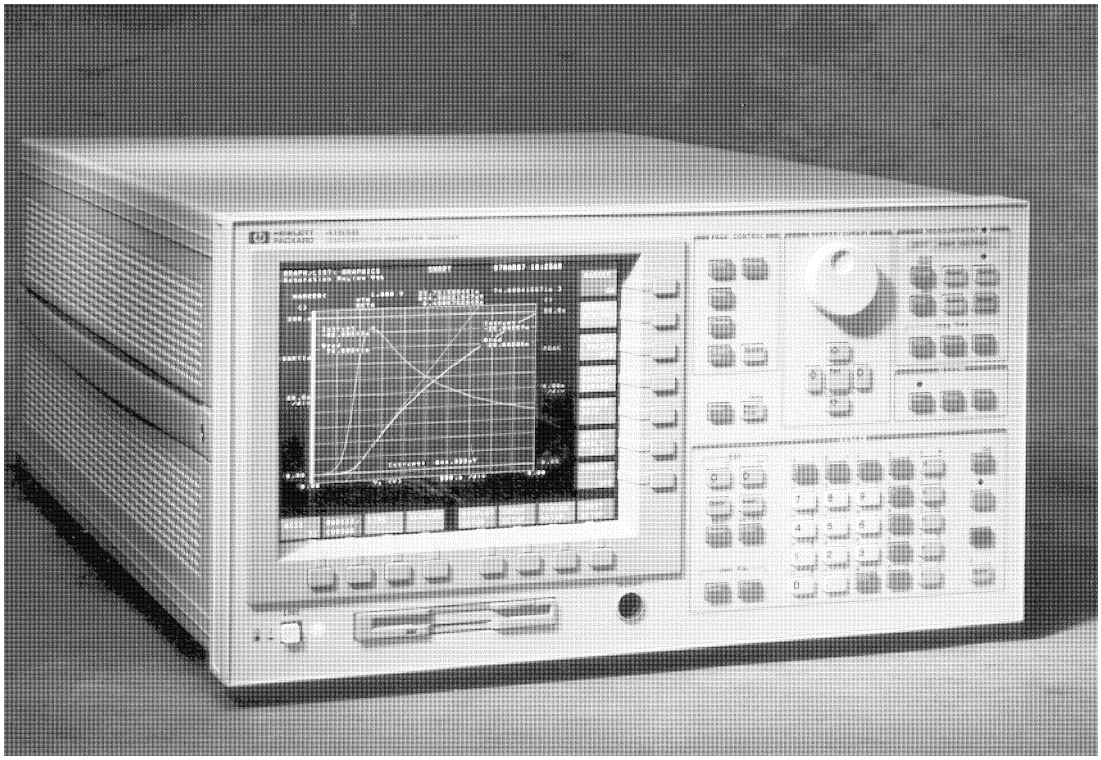
HP 4155B / 4156B New Semiconductor Parameter Analyzers

HEWLETT® PACKARD

Product Note - 1

Differences from HP 4155A / 4156A

HP 4155B / 4156B
New Semiconductor
Parameter Analyzer



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1. Introduction

The HP 4155B and HP 4156B are new semiconductor parameter analyzers for evaluating next generation sub-micron geometry devices. The HP 4155B / 4156B retains all the features and unprecedented accuracy of the HP 4155A / 4156A, yet adds powerful new features. This product note describes these new features.

2. New Features of HP 4155B / 4156B Semiconductor Parameter Analyzers

For More Comfortable Operation and for Higher Throughput

The HP 4155B / 4156B is designed for faster test, yet without sacrificing the accuracy, flexibility, and ease-of-use of the HP 4155A / 4156A. A powerful CPU and more memory enhance the front panel operation.

A potent new user command language, HP FLEX (Fast Language for EXecution), gives direct and fast control over the instrument hardware, independent of the measurement setup page syntax. It can be used for high speed automated test. For users demanding the highest possible throughput, the new program memory enables them to store repeatedly executed HP FLEX commands thereby reducing bus and controller activity.

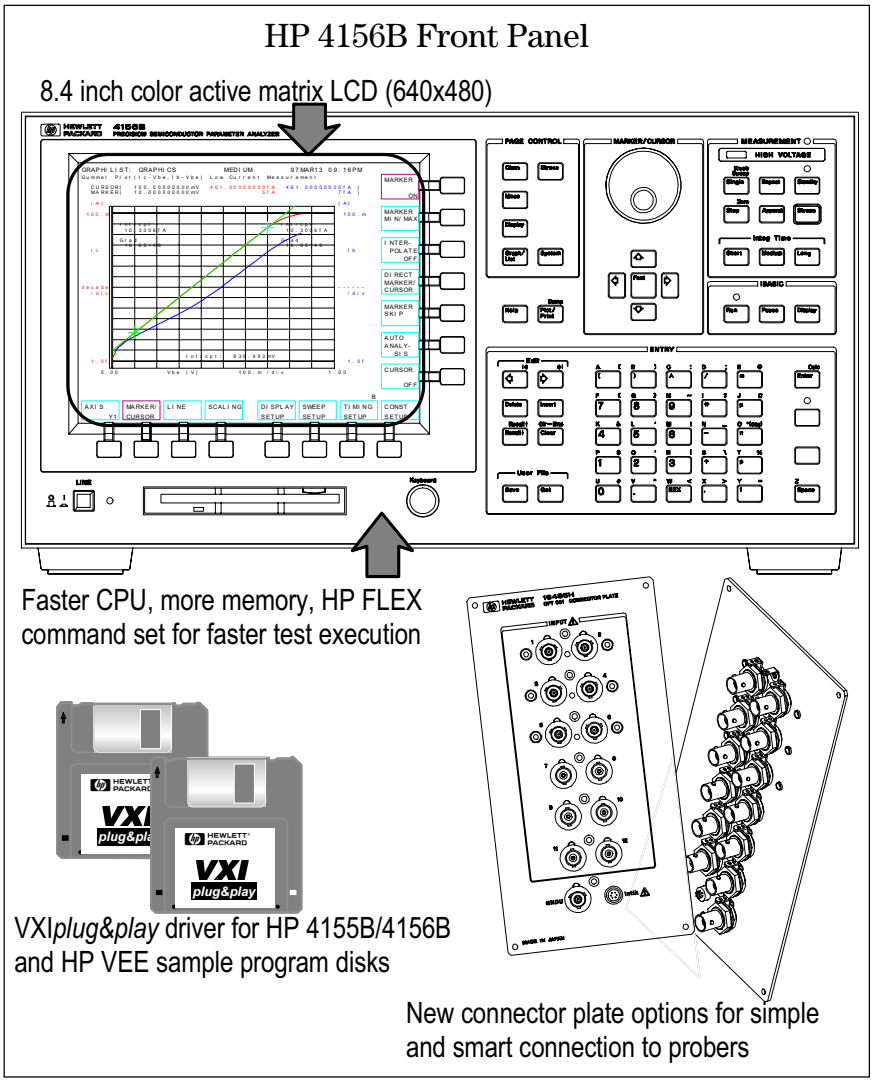
For configuring an automated test system with intuitive programming

The HP 4155B / 4156B supports the popular open-system standards of the VXI*plug&play* alliance. It allows users desiring a more intuitive programming to use the HP Visual Engineering Environment (HP VEE). HP VEE is a powerful visual programming language. With a variety of instrument drivers and DDE capability to communicate with prober control software, you can easily configure an automated test system to meet your needs.

For more efficient test environment

The newly added LAN port of the HP 4155B / 4156B enables sharing of measurement setup and data libraries on a site-wide basis. This eliminates the tedious job of transferring data on floppy disks, and permits company standardization.

The printing / plotting capability is also enhanced. A parallel port replaced the serial port. You can directly connect popular HP printers without a converter. The HP 4155B



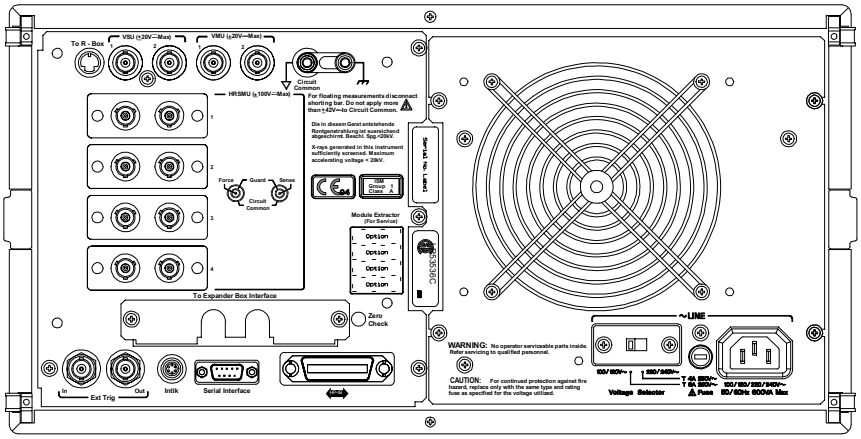
/ 4156B can also output graphics images to a remote printer outside of a clean room via its LAN port. With newly added printing modes, the printing quality is also improved. Support for the popular TIFF graphics image format eases the creation of test reports.

In addition, Hewlett-Packard designed the HP 4155B / 4156B with several other convenient new features, such as a new and larger LCD, improved VMU leakage current circuitry, and a new connector plate design.

