for UNIX [local]* in the component tree of the *Services For UNIX Administration* window.
3. Click Settings tab, and fill in the following field.

Field Name	Description	Example
Computer name	Name of the computer used for user name mapping between Windows and Unix.	PC001

4. Click Apply.

Connecting to Network If You Use a Windows PC

Step 4.

Group Registration

1. Click *Server for PCNFS* in the component tree of the *Services For UNIX Administration* window.
2. Click Group tab.
3. Fill in the following fields, and click New.

Field Name	Description	Example
Group name	Group name.	Users
Group ID (GID)	Group ID. Not used by 4155C/4156C.	100

4. Repeat 3 for all groups you want to register.
5. Click Apply.

Step 5.

User Registration

1. Click *Server for PCNFS* in the component tree of the *Services For UNIX Administration* window.
2. Click Users tab.
3. Click New, complete the PCNFS Users dialog box, and click OK.

Field Name	Description	Example
User name	User name.	name01
User logon name	Windows logon account name.	USER01
Password	Windows logon password for the user.	*****
Confirm password	Same as Password.	*****
Primary group name	Group name the user belongs.	Users
User ID (UID)	User ID. Not used by 4155C/4156C.	1001

4. Repeat 3 for all users you want to register.
5. Click Apply.

Step 6. User Mapping Configuration

1. Click *User Name Mapping* in the component tree of the *Services For UNIX Administration* window.
2. Click Configuration tab.
3. Select *Use Password and Group files* radio button.
4. Fill in the following fields. For the password file and group file, see Step 1.

Field Name	Description	Example
Password file path and name	Password file name.	C:\test\passwd
Group file path and name	Group file name	C:\test\group

5. Click Apply.

Step 7. User Name Mapping

1. Click *User Name Mapping* in the component tree of the *Services For UNIX Administration* window.
2. Click Maps tab.
3. Click *Show User Maps* of the Advanced maps.
4. Select Windows domain name, for example, \\PC001 for the computer named PC001.
5. Click List Windows Users. Windows logon accounts will be listed on the Windows users list box.
6. Click List UNIX Users. Unix users will be listed on the UNIX users list box.
7. Select a Windows user name and an UNIX user name to associate, then click Add. For example, set as shown below:

Windows user name	UNIX user name
USER01	user01

8. Repeat 7 for all users you want to register.
9. Click Apply.

Connecting to Network If You Use a Windows PC

Step 8.

Group Name Mapping

1. Click *User Name Mapping* in the component tree of the *Services For UNIX Administration* window.
2. Click Maps tab.
3. Click *Show Group Maps* of the Advanced maps.
4. Select Windows domain name, for example, \\PC001 for the computer named PC001.
5. Click List Windows Groups. Windows groups will be listed on the Windows groups list box.
6. Click List UNIX Groups. Unix groups will be listed on the UNIX groups list box.
7. Select a Windows group name and an UNIX group name to associate, then click Add. For example, set as shown below:

Windows group name	UNIX group name
Users	users

8. Repeat 7 for all groups you want to register.
9. Click Apply.

Step 9.

Map Maintenance

1. Click *User Name Mapping* in the component tree of the *Services For UNIX Administration* window.
2. Click Map Maintenance tab.
3. Enter the name of backup file.

Field Name	Description	Example
File path and name	Name of the user mapping backup file.	C:\test\backup.html

4. Click Back Up to create the backup file. The backup file saves the user mapping and group mapping data you set at Step 7 and Step 8.
5. Click Apply.

Finally, close the *Services for UNIX Administration* window to complete the setup of the NFS server. You may need to restart the computer. Then restart the computer, and log on to Windows again.

Connecting to Network If You Use a Windows PC

Step 10.

Export (Windows Explorer)

1. Open Windows Explorer.
2. Create a folder to export if you need.
3. Place the mouse pointer on a folder to export, for example, D4156, then click the right mouse button to display a pop-up menu.
4. Click Properties on the pop-up menu to open the properties dialog box for the folder.
5. Click the NFS Sharing tab.

Perform the following steps to specify the share name and permissions.

- a. Select the *Share this folder* radio button.
- b. Enter Share name, for example, DATA4156.

This value will be set to the 4155C/4156C to specify the network file system to mount. It must be a maximum 58 alphanumeric characters.

- c. Click Permissions to open the NFS Share Permissions dialog box.
- d. Repeat the following steps to add NFS clients for the folder.
 1. Click Add to open the Add Clients and ClientGroups dialog box.
 2. Enter the computer name of NFS client in the Add Names list box.
For example, enter ANALYZER for the 4155C/4156C.
 3. Click OK.
- e. Set Type of Access as you wish.

For example, if you want to allow the read write permission to ANALYZER only, set as shown below:

Name	Type of Access
ALL MACHINES	Read-Only
ANALYZER	Read-Write

- f. Click OK.
6. Click OK of the dialog box.

7. Open the Command Prompt window.

Click Start, All Programs, Accessories, and Command Prompt for Windows XP.

Click Start, Programs, Accessories, and Command Prompt for Windows 2000.

8. Change the permission of the folder as you wish by entering the CACLS command. For details of the command, refer to the help message displayed by entering the following statement.

```
C:\> HELP CACLS
```

Example:

```
C:\> CACLS D4156 /P USER01:F Users:R Everyone:R
```

This example sets the permission of the folder D4156 as shown below.

	Permission of D4156
USER01 (creator)	Full Control
Users (group)	Read
Everyone	Read

Then the 4155C/4156C (for example, host name ANALYZER) will be able to mount a folder you specified.

Connecting to Network
If You Use a Windows PC

4

File Operations

File Operations

This chapter covers the following file operations:

- selecting a mass storage device
- listing a file catalog
- storing setup or results data
- storing data in spreadsheet format
- loading setup or results data
- changing a file name
- removing a file/directory
- copying a file
- creating a directory on a network file system
- changing the working directory
- initializing a diskette
- backing up a diskette

You can use these file operations on the internal memory, a diskette in the built-in flexible disk drive, or on a network file system that Agilent 4155C/4156C mounts.

You can perform file operations by:

- selecting softkeys on the SYSTEM: FILER screen. (All file operations can be performed this way.)
- selecting the front-panel keys Get and Save from the User File key group. (Only store and load file operations can be performed this way.)

For details on the SYSTEM: FILER screen, refer to *Setup Screen Reference* manual.

NOTE**To Use the Network File System**

The 4155C/4156C can be an NFS client, and can use the network file system as a mass storage device.

To use the network file system:

1. Connect the 4155C/4156C to your LAN. See Chapter 3.
2. Complete the NETWORK SETUP table on the SYSTEM: MISCELLANEOUS screen.
3. Complete the NETWORK DRIVE SETUP table on the SYSTEM: MISCELLANEOUS screen.

For information on the SYSTEM: MISCELLANEOUS screen, see *Setup Screen Reference* manual.

NOTE**Situations When You Cannot Store/Load Files**

The Save and Get keys are available from any screen. However, the Save and Get functions will not work under the following conditions:

- during measurement or forcing stress
- when an error message is displayed
- when the HELP screen is displayed
- when the KNOB SWEEP screen is displayed
- when the SCREEN DUMP, PRINT/PLOT, or GRAPH PLOT dialog is displayed

Selecting a Mass Storage Device

To start a file operation, you must specify the mass storage device by selecting either the built-in flexible disk drive or a network file system.

1. Press System key.
2. Select FILER softkey to display the SYSTEM: FILER screen.
3. Move the cursor to the DISK entry field.
4. Select one of the following secondary softkeys.

FLOPPY Specifies the diskette in the built-in flexible disk drive.

Insert a diskette into the built-in flexible disk drive.

drive name If you have set up a drive label in the NETWORK DRIVE SETUP table, this label will appear as a softkey. Up to four softkeys can be added this way.

Before selecting one of these directories, it must be exported so that it can be mounted by the 4155C/4156C.

When this softkey is pressed, the 4155C/4156C mounts the directory on an NFS server, and displays the file catalog in the FILE CATALOG area. The directory name will be shown next to the DISK entry field, and it will be the root directory.

To unmount the directory, choose another secondary softkey or turn off the 4155C/4156C.

Listing a File Catalog

1. Press System key.
2. Select FILER softkey to display the SYSTEM: FILER screen.
3. Specify the mass storage device.
4. Select FILE CATALOG softkey. A maximum of 199 file names can be displayed in the FILE CATALOG area.
5. Use the rotary knob to move the cursor or to scroll through the list of file names.

For reference of the FILE CATALOG area, refer to *Setup Screen Reference* manual.

To Display File Comments (only for diskette)

If the built-in flexible disk drive is specified as the mass storage device, the FILE CATALOG area will not include the file comments. To display the file comments, select one of the following softkeys:

READ

COMMENT Reads and displays the comments for the selected file.

READ

COMMENT ALL Reads and displays the comments for all files.

To Exit the File Catalog

Select EXIT FILE CATALOG softkey.

To Search for a Desired File Name

Enter an alphanumeric character. The cursor will move to the first file name that starts with that character.

Storing Setup or Results Data

1. To store data to a file in the current mass storage device, press Save key to display the SAVE setup fields.
2. To change the mass storage device:
 - a. Press System key.
 - b. Select FILER softkey to display the SYSTEM: FILER screen.
 - c. Specify the new mass storage device.
 - d. Select SAVE softkey to display the SAVE setup fields.

FUNCTION: SAVE			
NAME	<input type="text"/>		
TYPE	<input type="text"/>	COMMENT	<input type="text"/>

3. In the NAME field, do one of the following:
 - To store the data in a new file on a diskette, enter a file name that is a maximum of 8 characters (for DOS format) or a maximum of 6 characters (for HP LIF format). For HP LIF format, do *not* use "_" as the last character of the filename.
 - To store data in a new file on the network file system, enter a file name, 36 characters maximum. The file name and directory path combined can be 58 characters maximum.
 - To store data in an existing file, select FILE CATALOG softkey. Use the rotary knob to move the cursor to the correct file, then press SELECT softkey.
 - To store data in an internal memory, select MEM1, MEM2, MEM3 or MEM4 softkey.

4. In the TYPE field, select:
 - MES softkey for measurement setup data.
 - STR softkey for stress setup data.
 - DAT softkey for measurement setup and results data.
 - MAT softkey for E5250A setup data.
 - CST softkey for customized system data. (This is not available when storing in internal memory.)
5. In the COMMENT field, you may enter a comment of up to 16 characters. (When using internal memory, the specified comment will be displayed on the softkey.)
6. Select EXECUTE softkey. The data will be stored in the specified file.
Any data previously stored in the existing file or internal memory will be overwritten.
7. Select EXIT softkey.

Storing Results Data in Spreadsheet Format

1. Specify the mass storage device.
2. Display the results data on the GRAPH/LIST: LIST screen.
To display the GRAPH/LIST: LIST screen, press Graph/List key. If the GRAPH/LIST: GRAPHICS screen is displayed, press Graph/List key again.
3. Select SPREAD SHEET softkey to display the ASCII SAVE setup fields.
For a list of files in the mass storage device, select FILE CATALOG softkey.

FUNCTION: ASCII SAVE			
NAME	<input type="text"/>		
	UNIT	<input type="text"/>	
OUTPUT DATA (INDEX NO)	DELIMITER	<input type="text"/>	
<input type="text"/> <--> <input type="text"/>	STRING MARK	<input type="text"/>	

4. In the NAME field, enter the name of the file (with no file extension) in which you want to save data. The file name may be:
 - a maximum of 8 characters to store on a DOS diskette.
 - To store data in a new file on the network file system, enter a file name, 36 characters maximum. The file name and directory path combined can be 58 characters maximum.
5. In the OUTPUT DATA field, enter the range of results data you want to save (corresponds to NO. column on the LIST screen). The left field is the lower limit and the right field is the upper limit.
Select ALL softkey to specify all results data.
6. In the UNIT field, select one for the following:
 - ON softkey will save the unit of measure (such as V or ms) with the results data. If the UNIT is ON, results data will be treated as string data.
 - OFF softkey will *not* save the units of measure. Results data will be treated as numeric data.

With UNIT ON or OFF, invalid data (----) will be treated as string data.

7. In the DELIMITER field, select:
 - SPACE softkey to specify a space as the data delimiter.
 - TAB softkey to specify a tab as the data delimiter.
 - COMMA softkey to specify a comma as the data delimiter.
8. In the STRING MARK field, select:
 - NONE softkey to specify no string marker.
 - " " softkey to specify " " as the string marker.
 - \ ' softkey to specify \ ' as the string marker.
9. Select EXECUTE softkey. The results data will be saved to the specified file, and a .TXT extension is automatically added.
10. Select EXIT softkey.

Output Format for the ASCII SAVE Function

The following is the output format for each item on the LIST screen. This notation is used to indicate the string or numeric type:

[S]	string
[S/N]	If the UNIT field is ON, the value is output as a string with a string marker. If the UNIT field is OFF, the value is output as a numeric value.
[N]	numeric value

1. user comment

User comment is output as a string with a specified string marker.

- Example (setups: STRING MARK = " ")

```
"Bipolar Tr. Vce-Ic"
```

2. VAR1 output range

For sweep measurements:

Format: <VAR1 name> = <start> to <stop> in <step> step

Type: [S] [S/N] [S] [S/N] [S] [S/N] [S]

For log sweep measurements, LOG is output for the step value.

- Example
(setups: UNIT=OFF, STRING MARK=" ", DELIMITER=COMMA)

```
"VCE=",0.0001,"to",1,"in","LOG","step"
```

For sampling measurements:

Format: @TIME = <start time> to <stop time>

Type: [S] [S/N] [S] [S/N]

- Example
(setups: UNIT=ON, STRING MARK=" ", DELIMITER=COMMA)

```
"@TIME=", "0.00 s", "to", "1.516 s"
```

3. VAR2 output range

Format: <VAR2 name> = <start value>to<stop value>in<step value>step

Type: [S] [S/N] [S] [S/N] [S] [S/N] [S]

- Example

(setups: UNIT=OFF, STRING MARK= " ", DELIMITER=COMMA)

"IB=" ,1E-05 , "to" , 5E-05 , "in" , 1E-05 , "step"

4. variable names

Format: NO. <variable name> <variable name>

Type: [S] [S] [S]

- Example (setups: STRING MARK= " ", DELIMITER=COMMA)

"NO." , "VCE" , "IC"

5. unit

Format: <blank><1st variable unit><2nd variable unit>

Type: [S] [S] [S]

- Example (setups: STRING MARK= " ", DELIMITER=COMMA)

" " , "V" , "A"

6. measurement data

Format: <index><1st variable data><2nd variable data>

Type: [N] [S/N] [S/N]

- Example (setups: UNIT=OFF, DELIMITER=COMMA)

1 , 0.001 , -9.265E-10 , . . . , . . .

Output Examples

1. Lotus 1-2-3 Output Example

- Setups
 - UNIT = OFF
 - DELIMITER = COMMA
 - STRING MARK = " "
- Output

```
"Bipolar Tr. Vce-Ic"  
"VCE=",0.0001,"to",1,"in","LOG","step"  
"IB=",1E-05,"to",5E-05,"in",1E-05,"step"  
"NO. ","VCE","IC"  
"","V","A"  
1,0.0001,-9.265E-10  
2,0.00013,1.0416E-09  
3,0.00016,1.527E-09  
4,0.0002,-8.975E-10  
5,0.00025,-1.7453E-09
```

2. Microsoft Excel Output Example

- Setups
 - UNIT = OFF
 - DELIMITER = TAB
 - STRING MARK = NONE
- Output

```
V3-I3 characteristics  
V3 = 0 to 1 in 0.1 step  
I3 = 2E-05 to 0.0001 in 2E-05 step  
NO.  V3  I3  
      V   A  
1     0  1.665E-09  
2    0.1 1.9072E-09  
3    0.2 1.4471E-08  
4    0.3 1.8823E-07  
5    0.4 2.1995E-06
```

3. Append Measurement Output Example

- Setups
 - UNIT = OFF
 - DELIMITER = TAB
 - STRING MARK = NONE

- Output

```

V3 = 0 to 1 in 0.5 step          <--Single
I2 = 2E-05 to 0.0001 in 2E-05 step <--Single
/* Append 1 */
V3 = 0 to 1 in 0.5 step          <--Append1
I2 = 2E-05 to 0.0001 in 2E-05 step <--Append1
/* Append 2 */
V3 = 0 to 1 in 0.5 step          <--Append2
I2 = 2E-05 to 0.0001 in 2E-05 step <--Append2
NO.  V3  I3                      ---+---Single
      V  A
1     0  4.3E-13
2     0.5 5.7E-13
3     1  3.1E-13
.
.
.
15    1  3.2E-13          ---+

/* Append 1 */                  ---+---Append1
NO.  V3  I3                      |
      V  A                        |
1     0  1.7E-13                  |
2     0.5 8E-13                    |
3     1  2.8E-13                  |
.                                    |
.                                    |
.                                    |
15    1  4.5E-13                  |          ---+

/* Append 2 */                  ---+---Append2
NO.  V3  I3                      |
      V  A                        |
1     0  1.5E-13                  |
2     0.5 7E-13                    |
3     1  2.5E-13                  |
.                                    |
.                                    |
.                                    |
15    1  5E-13                    |          ---+

```

Loading Setup or Results Data

1. To load data from a file in the present mass storage device, press Get key.
2. To change the mass storage device, do the following:
 - a. Press System key.
 - b. Select FILER softkey to display the SYSTEM: FILER screen.
 - c. Specify the new mass storage device.
 - d. Select GET softkey.

