# VXI*plug&play* Driver User's Guide

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

Agilent Technologies

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# In This Manual

This manual provides information about VXI*plug&play* driver for Agilent 4155/4156. This manual also introduces two sample application programs using Agilent VEE and the VXI*plug&play* driver for the 4155/4156.

- Installation

  This chapter describes hardware and software requirements to use the 4155/4156 VXI*plug&play* driver, and how to install the driver.

- Driver Functions

  This chapter lists the all driver functions for the 4155/4156 and Agilent E5250A Low Leakage Switch Mainframe.

- Programming Examples Using Agilent VEE

  This chapter describes how to create measurement program using Agilent VEE, and provides programming examples.

- Sample Application Programs For Agilent VEE

  This chapter provides how to install, execute, and modify the sample application programs stored in the VEE Sample Program Disk furnished with the 4155/4156.

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# 1 Installation

This chapter explains the environment requirements and installation of the VXI*plug&play* driver for Agilent 4155/4156.

- "Software Requirements"
- "Hardware Requirements with Agilent VEE"
- "Installing 4155/4156 Driver"

**NOTE**

The hardware required depends on the operating system and programming language used. This manual provides hardware requirements when using the driver with Agilent VEE software. When using the driver with a programming language other than Agilent VEE, refer to the appropriate programming manual.

# Software Requirements

The following software is required to use the VXI*plug&play* driver for the 4155/4156. You can select one from Windows NT and Windows 95. You can also select the most comfortable programming language to develop and run programs.

- Operating System
    - Windows NT revision 3.51 or later
    - Windows 95
- 32-bit VISA I/O Library

  I/O Library for GPIB Interface Card, or equivalent
- Programming Environment
    - Agilent VEE
    - Microsoft Visual Basic
    - Microsoft Visual C++
    - Borland C/C++
    - LabView
    - LabWindows
- VXIplug&play Driver Disk (furnished with the 4155/4156)
    - 4155/4156 Plug&Play Driver Disk
    - E5250A Plug&Play Driver Disk

**NOTE**

If you use the sample application programs, stored in the VEE Sample Program Disk furnished with the 4155/4156, VEE software must be version 4.0 or later. See Chapter 4. Also, if you use the Cascade Microtech Summit series semi-auto prober, confirm the operating system supported by the prober control software (PCS) supplied from Cascade Microtech, Inc. PCS version 2.50 supports Windows 95 and Windows 3.1.

**NOTE**

The E5250A Plug&Play Driver Disk stores the VXI*plug&play* driver for Agilent E5250A. This driver is required to use the sample application programs.

# Hardware Requirements with Agilent VEE

The following hardware is required to use Agilent VEE and the VXI*plug&play* drivers.

- Controller
  - 486/66 with Coprocessor (minimum recommendation)
  - 586(Pentium)/90 or better is recommended.
- Memory
  - For Windows 95: 16 Mbyte. 24 Mbyte or more is recommended.
  - For Windows NT: 24 Mbyte. 32 Mbyte or more is recommended.
- Hard disk (minimum disk space)
  - 20 Mbytes for Agilent VEE (HP VEE version 4.0)
  - 2 Mbytes for 4155/4156 driver
  - 1 Mbyte for E5250A driver
- Graphics

  1024 × 768. 1280 × 1024 is recommended.
- IEEE 488 Interface card

  Agilent 82341C GPIB Interface Card, or equivalent.
- CD-ROM drive

  A CD-ROM drive will be required to install the software needed to use the VXI*plug&play* driver.
- Flexible disk drive

  A 3.5 inch flexible disk drive is required to install the drivers.

# Installing 4155/4156 Driver

The installation flow for the VXI*plug&play* driver is shown below. If you have already installed the IEEE 488 interface card, VISA I/O library, and programming software on your PC, skip steps 1 through 4.

1. Install the IEEE 488 interface card into your PC.

   See the interface card manual. Note the model number of the interface card, as you may need it to configure the interface (in step 3).