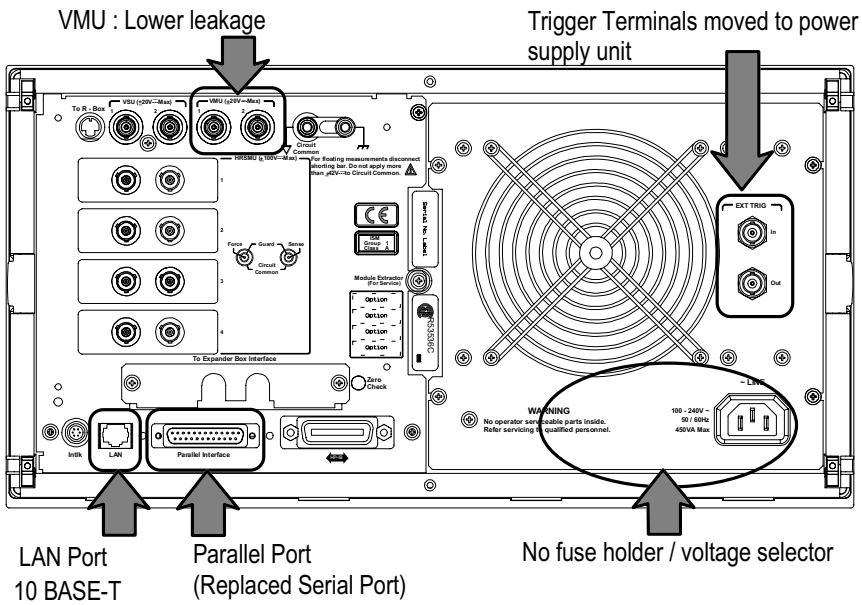
Summary of Differences from the HP 4155A / 4156A:

- Powerful CPU and more memory
- HP FLEX for automated test
- Program memory for faster test execution
- VXI*plug&play* driver for HP VEE and other programming languages
- LAN port for measurement setup and data file sharing
- Parallel port to connect directly to printers
- More popular format (TIFF) for creating screen image files
- Printing to remote printers via LAN port
- 8.5 inch color LCD
- New connector plate options
- VMU specification improvement

HP 4156A Rear Panel



HP 4156B Rear Panel



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3. New HP FLEX commands for automated tests

The HP 4155B / 4156B supports a new control command set, HP FLEX (Fast Language for EXecution). It speeds automated tests in which higher throughput is required.

	SCPI	4145 Syntax Mode		HP FLEX
		System Mode	User Mode	
Control method	Setup each page		Dynamically control meas units Independent of setup pages	
Command syntax	• IEEE 488 standard command set • Long	• Short / Simple • Almost compatible with HP 4145 commands		• Short / Simple • Similar to 4142B commands (Some unique for 4155B / 4156B)
Feature	• Support all measurement functions	• For 4145 program execution • Limited measurement functions (spot / sweep / time domain only)		• Faster execution • Support all measurement functions

Table 1. Comparing HP-IB Control Command Modes

Programming with the HP 4155A / 4156A

The HP 4155A / 4156A supports two command sets to control the instrument via HP-IB. They are SCPI mode and HP 4145 syntax mode. SCPI (Standard Command for Programmable Instruments) allows the user to standardize many programs to control measurement instruments. However, it has a cumbersome syntax which requires the user to set up each column of all setup pages of the HP 4155A / 4156A. The programs also tend to be lengthy and complicated. You can simplify the program by loading previously stored measurement setups saved on floppy disk into measurement hardware, but this slows disk access, which in turn lowers test throughput. For applications in which high test throughput is required, SCPI mode is not the best solution.

The HP 4145 syntax mode commands have a simple syntax. However, the HP 4145 syntax mode was designed to run 4145's programs on the HP 4155A / 4156A. Therefore, it only supports measurement modes which exist on the HP 4145. They are sweep mode and time domain (sampling) mode. Please refer to Tables 1 and 2.

Programming with HP FLEX

HP FLEX commands control the HP 4155B / 4156B's measurement hardware directly, as comparatively shown with SCPI in Figure 3. If the HP 4155B / 4156B is set to HP FLEX mode, the measurement setup screen is not updated. Each measurement unit can operate independently of the measurement setup pages. This control method frees the CPU of the HP 4155B / 4156B from unnecessary tasks (such as controlling the measurement hardware), and improves test execution time.

Table 2 compares the measurement modes and functions supported by the 4145 syntax mode and the HP FLEX mode. HP FLEX supports all of measurement modes and functions of the HP 4155B / 4156B. You can use HP FLEX for testing devices that are sensitive to thermal effects, and for reliability tests which require precise stressing or for reliability tests that require stress functions.

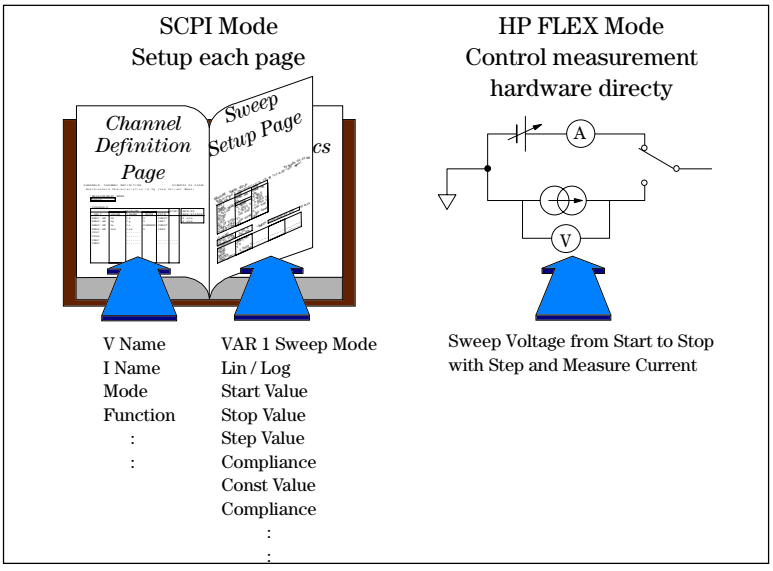

Figure 3. Hardware control methods - SCPI and FLEX

Measurement Mode/Function		4145 Syntax User Mode	FLEX
Spot Measurement		Yes	Yes
Staircase Sweept		No	Yes
1 channel pulse spot		No	Yes
Pulsed sweep		No	Yes
Staircase with pulse bias		No	Yes
Sampling		Yes	Yes
Stress		No	Yes
PGU Control		No	Yes
Trigger Control		No	Yes
Program Memory		No	Yes

Table 2. Measurement modes/functions

Simple Programming Using HP FLEX

You can simplify your test programs with HP FLEX. Sample SCPI and HP FLEX programs are shown in Figures 5 and 6. Both programs measure drain current (Id) - gate voltage (Vg) characteristics of an n channel MOSFET. While the Vg is swept, the Id is measured. The measurement circuit used for this test is shown in Figure 4.

In the SCPI programs, all of the setup pages are defined by sending many lengthy commands to define each setup field, which tends to make the program large. On the other hand, HP FLEX commands directly control the SMUs by sending commands such as DV (force voltage) , WV (sweep voltage) and so on. An HP FLEX program is much simpler than a SCPI program. In this example, the HP FLEX program is about 1/2 the length of the SCPI program. Thus, with the simpler commands of HP FLEX, you save time when both programming and debugging.

Though this example is written in HP IBASIC, you can use the HP FLEX commands with any text based programming language, such as Microsoft Visual C++ or Visual BASIC.

```
!************************ CHANNEL DEFINITION PAGE ***
! SMU1 SETUP
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:ALL:DIS"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU1:VNAM 'Vd'"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU1:INAM 'Id'"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU1:MODE V"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU1:FUNC CONS"
! SMU2 SETUP
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU2:VNAM 'Vg'"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU2:INAM 'Ig'"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU2:MODE V"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU2:FUNC VAR1"
! SMU3 SETUP
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU3:VNAM 'Vs'"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU3:INAM 'Is'"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU3:MODE COMM"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU3:FUNC CONS"
! SMU4 SETUP
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU4:VNAM 'Vsub'"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU4:INAM 'Isub'"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU4:MODE V"
 OUTPUT @Hp415x;":PAGE:CHAN:CDEF:SMU4:FUNC CONS"
!
!***************************** SWEEP SETUP PAGE ***
! VAR1 SETUP
 OUTPUT @Hp415x;":PAGE:MEAS:SWE:VAR1:MODE SING"
 OUTPUT @Hp415x;":PAGE:MEAS:SWE:VAR1:SPAC LIN"
 OUTPUT @Hp415x;":PAGE:MEAS:SWE:VAR1:STAR";Vg_start
 OUTPUT @Hp415x;":PAGE:MEAS:SWE:VAR1:STOP";Vg_stop
 OUTPUT @Hp415x;":PAGE:MEAS:SWE:VAR1:STEP";Vg_step
 OUTPUT @Hp415x;":PAGE:MEAS:SWE:VAR1:COMP";Vg_comp
! CONST SETUP SMU1-Drain  SMU4-Substrate
 OUTPUT @Hp415x;":PAGE:MEAS:SWE:CONS:SMU1:SOUR";Vd
 OUTPUT @Hp415x;":PAGE:MEAS:SWE:CONS:SMU1:COMP";Vd_comp
 OUTPUT @Hp415x;":PAGE:MEAS:SWE:CONS:SMU4:SOUR";Vsub
 OUTPUT @Hp415x;":PAGE:MEAS:SWE:CONS:SMU4:COMP";Vsub_comp
!
!***************************** DISPLAY SETUP PAGE ***
 OUTPUT @Hp415x;":PAGE:DISP:SET:MODE GRAP"
! X AXIS SETUP
 OUTPUT @Hp415x;":PAGE:DISP:SET:GRAP:X:NAME 'Vg'"
 OUTPUT @Hp415x;":PAGE:DISP:SET:GRAP:X:SCAL LIN"
 OUTPUT @Hp415x;":PAGE:DISP:SET:GRAP:X:MIN";Vg_start
 OUTPUT @Hp415x;":PAGE:DISP:SET:GRAP:X:MAX";Vg_stop
! Y1 AXIS SETUP
 OUTPUT @Hp415x;":PAGE:DISP:SET:GRAP:Y1:NAME 'Id'"
 OUTPUT @Hp415x;":PAGE:DISP:SET:GRAP:Y1:SCAL LOG"
 OUTPUT @Hp415x;":PAGE:DISP:SET:GRAP:Y1:MIN 1E-15"
 OUTPUT @Hp415x;":PAGE:DISP:SET:GRAP:Y1:MAX 1"
!
!***************************** SINGLE MEASUREMENT ***
 OUTPUT @Hp415x;":PAGE:SCON:MEAS:SING"
 OUTPUT @Hp415x;"*OPC?"
 ENTER @Hp415x;Complete
!
!********************************* DATA TRANSFER ***
 OUTPUT @Hp415x;":DATA? 'Id'"
 ENTER @Hp415x;Id(*)
!
```