FUNCTION: GET	
NAME	<input type="text"/>
TYPE	<input type="text"/>

3. In the NAME field, do one of following.
 - To load a file from a diskette or a network file system:
 - a. Select FILE CATALOG softkey.
 - b. Move the cursor to the desired file name using the rotary knob.
 - c. Press SELECT softkey. This sets the NAME and TYPE entries.
 - To load data from internal memory, select MEM1, MEM2, MEM3 or MEM4 softkey.
4. Select EXECUTE softkey.
5. Select EXIT softkey.

If the Setup File does not match the present configuration

If the information in the setup file is different than the current system unit configuration, the 4155C/4156C will change the setup values when loading the file.

- If the file has an HPSMU setup, but the current system does not have an HPSMU, two parameters will be changed:
 - Voltage Measurement Range: 200 V \Rightarrow 100 V
 - Current Measurement Range: 1 A \Rightarrow 100 mA
- If you try to load an 4156A/B setup on the 4155C, one parameter will be changed:
 - Current Measurement Range: 10 pA or 100 pA \Rightarrow 1 nA

File Type

The 4155C/4156C can load the following files:

MES file	Measurement setup data file.
STR file	Stress force setup data file.
DAT file	Measurement result data file. Includes the measurement setup.
MAT file	E5250A setup data file.
CST file	Customized system data file.
PRO file	Measurement setup data file for the 4145 parameter analyzer.

Changing a File Name

1. Press System key.
2. Select FILER softkey to display the SYSTEM: FILER screen.
3. Specify the mass storage device.
4. Select RENAME softkey to display the RENAME setup fields.

FUNCTION: RENAME	
NAME	<input type="text"/>
TYPE	<input type="text"/>
NEW NAME	<input type="text"/>

5. Select FILE CATALOG softkey.
6. Move the pointer to the file name to be changed using the rotary knob.
7. Select SELECT SOURCE softkey. This sets the NAME and TYPE entries.
8. In the NEW NAME field, enter a new name. The name may be:
 - a maximum of 6 characters for a diskette in HP LIF format. Do *not* use "_ " as the last character of the filename.
 - a maximum of 8 characters for a diskette in DOS format.
 - To store data in a new file on the network file system, enter a file name, 36 characters maximum. The file name and directory path combined can be 58 characters maximum.

To change the file name to an existing file name:

Select FILE CATALOG softkey, and move the pointer to the desired file name using the rotary knob. Then press SELECT TARGET softkey.

9. Select EXECUTE softkey. The file name will be changed to the specified new name.
10. Select EXIT softkey.

Removing a File/Directory

1. Press System key.
2. Select FILER softkey to display the SYSTEM: FILER screen.
3. Specify the mass storage device.
4. Select PURGE softkey.

FUNCTION: PURGE	
NAME	<input type="text"/>
TYPE	<input type="text"/>

5. Select FILE CATALOG softkey.
6. Move the pointer to the file or directory to be removed using the rotary knob. The directory to be removed must be empty.
7. Press SELECT softkey. This sets the NAME and TYPE entries.
8. Select EXECUTE softkey, then select one of the following:
 - YES softkey to remove the file/directory.
 - NO softkey to cancel.
9. Select EXIT softkey.

Removing multiple files

To remove multiple files with the same filename, but different file extensions, select * softkey in the TYPE field. When you execute, all file by that name will be deleted, regardless of their extension.

For example, if the NAME field is MOS1 and the TYPE field is *, then all the following files would be deleted:

```
MOS1.MES  
MOS1.STR  
MOS1.DAT  
MOS1.MAT  
MOS1.CST  
MOS1.PRO
```

Copying a File

1. Press System key.
2. Select FILER softkey to display the SYSTEM: FILER screen.
3. Specify the mass storage device.
4. Select COPY softkey to display the COPY setup fields.

FUNCTION: COPY	
SOURCE NAME	
TYPE	TARGET DISK
TARGET NAME	

5. In the SOURCE NAME field, do one of the following:
 - To copy from a diskette or a network file system:
 - a. Select FILE CATALOG softkey.
 - b. Move the pointer to the desired file name using the rotary knob.
 - c. Press SELECT SOURCE softkey. This sets the SOURCE NAME and TYPE entries.
 - To copy from internal memory, select MEM1, MEM2, MEM3 or MEM4 softkey.
6. To copy a file from one diskette to another diskette:
 - a. Move the pointer to the TARGET DISK field.
 - b. Select OTHER softkey. (SAME softkey will copy the file back onto the source diskette.)

7. In the TARGET NAME field, do one of the following:
 - To copy a file to a new file, enter the new file name.
 - a maximum of 6 characters for an HP LIF diskette. Do not use "_" as the last character of the filename.
 - a maximum of 8 characters for a DOS diskette.
 - To store data in a new file on the network file system, enter a file name, 36 characters maximum. The file name and directory path combined can be 58 characters maximum.
 - To copy a file to an existing file:
 - a. Select FILE CATALOG softkey.
 - b. Move the pointer to the desired file name using the rotary knob.
 - c. Press SELECT TARGET softkey. This sets the TARGET NAME entry.
 - To copy a file to internal memory, select MEM1, MEM2, MEM3 or MEM4 softkey.
8. Select EXECUTE softkey.
9. If you are copying a file from one diskette to another, follow these on-screen instructions.

Insert Source Diskette.
Continue? (YES / NO)

YES Insert the source diskette in the disk drive, then select this softkey.

NO Suspends the copy operation.

Insert Target Diskette.
Continue? (YES / NO)

YES Insert the target diskette in the disk drive, then select this softkey.

NO Suspends the copy operation.

10. Select EXIT softkey.

Creating a Directory on a Network File System

1. Press System key.
2. Select FILER softkey to display the SYSTEM: FILER screen.
3. Specify the mass storage device as a network file system.
4. Select MAKE DIRECTORY softkey.

FUNCTION:MAKE DIRECTORY	
NAME	<input type="text"/>

5. In the NAME field, enter the new directory name.
The directory name can be 36 characters maximum. The directory name and directory path combined can be 58 characters maximum.
6. Select EXECUTE softkey.
7. Select EXIT softkey.

Changing the Working Directory

1. Press System key.
2. Select FILER softkey to display the SYSTEM: FILER screen.
3. Specify the mass storage device as a network file system.
4. Select FILE CATALOG softkey.
5. To specify the working directory:
 - a. Move the pointer to the desired directory using the rotary knob.
 - b. Select CHANGE DIRECTORY softkey.
6. To change the working directory to the upper level, select one of the following:
 - UPPER DIR** Moves to the directory one level higher than the current directory.
 - ROOT DIR** Moves to the root directory.
7. Select EXIT FILE CATALOG softkey.

Initializing a Diskette

1. Press System key.
2. Select FILER softkey to display the SYSTEM: FILER screen.
3. Move the pointer to the DISK field.
4. Select FLOPPY softkey.
5. Select DISK OPERATION softkey to display the setup fields.
6. In the DISK OPERATION field, select DISK INIT softkey.
7. In the FORMAT field, select DOS softkey or HP LIF softkey.
8. (Optional) In the VOLUME NAME field, enter a volume name.
9. Select EXECUTE softkey.
10. After the confirmation message, insert a diskette in the flexible disk drive, then select:
 - YES softkey to initialize the diskette.
 - NO softkey to cancel.

The PROGRESS STATUS field shows what percentage of the initialization is completed.
11. Select EXIT softkey.

Backing Up a Diskette

1. Press System key.
2. Select FILER softkey to display the SYSTEM: FILER screen.
3. Move the pointer to the DISK field.
4. Select FLOPPY softkey.
5. Select DISK OPERATION softkey to display the setup fields.
6. In the DISK OPERATION field, select DISK COPY softkey.
7. Insert the source diskette, select EXECUTE softkey, then select one of the following:
 - YES softkey to execute the disk copy.
 - NO softkey to cancel the disk copy.
8. After the target diskette message is displayed, remove the source diskette and insert an initialized target diskette. The target and source diskettes must be the same format and size. Select:
 - YES softkey to execute the disk copy.
 - NO softkey to cancel the disk copy.

The PROGRESS STATUS field shows what percentage of the disk copy is complete.

The internal memory capacity may not be sufficient to perform the entire disk copy. If so, swap the source and target disks according to the on-screen instructions.
9. Select EXIT softkey.

File Operations
Backing Up a Diskette

5

Print/Plot Function

Print/Plot Function

Agilent 4155C/4156C print/plot function enables you to print, plot, or save to a file the following types of data:

- Screen images from the 4155C/4156C display
- Lists of setup data from the setup screens (except for the GRAPH/LIST and KNOB SWEEP screens)
- Lists of measurement data from the GRAPH/LIST: LIST screen
- Graphs of measurement data from the GRAPH/LIST: GRAPHICS and KNOB SWEEP screens

This chapter explains how to use the print/plot function, and consists of the following sections:

- “Output Formats”
- “Supported Peripherals”
- “Printing/Plotting Screen Images”
- “Printing/Plotting Setup Data Lists”
- “Printing/Plotting Measurement Data Lists”
- “Printing/Plotting Measurement Data Graphs”
- “Saving Screen Images”
- “Saving Setup Data Lists”
- “Saving Measurement Data Lists”
- “Saving Measurement Data Graphs”
- “Output Examples”

Output Formats

The print/plot function supports PCL, HP-GL, and TIFF formats, and provides the following five output modes:

PCL	For making hard copies using a peripheral that supports PCL, or for saving the hard copy image to a PCL file.
HR PCL	High resolution PCL. For making hard copies using a peripheral that supports PCL, or for saving the hard copy image to a PCL file. Output quality is higher than the PCL mode.
HP-GL	For making hard copies using a peripheral that supports HP-GL, or for saving the hard copy image to an HP-GL file. Mainly used for a plotter.
TIFF	For saving screen images to a TIFF file.
HR TIFF	High resolution TIFF. For saving screen images or measurement graph hard copy images to a TIFF file. Output quality is higher than the TIFF mode.

The display screens and output format available for each print, plot, or save function are as follows:

	4155C/4156C Display Screens	Output Format
Printing/plotting screen images (screen dumps)	all	PCL, HR PCL or HP-GL
Printing/plotting setup data lists	all setup ¹	
Printing/plotting measurement data lists	GRAPH/LIST: LIST	
Printing/plotting measurement data graphs	GRAPH/LIST: GRAPHICS, KNOB SWEEP	
Saving screen images to a file	all	PCL, HR PCL, HP-GL, TIFF or HR TIFF
Saving setup data lists to a file	all setup ¹	PCL, HR PCL or HP-GL
Saving measurement data lists to a file	GRAPH/LIST: LIST	
Saving measurement data graphs to a file	GRAPH/LIST: GRAPHICS, KNOB SWEEP	PCL, HR PCL, HP-GL or HR TIFF

1. All setup screens, except for GRAPH/LIST and KNOB SWEEP.

Differences Between PCL, HR PCL and HP-GL

There are major differences between the PCL, HR PCL and HP-GL modes for making hard copies. Use the comparison below to decide which mode is best for your needs.

	Mode	Description
Supported Peripheral	PCL	HP DeskJet, LaserJet, ThinkJet, PaintJet printers and HP C1202A serial printer
	HR PCL	
	HP-GL	HP DeskJet 1200C/1600C, LaserJet 4/4L printers and plotters
Screen Dump Output	PCL	Position is defined by OUTPUT REGION. Size depends on the OUTPUT REGION and RESOLUTION settings. RESOLUTION setting does not change the output quality. Aspect ratio cannot be changed. Print speed is faster than HR PCL.
	HR PCL	Position, size and aspect ratio are defined by OUTPUT REGION. Output resolution/quality depends on RESOLUTION setting.
	HP-GL	Position, size and aspect ratio are defined by OUTPUT REGION. Print speed is faster than PCL.
Data List Output	PCL	Print starting point is defined by OUTPUT REGION. Text font size depends on printer. RESOLUTION setting is ignored.
	HR PCL	Same as PCL.
	HP-GL	Position and text font size are defined by OUTPUT REGION. Print speed is faster than PCL.
Graph Output	PCL	Position is defined by OUTPUT REGION. Graph size depends on the OUTPUT REGION and RESOLUTION settings. Graph aspect ratio cannot be changed. Text font size depends on printer. RESOLUTION setting does not change the output quality. Print speed is faster than HR PCL.
	HR PCL	Position, size, and aspect ratio are defined by OUTPUT REGION. Output resolution/quality depends on RESOLUTION setting. All fonts are scaled with the output region.
	HP-GL	Position, size and aspect ratio are defined by OUTPUT REGION. All fonts are scaled with the output region. Print speed is faster than PCL.

Output Resolution

If you select the HR PCL or HR TIFF mode, you can change the resolution of the output. High resolution improves the output quality, but takes longer to print.

You can choose 75, 90, 100, 150, 180, 300 or 600 dpi (dots per inch) in the RESOLUTION field. This field appears in the PRINT/PLOT, GRAPH PLOT or SCREEN DUMP dialog box.

For the resolutions available for your printer, see “Supported Peripherals” on page 5-6.

RESOLUTION setting for PCL mode

In PCL mode, the RESOLUTION and OUTPUT REGION fields change the size and position of the output, but do not affect the output quality.

To set the output size and position, do the following procedure in the PRINT/PLOT, GRAPH PLOT or SCREEN DUMP dialog box.

1. In the RESOLUTION field, select one softkey (75 DPI to 600 DPI). A high RESOLUTION setting allows you to select various output sizes.
2. In the UPPER LEFT field, specify the upper-left corner position of the output image using the front-panel keys, rotary knob or keyboard, as follows:

UPPER LEFT X 0% Y 0%

The value may be 0% to 100%.

3. In the LOWER RIGHT field, specify the lower-right corner position of the output image using the rotary knob. The values available for the present RESOLUTION and UPPER LEFT settings are automatically calculated and displayed in the fields. You *cannot* change the aspect ratio of the output.

If the value exceeds 100%, change the RESOLUTION or UPPER LEFT settings. The value must be 0% to 100%.

Supported Peripherals

The 4155C/4156C supports the following peripherals. Use the table below to select the printer or plotter that best meets your needs.

Model	Interface	Output Format	Color ^a	P/L _b	Output Resolution (dpi) ^c
HP DeskJet 340	Parallel	PCL, HR PCL	B/W, FIX ^d	P	75, 100, 150, 300
HP DeskJet 500 (C2106A)	Parallel	PCL, HR PCL	B/W	P	75, 150, 300
HP DeskJet 500C (C2114A)	Parallel	PCL	B/W, FIX	P	75, 150, 300
HP DeskJet 550C	Parallel	PCL, HR PCL	B/W, FIX	P	75, 150, 300
HP DeskJet 560C (C2168A)	Parallel	PCL, HR PCL	B/W, FIX, COLOR ^e	P	75, 150, 300
HP DeskJet 660C (C2164A)	Parallel	PCL, HR PCL	B/W, FIX, COLOR ^e	P	75, 150, 300
HP DeskJet 694C	Parallel	PCL, HR PCL	B/W, FIX	P	75,100, 150, 300, 600 ^f
HP DeskJet 850C	Parallel	PCL, HR PCL	B/W, FIX, COLOR ^e	P	75, 150, 300, 600 ^g
HP DeskJet 895Cxi ^h	Parallel	PCL, HR PCL	B/W, FIX	P	100, 150, 300
HP DeskJet 970Cxi ^h	Parallel	PCL, HR PCL	B/W, FIX	P	100, 150, 300
HP DeskJet 990Cxi ^h	Parallel	PCL, HR PCL	B/W, FIX	P	100, 150, 300
HP DeskJet 1200C (C1676A)	Parallel	PCL, HP-GL	B/W, FIX, COLOR	P/L	75, 150, 300
		HR PCL	B/W	P/L	75, 150, 300
HP DeskJet 1600C	Parallel	PCL, HP-GL	B/W, FIX, COLOR	P/L	75, 150, 300
		HR PCL	B/W	P/L	75, 150, 300
HP LaserJet 4/4L (C2001A)	Parallel	PCL, HR PCL, HP-GL	B/W	P/L	75, 150, 300, 600
HP LaserJet 5L	Parallel	PCL, HR PCL	B/W	P/L	75, 100, 150, 180, 300

Model	Interface	Output Format	Color ^a	P/L _b	Output Resolution (dpi) ^c
HP LaserJet 6L ⁱ	Parallel	PCL, HR PCL, HP-GL	B/W	P/L	75, 100, 150, 180, 300,600
HP C1202A serial printer	GPIB	PCL	B/W	P	90, 150
HP ThinkJet (2225A/C/D)	GPIB, Parallel	PCL	B/W	P	75
HP PaintJet (3630A)	GPIB	PCL	B/W, FIX, COLOR	P	
HP 7440A/7475A plotters	GPIB	HP-GL	B/W, FIX	L	
HP 7550B plotter	GPIB	HP-GL	B/W, FIX	L	

- a. Available parameters for the COLOR/ B/W field on the PRINT/PLOT SETUP screen:
B/W = Black & White mode, FIX = Fixed color mode, COLOR = Color mode.
- b. P = Portrait, L = Landscape
- c. Available values for the output resolution setting.
- d. For screen image dump only.
- e. COLOR mode is available for HR PCL only. Available number of colors is 8.
- f. 600 dpi for PCL only.
- g. 600 dpi for B/W only.
- h. Enter \0033E into the TRAILER STRING field on the PRINT/PLOT SETUP screen before printing.
Else, the Form Feed indicator of the printer will blink after successful printing. To stop the blinking, press the Form Feed button of the printer.
- i. Additional memory is required when printing 2 graphs or 2 dumps on a sheet. Recommends total 2Mbyte or more.