2. Install VISA I/O library.

   Follow the instructions in the I/O library's setup program.

3. Configure and check the IEEE 488 interface.

   See the I/O library manual. If you use the Agilent I/O Library, also see "To Configure the Interface using Agilent I/O Library" on page 1-6.

4. Install the programming software.

   Follow the setup program instructions.

5. Install the VXI*plug&play* driver.

   See "To Install the Driver" on page 1-7.

6. Register the driver in the programming software.

   See the programming software manual. If you are using Agilent VEE, also see "Programming Basics" in Chapter 3.

## To Configure the Interface using Agilent I/O Library

After installing the IEEE 488 interface card and the Agilent I/O Library, configure the interface. The procedure shown below is the easiest way to configure the interface. First, execute I_O Config in the HP I_O Libraries folder. The I/O Config window is displayed. See Figure 1-1.

1. Click Auto Add.

   If the interface card is installed properly, I_O Config automatically detects the hardware configuration. The default names for SICL and VISA are assigned and listed, as shown in the Configured Interface list.

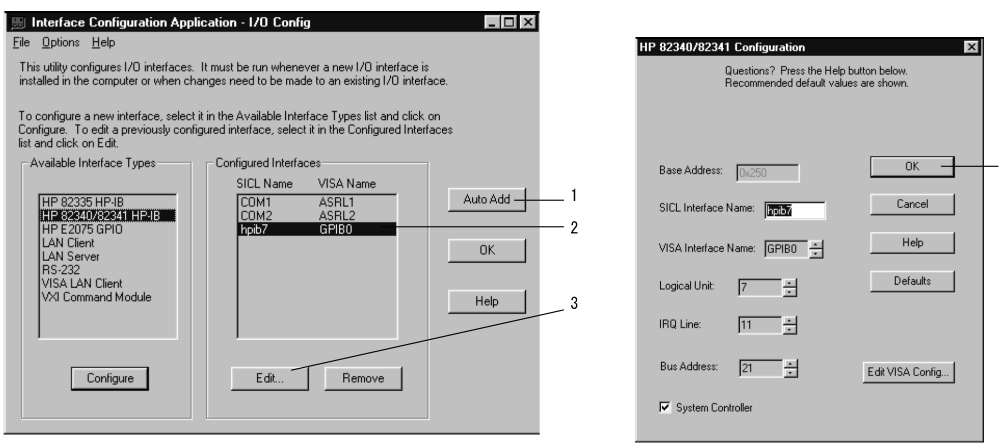
2. Click hpib7 GPIB0.

3. Click Edit to display the Configuration dialog box for the interface card.

   If you find any conflicts in the dialog box, such as IRQ line, you may need to change them manually. Normally you can exit without modifying the default setup.

4. Click OK to exit. Reboot your PC to configure the interface.

**Figure 1-1 To Configure the Interface using Agilent I/O Library**




**NOTE** VISA Name is used by the VXI*plug&play* drivers to access the interface.

## To Install the Driver

1. Insert the 4155/4156 Plug&Play Driver Disk into the flexible disk drive connected to your PC.
2. Execute the 4156B.EXE program stored on the diskette. The program automatically installs the driver in the following directory.
   - For Windows NT: \Vxipnp\Winnt\Hp4156b
   - For Windows 95: \Vxipnp\Win95\Hp4156b

   Following files are installed in the directory.
   - hp4156b.bas
   - hp4156b.c
   - hp4156b.def
   - hp4156b.fp
   - hp4156b.GID
   - hp4156b.h
   - hp4156b.hlp
   - readme.txt
   - DelsL1.isu
3. If you are also installing the driver for the E5250A, do the following.
   a. Insert the E5250A Plug&Play Driver Disk into the flexible disk drive connected to your PC.
   b. Execute the E5250A.EXE program stored on the diskette. The program automatically installs the driver in the following directory.
      - For Windows NT: \Vxipnp\Winnt\Hpe5250a
      - For Windows 95: \Vxipnp\Win95\Hpe5250a

      Following files are installed in the directory.
      - hpe5250a.bas
      - hpe5250a.c
      - hpe5250a.def
      - hpe5250a.fp
      - hpe5250a.GID
      - hpe5250a.h
      - hpe5250a.hlp
      - readme.txt
      - DelsL1.isu

# 2 Driver Functions

This section explains all the driver finctions available for Agilent 41555/4156 and Agilent E5250A.