Figure 5. SCPI Program Example for Id-Vg Measurement

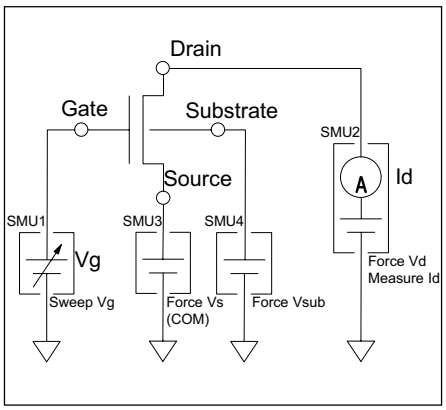

Figure 4. Id-Vg Measurement Circuit

```
!
 OUTPUT @Hp415x;"US"                          !User mode (FLEX)
!************************ CONSTANT VOLTAGE SETUP ***
 OUTPUT @Hp415x;"CN 1,2,3,4"                  !Connect SMUs
 OUTPUT @Hp415x;"DV 1,0,";Vd,Vd_comp          !SMU1: Force Vd
 OUTPUT @Hp415x;"DV 3,0,";Vs,Vs_comp          !SMU3: Force Vs
 OUTPUT @Hp415x;"DV 4,0,";Vsub,Vsub_comp      !SMU4: Force Vsub
!***** SWEEP GATE VOLTAGE & MEASURE DRAIN CURRENT ***
 OUTPUT @HP415x;"WV 2,1,0,";Vg_start,Vg_stop,No_of_step,Vg_
comp                                          !SMU2: Sweep Vg
 OUTPUT @HP415x;"MM 2,1"                      !Linear sweep meas
 OUTPUT @HP415x;"RI 1,";Id_range              !SMU1 meas range
 OUTPUT @Hp415x;"XE"                          !Execute sweep
 FOR I=1 TO No_of_step
    OUTPUT @Hp415x;"RMD? 1"                   !Read meas data
    ENTER @Hp415x USING "#,5X,13D,X";Id(I)
 NEXT I
!************************************ DISABLE SMU ***
 OUTPUT @Hp415x;"DZ"                          !Zero output
 OUTPUT @Hp415x;"CL 1,2,3,4"                  !Disconnect SMU
!
```

Figure 6. HP FLEX Program Example for Id-Vg Measurement

Program Memory for Faster Execution of Wafer Tests

You can use the new program memory to avoid communicating across the HP-IB bus, thus speeding up test execution. For example, HP FLEX commands can be stored locally in the internal program memory of the HP 4155B / 4156B. Program memory size is 100 Kbytes, and you can group these commands into as many as 255 subprograms (measurement algorithms). Each subprogram can be executed by simply sending a trigger command. This eliminates the following steps (thus increasing speed):

- Command transmission: Transmission of commands from the controller to the HP 4155B / 4156B.
- Command validation : Checking the syntax and content of transmitted commands.

For example, DV command execution time can be reduced by about 1.5 msec if the DV command is stored in the internal program memory. By storing repeatedly used command strings in the internal program memory, you reduce bus and controller to a minimum.

Note : Execution of a trigger command includes small overhead (approx. 10 msec). If the execution time of one algorithm is very short, then using program memory can actually decrease measurement speed.

Speed Comparison

Table 3 shows a measurement speed comparison between the HP 4156A with SCPI, and the HP 4156B with SCPI, HP FLEX and program memory. The measurement time for program memory is the average of ten measurements.

The table shows two types of sweep measurements: high current measurements (Id-Vd curve) with changing number of steps, and lower to higher current measurements (Id-Vg curve) with changing integration time. For spot measurements, high current spot (Idon) and low current spot (Idoff) measurements are also compared.

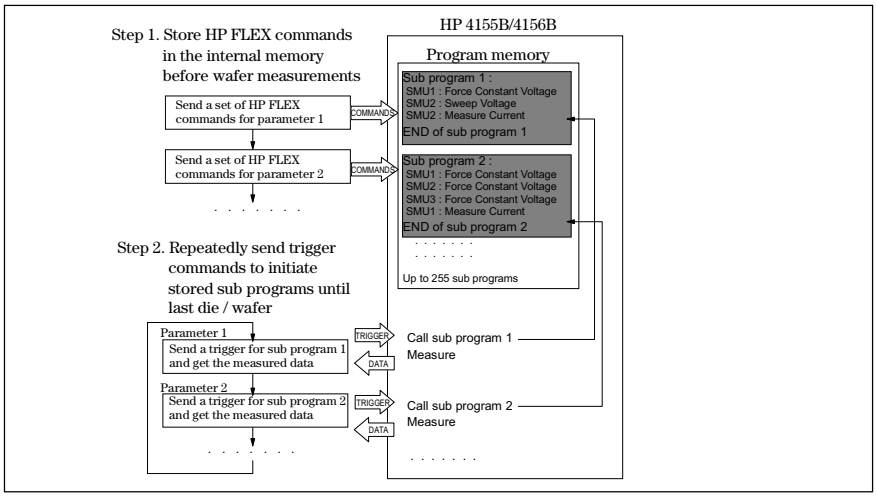

Figure 7. Program memory speeds repeatedly executed tests

Table 3 shows that SCPI runs on the HP 4156B about 1.5 to 3 times faster than on the HP 4156A. This is due to the faster CPU. Table 3 also shows that HP FLEX and program memory enable you to make faster measurements under the following conditions:

- Measuring higher current
- Less measurement points
- Shorter integration time

In particular, high current spot measurement speed is improved by using HP FLEX and program memory, due to the reduced command transmission time. Typically, you can expect higher throughput for wafer measurements in which stored algorithms are repeatedly executed at each test die of each wafer. In summary, you should use HP FLEX with program memory for fully automated tests in which test throughput is the primary concern.

Note : Table 3 does not include speed comparison of ultra low current measurements. In general, HP FLEX and program memory do not improve speed when the integration time is set to "long".

Table 3 is not comparison of total throughput including prober control.

Measurement	High Current Sweep Id - Vd Curve	High Current Sweep Id - Vd Curve	Low to High Current Sweep Id - Vg Curve	Low to High Current Sweep Id - Vg Curve	Low Current Spot Idoff	High Current Spot Idon
Conditions	Vd : 0 to 5 V Step 0.05 V Vg : 2 to 4 V Step 0.5 V Vsub : 0 V	Vd : 0 to 5 V Step 0.1 V Vg : 2 to 4 V Step 0.5 V Vsub : 0 V	Vd : 3 V Vg : -1 to 4 V Step 0.1 V Vsub : -1 V	Same as left	Vd : 3 V Vg : 0.5 V Vsub : -1V	Vd : 3 V Vg : 0.5 V Vsub : -1 V
No. of meas points	101 x 5	51 x 5	51		1	1
Integration mode	Short	Same as left	Medium	Short	Medium	Short
Integration time	640 usec		20 msec	640 usec	20 msec	640 usec
Meas range	100 mA Fixed		1 nA Limited Auto	Same as left	1 nA Fixed	100 mA Fixed
HP 4156A SCPI	7.53	5.78	8.08	5.26	4.25	4.06
HP 4156B SCPI	4.45 (x1.69)	3.01 (x1.92)	5.33 (x1.52)	2.52 (x2.09)	1.51 (x2.81)	1.24 (x3.27)
HP 4156B HP FLEX	3.72 (x2.02)	2.31 (x2.50)	3.74 (x2.16)	1.14 (x4.61)	0.54 (x7.87)	0.26 (x15.62)
HP 4156B Program Memory	3.50 (x2.15) [x1.06]	1.98 (x2.92) [x1.17]	3.62 (x2.23) [x1.03]	1.03 (x5.11) [x1.11]	0.42 (x10.12) [x1.29]	0.15 (x27.07) [x1.73]

Sampling mode is used (1 point sampling)
Repeated 10 times and averaged
( ) : Speed comparison to HP 4156A SCPI mode
[ ] : Speed comparison to HP 4156B HP FLEX mode
Unit : sec
PC platform : HP BASIC for Windows
Windows NT 4.0 / Pentium Pro 200

Table 3. Measurement Speed Comparison

4. VXI*plug&play* Driver for HP 4155B / 4156B

The HP 4155B / 4156B includes a VXI*plug&play* driver. The VXI *plug&play* driver can work with Windows software packages such as Microsoft Visual C++, Visual Basic, Borland C++, National Instruments LabWindows, and HP VEE. This allows you to choose the programming language with which you are most comfortable. This section describes how to use the VXI*plug&play* driver with HP VEE.