Connecting Peripherals

The 4155C/4156C has both GPIB and parallel interfaces for connecting peripherals.

To connect the peripheral to the interface connector, use one of the following cables:

GPIB: Agilent 10833A/B/C/D GPIB cable or equivalent

parallel: HP C2950A/C2951A printer cable or equivalent

For more information on connecting peripherals, see “Connecting Instruments or Peripherals” in Chapter 2.

If you use a remote printer via your printer server, connect the 4155C/4156C to your LAN. For more information, see Chapter 3 and *Setup Screen Reference* manual.

Printing/Plotting Screen Images

This section describes how to make hard copies of the screen images using a printer or a plotter.

Before beginning to print/plot, check the following:

- SYSTEM: MISCELLANEOUS screen

This screen specifies the 4155C/4156C control mode, GPIB address, output equipment, and so on. Set all the entry fields properly. For more information, see *Setup Screen Reference* manual.

- SYSTEM: PRINT/PLOT SETUP screen

This screen specifies the printer/plotter, information to print/plot, paper size, and so on. Set all the entry fields properly. For more information, see *Setup Screen Reference* manual.

The following entry fields must be set:

Entry Field	HP-GL	PCL	HR PCL
DESTINATION	√	√	√
FORM FEED	√	√	√
LINE			
COLUMN			
COLOR/B/W	√	√	√
PAPER	√	√	√
OUTPUT ITEM			
INIT STRING	√	√	√
TRAILER STRING	√	√	√

NOTE

Multiple Outputs

If you want to print two or more images on one sheet of paper, set the FORM FEED entry field to DISABLE for all images, except the last image. Set ENABLE for the last image.

To make a hard copy of a screen image:

1. Display the screen that you want to print out, then press:
 - a. the front-panel green key
 - b. Plot/Print key

The 4155C/4156C displays the SCREEN DUMP dialog box.

SCREEN DUMP			
*DESTINATION	PRINTER/PLOTTER		
*OUTPUT REGION			
UPPER LEFT	X 5%	Y 0%	
LOWER RIGHT	X 100%	Y 100%	
		*LANGUAGE	*RESOLUTION
		PCL	75 DPI

SCREEN DUMP			
*DESTINATION	PRINTER/PLOTTER		
*OUTPUT REGION			
UPPER LEFT	X 5%	Y 0%	
LOWER RIGHT	X 100%	Y 100%	
		*LANGUAGE	
		HP-GL	

In this dialog box, three softkeys are available:

PRINT/PLOT Executes the screen dump.

PR/PL SETUP Displays the PRINT/PLOT SETUP screen. To close the PRINT/PLOT SETUP screen, select EXIT softkey.

EXIT Closes the SCREEN DUMP dialog box and quits the print/plot function.

2. To set the DESTINATION to PRINTER/PLOTTER, select PRINTER/PLOTTER softkey.

Print/Plot Function

Printing/Plotting Screen Images

3. To set the LANGUAGE, select PCL, HR PCL, or HP-GL softkey.

If you select the PCL or HR PCL mode, set the RESOLUTION by selecting one softkey: 75 DPI to 600 DPI. For more information on selecting resolution, see “Output Resolution” on page 5-5.

If you select the HR PCL mode, setting the resolution too low will result in poor print quality.

4. If you select HR PCL or HP-GL, set the OUTPUT REGION. There are two available fields:

UPPER LEFT Specifies the position of the upper-left corner of the printed or plotted hard copy.

LOWER RIGHT Specifies the position of the lower-right corner of the printed or plotted hard copy.

Select one of the softkeys, or enter a value using the keyboard or the ENTRY keys on the front panel. The following softkeys are available for each OUTPUT REGION field:

WHOLE Sets the output region as the entire sheet.

UPPER LEFT Sets the output region to the upper-left quarter of the paper.

UPPER RIGHT Sets the output region to the upper-right quarter of the paper.

LOWER LEFT Sets the output region to the lower-left quarter of the paper.

LOWER RIGHT Sets the output region to the lower-right quarter of the paper.

STORE REGION Stores the OUTPUT REGION settings in the internal memory.

RECALL REGION Recalls the latest settings stored in the internal memory.

To set the output region to the upper half of the paper, it should be defined as follows:

```
*OUTPUT REGION
UPPER LEFT  X  0%  Y  0%  <--origin of printer
LOWER RIGHT X 100% Y 50%
```

5. To start the screen dump, select PRINT/PLOT softkey.
6. To close the SCREEN DUMP dialog box, select EXIT softkey.

Printing/Plotting Setup Data Lists

This section describes how to print/plot the data list on the setup screens, except for the GRAPH/LIST and KNOB SWEEP screens.

Before beginning to print/plot, check the following:

- SYSTEM: MISCELLANEOUS screen

This screen specifies the 4155C/4156C control mode, GPIB address, output equipment, and so on. Set all the entry fields properly. For more information, see *Setup Screen Reference* manual.

- SYSTEM: PRINT/PLOT SETUP screen

This screen specifies the printer/plotter, information to print/plot, paper size, and so on. Set all the entry fields properly. For more information, see *Setup Screen Reference* manual.

The following entry fields must be set:

Entry Field	HP-GL	PCL	HR PCL
DESTINATION	√	√	√
FORM FEED	√	√	√
LINE	√	√	√
COLUMN	√		√
COLOR/B/W	√	√	√
PAPER	√	√	√
OUTPUT ITEM	√	√	√
INIT STRING	√	√	√
TRAILER STRING	√	√	√

NOTE

Multiple Outputs

If you want to print two or more images on one sheet of paper, set the FORM FEED entry field to DISABLE for all images, except the last image. Set ENABLE for the last image.

Print/Plot Function

Printing/Plotting Setup Data Lists

To print/plot the setup data list:

1. Display the setup screen you want to print/plot, then press:

- Plot/Print key

The 4155C/4156C displays the PRINT/PLOT SETUP DATA dialog box.

PRINT/PLOT SETUP DATA			
*DESTINATION	<input type="text" value="PRINTER/PLOTTER"/>		
*OUTPUT REGION			
UPPER LEFT	<input type="text" value="X 5%"/>	<input type="text" value="Y 0%"/>	*OUTPUT PAGE <input type="text" value="CURRENT"/>
*PRINT/PLOT COMMENT	<input type="text" value="PCL"/>		*RESOLUTION <input type="text" value="75 DPI"/>
<input type="text"/>			

PRINT/PLOT SETUP DATA			
*DESTINATION	<input type="text" value="PRINTER/PLOTTER"/>		
*OUTPUT REGION			
UPPER LEFT	<input type="text" value="X 5%"/>	<input type="text" value="Y 0%"/>	*OUTPUT PAGE <input type="text" value="CURRENT"/>
LOWER RIGHT	<input type="text" value="X 100%"/>	<input type="text" value="Y 100%"/>	
*PRINT/PLOT COMMENT	<input type="text" value="HP-GL"/>		*LANGUAGE
<input type="text"/>			

In this dialog box, three softkeys are available:

- PRINT/PLOT** Executes the printing/plotting.
- PR/PL SETUP** Displays the PRINT/PLOT SETUP screen. To close the PRINT/PLOT SETUP screen, select EXIT softkey.
- EXIT** Closes the PRINT/PLOT SETUP DATA dialog box and quits the print/plot function.

2. To set the DESTINATION to PRINTER/PLOTTER, select PRINTER/PLOTTER softkey.
3. To set the LANGUAGE, select PCL, HR PCL, or HP-GL softkey.

If you select PCL or HR PCL, ignore the RESOLUTION setting. The text font size depends on the printer you use.

4. To specify the OUTPUT PAGE, select one of the following softkeys:

CURRENT	Selects the currently displayed setup screen.
GROUP	Selects the screen group that includes the currently displayed setup data.
ALL	Selects all the setup screens.

5. To set the OUTPUT REGION, enter the following entry fields.

UPPER LEFT	Specifies the position of the upper-left corner of the printed or plotted hard copy.
LOWER RIGHT	Specifies the position of the lower-right corner of the printed or plotted hard copy. (If you set the LANGUAGE to PCL or HR PCL, ignore the LOWER RIGHT entry fields.)

Select one of the following softkeys, or enter a value using the keyboard or the ENTRY keys on the front panel. These softkeys are available for each OUTPUT REGION field.

WHOLE	Sets the output region as the entire sheet.
UPPER LEFT	Sets the output region to the upper-left quarter of the paper.
UPPER RIGHT	Sets the output region to the upper-right quarter of the paper.
LOWER LEFT	Sets the output region to the lower-left quarter of the paper.
LOWER RIGHT	Sets the output region to the lower-right quarter of the paper.
STORE REGION	Stores the OUTPUT REGION settings in the internal memory.
RECALL REGION	Recalls the latest settings stored in the internal memory.

To set the output region to the upper half of the paper, the OUTPUT REGION should be defined as follows:

```
*OUTPUT REGION
UPPER LEFT   X  0%   Y  0%   <--origin of printer
LOWER RIGHT  X 100%  Y  50%
```

6. Optional: Enter a comment of up to 58 characters into the PRINT/PLOT COMMENT field. This comment is printed only when this field is enabled on the SYSTEM: PRINT/PLOT SETUP screen.
7. To start printing/plotting, select PRINT/PLOT softkey.
8. To close the PRINT/PLOT SETUP DATA dialog box, select EXIT softkey.

Printing/Plotting Measurement Data Lists

This section describes how to print/plot the list of measurement results displayed on the GRAPH/LIST: LIST screen.

Before beginning to print/plot, check the following:

- SYSTEM: MISCELLANEOUS screen

This screen specifies the 4155C/4156C control mode, GPIB address, output equipment, and so on. Set all the entry fields properly. For more information, see *Setup Screen Reference* manual.

- SYSTEM: PRINT/PLOT SETUP screen

This screen specifies the printer/plotter, information to print/plot, paper size, and so on. Set all the entry fields properly. For more information, see *Setup Screen Reference* manual.

The following entry fields must be set:

Entry Field	HP-GL	PCL	HR PCL
DESTINATION	√	√	√
FORM FEED	√	√	√
LINE	√	√	√
COLUMN	√		√
COLOR/B/W	√	√	√
PAPER	√	√	√
OUTPUT ITEM	√	√	√
INIT STRING	√	√	√
TRAILER STRING	√	√	√

NOTE

Multiple Outputs

If you want to print two or more images on one sheet of paper, set the FORM FEED entry field to DISABLE for all images, except the last image. Set ENABLE for the last image.

To print/plot the measurement result list:

1. Display the GRAPH/LIST: LIST screen, then press:

- Plot/Print key

The 4155C/4156C displays the PRINT/PLOT DATA LIST dialog box.

PRINT/PLOT DATA LIST			
*DESTINATION	PRINTER/PLOTTER		
*OUTPUT REGION			*OUTPUT DATA (INDEX NO)
UPPER LEFT	X 5%	Y 0%	1 <--> MAX
			*LANGUAGE *RESOLUTION
*PRINT/PLOT COMMENT	PCL	75 DPI	

PRINT/PLOT DATA LIST			
*DESTINATION	PRINTER/PLOTTER		
*OUTPUT REGION			*OUTPUT DATA (INDEX NO)
UPPER LEFT	X 5%	Y 0%	1 <--> MAX
LOWER RIGHT	X 100%	Y 100%	
			*LANGUAGE
*PRINT/PLOT COMMENT	HP-GL		

In this dialog box, three softkeys are available:

- PRINT/PLOT** Executes the printing/plotting.
- PR/PL SETUP** Displays the PRINT/PLOT SETUP screen. To close the PRINT/PLOT SETUP screen, select EXIT softkey.
- EXIT** Closes the PRINT/PLOT DATA LIST dialog box and quits the print/plot function.

2. To set the DESTINATION to the PRINTER/PLOTTER, select PRINTER/PLOTTER softkey.
3. To set the LANGUAGE, select PCL, HR PCL, or HP-GL softkey.

If you select PCL or HR PCL, ignore the RESOLUTION setting. The text font size depends on the printer you use.

Printing/Plotting Measurement Data Graphs

This section describes how to print/plot a graph of the measurement results on the GRAPH/LIST: GRAPHICS screen.

Before beginning to print/plot, check the following:

- **SYSTEM: MISCELLANEOUS** screen
 This screen specifies the 4155C/4156C control mode, GPIB address, output equipment, and so on. Set all the entry fields properly. For more information, see *Setup Screen Reference* manual.
- **SYSTEM: PRINT/PLOT SETUP** screen
 This screen specifies the printer/plotter, information to print/plot, paper size, and so on. Set all the entry fields properly. For more information, see *Setup Screen Reference* manual.

The following entry fields must be set:

Entry Field	HP-GL	PCL	HR PCL
DESTINATION	√	√	√
FORM FEED	√	√	√
LINE	√	√	√
COLUMN	√		√
COLOR/B/W	√	√	√
PAPER	√	√	√
OUTPUT ITEM	√	√	√
INIT STRING	√	√	√
TRAILER STRING	√	√	√

NOTE

Multiple Outputs

If you want to print two or more images on one sheet of paper, set the FORM FEED entry field to DISABLE for all images, except the last image. Set ENABLE for the last image.

Print/Plot Function

Printing/Plotting Measurement Data Graphs

To print/plot a measurement result graph:

1. Display the GRAPH/LIST: GRAPHICS screen, then press:

- Plot/Print key

The 4155C/4156C displays the GRAPH PLOT dialog box.

GRAPH PLOT			
*DESTINATION	PRINTER/PLOTTER		
*OUTPUT REGION			*PRINT SETUP DATA
UPPER LEFT	X 5%	Y 0%	YES
LOWER RIGHT	X 100%	Y 100%	
		*LANGUAGE	*RESOLUTION
*PRINT/PLOT COMMENT	PCL	75 DPI	
<input type="text"/>			

GRAPH PLOT			
*DESTINATION	PRINTER/PLOTTER		
*OUTPUT REGION			*GRAPH TRACE ONLY
UPPER LEFT	X 5%	Y 0%	NO
LOWER RIGHT	X 100%	Y 100%	*PRINT SETUP DATA
			YES
			POSITION
			BOTTOM
		*LANGUAGE	*RESOLUTION
*PRINT/PLOT COMMENT	HR PCL	75 DPI	
<input type="text"/>			

GRAPH PLOT			
*DESTINATION	PRINTER/PLOTTER		
*OUTPUT REGION			*GRAPH TRACE ONLY
UPPER LEFT	X 5%	Y 0%	NO
LOWER RIGHT	X 100%	Y 100%	*PRINT SETUP DATA
			YES
			POSITION
			BOTTOM
		*LANGUAGE	
*PRINT/PLOT COMMENT	HP-GL		
<input type="text"/>			

In this dialog box, three softkeys are available:

- PRINT/PLOT** Executes the printing/plotting.
- PR/PL SETUP** Displays the PRINT/PLOT SETUP screen. To close the PRINT/PLOT SETUP screen, select EXIT softkey.
- EXIT** Closes the GRAPH PLOT dialog box and quits the print/plot function.

2. To set the DESTINATION to the PRINTER/PLOTTER, select PRINTER/PLOTTER softkey.
3. To set the LANGUAGE, select PCL, HR PCL, or HP-GL softkey.