- "Driver Functions for the 4155/4156"
- "Driver Functions for the E5250A"

**NOTE**

For additional information on each function. refer to the on-line help for the VXI*plug&play* drivers, or open the hp4156b.hlp or hpe5250a.hlp file in the direcroty the driver is installed. See "Installing 4155/4156 Driver" in Chpater 1.

# Driver Functions for the 4155/4156

Table 2-1 lists all the functions for the 4155/4156. You will see a brief description of the functions in the table.

For the description, syntax and parameters of the function, refer to the reference section following this table. The driver functions in the reference section will appear in the alphabetical order.

**Table 2-1** **4155/4156 Driver Function Lists**

| Category | Function | Description |
|---|---|---|
| Miscellaneous | hp4156b_init | Initializes the 4155/4156. |
| | hp4156b_close | Closes the connection with the 4155/4156. |
| | hp4156b_reset | Executes the 4155/4156 reset. |
| | hp4156b_self_test | Executes the 4155/4156 self-test. |
| | hp4156b_error_query | Queries the 4155/4156 for error code/message. |
| | hp4156b_error_message | Queries for the driver errors. |
| | hp4156b_revision_query | Queries for the 4155/4156 firmware/driver revisions. |
| | hp4156b_timeOut | Sets the timeout. |
| | hp4156b_timeOut_Q | Queries for the timeout setting. |
| | hp4156b_errorQueryDetect | Sets the automatic error checking. |
| | hp4156b_errorQueryDetect_Q | Queries for the automatic error checking setting. |
| | hp4156b_dcl | Sends the Device Clear. |
| | hp4156b_esr_Q | Queries the ESR status. |
| | hp4156b_readStatusByte_Q | Reads the 4155/4156 status byte. |
| | hp4156b_opc_Q | Checks the 4155/4156 operation completion status. |
| Primitive Measurement Functions | hp4156b_startMeasure | Starts a measurement. |
| | hp4156b_readData | Reads a measurement result. |
| | hp4156b_stopMode | Sets the measurement completion mode. |
| | hp4156b_abortMeasure | Aborts output or measurement. |
| Calibration | hp4156b_autoCal | Sets the auto calibration mode |
| | hp4156b_execCal | Executes the 4155/4156 calibration |
| Zero Offset Cancel | hp4156b_offsetCancel | Sets the zero offset cancel. |
| | hp4156b_execOffsetCancel | Executes the zero offset cancel. |