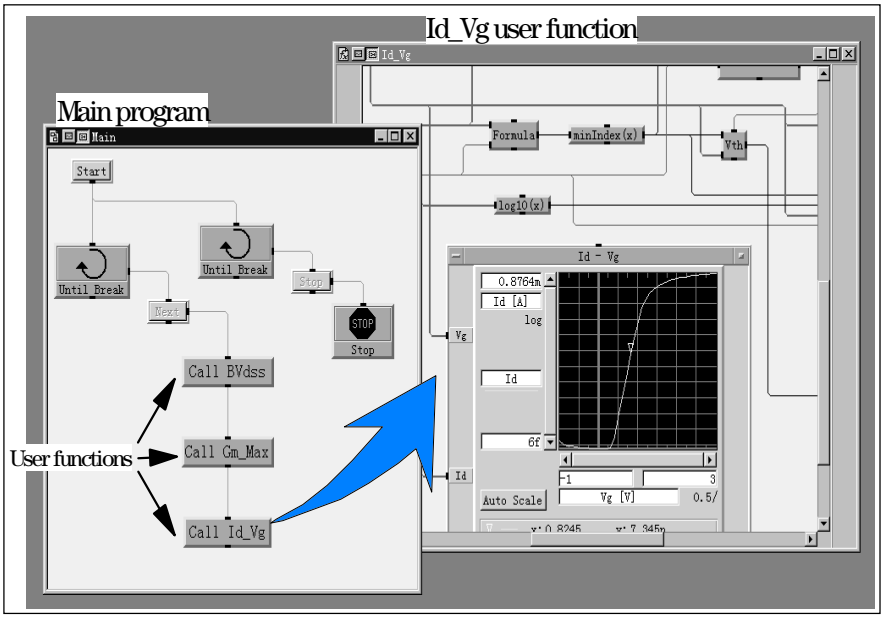

Figure 8. HP VEE program resembling a block diagram

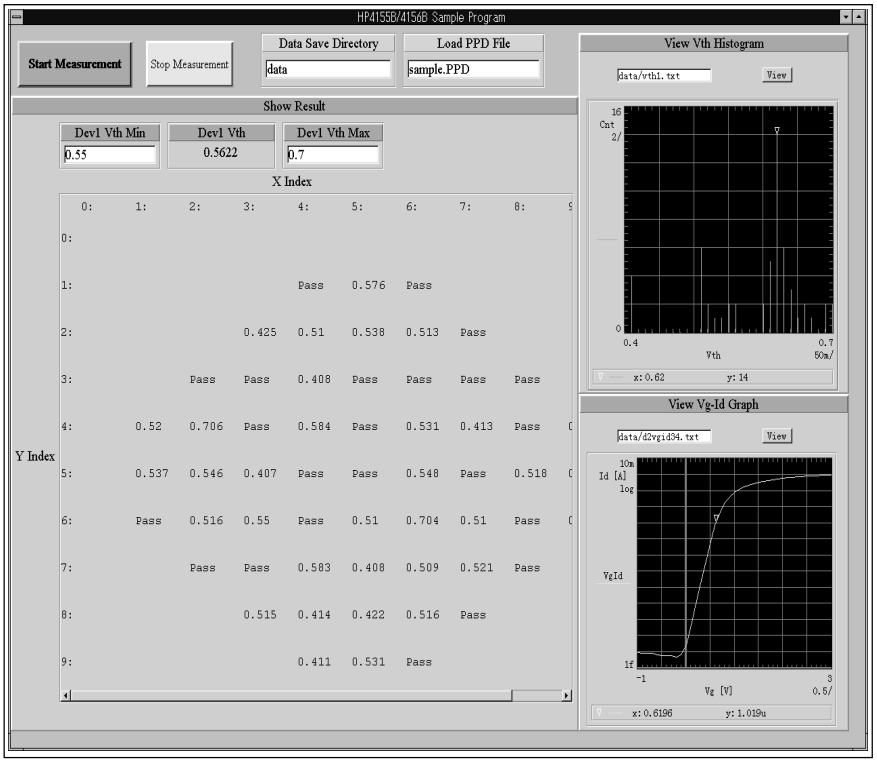

Figure 9. Operator interface of HP VEE - an example of wafer test

Visual Programming Environment - HP VEE

HP VEE is a powerful visual programming environment for instrument control. To develop programs, you connect graphical objects instead of writing lines of code. The HP VEE programs resemble easy-to-understand block diagrams with lines. Figure 8 shows a program for parametric test including breakdown, Gm max and threshold voltage extraction from Id-Vg curves. The left window shows the main program, which looks just like a block diagram. The right window shows the contents of a user function for Id-Vg measurement which is called by main program. HP VEE includes many objects, such as math functions, repeat, if then, data manipulation and so on. You just select objects and connect them with lines. You can create user object by grouping some objects into one box. Object based programming simplifies program structure.

One extremely nice feature of HP VEE is the operator panel mode. It allows users to hide lines and objects which do not need to appear in the user interface, thus only showing those objects necessary for operation. Figure 9 shows a sample program for wafer measurement automation using the panel mode. This example panel includes only objects to control the test and the test results, such as a wafer map and an individual measurement curve in an X-Y graph. Also, statistical analysis is done and the analyzed data is drawn in a histogram. Thus, the panel mode provides a nice operator interface and simplifies program operation.

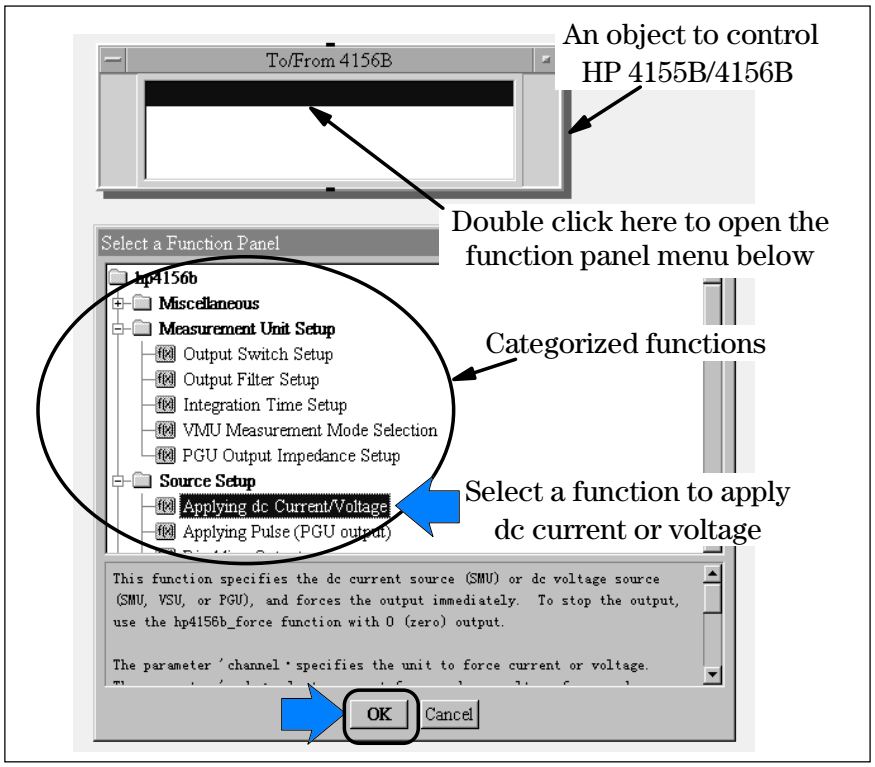

Figure 10. VXI*plug&play* driver panel menu

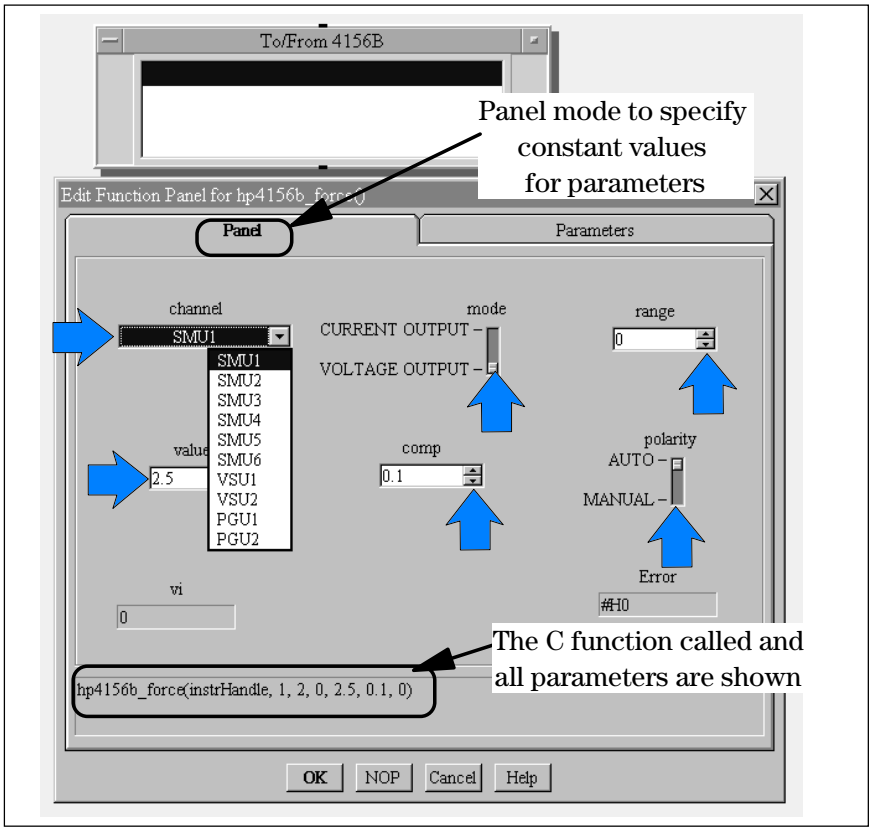

Figure 11. Constant setup in hp4156b_force function panel

Using HP 4155B / 4156B VXI*plug&play* Driver

Figure 10 - 13 show how to use the HP 4155B / 4156B VXI*plug&play* driver with the HP VEE.

Figure 10 shows the VXI*plug&play* driver panel menu for the HP 4155B / 4156B. There are several categories in this menu, such as Measurement Unit Setup, Source Setup, Measurement Execution, etc. Over 30 functions are available. Here, Applying dc Current / Voltage function is selected.

Single clicking on "Applying dc Current/Voltage" opens the function panel editor as shown in Figure 11. In panel mode, you can manually set parameters to be used in the selected function. Operation of this mode is very intuitive. Set parameters using the drop-down list and slider switch. All parameters set in this mode are constants, and are shown at the bottom of the panel. This example shows SMU1 forcing voltage in auto range (0) with a voltage value of 2.5 V and a compliance of 100 mA.

The VXI*plug&play* driver also allows you to dynamically change settings by changing the parameters to variables. Click the "Parameters" tab and open the parameter setup menu as shown in Figure 12. In this example, the force channel parameter is set to a variable. Variable name is set to "SMU". By clicking on the "Create Input Terminal" check box, a input terminal named "SMU" is automatically created in the To/ From 4156B object, which is shown in Figure 13. Though the channel parameter is set to a variable in this example, any of the other parameters can also be variables. By connecting the VXI*plug& play* driver with other HP VEE objects, you can automate tests and change the measurement setup.