If you select the PCL or HR PCL mode, set RESOLUTION by selecting one softkey: 75 DPI to 600 DPI. For more information on selecting resolution, see “Output Resolution” on page 5-5.

If you select the HR PCL mode, setting the resolution too low will result in poor print quality.

4. If you select HR PCL or HP-GL, set the GRAPH TRACE ONLY field by selecting YES or NO softkey.

- YES** Graph trace only output.
- NO** Outputs the graph information enabled on PRINT/PLOT SETUP screen OUTPUT ITEM fields.

5. Set the PRINT SETUP DATA field by selecting YES or NO softkey.

- YES** Graph output with setup data.
- NO** Graph output only.

If you select YES, set the POSITION entry field. (For PCL, the POSITION field is not displayed and is always set to BOTTOM.)

- BOTTOM** Places the setup data below the graph.
- RIGHT** Places the setup data to the right of the graph.

6. If you select HR PCL or HP-GL, set the OUTPUT REGION. There are two available fields:

- UPPER LEFT** Specifies the position of the upper-left corner of the printed or plotted hard copy.
- LOWER RIGHT** Specifies the position of the lower-right corner of the printed or plotted hard copy.

Print/Plot Function

Printing/Plotting Measurement Data Graphs

Select one of the following softkeys, or enter a value using the keyboard or the ENTRY keys on the front panel. These softkeys are available for each OUTPUT REGION field.

WHOLE	Sets the output region as the entire sheet.
UPPER LEFT	Sets the output region to the upper-left quarter of the paper.
UPPER RIGHT	Sets the output region to the upper-right quarter of the paper.
LOWER LEFT	Sets the output region to the lower-left quarter of the paper.
LOWER RIGHT	Sets the output region to the lower-right quarter of the paper.
STORE REGION	Stores the OUTPUT REGION settings in the internal memory.

RECALL REGION Recalls the latest settings stored in the internal memory.

If you want to set the output region to the upper half of the paper, the OUTPUT REGION should be defined as follows:

```
*OUTPUT REGION
  UPPER LEFT   X  0%   Y  0%  <--origin of printer
  LOWER RIGHT  X 100%  Y 50%
```

7. Optional: Enter a comment of up to 58 characters in the PRINT/PLOT COMMENT field. This comment is printed only when this field is enabled on the SYSTEM: PRINT/PLOT SETUP screen.
8. To start printing/plotting, select PRINT/PLOT softkey.
9. To close the GRAPH PLOT dialog box, select EXIT softkey.

Saving Screen Images

This section describes how to save screen images (screen dump information).

Before beginning to save the setup data list, check the following:

- SYSTEM: FILER screen

This screen sets the DISK entry field to specify the mass storage device used to save a PCL, HP-GL, or TIFF file. See *Setup Screen Reference* manual.

- SYSTEM: PRINT/PLOT SETUP screen

This screen specifies the information to save, paper size, and so on. Set all the entry fields properly. For more information, see *Setup Screen Reference* manual.

The following entry fields must be set:

Entry Field	HP-GL	PCL	HR PCL	TIFF	HR TIFF
DESTINATION					
FORM FEED	√	√	√		
LINE					
COLUMN					
COLOR/B/W	√	√	√	√	√
PAPER	√	√	√		
OUTPUT ITEM					
INIT STRING	√	√	√		
TRAILER STRING	√	√	√		

Print/Plot Function

Saving Screen Images

To save the screen images:

1. Display the screen that you want to print out, then press:
 - a. the front-panel green key
 - b. Plot/Print key

The 4155C/4156C displays the SCREEN DUMP dialog box.

SCREEN DUMP			
*DESTINATION	<input type="text" value="FILE"/>	*FILE NAME	<input type="text"/>
*OUTPUT REGION			
UPPER LEFT	<input type="text" value="X 5%"/>	<input type="text" value="Y 0%"/>	
LOWER RIGHT	<input type="text" value="X 100%"/>	<input type="text" value="Y 100%"/>	
	*LANGUAGE	*RESOLUTION	
	<input type="text" value="PCL"/>	<input type="text" value="75 DPI"/>	

In this dialog box, three softkeys are available:

- | | |
|--------------------|--|
| PRINT/PLOT | Executes the screen image save. |
| PR/PL SETUP | Displays the PRINT/PLOT SETUP screen. To close the PRINT/PLOT SETUP screen, select EXIT softkey. |
| EXIT | Closes the SCREEN DUMP dialog box and quits the print/plot function. |

2. To set the DESTINATION to FILE, select FILE softkey.
3. Enter the file name in the FILE NAME field.

To save a file to a diskette in the built-in flexible disk drive, the file name must be:

- a maximum of 8 characters for DOS format
- a maximum of 6 characters for HP LIF format (Do not use "_" as the last character of the filename.)

To save a file to the network drive, the file name can be a maximum of 36 characters. The file name and directory path can be a maximum of 58 characters.

4. To set the LANGUAGE, select PCL, HR PCL, HP-GL, TIFF or HR TIFF softkey.

If you select PCL, HR PCL, or HR TIFF mode, set the RESOLUTION by selecting one softkey: 75 DPI to 600 DPI. For more information on selecting resolution, see “Output Resolution” on page 5-5.

If you select the HR PCL mode, setting the resolution too low will result in poor print quality.

5. If you select HR PCL or HP-GL, set the OUTPUT REGION. There are two available fields:

UPPER LEFT Specifies the position of the upper-left corner of the printed or plotted hard copy.

LOWER RIGHT Specifies the position of the lower-right corner of the printed or plotted hard copy.

Select one of the following softkeys, or enter a value using the keyboard or the ENTRY keys on the front panel. These softkeys are available for each OUTPUT REGION field:

WHOLE Sets the output region as the entire sheet.

UPPER LEFT Sets the output region to the upper-left quarter of the paper.

UPPER RIGHT Sets the output region to the upper-right quarter of the paper.

LOWER LEFT Sets the output region to the lower-left quarter of the paper.

LOWER RIGHT Sets the output region to the lower-right quarter of the paper.

STORE REGION Stores the OUTPUT REGION settings in the internal memory.

RECALL REGION Recalls the latest settings stored in the internal memory.

To set the output region to the upper half of the paper, the OUTPUT REGION should be defined as follows:

```
*OUTPUT REGION
UPPER LEFT   X   0%   Y   0%   <--origin of printer
LOWER RIGHT  X 100%   Y  50%
```

6. To start to save the screen image, select PRINT/PLOT softkey.
7. To close the SCREEN DUMP dialog box, select EXIT softkey.

Saving Setup Data Lists

This section describes how to save the setup data list on setup screens, except for the GRAPH/LIST and KNOB SWEEP screens, as a PCL or HP-GL file.

Before beginning to save the setup data list, check the following:

- SYSTEM: FILER screen

This screen sets the DISK entry field to specify the mass storage device used to save a PCL or HP-GL file. For more information, see *Setup Screen Reference* manual.

- SYSTEM: PRINT/PLOT SETUP screen

This screen specifies the information to save, paper size, and so on. Set all the entry fields properly. For more information, see *Setup Screen Reference* manual.

The following entry fields must be set:

Entry Field	HP-GL	PCL	HR PCL
DESTINATION			
FORM FEED	√	√	√
LINE	√	√	√
COLUMN	√		√
COLOR/B/W	√	√	√
PAPER	√	√	√
OUTPUT ITEM	√	√	√
INIT STRING	√	√	√
TRAILER STRING	√	√	√

To save the setup data list:

1. Display the setup screen you want to save, then press:

- Plot/Print key

The 4155C/4156C displays the PRINT/PLOT SETUP DATA dialog box:

PRINT/PLOT SETUP DATA			
*DESTINATION	FILE	*FILE NAME	
		*OUTPUT PAGE	CURRENT
		*LANGUAGE	*RESOLUTION
*PRINT/PLOT COMMENT	PCL		75 DPI

PRINT/PLOT SETUP DATA			
*DESTINATION	FILE	*FILE NAME	
*OUTPUT REGION		*OUTPUT PAGE	CURRENT
UPPER LEFT	X 5%	Y 0%	
LOWER RIGHT	X 100%	Y 100%	
		*LANGUAGE	
*PRINT/PLOT COMMENT		HP-GL	

In this dialog box, three softkeys are available:

- PRINT/PLOT** Executes the file save.
- PR/PL SETUP** Displays the PRINT/PLOT SETUP screen. To close the PRINT/PLOT SETUP screen, select EXIT softkey.
- EXIT** Closes the PRINT/PLOT SETUP DATA dialog box and quits the print/plot function.

2. To set the DESTINATION to FILE, select FILE softkey.

Print/Plot Function

Saving Setup Data Lists

3. Enter the file name in the FILE NAME entry field.

To save a file to a diskette in the built-in flexible disk drive, the file name must be:

- a maximum of 8 characters for DOS format
- a maximum of 6 characters for HP LIF format (Do not use "_" as the last character of the filename.)

To save a file to the network drive, the file name can be a maximum of 36 characters. The file name and directory path can be a maximum of 58 characters.

4. To set the LANGUAGE, select PCL, HR PCL, or HP-GL softkey.

If you select the PCL or HR PCL mode, ignore the RESOLUTION setting. The text font size depends on the printer you use.

5. To specify the OUTPUT PAGE, select one of the following softkeys.

CURRENT Selects the currently displayed setup screen.

GROUP Selects the screen group that includes the currently displayed setup data.

ALL Selects all the setup screens.

6. If you select HP-GL, set the OUTPUT REGION. There are two available fields:

UPPER LEFT Specifies the position of the upper-left corner of the printed or plotted hard copy.

LOWER RIGHT Specifies the position of the lower-right corner of the printed or plotted hard copy.

Select one of the following softkeys, or enter a value using the keyboard or the ENTRY keys on the front panel. These softkeys are available for each OUTPUT REGION field.

WHOLE Sets the output region as the entire sheet.

UPPER LEFT Sets the output region to the upper-left quarter of the paper.

UPPER RIGHT Sets the output region to the upper-right quarter of the paper.

LOWER LEFT Sets the output region to the lower-left quarter of the paper.

LOWER RIGHT Sets the output region to the lower-right quarter of the paper.

STORE REGION Stores the OUTPUT REGION settings in the internal memory.

RECALL REGION Recalls the latest settings stored in the internal memory.

To set the output region to the upper half of the paper, the OUTPUT REGION should be defined as follows:

```
*OUTPUT REGION
UPPER LEFT  X  0%  Y  0%  <--origin of printer
LOWER RIGHT X 100% Y  50%
```

7. Optional: Enter a comment of up to 58 characters in the PRINT/PLOT COMMENT field. This comment is printed only when this field is enabled on the SYSTEM: PRINT/PLOT SETUP screen.
8. To start the file save, select PRINT/PLOT softkey.
9. To close the PRINT/PLOT SETUP DATA dialog box, select EXIT softkey.

Saving Measurement Data Lists

This section describes how to save the list of measurement results displayed on the GRAPH/LIST: LIST screen as a PCL or HP-GL file.

Before beginning to save the measurement data list, check the following:

- SYSTEM: FILER screen

This screen sets the DISK entry field to specify the mass storage device used to save a PCL or HP-GL file. See *Setup Screen Reference* manual.

- SYSTEM: PRINT/PLOT SETUP screen

This screen specifies the information to save, paper size, and so on. Set all the entry fields properly. See *Setup Screen Reference* manual.

The following entry fields must be set:

Entry Field	HP-GL	PCL	HR PCL
DESTINATION			
FORM FEED	√	√	√
LINE	√	√	√
COLUMN	√		√
COLOR/B/W	√	√	√
PAPER	√	√	√
OUTPUT ITEM	√	√	√
INIT STRING	√	√	√
TRAILER STRING	√	√	√

To save the measurement result list:

1. Display the GRAPH/LIST: LIST screen, then press:

- Plot/Print key

The 4155C/4156C displays the PRINT/PLOT DATA LIST dialog box.

PRINT/PLOT DATA LIST

*DESTINATION *FILE NAME

*OUTPUT DATA (INDEX NO)
 <-->

*PRINT/PLOT COMMENT

*LANGUAGE *RESOLUTION

PRINT/PLOT DATA LIST

*DESTINATION *FILE NAME

*OUTPUT REGION
UPPER LEFT

X	5%	Y	0%
X	100%	Y	100%

*OUTPUT DATA (INDEX NO)
 <-->

*PRINT/PLOT COMMENT

*LANGUAGE

In this dialog box, three softkeys are available:

- PRINT/PLOT** Executes the file save.
- PR/PL SETUP** Displays the PRINT/PLOT SETUP screen. To close the PRINT/PLOT SETUP screen, select EXIT softkey.
- EXIT** Closes the PRINT/PLOT DATA LIST dialog box and quits the print/plot function.

2. To set the DESTINATION to FILE, select FILE softkey.

Print/Plot Function

Saving Measurement Data Lists

3. Enter the file name into the FILE NAME entry field.

To save a file to a diskette in the built-in flexible disk drive, the file name must be:

- a maximum of 8 characters for DOS format
- a maximum of 6 characters for HP LIF format (Do not use "_" as the last character of the filename.)

To save a file to the network drive, the file name can be a maximum of 36 characters. The file name and directory path can be a maximum of 58 characters.

4. To set the LANGUAGE, select PCL, HR PCL, or HP-GL softkey.

If you select PCL or HR PCL, ignore the RESOLUTION setting. The text font size depends on the printer you use.

5. Set the OUTPUT DATA (INDEX NO) to be saved.

- a. Select the data INDEX numbers 1 to 100, by entering the following:

```
*OUTPUT DATA (INDEX NO)
  _____ 1 <--> _____ 100
```

- b. Select all the measurement data by selecting ALL softkey.

6. If you select HP-GL, set the OUTPUT REGION. There are two available fields:

UPPER LEFT Specifies the position of the upper-left corner of the printed or plotted hard copy.

LOWER RIGHT Specifies the position of the lower-right corner of the printed or plotted hard copy.

Select one of the following softkeys, or enter a value using the keyboard or the ENTRY keys on the front panel. These softkeys are available for each OUTPUT REGION field.

WHOLE Sets the output region as the entire sheet.

UPPER LEFT Sets the output region to the upper-left quarter of the paper.

UPPER RIGHT Sets the output region to the upper-right quarter of the paper.

LOWER LEFT Sets the output region to the lower-left quarter of the paper.

LOWER RIGHT Sets the output region to the lower-right quarter of the paper.

STORE REGION Stores the OUTPUT REGION settings in the internal memory.

RECALL REGION Recalls the latest settings stored in the internal memory.

To set the output region to the upper half of the paper, the OUTPUT REGION should be defined as follows:

```
*OUTPUT REGION
UPPER LEFT  X  0%  Y  0%  <--origin of printer
LOWER RIGHT X 100% Y  50%
```

7. Optional: Enter a comment of up to 58 characters in the PRINT/PLOT COMMENT entry field. This comment is printed only when this field is enabled on the SYSTEM: PRINT/PLOT SETUP screen.
8. To start the file save, select PRINT/PLOT softkey.
9. To close the PRINT/PLOT DATA LIST dialog box, select EXIT softkey.

Saving Measurement Data Graphs

This section describes how to save the list of measurement results displayed on the GRAPH/LIST: GRAPHICS screen as a PCL, HP-GL, or TIFF file.

Before beginning to save the measurement data graph, check the following:

- SYSTEM: FILER screen

This screen sets the DISK entry field to specify the mass storage device used to save a PCL, HP-GL, or TIFF file. See *Setup Screen Reference* manual.

- SYSTEM: PRINT/PLOT SETUP screen

This screen specifies the information to save, paper size for printing/plotting, and so on. Set all the entry fields properly. See *Setup Screen Reference* manual.

The following entry fields must be set:

Entry Field	HP-GL	PCL	HR PCL	HR TIFF
DESTINATION				
FORM FEED	√	√	√	
LINE	√	√	√	
COLUMN	√		√	
COLOR/B/W	√	√	√	√
PAPER	√	√	√	
OUTPUT ITEM	√	√	√	√
INIT STRING	√	√	√	
TRAILER STRING	√	√	√	

To save a measurement result graph:

1. Display the GRAPH/LIST: GRAPHICS screen, then press Plot/Print key.

The 4155C/4156C displays the GRAPH PLOT dialog box.