| Category | Function | Description |
|---|---|---|
| Measurement Unit Setup | hp4156b_setSwitch | Sets the output switch. |
| | hp4156b_setFilter | Sets the output filter. |
| | hp4156b_setInteg | Sets the integration time. |
| | hp4156b_setVm | Sets the VMU measurement mode. |
| | hp4156b_setPguR | Sets the PGU output impedance. |
| Source Setup | hp4156b_force | Applies a dc current or voltage. |
| | hp4156b_forcePulse | Applies a pulse by using PGU. |
| | hp4156b_zeroOutput | Disables output. |
| | hp4156b_recoverOutput | Recovers output. |
| | hp4156b_setIv | Sets the sweep source. |
| | hp4156b_setPbias | Sets the pulsed bias source. |
| | hp4156b_setPiv | Sets the pulsed sweep source. |
| | hp4156b_setSweepSync | Sets the synchronous sweep source. |
| Measurement Execution | hp4156b_spotMeas | Executes a high speed spot measurement. |
| | hp4156b_measureM | Executes a multi-channel spot measurement. |
| | hp4156b_sweepIv | Executes a one channel sweep measurement. |
| | hp4156b_sweepMiv | Executes a multi-channel sweep measurement. |
| | hp4156b_measureP | Executes a pulsed spot measurement. |
| | hp4156b_sweepPiv | Executes a pulsed sweep measurement. |
| | hp4156b_sweepPbias | Executes a sweep measurement with pulsed bias. |
| Sampling Measurements | hp4156b_setSample | Sets the timing parameters. |
| | hp4156b_addSampleSynclv | Sets the dc source. |
| | hp4156b_addSampleSyncPulse | Sets the pulse source. |
| | hp4156b_sample | Executes a sampling measurement. |
| | hp4156b_clearSampleSync | Clears the source setup. |
| Stress Force | hp4156b_setStress | Sets the timing parameters. |
| | hp4156b_addStressSyncIv | Sets the dc stress source. |
| | hp4156b_addStressSyncPulse | Sets the pulse stress source. |
| | hp4156b_stress | Forces stress. |
| | hp4156b_clearStressSync | Clears the source setup. |

| Category | Function | Description |
|---|---|---|
| Passthrough Functions | hp4156b_cmd | Sends a command. |
| | h4156b_cmdInt | Sends a command with an integer parameter. |
| | hp4156b_cmdReal | Sends a command with a real parameter. |
| | hp4156b_cmdData_Q | Sends a command to read any data. |
| | hp4156b_cmdString_Q | Sends a command to read string response. |
| | hp4156b_cmdInt16_Q | Sends a command to read 16 bit integer response. |
| | hp4156b_cmdInt16Arr_Q | Sends a command to read 16 bit integer array response. |
| | hp4156b_cmdInt32_Q | Sends a command to read 32 bit integer response. |
| | hp4156b_cmdInt32Arr_Q | Sends a command to read 32 bit integer array response. |
| | hp4156b_cmdReal64_Q | Sends a command to read 64 bit real response. |
| | hp4156b_cmdReal64Arr_Q | Sends a command to read 64 bit real array response. |

## hp4156b_abortMeasure

This function aborts the 4155/4156's present operation, such as the measurement executed by the hp4156b_startMeasure function, the pulse output by the hp4156b_forcePulse function, the stress force by the hp4156b_stress function, and so on.

**Syntax**

ViStatus _VI_FUNC hp4156b_abortMeasure(ViSession vi);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |

## hp4156b_addSampleSyncIv

This function specifies the constant current source or constant voltage source used for the sampling measurements, and sets the parameters. Source output starts at the beginning of the sampling measurement (beginning of the hold time), and stops at the end of the last sampling measurement point.

Sampling measurement channels are defined by the hp4156b_sample function, and sampling measurement timing is defined by the hp4156b_setSample function.

**Syntax**

ViStatus _VI_FUNC hp4156b_addSampleSyncIv(ViSession vi, ViInt32 channel, ViInt32 mode, ViReal64 range, ViReal64 base, ViReal64 bias, ViReal64 comp);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the source unit. 1 to 6 (SMU1 to SMU6), 21 (VSU1), 22 (VSU2), 27 (PGU1), or 28 (PGU2) |
| mode | Output mode. 1 (current output, only for SMU) or 2 (voltage output). |
| range | Output range. 0 (auto ranging) or positive value (limited auto ranging). See below.<br>For current output: 1E-11 to 1.0 A, or 0.<br>For voltage output: 2.0 to 200.0 V, or 0. |
| base | Base value. -1.0 to 1.0 A for current output, -200.0 V to 200.0 V for voltage output. |
| bias | Bias value. -1.0 to 1.0 A for current output, -200.0 V to 200.0 V for voltage output. |
| comp | Compliance value. -200.0 V to 200.0 V for voltage compliance, -1.0 to 1.0 A for current compliance. |

# hp4156b_addSampleSyncPulse

This function specifies the pulse source (PGU) used for the sampling measurements, and sets the parameters. Pulse outputs start at the beginning of the sampling measurement (beginning of the hold time), and stop at the end of the last sampling measurement point or stop at the last pulse if it comes earlier than the last sampling measurement point.