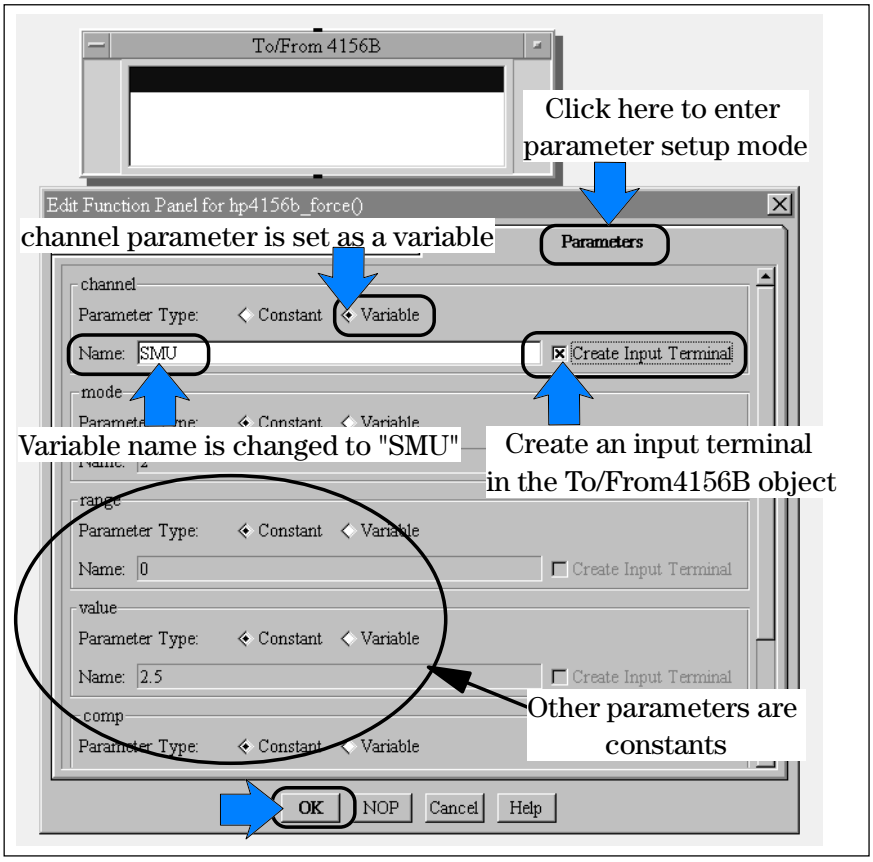

Figure 12. Parameter setup panel of the hp4156b_force function

As you can see, instrument control within HP VEE is greatly simplified by using the function panel of the VXI*plug&play* driver. Figure 14 shows a small but complete program which steps force voltage and measures current using one SMU. In this program, the HP 4155B / 4156B VXI*plug&play* driver is used with HP VEE's variable input objects and X-Y graph object. Thus, HP VEE and VXI*plug&play* drivers ease the task of developing programs to automate tests.

Systematic Solutions

The HP VEE supports many drivers for measurement instruments. You can configure a test system using the HP 4155B / 4156B with a power supply, a pulse generator, an LCR meters and/or a switch. If you have an instrument that does not have a driver, you can easily create your own driver by using direct I/O function. You can register HP-IB commands in input fields. All of these features make it simple and easy to customize a system for your specific needs.

HP VEE also supports DDE (Dynamic Data Exchange). DDE allows you to communicate with any other software package that works on Windows. For example, if you use HP VEE with prober control software, you can automate wafer measurements through DDE. In addition, using DDE you can transfer measurement data to database software or data analysis software, and perform complicated statistical analyses to help with issues such as yield management.

Note : The HP 4155B / 4156B VXI*plug&play* driver works only with HP VEE version 4.0 for Win 95 / Win NT.

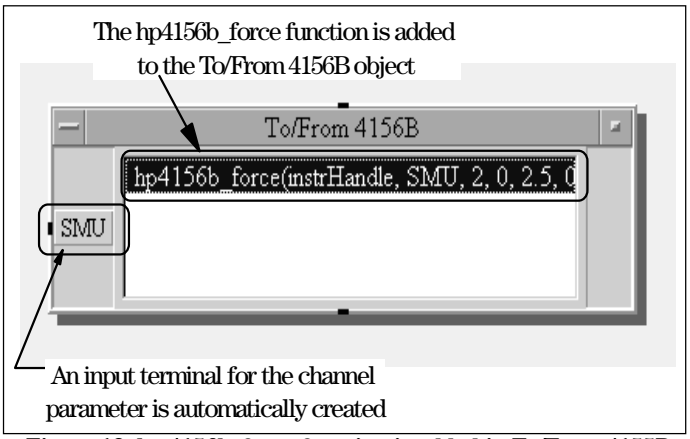

Figure 13. hp 4156b_force function is added in To/From 4155B object

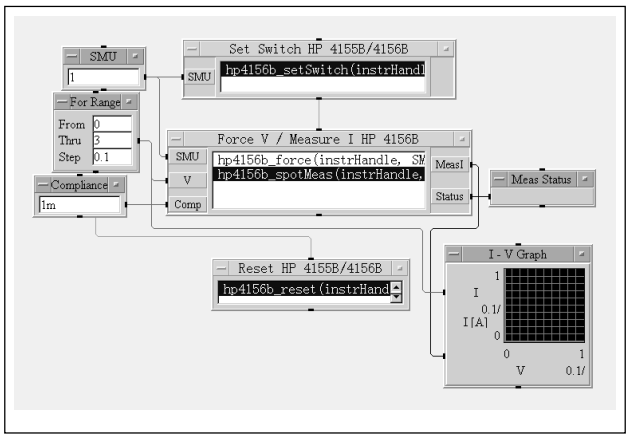

Figure 14. Small example program to control HP 4155B / 4156B

5. LAN Capability

The HP 4155B / 4156B has a 10 BASE-T connector (LAN port), through which the HP 4155B / 4156B can access the hard disk of an NFS server. This feature yields two important benefits: entrance to a large capacity mass storage device for file and data storage, and improved access speed. Once a network drive is mounted on the HP 4155B / 4156B, you have seamless access to it (just as if a hard disk were directly attached).

Connecting HP 4155B / 4156B to a Local Area Network using NFS

The HP 4155B / 4156B can work as an NFS (Network File System) client, meaning that it can mount a directory from an NFS server. Once mounted, any measurement data or setup can be quickly saved and restored onto the server's directory via the LAN.

Figure 16 shows the SYSTEM : MISCELLANEOUS page of the HP 4155B / 4156B. In this page, network setup is done to connect the HP 4155B / 4156B to the LAN. Specify the IP address of the HP 4155B / 4156B with network host name, and your user ID and group ID (which must correspond to the settings on the NFS server.).

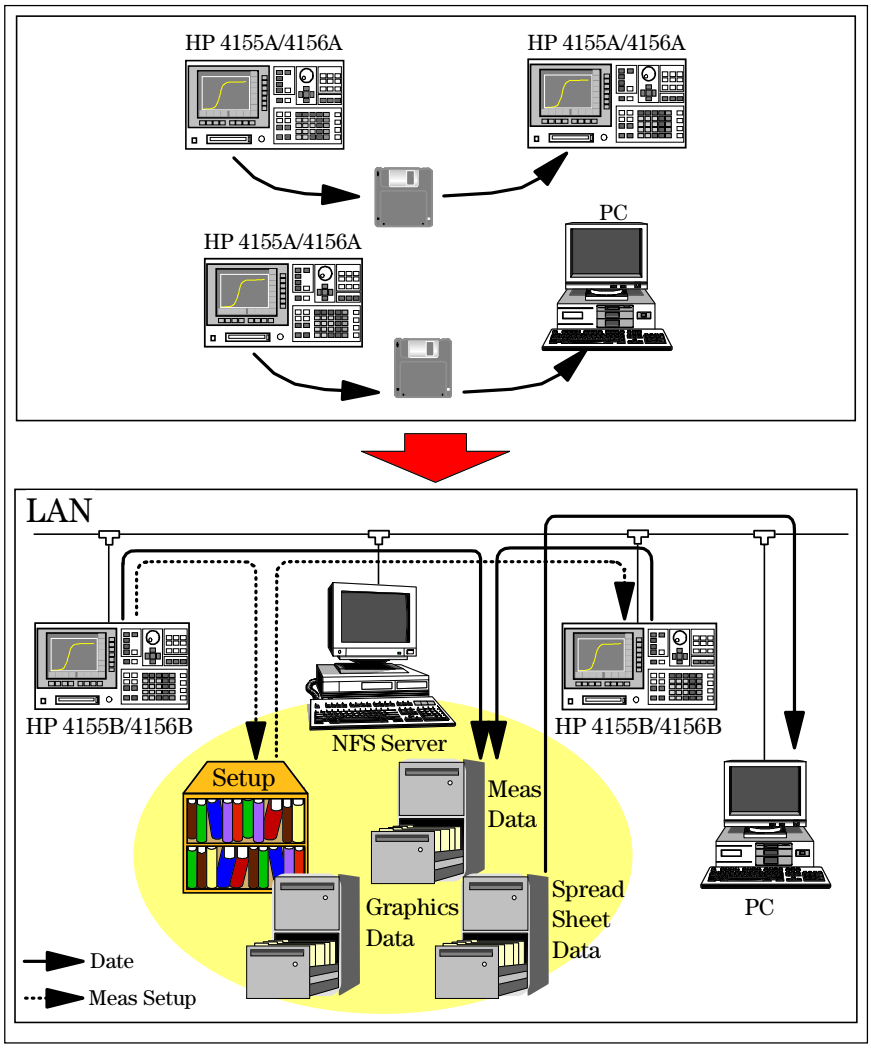

Figure 15. File transfer and data sharing using LAN

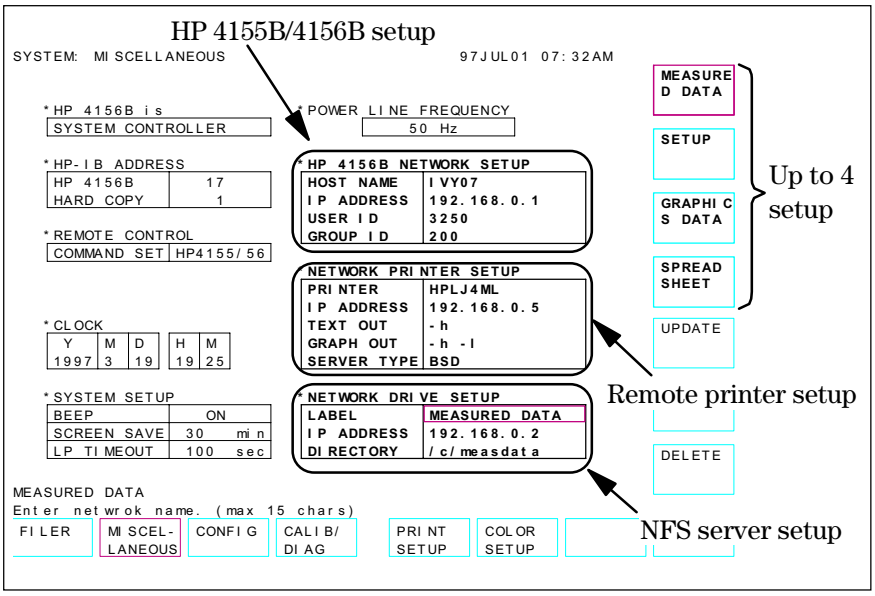

Figure 16. Network setup in SYSTEM: MISCELLANEOUS Page

Next, set the network drive setup. Specify the IP address of the NFS server and the directory where you wish to mount the HP 4155B / 4156B. You may use any name in the network drive setup for the LABEL field. You can register up to 4 setups by specifying different IP addresses or different directories. The attribute names of the registered setups are shown as the labels of secondary softkeys. In this example, "MEASURED DATA", "MEASURE SETUP", "GRAPHICS

DATA" and "SPREAD SHEET" are the attribute names. Once you have completed the network setup, all of network information is stored in non-volatile memory so that it is restored in the boot up process.