GRAPH PLOT			
*DESTINATION	FILE	*FILE NAME	
*OUTPUT REGION			
UPPER LEFT	X 5%	Y 0%	*PRINT SETUP DATA YES
LOWER RIGHT	X 100%	Y 100%	
*PRINT/PLOT COMMENT		*LANGUAGE PCL	*RESOLUTION 75 DPI

GRAPH PLOT			
*DESTINATION	FILE	*FILE NAME	
*OUTPUT REGION			
UPPER LEFT	X 5%	Y 0%	*GRAPH TRACE ONLY NO
LOWER RIGHT	X 100%	Y 100%	*PRINT SETUP DATA YES
*PRINT/PLOT COMMENT		*LANGUAGE HR PCL	*RESOLUTION 75 DPI

GRAPH PLOT			
*DESTINATION	FILE	*FILE NAME	
*OUTPUT REGION			
UPPER LEFT	X 5%	Y 0%	*GRAPH TRACE ONLY NO
LOWER RIGHT	X 100%	Y 100%	*PRINT SETUP DATA YES
*PRINT/PLOT COMMENT		*LANGUAGE HP-GL	POSITION BOTTOM

Print/Plot Function

Saving Measurement Data Graphs

GRAPH PLOT			
*DESTINATION	FILE	*FILE NAME	
		*GRAPH TRACE ONLY	NO
		*PRINT SETUP DATA	YES
		POSITION	BOTTOM
		*LANGUAGE	*RESOLUTION
*PRINT/PLOT COMMENT	HR TIFF	75 DPI	

In this dialog box, three softkeys are available:

- PRINT/PLOT** Executes the file save.
- PR/PL SETUP** Displays the PRINT/PLOT SETUP screen. To close the PRINT/PLOT SETUP screen, select EXIT softkey.
- EXIT** Closes the GRAPH PLOT dialog box and quits the print/plot function.

- To set the DESTINATION to FILE, select FILE softkey.
- Enter the file name into the FILE NAME entry field.

To save a file to a diskette, the file name must be:

- a maximum of 8 characters for DOS format
- a maximum of 6 characters for HP LIF format (Do not use "_" as the last character of the filename.)

To save a file to the network drive, the file name can be a maximum of 36 characters. The file name and directory path can be a maximum of 58 characters.

- To set the LANGUAGE, select PCL, HR PCL, HP-GL or HR TIFF softkey.

If you select the PCL, HR PCL or HR TIFF mode, set the RESOLUTION by selecting one softkey: 75 DPI to 600 DPI. For more information on selecting the resolution, see "Output Resolution" on page 5-5.

If you select the HR PCL mode, setting the resolution too low will result in poor print quality.

5. If you select HR PCL, HR TIFF or HP-GL, set the GRAPH TRACE ONLY field by selecting YES or NO softkey.

YES Graph trace only output.

NO Outputs the graph information enabled on PRINT/PLOT SETUP screen OUTPUT ITEM fields.

6. Set the PRINT SETUP DATA field by selecting YES or NO softkey.

YES Graph output with setup data.

NO Graph output only.

If you select YES, set the POSITION entry field. (For the PCL mode, the POSITION field is not displayed and is always set to BOTTOM.)

BOTTOM Places the setup data below the graph.

RIGHT Places the setup data to the right of the graph.

7. If you select HR PCL or HP-GL, set the OUTPUT REGION. There are two available fields:

UPPER LEFT Specifies the position of the upper-left corner of the printed or plotted hard copy.

LOWER RIGHT Specifies the position of the lower-right corner of the printed or plotted hard copy.

Select one of the following softkeys, or enter a value using the keyboard or the ENTRY keys on the front panel. These softkeys are available for each OUTPUT REGION field:

WHOLE Sets the output region as the entire sheet.

UPPER LEFT Sets the output region to the upper-left quarter of the paper.

UPPER RIGHT Sets the output region to the upper-right quarter of the paper.

LOWER LEFT Sets the output region to the lower-left quarter of the paper.

LOWER RIGHT Sets the output region to the lower-right quarter of the paper.

STORE REGION Stores the OUTPUT REGION settings in the internal memory.

RECALL REGION Recalls the latest settings stored in the internal memory.

Print/Plot Function

Saving Measurement Data Graphs

To set the output region to the upper half of the paper, the OUTPUT REGION should be defined as follows:

```
*OUTPUT REGION
UPPER LEFT  X  0%  Y  0%  <--origin of printer
LOWER RIGHT X 100% Y  50%
```

8. Optional: Enter a comment of up to 58 characters in the PRINT/PLOT COMMENT field. This comment is printed only when this field is enabled on the SYSTEM: PRINT/PLOT SETUP screen.
9. To start printing/plotting, select PRINT/PLOT softkey.
10. To close the GRAPH PLOT dialog box, select EXIT softkey.

Output Examples

This section shows examples of the 4155C/4156C print/plot output.

- “Screen Dump Output”
- “Setup Data List Output”
- “Measurement Result List Output”
- “Measurement Result Graph Output”

Screen Dump Output

This is an example of the GRAPH/LIST: GRAPHICS screen dump, in HP-GL format, using an HP LaserJet printer in landscape mode.

Setup

- Screen: GRAPH/LIST: GRAPHICS
- USER COMMENT on the Screen:

ID-VG CHARACTERISTICS

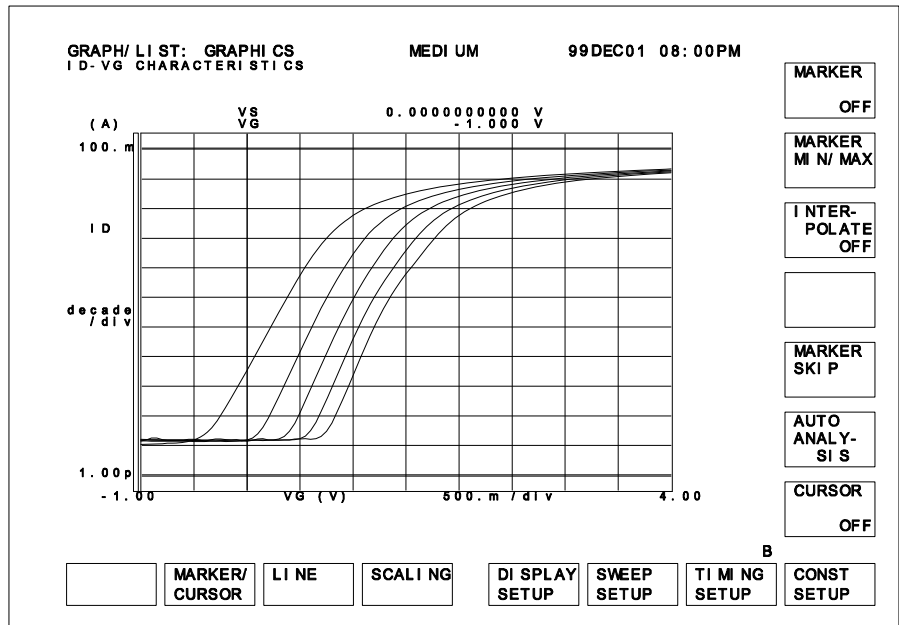
- SYSTEM: PRINT/PLOT SETUP screen:

```
*FORM FEED          ENABLE
*COLOR/B/W          B/W
*PAPER
    SIZE             A4
    FEED DIR         LONG SIDE
*INIT STRING        \0033&l10\0033%0B
*TRAILER STRING     \0033%A\0033&l00
```

- SCREEN DUMP dialog:

SCREEN DUMP			
*DESTINATION	<input type="text" value="PRINTER/PLOTTER"/>		
*OUTPUT REGION			
UPPER LEFT	<input type="text" value="X 5%"/>	<input type="text" value="Y 0%"/>	
LOWER RIGHT	<input type="text" value="X 100%"/>	<input type="text" value="Y 100%"/>	
			*LANGUAGE
			<input type="text" value="HP-GL"/>

Output Example



Setup Data List Output

This an example of the CHANNEL DEFINITION screen in the PCL format.

Setup

- Screen: CHANNELS: CHANNEL DEFINITION
- USER COMMENT on the Screen:

ID-VG CHARACTERISTICS

- SYSTEM: PRINT/PLOT SETUP screen:

```
*FORM FEED          ENABLE
*COLOR/B/W          B/W
*LINE                60
*PAPER
      SIZE           A4
      FEED DIR       SHORT SIDE
*OUTPUT ITEM        ENABLE for all
```

- PRINT/PLOT SETUP DATA dialog:

PRINT/PLOT SETUP DATA			
*DESTINATION	<input type="text" value="PRINTER/PLOTTER"/>		
*OUTPUT REGION			
UPPER LEFT	<input type="text" value="X 5%"/>	<input type="text" value="Y 0%"/>	*OUTPUT PAGE <input type="text" value="CURRENT"/>
		*LANGUAGE	*RESOLUTION
*PRINT/PLOT COMMENT	<input type="text" value="PCL"/>	<input type="text" value="75 DPI"/>	
<input type="text" value="SAMPLE DEVICE 1"/>			

Output Example

*** Agilent 4156C SETUP DATA *** Jan 10 20:00:00 2001 PAGE 1

ID-VG CHARACTERISTICS
SAMPLE DEVICE1

CHANNELS: CHANNEL DEFINITION

*MEASUREMENT MODE SWEEP

*CHANNELS

MEASURE					STBY	SERIES
UNIT	VNAME	INAME	MODE	FCTN		RESISTANCE
SMU1:HR	VS	IS	COMMON	CONST		0 ohm
SMU2:HR	VG	IG	V	VAR1		0 ohm
SMU3:HR	VD	ID	V	CONST		
SMU4:HR	VSB	ISB	V	VAR2		
VSU1		-----				
VSU2		-----				
VMU1		-----		----	----	
VMU2		-----		----	----	

Measurement Result List Output

This is an example of the measurement result list using the PCL format.

Setup

- Screen: GRAPH/LIST: LIST
- USER COMMENT on the Screen:

ID-VG CHARACTERISTICS

- SYSTEM: PRINT/PLOT SETUP screen:

```
*FORM FEED          ENABLE
*COLOR/B/W          B/W
*LINE                60
*PAPER
      SIZE           A4
      FEED DIR       SHORT SIDE
*OUTPUT ITEM         ENABLE for all
```

- PRINT/PLOT DATA LIST dialog:

PRINT/PLOT DATA LIST			
*DESTINATION	<input type="text" value="PRINTER/PLOTTER"/>		
*OUTPUT REGION			*OUTPUT DATA (INDEX NO)
UPPER LEFT	<input type="text" value="X 5%"/>	<input type="text" value="Y 0%"/>	<input type="text" value="1"/> <--> <input type="text" value="65"/>
*PRINT/PLOT COMMENT			*LANGUAGE *RESOLUTION
<input type="text" value="SAMPLE DEVICE 1"/>		<input type="text" value="PCL"/>	<input type="text" value="75 DPI"/>

Output Example

- First sheet:

*** Agilent 4156C DATA LIST *** Jan 10 20:00:00 2001 PAGE 1

ID-VG CHARACTERISTICS

SAMPLE DEVICE1

VG = -1.000 V to 4.000 V in 50mV step
VSB = 0.0000 V to -2.0000 V in -500.0mV step

NO.	VG (V)	ID (A)
1	-1.000 V	10.89pA
2	-950mV	11.01pA
:	:	:
:	:	:
:	:	:
49	1.400 V	2.44708mA

- Second sheet:

*** Agilent 4156C DATA LIST *** Jan 10 20:00:00 2001 PAGE 2

ID-VG CHARACTERISTICS

SAMPLE DEVICE1

NO.	VG (V)	ID (A)
50	1.450 V	2.75585mA
51	1.500mV	3.07660mA
:	:	:
:	:	:
:	:	:
65	2.200 V	8.27044mA

- Last sheet:

*** Agilent 4156C DATA LIST *** Jan 10 20:00:00 2001 PAGE 3

ID-VG CHARACTERISTICS

SAMPLE DEVICE1

MARKER POSITION : DATA# 1 [1/1]

Measurement Result Graph Output

This is an example of a measurement result graph in HP-GL format, using an HP LaserJet printer in portrait mode.

Setup

- Screen: GRAPH/LIST: GRAPHICS
- USER COMMENT on the Screen:

ID-VG CHARACTERISTICS

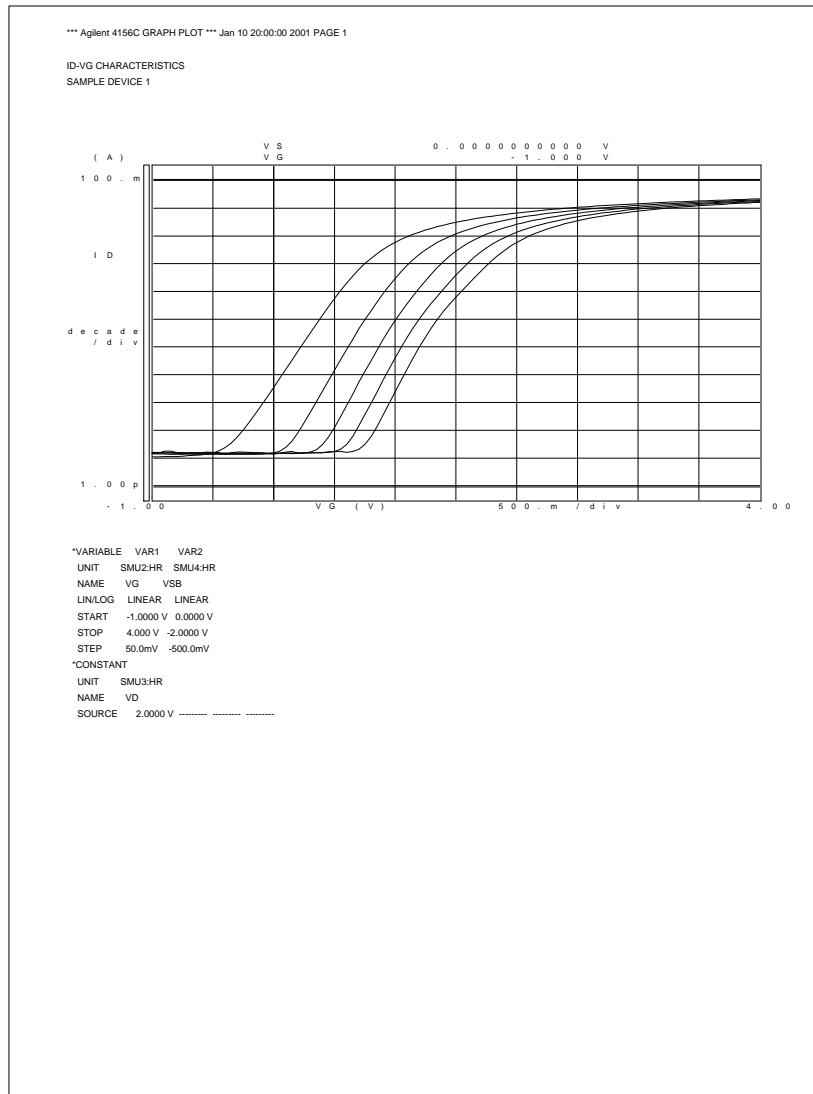
- SYSTEM: PRINT/PLOT SETUP screen:

```
*FORM FEED          ENABLE
*COLOR/B/W          B/W
*LINE                60
*COLUMN              80
*PAPER
    SIZE             A4
    FEED DIR         SHORT SIDE
*OUTPUT ITEM         ENABLE for all
*INIT STRING         \0033%0B
*TRAILER STRING      \0033%A
```

- GRAPH PLOT dialog:

GRAPH PLOT				
*DESTINATION	PRINTER/PLOTTER			
*OUTPUT REGION			*GRAPH TRACE ONLY	NO
UPPER LEFT	X 5%	Y 0%	*PRINT SETUP DATA	YES
LOWER RIGHT	X 100%	Y 100%	POSITION	BOTTOM
			*LANGUAGE	
*PRINT/PLOT COMMENT	HP-GL			
SAMPLE DEVICE 1				

Output Example



NOTE

PCL Mode Output

If you select the PCL mode, the font size of the header line, comment and setup data depends on the printer.

Print/Plot Function
Output Examples

6

External Keyboard

External Keyboard

You can operate Agilent 4155C/4156C from an external keyboard instead of by pressing front-panel keys and softkeys. This chapter describes the correspondence between front-panel keys/softkeys and the external keyboard.

For functions of front-panel keys, refer to “Overview” in Chapter 1.

For correspondence when using the Instrument BASIC, refer to *Programmer's Guide*.

NOTE

The following functions are not available for the external keyboard:

- Keys not on the external keyboard

PAGE CONTROL key group:

- Chan
- Meas
- Display
- Graph/List
- Stress
- System
- Characters you cannot enter from the external keyboard
 - Ω
 - $^{\circ}$ (deg)

NOTE

When using an external keyboard, connect the external keyboard to the 4155C/4156C before applying power. If you connect the keyboard to the 4155C/4156C after applying power, the keyboard does not work.