Sampling measurement channels are defined by the hp4156b_sample function, and sampling measurement timing is defined by the hp4156b_setSample function.

If you want to let the pulse output synchronize with the sampling measurement timing, you should define carefully both the hp4156b_addSampleSyncPulse timing parameters (count, period, width, delay, rise and fall) and the hp4156b_setSample timing parameters.

**Syntax**

ViStatus _VI_FUNC hp4156b_addSampleSyncPulse(ViSession vi, ViInt32 channel, ViReal64 base, ViReal64 peak, ViInt32 count, ViReal64 period, ViReal64 width, ViReal64 delay, ViReal64 rise, ViReal64 fall);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the pulse generator unit.<br>27 (PGU1) or 28 (PGU2) |
| base | Pulse base value. -40.0 to 40.0 V. |
| peak | Pulse peak value. -40.0 to 40.0 V. |
| count | Pulse count (number of pulses). 1 to 65535, or 0 (free run mode). |
| period | Pulse period. 1E-6 to 10.0 seconds. |
| width | Pulse width. 1E-6 to 9.99 seconds. |
| delay | Pulse delay time. 0.0 to 10.0 seconds. |
| rise | Pulse leading time. 0.1E-6 to 10E-3 seconds. |
| fall | Pulse trailling time. 0.1E-6 to 10E-3 seconds. |

## hp4156b_addStressSyncIv

This function specifies the DC stress source, and sets the parameters. You can use maximum 4 stress sources at once by using the hp4156b_addStressSyncIv and/or hp4156b_addStressSyncPulse functions.

**Syntax**

ViStatus _VI_FUNC hp4156b_addStressSyncIv(ViSession vi, ViInt32 source, ViInt32 channel, ViInt32 mode, ViReal64 range, ViReal64 base, ViReal64 stress, ViReal64 comp);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| source | Reference number of the stress source. 1, 2, 3, or 4. |
| channel | Channel number of the stress source.<br>1 to 6 (SMU1 to SMU6), 21 (VSU1), 22 (VSU2), 27 (PGU1), or 28 (PGU2) |
| mode | Output mode. 1 (current output, only for SMU) or 2 (voltage output). |
| range | Output range. 0 (auto ranging) or positive value (limited auto ranging). See below.<br>For current output: 1E-11 to 1.0 A, or 0.<br>For voltage output: 2.0 to 200.0 V, or 0. |
| base | Base value. -1.0 to 1.0 A for current output, -200.0 V to 200.0 V for voltage output. |
| stress | Stress value. -1.0 to 1.0 A for current output, -200.0 V to 200.0 V for voltage output. |
| comp | Compliance value. -200.0 V to 200.0 V for voltage compliance, -1.0 to 1.0 A for current compliance. |

## hp4156b_addStressSyncPulse

This function specifies the pulse stress source (PGU), and sets the parameters. You can use maximum 4 stress sources at once by using the hp4156b_addStressSyncIv and/or hp4156b_addStressSyncPulse functions. See “hp4156b_stress” on page 41 for the setting of width and delay.

**Syntax**

ViStatus _VI_FUNC hp4156b_addStressSyncPulse(ViSession vi, ViInt32 source, ViInt32 channel, ViReal64 base, ViReal64 stress, ViReal64 width, ViReal64 delay, ViReal64 rise, ViReal64 fall);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| source | Reference number of the stress source. 1, 2, 3, or 4. |
| channel | Channel number of the pulse generator unit. |
| | 27 (PGU1) or 28 (PGU2) |
| base | Stress pulse base value. -40.0 to 40.0 V. |
| stress | Stress pulse peak value. -40.0 to 40.0 V. |
| width | Pulse width. 1E-6 to 9.99 seconds. |
| delay | Pulse delay time. 0.0 to 10.0 seconds. |
| rise | Pulse leading time. 0.1E-6 to 10E-3 seconds. |
| fall | Pulse trailling time. 0.1E-6 to 10E-3 seconds. |

## hp4156b_autoCal

This function enables or disables the auto calibration function.