On the NFS server, you must export the local directory onto which you wish to mount the HP 4155B / 4156B.

Figure 17 is the SYSTEM : FILER page, where you can select network drive to be mounted on the HP 4155B / 4156B. In this example, MEASURE DATA is selected as the current mass-storage and the /c/measure directory is mounted. In this page you can catalogue files, create sub directories, and change directories. Once a directory is selected, you can both save and get measurement data and setup files through the LAN.

Stored setup files can be shared with multiple HP 4155B / 4156Bs. You can build measurement setup libraries for standardization of parametric measurements.

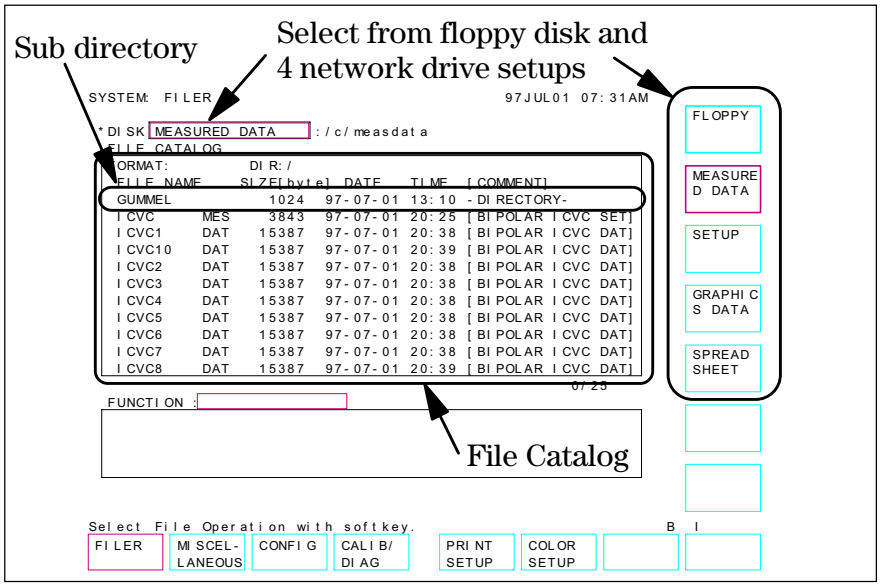

Figure 17. Mounting network drive on HP 4155B / 4156B in SYSTEM: FILER page

Importing Measurement Data to a PC via an NFS server

The HP 4155B / 4156B can store measurement data into a text file that is compatible with spread sheet software. By connecting to the NFS server, you can easily transfer measurement data to spread sheet software on your PC. Figure 18 shows an example of transferring Ic - Vc (collector family curve) data of a bipolar transistor to Lotus 1-2-3. In the GRAPH / LIST: LIST page, select the "SPREAD SHEET" softkey to create a spread sheet type file on the NFS server. Specify file name, and select data separator and string mark before saving the data. In the right side, the file is imported (opened as a text file with specifying terminator type) into Lotus 1-2-3. Using macros, you can statistically analyze measurement data from multiple devices (such as histograms, trend charts, etc.). This capability will aid you in generating test reports for use in process control.

Note

1 : For the NFS server, use HP-UX or SuperNFS / SuperTCP Suite from Frontier Technologies Corp. for Windows 95 / NT. To connect your PC to the HP-UX server, use NFS client software.

2 : The HP 4155B / 4156B can not be controlled over the LAN interface. Use the HP E2050A for this purpose.

3 : The HP 4155B / 4156B does not have capability for access to NFS servers beyond gateways.

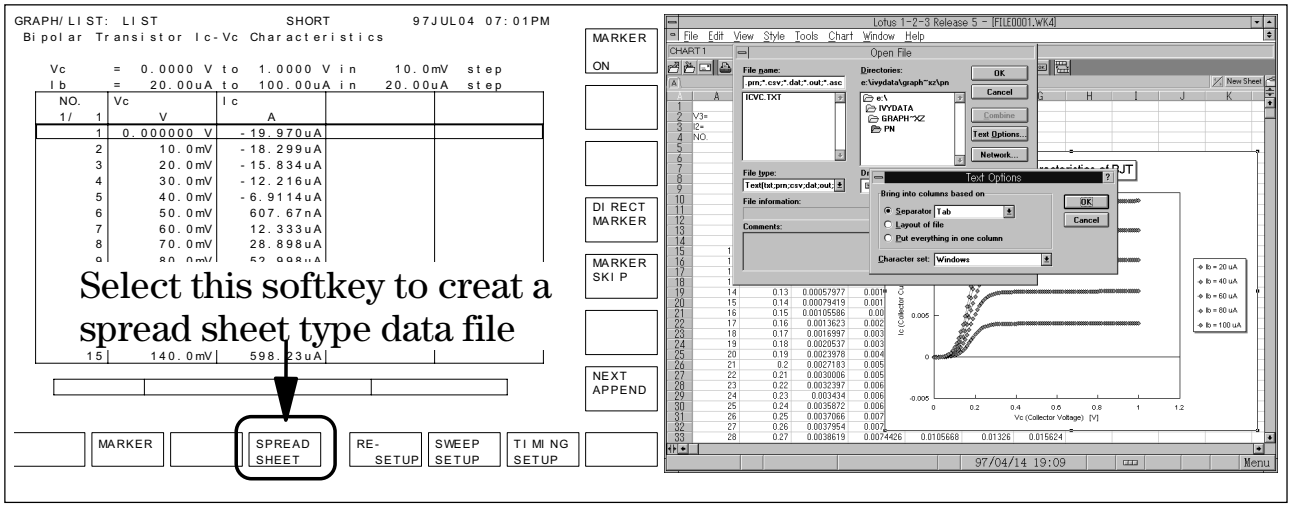

Figure 18. Spread sheet file creation in GRAPH/LIST: LIST Page (left) and importing the data into Lotus 1-2-3 (right)

6. Improved Printing / Plotting Capability

The HP 4155B / 4156B now has a parallel interface (Centronics). You can connect directly to most of the popular HP printers without inserting a converter. In addition, a LAN interface allows you to output test results directly to network remote printers (Figure 19).

The HP 4155A / 4156A supports PCL (Printer Command Language) and HPGL (HP Graphics Language) modes to output your test results to printing / plotting peripherals. Moreover, the HP 4155B / 4156B supports a new HR PCL (High Resolution PCL) mode for higher quality printing.

The HP 4155B / 4156B can also output graphics information to files in TIFF (Tagged Image File Format), which is one of the most popular formats for manipulating graphical images. You can easily generate test reports by importing TIFF files into word-processing software. HR TIFF (High Resolution TIFF) mode is also available (Figure 19).

In the HR PCL, HR TIFF and HPGL mode, you can determine the graphics output aspect ratio of width to height. The faster CPU also improves the printing / plotting performance, whether to a dedicated printer or to a remote printer via printer server.

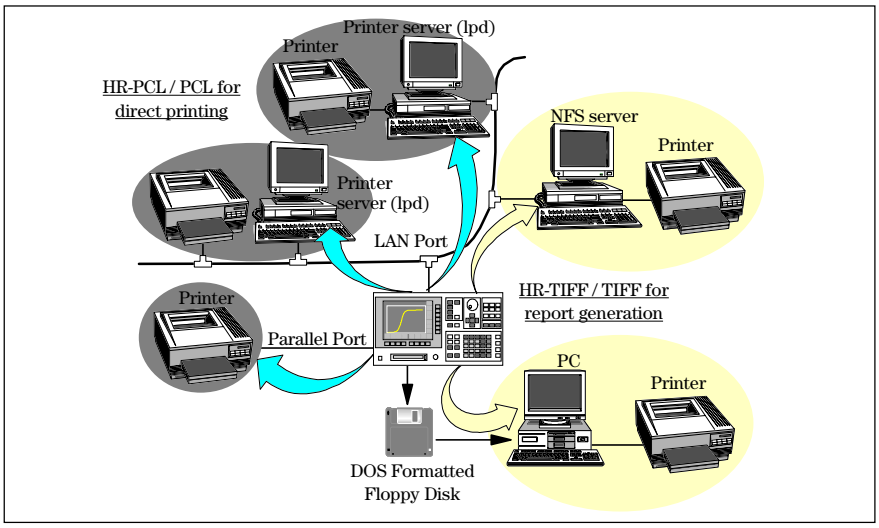

Figure 19. Wide selection of HP 4155B / 4156B printing destination

Supported Printers / Plotters and Connection

The following are supported peripherals for printing / plotting:

- HP LaserJet 4 / 5 series printers for high speed print (PCL & HPGL , Network option available)
- HP DeskJet 300/600/800 series printer (PCL)
- HP DeskJet 1200C / 1600C printers for high speed color printing (PCL and HPGL - Network option available)
- HP 74XX / 75XX pen plotter (Discontinued) (HPGL)

Most of the above printers have a parallel (Centronics) interface. Using a parallel cable (HP C2950A), you can directly connect to a printer. For pen plotters, use an HP-IB cable.

Remote printers can be used with a printer server supporting lpd (Line Printer Daemon) protocol. For more information on supported peripherals, refer to HP 4155B / 4156B Product Note - 2 "Printing Function".

Supported Graphics Formats

The HP 4155A / 4156A supports only PCL and HPGL modes. The HP 4155B / 4156B supports 5 new modes which are shown in Table 4.