Front-Panel Keys		External Keyboard
softkeys	(from the left side) primary softkey 1 to 8	F1 to F8
	(from the top) secondary softkey 1 to 7	Shift+F1 to Shift+F7
MEASUREMENT key group	Single	Ctrl+S
	Repeat	Ctrl+R
	Append	Ctrl+A
	Stop	Ctrl+C
	Standby	Ctrl+Y
	Stress	Ctrl+T
	green key+ Single	Ctrl+N
green key+ Stop	Ctrl+Z	
Integ Time key group	Short	Ctrl+I
	Medium	Ctrl+J
	Long	Ctrl+K
IBASIC	Run	Ctrl+U or enter "RUN" in the data entry field on the IBASIC screen
	Pause	Ctrl+P or Pause
	Display	Ctrl+G or F9
arrow keys in the MARKER/CURSOR key group	←	←
	⇒	→
	↑	↑
	↓	↓
	Fast+	Shift+ ←
	Fast+ ⇒	Shift+ →
	Fast+ ↑	Shift+ ↑
	Fast+ ↓	Shift+ ↓

External Keyboard

Front-Panel Keys		External Keyboard
rotary knob	clockwise	Alt+ →
	counterclockwise	Alt+ ←
	Fast+clockwise	Alt+Shift+ →
	Fast+counterclockwise	Alt+Shift+ ←
Print/Plot function	Plot/Print	Ctrl+D or Print Screen
	green key+ Plot/Print	Shift+Print Screen
Help	Help	Ctrl+Shift+H
User File	Save	Ctrl+Shift+S
	Get	Ctrl+Shift+R
Edit key group	←	Ctrl+B, Shift+Tab, or Backspace
	green key+ ←	Ctrl+Shift+B, Ctrl+Shift+Tab, or Ctrl+Backspace
	⇒	Ctrl+F or Tab
	green key+ ⇒	Ctrl+Shift+F or Ctrl+Tab
	Delete	Delete or Alt+D
	Insert	Insert or Alt+I
	Recall ↓	Ctrl+L
	green key+ Recall ↓	Ctrl+Shift+L
	Clear	Shift+F11 or Ctrl+Delete
	green key+ Clear	F11
ENTRY key group	μ	u
	Exp	E
	Enter	Enter
	green key+ Enter	Shift+Enter
	Space	space bar
	Other front-panel keys (except for Ω , ° (deg), blue key, and green key) correspond to same keys on the external keyboard.	

Initial Settings

This chapter explains the following:

- user-defined initial settings

Agilent 4155C/4156C can automatically get files from a diskette after applying power, and set the 4155C/4156C according to the files. This function saves you the trouble of getting application files every time you turn on the 4155C/4156C.

- default initial settings

If you turn on the 4155C/4156C without a diskette, the 4155C/4156C is set to the default initial settings. In this condition, internal memories contain measurement setup data for the most common applications.

User-Defined Initial Settings

If you turn on an 4155C/4156C with a diskette in the flexible disk drive, the 4155C/4156C automatically loads the following files from the diskette:

- files for setting setup and result screens
 The fields of the setup and result screens are automatically set according to the files on the diskette. Also, you can specify which screen is displayed after turning on the 4155C/4156C.
- files for setting internal memories
 If the diskette has files that can be loaded into the internal memories of the 4155C/4156C, the files are automatically loaded after turning on the 4155C/4156C.
- IBASIC programming file
 If an IBASIC programming file with name "AUTOST" is on the diskette, this file is automatically loaded and started after loading the files for setting setup and result screens and internal memories. For details about "AUTOST" file, refer to the 4155C/4156C *Programmer's Guide*.

Files for setting setup and result screens

If the following files exist on diskette, the setup and result screens are automatically set up according to the files after you turn on the 4155C/4156C:

File Type	File Name
measurement setup file	INIT.MES
stress setup file	INIT.STR
measurement setup/result file	INIT.DAT
customize file	INIT.CST

The 4155C/4156C can get multiple INIT files. So, if INIT.CST, INIT.MES, and INIT.STR files exist on the diskette, all of them are loaded. However, the INIT.MES and INIT.DAT file both contain measurement setup data. So, if both these files exist on the diskette, the 4155C/4156C gets INIT.DAT, not INIT.MES.

NOTE

Which Screen is Displayed after Getting Setup Files?

If the INIT.MES or INIT.DAT file exists on the diskette, the screen that is displayed after getting the setup files is as follows.

- if file was created by SAVE

When you create INIT.MES or INIT.DAT file by using SAVE function on the SYSTEM: FILER screen, you can select one of the following screens to be displayed after getting the files:

- GRAPH/LIST: GRAPH screen
 - GRAPH/LIST: LIST screen
 - KNOB SWEEP screen
 - CHANNELS: CHANNEL DEFINITION screen
- if file was created by RENAME or COPY

When you create INIT.MES or INIT.DAT file by using RENAME or COPY function on the SYSTEM: FILER screen, you cannot select which screen is displayed. The CHANNELS: CHANNEL DEFINITION screen is always displayed after getting the files.

Files for setting internal memories

If the following files exist on diskette, they are loaded automatically from diskette to internal memory after you turn on the 4155C/4156C:

- measurement setup files (MEM.MES)
- stress setup files (MEM.STR)
- measurement setup/result files (MEM.DAT)

Where MEM means MEM1, MEM2, MEM3, or MEM4, which correspond to the four internal memory areas. Only the above types of files can be loaded into internal memory.

If the same internal memory is specified by multiple files (for example, MEM1.MES, MEM1.DAT, and MEM1.STR), the priority is:

1. DAT
2. MES
3. STR

Default Initial Settings

When you turn on the 4155C/4156C without a diskette, the 4155C/4156C is set the default initial settings after finishing the power on test.

The default initial settings, except for system screen group, are also set by selecting DEFAULT MEASURE SETUP secondary softkey in the MEASUREMENT MODE field on the CHANNELS: CHANNEL DEFINITION screen. The default initial settings are as follows:

Measurement Units

Measurement units that are verified as operating normally are turned on and set to the idle state.

Setup items of setup and result screens

These items are set to the default initial settings whenever power is applied or *RST command is sent, except for the following items, which keep the same value that they had before *RST or before power was turned off.

- SYSTEM: MISCELLANEOUS screen
 - 4155 (or 4156) is System Controller or not
 - GPIB Address
 - Power Line Frequency
 - Screen Save
 - Network Setup
 - Network Printer Setup
 - Network Drive Setup
- User comment field

The default initial settings for USER COMMENT fields of the MEASURE screen group and STRESS screen group are blank.

Internal memories

For the initial settings, internal memories contain the measurement setup data for the following basic applications.

- measurement setup data for bipolar transistor V_{ce} - I_c characteristics
- measurement setup data for FET (field effect transistor) V_{ds} - I_d characteristics
- measurement setup data for FET (field effect transistor) V_{gs} - I_d characteristics
- measurement setup data for diode V_f - I_f characteristics

You can select the secondary softkeys for the above applications when the pointer is in the MEASUREMENT MODE field on the CHANNELS: CHANNEL DEFINITION screen. The softkeys set the setup screens for the application, thus saving time.

8

Specifications

Specifications

This chapter lists complete specifications and supplemental information of Agilent 4155C/4156C and Agilent 41501B. The specifications are the performance standards or limits against which the 4155C/4156C and 41501B are tested. When the 4155C/4156C and 41501B is shipped from the factory, it meets the specifications. The supplemental information are not specifications but are typical characteristics included as additional information for the operator.

Agilent 4155C/4156C functions:

- Set measurement and/or stress conditions
- Control measurement and/or stress execution
- Perform arithmetic calculations
- Display measured and calculated results on the LCD display
- Perform graphical analysis
- Store and recall measurement setups, and measurement and graphical display data
- Dump to printers or plotters for hardcopy output
- Perform measurement and analysis with internal Instrument BASIC
- Self-test, Auto-calibration

Agilent 4155C configuration:

- four medium power source monitor units (MPSMUs: 10 fA/2 μ V to 100 mA/100 V)
- two voltage source units (VSUs)
- two voltage monitor units (VMUs)

Agilent 4156C configuration:

- four high resolution source monitor units (HRSMUs: 1 fA/2 μ V to 100 mA/100 V)
- two voltage source units (VSUs)
- two voltage monitor units (VMUs)

Agilent 41501B (Option) configuration:

- two pulse generator units (PGUs) (Option)
- one high power source monitor unit (HPSMU: 10 fA/2 μ V to 1 A/200 V) or two MPSMUs (Option).
- one ground unit (GNDU)

Specification Conditions:

The “supplemental information” and “typical” entries, in the following specifications are not warranted, but provide useful information about the functions and performance of the instruments.

The measurement and output accuracies are specified at the rear panel connector terminals when referenced to the Zero Check terminal under the following conditions:

1. $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ (double for 5 to 18 °C, and for 28 to 40 °C if not noted otherwise).
2. After 40 minutes warm-up.
3. Ambient temperature changes less than $\pm 1\text{ }^{\circ}\text{C}$ after auto calibration execution.
4. Integration time: medium or long
5. Filter: ON (for SMUs)
6. Kelvin connection (for HRSMU, HPSMU, and GNDU)
7. Calibration period: 1 year

Hardware

4156C Precision Semiconductor Parameter Analyzer

HRSMU (High Resolution SMU) Specifications

- Current Range, Resolution, and Accuracy: See Table 8-1.
- Voltage Range, Resolution, and Accuracy: See Table 8-3.
- Output terminal/connection

Dual triaxial connectors, Kelvin (remote sensing)

- Voltage/Current Compliance (Limiting)

The SMU can limit output voltage or current to prevent damaging the device under test.

Voltage 0 V to ± 100 V

Current ± 100 fA to ± 100 mA

Compliance accuracy Same as current (voltage) set accuracy.

- HRSMU supplemental information

Allowable cable resistance maximum 10 Ω (for both Force and Sense. Kelvin connection.)

Voltage source output resistance typical 0.2 Ω (Force line. Non-Kelvin connection.)

Voltage measurement input resistance $\geq 10^{15}$ Ω

Current source output resistance $\geq 10^{15}$ Ω (10 pA range)

Current compliance setting accuracy (for opposite polarity)

For 10 pA to 10 nA range:
V/I setting accuracy ± 12 % of range

For 100 nA to 100 mA range:
V/I setting accuracy ± 2.5 % of range

Table 8-1 HRSMU Current Range, Resolution, and Accuracy

Current Range	Set Reso.	Set Accuracy ^a	Meas. Reso.	Measurement Accuracy ^a	Max. Voltage ^b
± 10 pA	10 fA	± (4 % + 400 fA) ^{c d}	1 fA	± (4 % + 20 fA + 1 fA × Vout/100) ^{c d}	100 V
± 100 pA	10 fA	± (4 % + 400 fA) ^{c d}	1 fA	± (4 % + 40 fA + 10 fA × Vout / 100) ^{c d}	100 V
± 1 nA	100 fA	± (0.5 % + 0.7 pA + 1 fA × Vout)	10 fA	± (0.5 % + 0.4 pA + 1 fA × Vout)	100 V
± 10 nA	1 pA	± (0.5 % + 4 pA + 10 fA × Vout)	10 fA	± (0.5 % + 2 pA + 10 fA × Vout)	100 V
± 100 nA	10 pA	± (0.12 % + 40 pA + 100 fA × Vout)	100 fA	± (0.1 % + 20 pA + 100 fA × Vout)	100 V
± 1 μA	100 pA	± (0.12 % + 400 pA + 1 pA × Vout)	1 pA	± (0.1 % + 200 pA + 1 pA × Vout)	100 V
± 10 μA	1 nA	± (0.07 % + 4 nA + 10 pA × Vout)	10 pA	± (0.05 % + 2 nA + 10 pA × Vout)	100 V
± 100 μA	10 nA	± (0.07 % + 40 nA + 100 pA × Vout)	100 pA	± (0.05 % + 20 nA + 100 pA × Vout)	100 V
± 1 mA	100 nA	± (0.06 % + 400 nA + 1 nA × Vout)	1 nA	± (0.04 % + 200 nA + 1 nA × Vout)	100 V
± 10 mA	1 μA	± (0.06 % + 4 μA + 10 nA × Vout)	10 nA	± (0.04 % + 2 μA + 10 nA × Vout)	100 V
± 100 mA	10 μA	± (0.12 % + 40 μA + 100 nA × Vout)	100 nA	± (0.1 % + 20 μA + 100 nA × Vout)	100 V (Iout ≤ 20mA)
					40V (20mA < Iout ≤ 50mA)
					20V (50mA < Iout ≤ 100mA)

- Accuracy: ± (% of reading or setting value + offset value). Vout is the output voltage in volts.
- Iout is the output current in amps.
- The accuracy is applicable when offset cancellation has been performed.
- The offset current specification is multiplied by one of the following factors depending upon the ambient temperature and humidity. See Table 8-2.

Table 8-2 Multiplier Factor of the Offset Current at 10 pA/100 pA Range

Temperature	Humidity	
	5 to 60 % RH	60 to 80 % RH
5 to 18 °C	× 2	× 2
18 to 28 °C	× 1	× 2
28 to 40 °C	× 2	× 5

Table 8-3 HRSMU Voltage Range, Resolution, and Accuracy

Voltage Range	Set Reso.	Set Accuracy ^a	Meas. Reso.	Measurement Accuracy ^a	Max. Current ^b
± 2 V	100 μV	± (0.02 % + 400 μV)	2 μV	± (0.01 % + 200 μV)	100 mA
± 20 V	1 mV	± (0.02 % + 3 mV)	20 μV	± (0.01 % + 1 mV)	100 mA
± 40 V	2 mV	± (0.025 % + 6 mV)	40 μV	± (0.015 % + 2 mV)	100 mA (V _{out} ≤ 20 V)
					50 mA (20 V < V _{out} ≤ 40 V)
± 100 V	5 mV	± (0.03 % + 15 mV)	100 μV	± (0.02 % + 5 mV)	100 mA (V _{out} ≤ 20 V)
					50 mA (20 V < V _{out} ≤ 40 V)
					20 mA (40 V < V _{out} ≤ 100 V)

a. Accuracy: ± (% of reading or setting value + offset value).

b. V_{out} is the output voltage in volts.

HRSMU, MPSMU, and HPSMU Supplemental Information

Capacitive load	maximum 1000 pF
Guard capacitance	maximum 900 pF
Shield capacitance	maximum 5000 pF
Guard offset voltage	maximum ± 1 mV
Noise characteristics	(typical, filter ON) Voltage source: 0.01 % of V range (rms) Current source: 0.1 % of I range (rms) Voltage monitor: 0.02 % of V range (p-p) Current monitor: 0.2 % of I range (p-p)
Output overshoot	(typical, filter ON) Voltage source: 0.03 % of V range Current source: 1 % of I range
Range switching transient noise	(typical, filter ON) Voltage ranging: 250 mV Current ranging: 10 mV
Slew rate	maximum 0.2 V/ μ s

VSU (Voltage Source Unit) Specifications

- Voltage Range, Resolution, and Accuracy

Voltage Range	Resolution	Accuracy ^a	Max. Output Current
± 20 V	1 mV	$\pm (0.05 \% \text{ of setting} + 10 \text{ mV})$ ^b	100 mA

a. Accuracy: \pm (% of setting value + offset value).

b. Specification is applicable under no load current.

- VSU supplemental information

Output resistance typical 0.2 Ω

Capacitive load maximum 10 μF

Slew rate maximum 0.2 V/ μs

Current limit typical 120 mA

Output Noise typical 1 mV rms

VMU (Voltage Monitor Unit) Specifications

- Voltage Range, Resolution, and Accuracy

Grounded measurement mode

Voltage Range	Meas. Reso.	Meas. Accuracy ^a
± 2 V	2 μV	± (0.02 % + 200 μV)
± 20 V	20 μV	± (0.02 % + 1 mV)

a. Accuracy: ± (% of reading value + offset value).

Differential measurement mode

Differential Voltage Range	Meas. Reso.	Meas. Accuracy ^a	Max. Common Mode Voltage
± 0.2 V	0.2 μV	± (0.03 % + 10 μV + 0.3 μV × V _i ^b)	± 20 V
± 2 V	2 μV	± (0.02 % + 100 μV + 3 μV × V _i ^b)	± 20 V

a. Accuracy: ± (% of reading value + offset value + common mode error).

b. V_i is the input voltage of VMU2 in volts.

- VMU supplemental information

Input impedance ≥ 1 GΩ

Input leakage current ≤ 500 pA (at 0 V)

Measurement noise typical 0.01 % of range (p-p). when the integration time is 10 PLC.

Differential mode measurement noise typical 0.005 % of range (p-p). when the integration time is short.

4155C Semiconductor Parameter Analyzer

MPSMU (Medium Power SMU) Specifications

- Voltage Range, Resolution, and Accuracy
See Table 8-5.
- Current Range, Resolution, and Accuracy
See Table 8-4.
- Output terminal/connection
Single triaxial connector, non-Kelvin (no remote sensing)
- Voltage/Current Compliance (Limiting)
The SMU can limit output voltage or current to prevent damaging the device under test.