**Syntax**

ViStatus _VI_FUNC hp4156b_autoCal(ViSession vi, ViInt32 state);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| state | Auto calibration mode. 0 (OFF) or 1 (ON). |

## hp4156b_clearSampleSync

This function clears the settings of the constant voltage/current source defined by the hp4156b_addSampleSyncIv function, and the settings of the pulse source defined by the hp4156b_addSampleSyncPulse function.

**Syntax** ViStatus _VI_FUNC hp4156b_clearSampleSync(ViSession vi);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |

## hp4156b_clearStressSync

This function clears the settings of the stress sources defined by the hp4156b_addStressSyncIv function and the hp4156b_addStressSyncPulse function.

**Syntax** ViStatus _VI_FUNC hp4156b_clearStressSync(ViSession vi);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |

## hp4156b_close

This function terminates the software connection to the instrument and deallocates system resources. It is generally a good programming habit to close the instrument handle when the program is done using the instrument.

**Syntax** ViStatus _VI_FUNC hp4156b_close(ViSession vi);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |

## hp4156b_cmd

This function passes the cmd_str string to the instrument. Must be a NULL terminated C string.

**Syntax** ViStatus _VI_FUNC hp4156b_cmd(ViSession vi, ViString cmd_str);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |

## hp4156b_cmdData_Q

This function passes the cmd_str string to the instrument. This entry point will wait for a response which may be any data. You specify the cmd_str and size parameters, and get result[ ].

**Syntax**

ViStatus _VI_FUNC hp4156b_cmdData_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViChar _VI_FAR result[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| size | Length of result in bytes. 2 to 32767. |
| result[ ] | Response from instrument. |

## hp4156b_cmdInt

This function passes the cmd_str string to the instrument. This entry point passes the string in cmd_str followed by a space and then the integer in value. Note that either an Int16 or 32 can be passed as the Int16 will be promoted.

**Syntax**

ViStatus _VI_FUNC hp4156b_cmdInt(ViSession vi, ViString cmd_str, ViInt32 value);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| value | Parameter for command. -2147483647 to 2147483647. |

## hp4156b_cmdInt16Arr_Q

This function passes the cmd_str string to the instrument. This command expects a response that is a definite arbitrary block of 16 bit integers. You specify the cmd_str and size parameters, and get result[ ] and count.

**Syntax**

ViStatus _VI_FUNC hp4156b_cmdInt16Arr_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViInt16 _VI_FAR result[ ], ViPInt32 count);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| size | Size of result[ ] (number of items in the array).<br>1 to 2147483647. |
| result[ ] | Response from instrument. |
| count | Count of valid items in result[ ]. |

## hp4156b_cmdInt16_Q

This function passes the cmd_str string to the instrument. This command expects a response that can be returned as a 16 bit integer.

**Syntax**

ViStatus _VI_FUNC hp4156b_cmdInt16_Q(ViSession vi, ViString cmd_str, ViPInt16 result);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| result | Response from instrument. |

## hp4156b_cmdInt32Arr_Q

This function passes the cmd_str string to the instrument. This command expects a response that is a definite arbitrary block of 32 bit integers. You specify the cmd_str and size parameters, and get result[ ] and count.

**Syntax**

ViStatus _VI_FUNC hp4156b_cmdInt32Arr_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViInt32 _VI_FAR result[ ], ViPInt32 count);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| size | Size of result[ ] (number of items in the array).<br>1 to 2147483647. |
| result[ ] | Response from instrument. |
| count | Count of valid items in result[ ]. |

## hp4156b_cmdInt32_Q

This function passes the cmd_str string to the instrument. This command expects a response that can be returned as a 32 bit integer.