The HR PCL mode is for high quality graphics printing. Internal data manipulation takes a little longer than for the PCL mode, but you can achieve crisper and cleaner results. You can also set the graph's aspect ratio of width to height, which is impossible in the PCL mode. You may print the measurement setup

Mode	4155A 4156A	4155B 4156B	Destination			Printing Quality	Change Graph Aspect	Importing Word Processing Software	Printing Speed
			Printer	Plotter	File				
PCL	Yes	Yes	Yes (HP printers)	No	Yes	Lower *2	No	Difficult	Fastest text print
HR-PCL	No	Yes New	Yes (HP printers)	No	Yes	High	Possible	Difficult	Depends on color / resolution
HPGL	Yes	Yes	Yes *1	Yes	Yes	High	Possible	Easier *3	Fastest graphics output
TIFF	No	Yes New	No	No	Yes	Lower	No	Easiest (popular format)	Depends on color
HR-TIFF	No	Yes New	No	No	Yes	High	No	Easiest (popular format)	Depends on color / resolution

*1 : LaserJet and DeskJet 1200/1600 only
*2 : Can be higher when printing region is smaller
*3 : File suffix for HPGL varies by word processing software

Table 4. Printing / Plotting modes supported by HP 4155B / 4156B

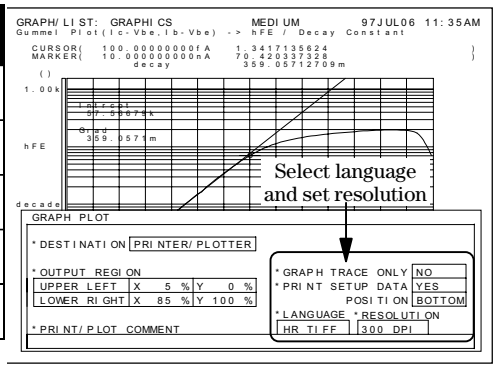

Figure 20. GRAPH PLOT Setup for HR PCL Printing

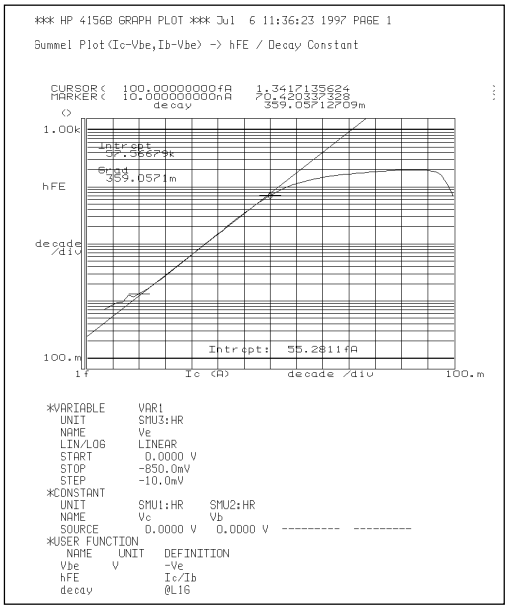

Figure 21. HR PCL printing example

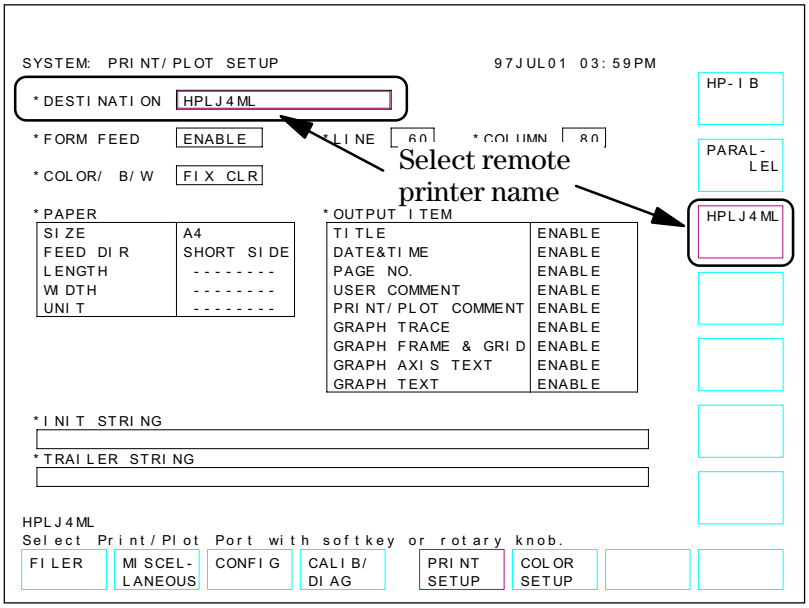

Figure 23. Specifying destination in the SYSTEM: PRINT/PLOT SETUP page

with graph too. In Figure 20, an example of graph plot window setup is shown. In the LANGUAGE field, HR PCL is selected. Figure 21 shows a sample printing result using the HR PCL mode.

Figure 22 compares the PCL and HR PCL outputs. Using the PCL mode, the curves are ragged and hard to distinguish. In contrast, the HR PCL mode output is very clear.

Printing to Remote Printers via LAN port

The HP 4155B / 4156B can output graphics data to remote printers via its LAN port. The HP 4155B / 4156B sends printing commands lpr (Line Printer Remote) with printing data to a printer server. When lpd (Line Printer Daemon) receives the command, the printer server outputs print data to the selected printer.

In the SYSTEM: MISCELLANEOUS page, you can setup network printer information (refer to Figure 16 in Page 10). For the printer name, use exactly same name as the printer name used in the printer server. Also, the IP address of the server, server type, lpr command options for graphics and text printing are registered in this page.

Figure 23 shows the SYSTEM: PRINT/PLOT page. Determine the destination by selecting secondary softkey. In this example, HPLJ4ML is the printer name which is registered in the SYSTEM: MISCELLANEOUS page. Now you can print to the remote printer with the setup shown in Figure 20.

Although you can not bring a printer into a clean room, you can print to a remote printer in office area from clean room by using this capability.

Note : LPD is bundled in HP-UX and Windows NT . For Windows 95, use SuperNFS / Super TCP Suite for the printer server capability. The lpd service should be enabled beforehand.

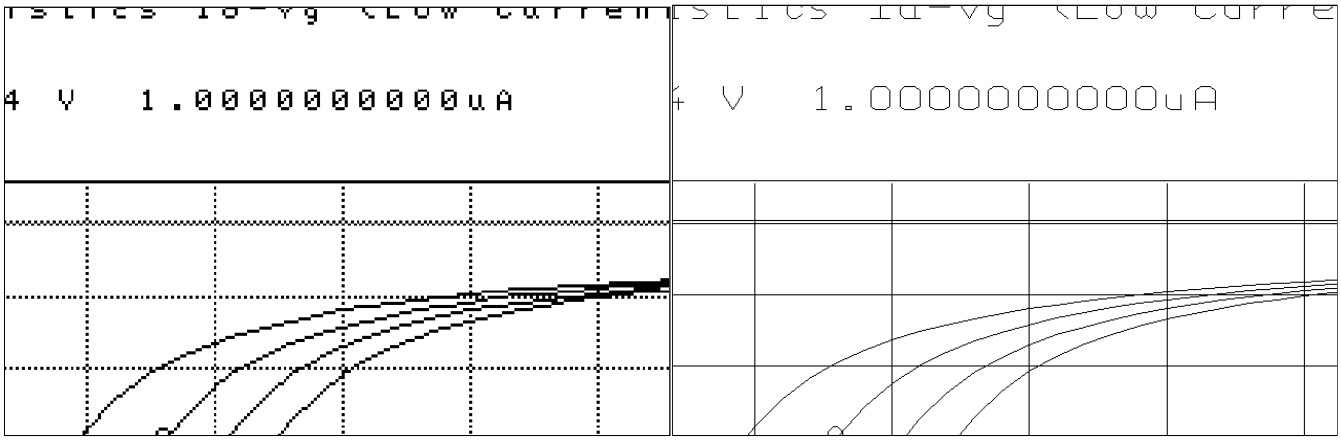

Figure 22. Comparing PCL (left) and HR PCL (right) outputs

Generating Test Reports Using TIFF / HR TIFF Mode

You can easily generate test reports by creating graphics screen image files in TIFF. Once you connect the HP 4155B / 4156B to the LAN, you can place TIFF files onto a directory of an NFS server, and then you can import the files into word processing software on a PC. Most of popular word processing software packages support TIFF. HR TIFF is for higher quality report generation.

In Figure 24, a graph plot window is shown. Select FILE in DESTINATION field and type a file name. In this example, IDVG01 is entered. In LANGUAGE field, HR-TIFF is selected. This creates IDVG01.TIF file on current directory of mass storage on the server.

Created file can be manipulated on PCs that are connected to the NFS server. In Figure 25, the IDVG01.TIF file is imported into Lotus Word Pro and a test report is created.