Voltage 0 V to ± 100 V

Current ± 1 pA to ± 100 mA

Compliance accuracy Same as current (voltage) set accuracy.

- MPSMU supplemental information

Voltage source output resistance typical 0.3Ω

Voltage measurement input resistance $\geq 10^{13} \Omega$

Current source output resistance $\geq 10^{13} \Omega$ (1 nA range)

Current compliance setting accuracy (for opposite polarity)

For 1 nA to 10 nA range:
V/I setting accuracy ± 12 % of range

For 100 nA to 100 mA range:
V/I setting accuracy ± 2.5 % of range

Table 8-4 MPSMU Current Range, Resolution, and Accuracy

Current Range	Set Reso.	Set Accuracy ^a	Meas. Reso.	Measurement Accuracy ^a	Max. Voltage ^b
± 1 nA	100 fA	± (0.5 % + 3 pA + 2 fA × Vout)	10 fA	± (0.5 % + 3 pA + 2 fA × Vout)	100 V
± 10 nA	1 pA	± (0.5 % + 7 pA + 20 fA × Vout)	10 fA	± (0.5 % + 5 pA + 20 fA × Vout)	100 V
± 100 nA	10 pA	± (0.12 % + 50 pA + 200 fA × Vout)	100 fA	± (0.1 % + 30 pA + 200 fA × Vout)	100 V
± 1 μA	100 pA	± (0.12 % + 400 pA + 2 pA × Vout)	1 pA	± (0.1 % + 200 pA + 2 pA × Vout)	100 V
± 10 μA	1 nA	± (0.12 % + 5 nA + 20 pA × Vout)	10 pA	± (0.1 % + 3 nA + 20 pA × Vout)	100 V
± 100 μA	10 nA	± (0.12 % + 40 nA + 200 pA × Vout)	100 pA	± (0.1 % + 20 nA + 200 pA × Vout)	100 V
± 1 mA	100 nA	± (0.12 % + 500 nA + 2 nA × Vout)	1 nA	± (0.1 % + 300 nA + 2 nA × Vout)	100 V
± 10 mA	1 μA	± (0.12 % + 4 μA + 20 nA × Vout)	10 nA	± (0.1 % + 2 μA + 20 nA × Vout)	100 V
± 100 mA	10 μA	± (0.12 % + 50 μA + 200 nA × Vout)	100 nA	± (0.1 % + 30 μA + 200 nA × Vout)	100 V (Iout ≤ 20mA)
					40V (20mA < Iout ≤ 50mA)
					20V (50mA < Iout ≤ 100mA)

a. Accuracy: ± (% of reading or setting value + offset value). Vout is the output voltage in volts.

b. Iout is the output current in amps.

Table 8-5 **MPSMU Voltage Range, Resolution, and Accuracy**

Voltage Range	Set Reso.	Set Accuracy ^a	Meas. Reso.	Measurement Accuracy ^a	Max. Current ^b
± 2 V	100 µV	± (0.03 % + 900 µV + 0.3 × Iout)	2 µV	± (0.02 % + 700 µV + 0.3 × Iout)	100 mA
± 20 V	1 mV	± (0.03 % + 4 mV + 0.3 × Iout)	20 µV	± (0.02 % + 2 mV + 0.3 × Iout)	100 mA
± 40 V	2 mV	± (0.03 % + 7 mV + 0.3 × Iout)	40 µV	± (0.02 % + 3 mV + 0.3 × Iout)	100 mA (Vout ≤ 20 V)
					50 mA (20 V < Vout ≤ 40 V)
± 100 V	5 mV	± (0.04 % + 15 mV + 0.3 × Iout)	100 µV	± (0.03 % + 5 mV + 0.3 × Iout)	100 mA (Vout ≤ 20 V)
					50 mA (20 V < Vout ≤ 40 V)
					20 mA (40 V < Vout ≤ 100 V)

a. Accuracy: ± (% of reading or setting value + offset value). Iout is the output current in amps.

b. Vout is the output voltage in volts.

VSU (Voltage Source Unit) Specifications

Same as the 4156C VSU.

VMU (Voltage Monitor Unit) Specifications

Same as the 4156C VMU.

41501B SMU and Pulse Generator Expander

HPSMU (High Power SMU) Specifications

- Current Range, Resolution, and Accuracy

See Table 8-6.

- Voltage Range, Resolution, and Accuracy

See Table 8-7.

- Output terminal/connection

Dial triaxial connectors, Kelvin (remote sensing)

- Voltage/Current Compliance (Limiting)

The SMU can limit output voltage or current to prevent damaging the device under test.

Voltage 0 V to ± 200 V

Current ± 1 pA to ± 1 A

Compliance accuracy Same as current (voltage) set accuracy.

- HPSMU supplemental information

Allowable cable resistance (Kelvin connection.)

Force: maximum 0.7Ω (100 mA to 1A)

Force: maximum 10Ω (≤ 100 mA)

Sense: maximum 10Ω

Voltage source output resistance typical 0.2Ω (Force line. Non Kelvin connection.)

Voltage measurement input resistance $\geq 10^{13} \Omega$

Current source output resistance $\geq 10^{13} \Omega$ (1 nA range)

Current compliance setting accuracy (for opposite polarity)

For 1 nA to 10 nA range:

V/I setting accuracy ± 12 % of range

For 100 nA to 1 A range:

V/I setting accuracy ± 2.5 % of range

Specifications
Hardware

Table 8-6 HPSMU Current Range, Resolution, and Accuracy

Current Range	Set Reso.	Set Accuracy ^a	Meas. Reso.	Measurement Accuracy ^a	Max. Voltage ^b
± 1 nA	100 fA	± (0.5 % + 3 pA + 2 fA × Vout)	10 fA	± (0.5 % + 3 pA + 2 fA × Vout)	200 V
± 10 nA	1 pA	± (0.5 % + 7 pA + 20 fA × Vout)	10 fA	± (0.5 % + 5 pA + 20 fA × Vout)	200 V
± 100 nA	10 pA	± (0.12 % + 50 pA + 200 fA × Vout)	100 fA	± (0.1 % + 30 pA + 200 fA × Vout)	200 V
± 1 µA	100 pA	± (0.12 % + 400 pA + 2 pA × Vout)	1 pA	± (0.1 % + 200 pA + 2 pA × Vout)	200 V
± 10 µA	1 nA	± (0.12 % + 5 nA + 20 pA × Vout)	10 pA	± (0.1 % + 3 nA + 20 pA × Vout)	200 V
± 100 µA	10 nA	± (0.12 % + 40 nA + 200 pA × Vout)	100 pA	± (0.1 % + 20 nA + 200 pA × Vout)	200 V
± 1 mA	100 nA	± (0.12 % + 500 nA + 2 nA × Vout)	1 nA	± (0.1 % + 300 nA + 2 nA × Vout)	200 V
± 10 mA	1 µA	± (0.12 % + 4 µA + 20 nA × Vout)	10 nA	± (0.1 % + 2 µA + 20 nA × Vout)	200 V
± 100 mA	10 µA	± (0.12 % + 50 µA + 200 nA × Vout)	100 nA	± (0.1 % + 30 µA + 200 nA × Vout)	200 V (Iout ≤ 50 mA)
					100 V (50mA < Iout ≤ 100mA)
± 1 A	100 µA	± (0.5 % + 500 µA + 2 µA × Vout)	1 µA	± (0.5 % + 300 µA + 2 µA × Vout)	200 V (Iout ≤ 50 mA)
					100 V (50mA < Iout ≤ 125mA)
					40 V (125mA < Iout ≤ 500mA)
					20 V (500 mA < Iout ≤ 1 A)

a. Accuracy: ± (% of reading or setting value + offset value). Vout is the output voltage in volts.

b. Iout is the output current in amps.

Table 8-7 HPSMU Voltage Range, Resolution, and Accuracy

Voltage Range	Set Reso.	Set Accuracy ^a	Meas. Reso.	Measurement Accuracy ^a	Max. Current
± 2 V	100 µV	± (0.03 % + 900 µV)	2 µV	± (0.02 % + 700 µV)	1 A
± 20 V	1 mV	± (0.03 % + 4 mV)	20 µV	± (0.02 % + 2 mV)	1 A
± 40 V	2 mV	± (0.03 % + 7 mV)	40 µV	± (0.02 % + 3 mV)	500 mA
± 100 V	5 mV	± (0.04 % + 15 mV)	100 µV	± (0.03 % + 5 mV)	125 mA
± 200 V	10 mV	± (0.045 % + 30 mV)	200 µV	± (0.035 % + 10 mV)	50 mA

a. Accuracy: ± (% of reading or setting value + offset value).

MPSMU Specifications

Same as the 4155C MPSMU.

GNDU (Ground Unit) Specifications

- Specifications

Output voltage 0 V ± 100 µV

Sink current maximum 1.6 A

Output terminal/connection Single triaxial connector, Kelvin (remote sensing)

- Supplemental information

Load capacitance ≤ 1 µF

Cable resistance Force ≤ 1 Ω
Sense ≤ 10 Ω

PGU (Pulse Generator Unit) Specifications

- General

Modes	pulse or constant
Amplitude	0 V _{pp} to 40 V _{pp}
Window	-40.0 V to +40.0 V
Maximum current	± 200 mA (width: ≤ 1 ms, average current ≤ 100 mA) ± 100 mA
Output impedance	50 Ω and low impedance (≤ 1 Ω)
Burst count range	1 to 65535
Trigger output	Level: TTL Timing: same timing and width as PGU1 pulse output.

- Pulse/dc Output Voltage and Accuracy

See Table 8-8.

- Timing Parameters

See Table 8-9.

- Accuracy of Timing parameters

The following data is applied when leading time and trailing time are the same value.

Period	± (2 % + 2 ns)
Width	± (3 % + 2 ns)
Delay	± (2 % + 40 ns)

- Leading Time and Trailing Time

See Table 8-10.

- Restrictions of Pulse Timing Parameters Setup

- Pulse width < Pulse period
- Delay time < Pulse period
- Leading time < Pulse width × 0.8
- Trailing time < (Pulse period - Pulse width) × 0.8

- PGU supplemental information

Overshoot (Undershoot, ringing)	$\leq \pm 5\%$ of amplitude ± 10 mV (50 Ω output impedance to 50 Ω load)
Pulse width jitter	0.2 % + 100 ps
Pulse period jitter	0.2 % + 100 ps
Slew rate	maximum 100 V/ μ s (50 Ω output impedance to 50 Ω load)
Noise	0.2 % of range (at dc output)

Table 8-8 Pulse/dc Output Voltage and Accuracy

Set Parameter	Voltage Range	Resolution	Accuracy ^a
Base ^b	± 20 V	4 mV	$\pm (1\%$ of Base + 50 mV + 1 % of Pulse)
	± 40 V	8 mV	$\pm (1\%$ of Base + 50 mV + 1 % of Pulse)
Pulse	± 20 V	4 mV	$\pm (3\%$ of Base + 50 mV)
	± 40 V	8 mV	$\pm (3\%$ of Base + 50 mV)

a. Accuracy is specified at leading = trailing time = 1 μ s.

b. dc output is performed by the Base parameter.

Table 8-9 **Timing Parameters**

Range^a	Period	Width	Delay	Set resolution
1	2 μ s to 100 μ s	1 μ s to 99.9 μ s	0 to 100 μ s	0.1 μ s
2	100 μ s to 1000 μ s	1 μ s to 999 μ s	0 to 1000 μ s	1 μ s
3	1 ms to 10 ms	0.01 ms to 9.99 ms	0 to 10 ms	10 μ s
4	10 ms to 100 ms	0.1 ms to 99.9 ms	0 to 100 ms	100 μ s
5	100 ms to 1000 ms	1 ms to 999 ms	0 to 1000 ms	1 ms
6	1 s to 10 s	0.01 s to 9.99 s	0 to 10 s	10 ms

a. Period, width, and delay of PGU1 and PGU2 must be in the same range.

Table 8-10 **Leading Time and Trailing Time**

Range^a	Leading/Trailing Time	Set Resolution	Accuracy
1	100 ns to 1000 ns	1 ns	\pm (5 % + 10 ns)
2	0.5 μ s to 10.0 μ s	10 ns	\pm (5 % + 10 ns)
3	5.0 μ s to 100.0 μ s	100 ns	\pm (5 % + 10 ns)
4	50 μ s to 1000 μ s	1 μ s	\pm (5 % + 10 ns)
5	0.5 ms to 10.0 ms	10 μ s	\pm (5 % + 10 ns)

a. Leading time and trailing time for a PGU must be in the same range.

Functions

- Measurement setup
- Measurement capability
- Arithmetic and analysis functions
- Repeating and automating test
- Output
- Data storage
- Other capabilities

Measurement Setup

- Fill-in-the-blanks using front-panel or full-size external keyboard
- Load settings from a diskette
- Program using internal Instrument BASIC or via GPIB
- HELP function
- Library: Default Measure Setup, Vce-Ic, Vds-Id, Vgs-Id, and Vf-If are pre-defined softkeys
- User-defined measurement setup library
- Auto file load function on power-up

Measurement Capability

The 4155C/4156C can perform dc or pulsed force/measure, and stress force. For dc, voltage/current sweep and sampling (time domain) measurements are available.

Voltage/Current Sweep Measurement Characteristics

SMUs or VSUs can be set using VAR1 (primary sweep), VAR2 (subordinate sweep), VAR1' (synchronous sweep), or CONST (constant output).

- VAR1
Primary sweep, controls the staircase (dc or pulsed) voltage or current sweep.
Number of steps Maximum 1001 for one VAR1 sweep.
Sweep type Linear or logarithmic
Sweep direction Single or double sweep
Hold time Initial wait time or wait time after VAR2 is set, 0 to 655.35 s with 10 ms resolution
Delay time Wait time from VAR1 step to the start of the measurement, 0 to 65.535 s with 100 μ s resolution
- VAR2
Subordinate linear staircase or linear pulsed sweep. After primary sweep is completed, the VAR2 unit output is incremented. Maximum number of steps is 128.

- VAR1'

Staircase or pulsed sweep synchronized with the VAR1 sweep. Sweep is made with a user specified ratio and offset value. VAR1' output is calculated as $VAR1' = a \times VAR1 + b$, where "a" is the user-specified ratio and "b" is the user-specified offset value.

- CONSTANT

A source unit can be set as a constant voltage or current source depending on the unit.

- PULSE

One of SMUs can be set as a pulse source.

Pulse width 0.5 ms to 100 ms, 100 μ s resolutions.

Pulse period 5 ms to 1 s (\geq pulse width + 4 ms), 100 μ s resolutions.

SMU pulse setting accuracy (supplemental information):

Conditions: fixed range measurement except multi channel measurement

Width 0.5 % + 50 μ s

Period 0.5 % + 100 μ s

Trigger out delay (for pulsed measurements.)

0 to 32.7 ms with 100 μ s resolution (< pulse width)

Sampling (Time Domain) Measurement Characteristics

Displays the time sampled voltage/current data versus time. The source unit is SMU, VSU, or PGU.

Sampling points Maximum 10,001 (Linear)

Sampling mode linear, log, and thinned-out

Sampling interval For linear scale (auto mode):

- 60 μ s to 480 μ s range, 20 μ s resolution
- 480 μ s to 1 s range, 80 μ s resolution
- 1 s to 65.535 s range, 2 ms resolution

For linear scale (no limit mode), log scale, and thinned-out modes:

- 560 μ s (720 μ s at thinned-out mode) to 1 s range, 80 μ s resolution
- 1 s to 65.535 s range, 2 ms resolution

Hold time initial wait time, 0.03 to 655.35 s, 100 μ s resolution.

Stop condition a condition to stop the sampling can be defined.

Sampling interval setting accuracy (supplemental data)

- 0.5 % + 10 μ s (sampling interval \leq 480 μ s)
- 0.5 % + 10 μ s (560 μ s \leq sampling interval $<$ 2 ms)
- 0.5 % + 100 μ s (2 ms \leq sampling interval)

The thinned-out mode is similar to reverse-log sampling. Sampling measurement continues by thinning out older data until the sampling completion condition is satisfied.

There are the following restrictions if initial interval is less than 2 ms.

- Number of measurement channels must be 1.
- Measurement ranging must be the fixed range.
- Stop condition must be disabled.

C-V Measurement Characteristics

Capacitance is calculated value derived from the following equation:

$$C=dQ/dV$$

dQ is the charge when dV, the step voltage (QSCV measurement voltage), is applied by the SMU; dQ is derived from the measurement current (amps) and the integration time (seconds).

Maximum value	Maximum measurement value depends on the current range, integration time, and step voltage (QSCV measurement voltage). <ul style="list-style-type: none"> • Current range (4156C): 10 pA, 100 pA, 1 nA, 10 nA • Current range (4155C): 1 nA, 10 nA • Voltage range: 2 V, 20 V, 40 V, 100 V, 200 V
Accuracy	Capacitance calculation accuracy is dependent on accuracy of the current measurement and voltage measurement, and the stray capacitance and leakage current of measurement path etc. (refer to supplemental data shown below).
Zero Offset	Cancels stray capacitance of the fixtures and test leads.
Current Compensation	Cancels the influence of the leakage current to the capacitance measurement.

Capacitance Calculation Accuracy (Supplemental Data).

Accuracy is derived from the current range, voltage range, capacitance measurement and leakage current measurement integration times, and the guard capacitance of cabling and the QSCV measurement voltage. The information in Table 8-11 and Table 8-12 is based on the following conditions:

- Voltage range: 20 V
- QSCV measurement voltage: 100 mV
- Guard capacitance: 100 pF
- Equivalent parallel resistance of DUT: $10^{15} \Omega$
- The ratio of integration times for capacitance measurement and leakage current measurement is 1:1.

Table 8-11

Calculation Example of Measurement Accuracy using HRSMU

Current Range	Integration Time	Maximum Value	Meas. Reso.	Accuracy
10 pA/ 100 pA	0.5 sec	100 fF/1 pF	5 fF	$\pm (4.2 \% + 70 \text{ pF})$
	1 sec	2 pF/20 pF	10 fF	$\pm (4.3 \% + 90 \text{ pF})$
	2 sec	76 pF/760 pF	20 fF	$\pm (4.3 \% + 130 \text{ fF})$
1 nA	0.1 sec	700 pF	10 fF	$\pm (0.84 \% + 160 \text{ fF})$
	0.5 sec	4.5 nF	40 fF	$\pm (0.85 \% + 280 \text{ fF})$
	2 sec	18 nF	200 fF	$\pm (0.93 \% + 740 \text{ fF})$
10 nA	0.1 sec	7 nF	10 fF	$\pm (0.84 \% + 200 \text{ fF})$
	0.5 sec	45 nF	40 fF	$\pm (0.85 \% + 440 \text{ fF})$
	2 sec	180 nF	200 fF	$\pm (0.93 \% + 1.4 \text{ pF})$
	10 sec	940 nF	1 pF	$\pm (1.3 \% + 6.2 \text{ pF})$

Table 8-12

Calculation Example of Measurement Accuracy using MPSMU/HPSMU

Current Range	Integration Time	Maximum Value	Meas. Reso.	Accuracy
1 nA	0.1 sec	700 pF	10 fF	$\pm (0.91 \% + 170 \text{ fF})$
	0.5 sec	4.5 nF	40 fF	$\pm (0.94 \% + 340 \text{ fF})$
	2 sec	18 nF	200 fF	$\pm (1 \% + 1 \text{ pF})$
10 nA	0.1 sec	7 nF	10 fF	$\pm (0.91 \% + 180 \text{ fF})$
	0.5 sec	45 nF	40 fF	$\pm (0.94 \% + 480 \text{ fF})$
	2 sec	180 nF	200 fF	$\pm (1 \% + 1.6 \text{ pF})$
	10 sec	940 nF	1 pF	$\pm (1.6 \% + 7.6 \text{ pF})$

Accuracy: $\pm (\% \text{ of reading}) \pm (\text{offset value})$

Maximum value is applicable when the following conditions are satisfied.

- Current compliance is smaller than the current range.
- Capacitance of the DUT and measurement path is smaller than the maximum measurement value.

Stress Force Characteristics

SMU, VSU, and PGU output can be forced for the user specified period.

Stress time	500 μ s to 31,536,000 s (365 days)
Resolution	100 μ s (500 μ s \leq stress time \leq 10 s) 10 ms (10 s \leq stress time \leq 31,536,000 s)
Burst pulse count	1 to 65,535 (PGU only)
Trigger	The 4155C/4156C outputs a gate trigger while stress channels are forcing stress.

Knob Sweep

In the knob sweep mode, sweep range is controlled instantaneously with the front-panel rotary knob. Only the CHANNELS: CHANNEL DEFINITION screen needs to be defined.

Standby Mode

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

Other Characteristics (measurement control)

Measurement control	single, append, repeat, and stop
Stress control	stress force, and stop
SMU settings capabilities	limited auto-ranging, voltage/current compliance, power compliance, automatic sweep abort functions, self-test, and self calibration.

Arithmetic and Analysis Functions

- Arithmetic Functions

User functions up to six USER FUNCTIONs can be defined using arithmetic expressions. Measured data and analyzed variables from graphics analysis (marker, cursor and line data) can be used in the computation. The results can be displayed on the screen.

Arithmetic operators

+, -, *, /, ^, LGT (logarithm, base 10), LOG (logarithm, base e), EXP (Napierian constant), DELTA, DIFF (differential), INTEG (integration), MAVG (moving average), SQRT, ABS (absolute), MAX, MIN, AVG (averaging), COND (conditional evaluation).

Physical constants Keyboard constants are stored in memory as follows.

- q : Electron Charge, 1.602177 E-19 C
- k : Boltzmann's Constant, 1.380658 E-23
- e : Dielectric Constant of vacuum, 8.854188 E-12

Engineering units The following unit symbols are also available on the keyboard. m (10^{-3}), μ (10^{-6}), u (10^{-6}), n (10^{-9}), p (10^{-12}), f (10^{-15}), k (10^3), M (10^6), G (10^9)

- Analysis Capabilities

Overlay graph comparison

a graphic plot can be stored and later recalled as an overlay plane. Four overlay planes can be stored. One plane can be overlaid onto the current data.

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

Cursor long and short, direct cursor

Line two lines, normal mode, grad mode, tangent mode, and regression mode

Scaling auto scale and zoom

Data variable display

Up to two user defined parameters can be displayed on measurement result screen.

Read Out Function

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

Automatic 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.

User Variable Displays the data on the screen via GPIB or Instrument BASIC.

Repeating and Automating Test

- Instrument Control

Function control internal or external computer can control the 4155C/4156C functions via GPIB interface.

Commands set SCPI Commands set
4155C/4156C FLEX Commands set
4145B Syntax Commands set

Program memory Using the 4155C/4156C FLEX Commands set, program code can be stored in the 4155C or 4156C. Maximum number of program set is 255.

External instrument

remote control internal Instrument BASIC controller can control external equipment via GPIB interface.

Specifications

Functions

- Instrument BASIC

Instrument BASIC is a subset of HP BASIC.

Functions arithmetic operation, binary operation, string manipulation, logical operation, array operation, program flow control, event-initiated branching, program editing and debugging support, mass storage operation, instrument control, real-time clock, softkey operation, and graphics.

Typing aid 4145B ASP (Auto Sequence Program) like syntax softkeys are available in Instrument BASIC. An ASP file cannot be read by the 4155C/4156C.

Remote control Instrument BASIC is remote controllable from an external computer via the GPIB interface.

IBASIC supplemental information:

Program (text) area 16 Kbyte.

Variable/stack area 500 Kbyte.

Common variable area 600 Kbyte. This size is decreased when hard copy or disk operation is executed.

- Trigger

Input external trigger input starts a sweep or sampling measurement or can be used as a trigger input for continuing Instrument BASIC program.

Input level TTL level, negative or positive edge trigger

Output external trigger can be generated by the following events: start of each sweep measurement step, start of each pulse (SMU) output, while the stress source is forcing, and Instrument BASIC trigger out command execution.

Output level TTL level, negative or positive logic

Output

- Display
 - Display modes** graphics and list
 - Graphics display** two-axes (X-Y) or three-axes (X-Y1,Y2) plot of source current/voltage, measured current/voltage, time, or calculated USER FUNCTION data.
 - 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 eight data sets can be displayed.
 - Display** 8.4 inch diagonal color active matrix LCD, 640 dot (H) by 480 dot (V). More than 99.99 % of the pixels on an LCD are active.
- Hard Copy Functions
 - Graphics hard copy** measured data and all data appearing on the screen can be output via GPIB, parallel, or network interface to a supported plotter or printer. PCL and HP-GL formats are supported (selectable).
 - Text hard copy** print out setup information or measured data list as an ASCII text via GPIB, parallel, or network interface to a supported plotter or printer. PCL and HP-GL formats are supported (selectable).
 - Hard copy file** hard copy output file can be stored to an internal or network mass storage devices instead of sending it to a printer or plotter. The data can be stored in PCL, HP-GL, or TIF formats.
 - Hard copy via network interface** lpr client capability

Data Storage

- Internal mass storage device

Mass storage device built-in 3.5 inch flexible disk drive

Media 3.5 inch 2HD or 2DD diskette

Format type HP LIF and DOS

User area 1.44 Mbyte (2HD) or 720 Kbyte (2DD)

File types auto start program file, initial setup file, measurement setup file, measurement setup/result file, stress setup file, customize file, hard copy data file, and Instrument BASIC program and data file.

Program files data made by HP BASIC program and data made by Instrument BASIC program are compatible.

- Network mass storage device

Mass storage device an NFS mountable mass storage device

File types auto start program file, initial setup file, measurement setup file, measurement setup/result file, stress setup file, customize file and hard copy data file.

Number of files maximum 199 files (including directories) in the working directory.

- Data Storage supplemental information

Volume size available bytes = 1457 Kbyte (for 2HD DOS formatted diskette)

File size Measurement setup: 3843 byte Stress setup: 601 byte Measurement setup/result: typical 15387 byte (VAR1: 101, VAR2: 5) Customized system setup: 1661 byte Hardcopy data: 30317 byte (monochrome PCL, 75DPI file) Hardcopy data: 38702 byte (monochrome TIFF file)

Number of files maximum 199 can be stored (for HP LIF format).

Other Capabilities

- 4145B Data Compatibility and 4145B Syntax Commands

Setup/data file loads measurement setup and data of the 4145B

GPIB program GPIB programs for the 4145B can be used when the 4145B syntax command set is selected. There is a possibility that GPIB programs for the 4145B need to be modified before using.

- Interfaces
 - GPIB interface: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C1, C2, C3, C4, C11, E2
 - Parallel interface
 - RJ45 connector : Ethernet IEEE 802.3 10BASE-T for a 10Mbps CSMA/CD local area network
 - External keyboard : compatible PC-style 101-key keyboard (mini DIN connector)
 - Interlock and LED connector
 - R-BOX control connector
 - Trigger in/out
 - SMU/PGU Selector control connector (Agilent 41501A/B)
- VXIplug&play drivers

The VXIplug&play drivers for Agilent 4155/4156/E5250A are available. The drivers support Microsoft Windows XP Professional, Windows 2000, Windows NT 4.0, Windows 98, and Windows 95.
- Agilent VEE Sample Application Programs
 - Vth measurement using an 4155C/4156C, an E5250A, and a prober

Specifications

Functions

- Sample Application Programs
 - Flash EEPROM test
 - TDDB
 - Constant I (Electromigration test)
 - V-Ramp test
 - J-Ramp test
 - SWEAT
 - GO/NO-GO test
 - HCI degradation test
 - Charge pumping test

General Specifications

- Temperature range
 - Operating** +10 °C to +40 °C (with disk drive operation)
+5 °C to +40 °C (without disk drive operation)
 - Storage** -22 °C to +60 °C
- Humidity range
 - Operating** 20 % to 80 % RH, non-condensing and wet bulb temperature 29 °C or below (with disk drive operation)
15 % to 80 % RH, non-condensing and wet bulb temperature 29 °C or below (without disk drive operation)
 - Storage** 5 % to 90 % RH, non-condensing and wet bulb temperature 39 °C or below
- Altitude
 - Operating** 0 to 2,000 m
 - Storage** 0 to 4,600 m
- Power requirement
90 V to 264 V, 47 Hz to 63 Hz
- Maximum VA
 - 4155C/4156C** 450 VA (Max)
 - 41501B** 350 VA (Max)
- Regulatory Compliance
 - EMC** EN61326-1, AS/NZS CISPR 11
 - Safety** CSA C22.2 No.1010.1-1992
IEC61010-1 / EN61010-1
UL Std No. 61010B-1
 - Certification** CE, CSA(c/us), C-Tick
- Dimensions
 - 4155C/4156C** 426 mmW by 235 mmH by 600 mmD
 - 41501B** 426 mmW by 190 mmH by 600 mmD
- Weight (approx.)
 - 4155C/4156C** 21 kg
 - 41501B** 16 kg (option 412. with HPSMU and 2 PGUs)

Furnished Accessories

The following are the furnished accessories for the 4155C/4156C.

- Triaxial Cable, 4 ea. (4155C)
- Kelvin Triaxial Cable, 4 ea. (4156C)
- Coaxial Cable, 4 ea.
- Interlock Cable, 1 ea.
- Keyboard, 1 ea.
- User Manual, 1 set
- Sample Application Program Disk, 1 ea.
- VEE Sample Program Disk, 1 ea.
- 4155/4156 VXIplug&play Drivers Disk, 1ea.
- E5250A VXIplug&play Drivers Disk, 1ea.
- LAN Interface Test Adapter, 1 ea.

Accessories and Options

The following table lists accessories and options for Agilent 4155C/4156C.

Model Number	Option Item	Description
4155C		Semiconductor Parameter Analyzer
	4155C-200	1.5 m interlock, 4×coax, 4×triaxial cables
	4155C-230	3.0 m interlock, 4×coaxial, 4×triaxial cables
	4155C-A6J	ANSI Z540 compliant calibration
	4155C-UK6	Commercial cal. certificate w/ test data
	4155C-0KN	Self-paced Training Kit
4156C		Precision Semiconductor Parameter Analyzer
	4156C-010	Delete kelvin triaxial cables
	4156C-200	1.5 m interlock, 4×coaxial, 4×kelvin triaxial cables
	4156C-230	3.0 m interlock, 4×coaxial, 4×kelvin triaxial cables
	4156C-A6J	ANSI Z540 compliant calibration
	4156C-UK6	Commercial cal. certificate w/ test data
	4156C-0KN	Self-paced Training Kit

Model Number	Option Item	Description
16353A		Standard Resistor Set
16434A		Kelvin Triaxial Cable (4156 kelvin to 4142 kelvin)
	16434A-001	1.5 m length
	16434A-002	3.0 m length
16440A		SMU/Pulse Generator Selector
	16440A-001	Control cable (1.5 m)
	16440A-002	Control cable (3.0 m)
	16440A-003	Control cable (0.4 m) for 2nd selector
16441A		R-Box
	16441A-001	Control cable (1.5 m)
	16441A-002	Control cable (3.0 m)
16442A		Test Fixture
	16442A-010	Add 1.5 m triaxial cables for 4156C
	16442A-011	Add 3.0 m triaxial cables for 4156C
	16442A-800	Extra blank teflon board
	16442A-801	Universal socket module, 0.1 inch pitch, with 10 pins
	16442A-802	Universal socket module, 0.075 inch pitch, with 10 pins
	16442A-803	Universal socket module, 0.05 inch pitch, with 10 pins
	16442A-810	Extra pin set (for universal socket module, 10 pins.)
	16442A-811	Extra wire set (mini banana to pin plug, 6 ea.)
	16442A-812	Extra wire set (pin plug to pin plug, 6 ea.)
	16442A-813	Extra wire set (mini banana to mini clip, 6 ea.)
	16442A-814	Extra wire set (mini banana to mini banana, 6 ea.)
	16442A-821	Socket module, 4-pin TO package
	16442A-822	Socket module, 18-pin DIP package
	16442A-823	Extra socket module, 28-pin DIP package
	16442A-890	Extra accessory case

Accessories and Options

Model Number	Option Item	Description
16493B		Coaxial Cable
	16493B-001	1.5 m length
	16493B-002	3.0 m length
16493C		Triaxial Cable
	16493C-001	1.5 m length
	16493C-002	3.0 m length
16493J		Interlock Cable for 4155/4156
	16493J-001	1.5 m length
	16493J-002	3.0 m length
16493K		Kelvin Triaxial Cable (4156 kelvin to 4156 kelvin)
	16493K-001	1.5 m length
	16493K-002	3.0 m length
16495H		Connector plate w/ 6×triax., 6×coax, intlk., GNDU
	16495H-001	Bulkhead feedthrough connectors (female to female)
	16495H-002	Connectors to contacts for soldering
16495J		Connector plate w/ 8×triax., 4×coax, intlk., GNDU
	16495J-001	Bulkhead feedthrough connectors (female to female)
	16495J-002	Connectors to contacts for soldering
41501B		SMU and Pulse Generator Expander
	41501B-201	1.5 m measurement cables
	41501B-231	3.0 m measurement cables
	41501B-402	2 PGUs
	41501B-410	HPSMU
	41501B-412	HPSMU and 2 PGUs
	41501B-420	2 MPSMUs
41501B-422	2 MPSMUs and 2 PGUs	