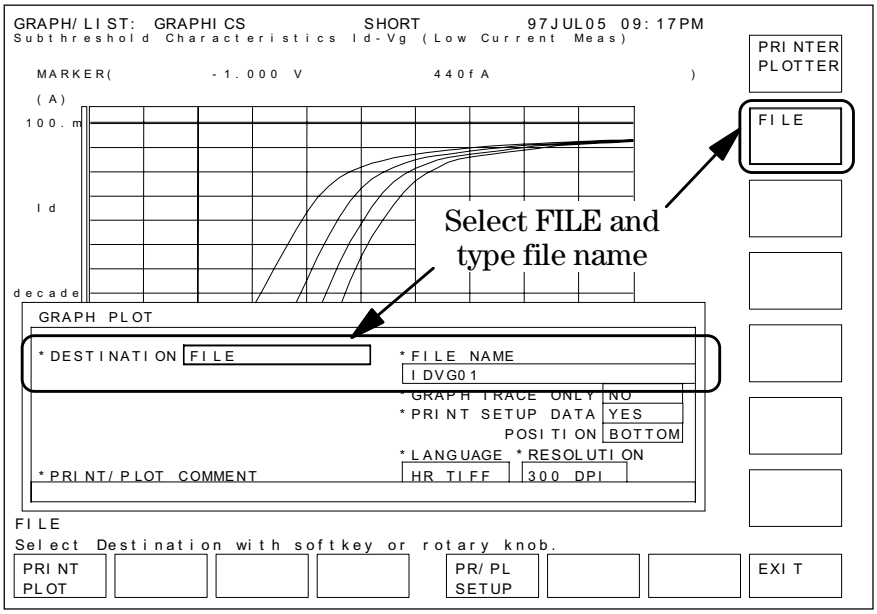

Figure 24. Creating a TIFF file

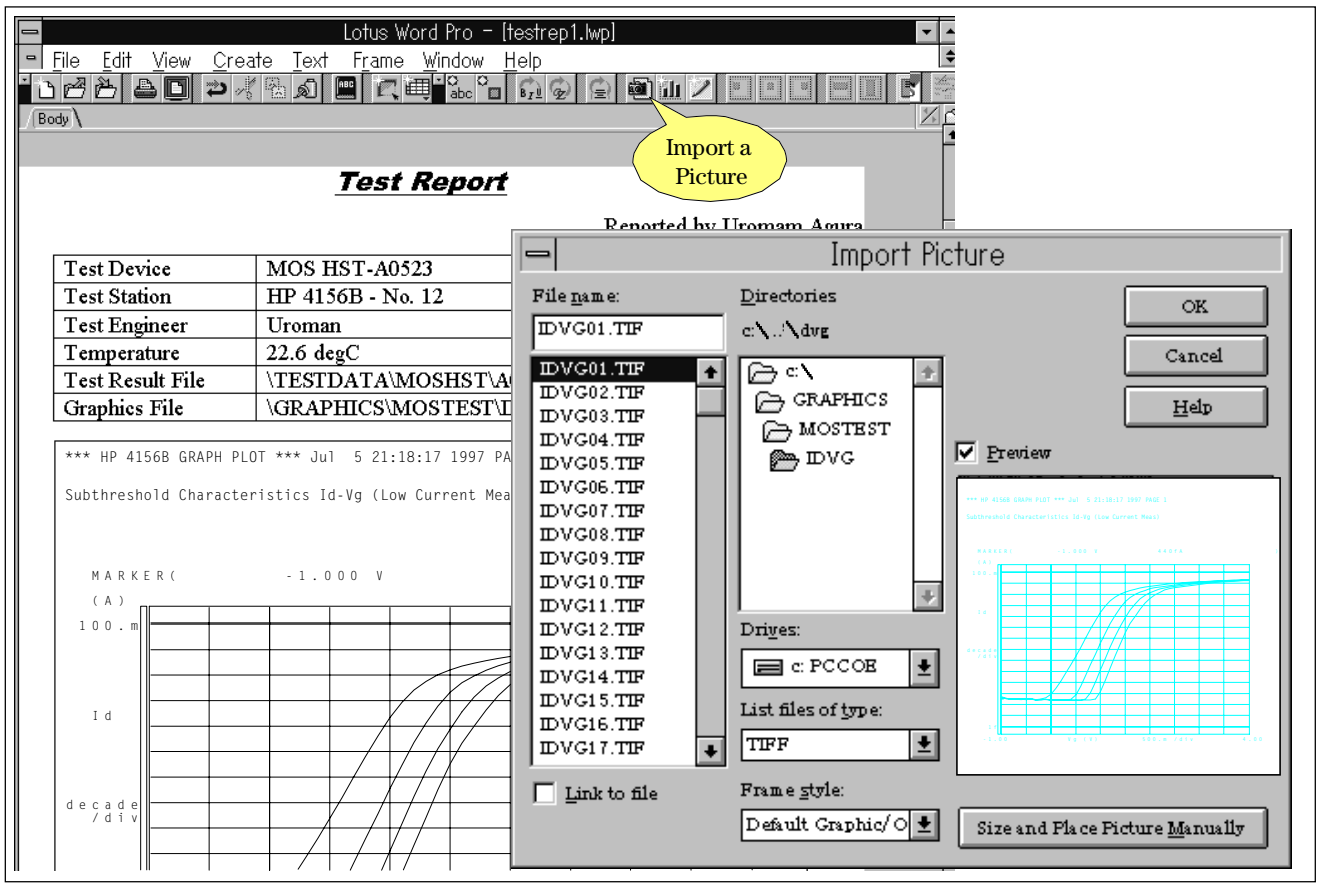

Figure 25. Importing a TIFF file into a test report generated using Lotus Word Pro

7. Miscellaneous New Functions

New LCD

The HP 4155A / 4156A had a 7.5 inch CRT, but the HP 4155B / 4156B has an 8.4 inch active color matrix LCD. The screen resolution has been improved from 512x400 to 640x480 dots (same as VGA resolution). You get a fully flat and clear view. In addition, a screen saver function has been added to improve the screen life.

Low Leakage VMU

The measurement performance of VMU (Voltage Monitor Unit) has been improved. The leakage current of buffer amplifier at the input of VMU is lowered from typical 10 nA to less than 500 pA. This helps you measure the voltages of devices that have higher impedance, and saves sensitive devices from unexpected damage.

New Connector Plate Options

HP really cares about the fixturing and cabling you need to perform accurate ultra low current measurements. You must have good connections to devices to get accurate test results. With the previous connector plates supplied with the HP 4155A / 4156A, you needed to solder the terminals and measurement cables to connect probing needles. This practive sometimes introduced large leakage current paths when the soldering flux spread over the surface of the terminal on the connector plate, or when finger oils were inattentively placed there during soldering.

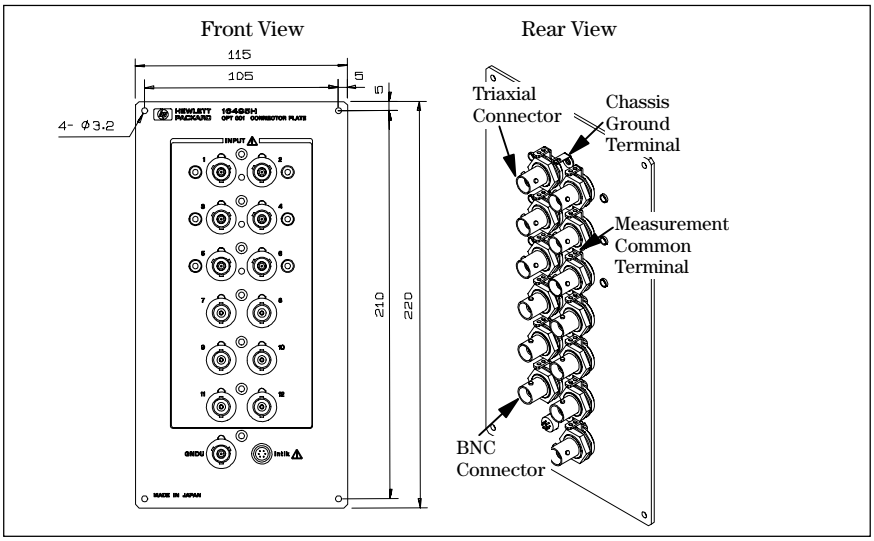

Figure 26. New Connector Plate (HP 16495H option 001)

With new connector plate options of the HP 4155B / 4156B, you are free from soldering. Option 301 and 311 of the HP 4155B / 4156B include connector plates that have feed-through type (triaxial connector to triaxial connector) terminals (see Figure 26). You can directly screw triaxial cables into these connectors, which interconnect to the probe needles. Option 302 and 312 are the connector plates that have connector-to-contacts for soldering type terminals. If your prober does not have triaxial interconnect cables, then you still must use these connectors (please solder them carefully). These connector plates can be separately ordered from the HP 4155B / 4156B as shown in Table 5.

New connector plates are a half size panel of previous ones furnished with the HP 4155A / 4156A as shown in Figure 26. Thus, cable connections at the shield box can be smarter. The terminals are separated from the chassis ground. For the cases that require connecting the chassis ground to the measurement common, or connecting the outer shield of the connectors, there is a soldering contact for each terminal.

Conclusion

The HP 4155B / 4156B is the new parameter analyzer, designed for higher throughput, maximum efficiency, and systemization for automated test.

It enables you to improve your semiconductor quality, starting at material evaluation and device characterization on all the way through final packaged device inspection and failure analysis. It delivers the right solution for today's needs and the flexibility to meet tomorrow's challenges.

Model	Option	Description
4155B / 4156B		Semiconductor Parameter Analyzer
	301	Add HP 16495H Option 001
	302	Add HP 16495H Option 002
	311	Add HP 16495J Option 001
	312	Add HP 16495J Option 002

Model	Option	Description
16495H		Connector Plate with 6 Triaxial, 6 BNC, Interlock and GNDU Terminals
	001	Bulkhead Feedthru Type
	002	Connector to Contacts for Soldering Type
16495J		Connector Plate with 8 Triaxial, 4 BNC, Interlock and GNDU Terminals
	001	Bulkhead Feedthru Type
	002	Connector to Contacts for Soldering Type

Table 5. New Connector Plate Options

For more information on Hewlett-Packard Test & Measurement products, applications or services please call your local Hewlett-Packard sales offices. A current listing is available via Web through AccessHP at http://www.hp.com. If you do not have access to the Internet please contact one of the HP centers listed below, and they will direct you to your nearest HP representative.

United States:
Hewlett-Packard Company
Test and Measurement Organization
5301 Stevens Creek Blvd.
Bldg. 51L-SC
Santa Clara, CA 95052-8059
1-800-452-4844

Canada:
Hewlett-Packard Canada Ltd.
5150 Spectrum Way
Mississauga, Ontario
L4W 5G1
905-206-4725

Europe:
Hewlett-Packard
European Marketing Centre
P.O. Box 999
1180 AZ Amstelveen
The Netherlands

Japan:
Hewlett-Packard Japan Ltd.
Measurement Assistance Center
9-1, Takakura-Cho, Hachioji-Shi,
Tokyo 192, Japan
Tel: (81-426) 48-0722
Fax: (81-426) 48-1073

Latin America:
Hewlett-Packard
Latin American Region Headquarters
5200 Blue Lagoon Drive
9th Floor
Miami, Florida 33126 USA.
305-267-4245/4220

Australia/New Zealand:
Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130
Australia
131-347 ext. 2902

Asia Pacific:
Hewlett-Packard Asia Pacific Ltd.
17-21/F Shell Tower, Times Square,
1 Matheson Street, Causeway Bay,
Hong Kong
852-2599-7070

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