**Syntax**

ViStatus _VI_FUNC hp4156b_cmdInt32_Q(ViSession vi, ViString cmd_str, ViPInt32 result);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| result | Response from instrument. |

## hp4156b_cmdReal

This function passes the cmd_str string to the instrument. This entry point passes the string in cmd_str followed by a space and then the real in value. Note that either an Real32 or 64 can be passed as the Real32 will be promoted.

**Syntax**

ViStatus _VI_FUNC hp4156b_cmdReal(ViSession vi, ViString cmd_str, ViReal64 value);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| value | Parameter for command. -1E+300 to 1E+300. |

## hp4156b_cmdReal64Arr_Q

This function passes the cmd_str string to the instrument. This command expects a response that is a definite arbitrary block of 64 bit reals. You specify the cmd_str and size parameters, and get result[ ] and count.

**Syntax**

ViStatus _VI_FUNC hp4156b_cmdReal64Arr_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViReal64 _VI_FAR result[ ], ViPInt32 count);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| size | Size of result[ ] (number of items in the array).<br>1 to 2147483647. |
| result[ ] | Response from instrument. |
| count | Count of valid items in result[ ]. |

## hp4156b_cmdReal64_Q

This function passes the cmd_str string to the instrument. This command expects a response that can be returned as a 64 bit real.

**Syntax**

ViStatus _VI_FUNC hp4156b_cmdReal64_Q(ViSession vi, ViString cmd_str, ViPReal64 result);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| result | Response from instrument. |

## hp4156b_cmdString_Q

This function passes the cmd_str string to the instrument. This entry point will wait for a response which must be a string (character data). You specify the cmd_str and size parameters, and get result[ ].

**Syntax**

ViStatus _VI_FUNC hp4156b_cmdString_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViChar _VI_FAR result[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| size | Length of result in bytes. 2 to 32767. |
| result[ ] | Response from instrument. |

## hp4156b_dcl

This function sends a device clear (DCL) to the instrument.

A device clear will abort the present operation and enable the instrument to accept a new command or query. This is particularly useful in situations where it is not possible to determine the instrument state. In this case, it is customary to send a device clear before issuing a new instrument driver function. The device clear ensures that the instrument will be able to begin processing the new commands.

**Syntax**

ViStatus _VI_FUNC hp4156b_dcl(ViSession vi);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |

## hp4156b_error_message

This function translates the error return value from an instrument driver function to a readable string.

**Syntax**

ViStatus _VI_FUNC hp4156b_error_message(ViSession vi, ViStatus error_number, ViChar _VI_FAR message[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| error_number | Error return value from the driver function. |
| message[ ] | Error message string. This is limited to 256 characters. |

## hp4156b_error_query

This function returns the error numbers and corresponding error messages in the error queue of a instrument. See *If You Have a Problem* manual for a listing of the instrument error numbers and messages.

Instrument errors may occur when you places the instrument in a bad state such as sending an invalid sequence of coupled commands. Instrument errors can be detected by polling. Automatic polling can be accomplished by using the hp4156b_errorQueryDetect function.

**Syntax**

ViStatus _VI_FUNC hp4156b_error_query(ViSession vi, ViPInt32 error_number, ViChar _VI_FAR error_message[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| error_number | Instrument's error code. |
| error_message[ ] | Instrument's error message. This is limited to 256 characters. |

## hp4156b_errorQueryDetect

This function enables or disables automatic instrument error checking.

If automatic error checking is enabled then the driver will query the instrument for an error at the end of each function call.

**Syntax**

ViStatus _VI_FUNC hp4156b_errorQueryDetect(ViSession vi, ViBoolean errorQueryDetect);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| errorQueryDetect | Error checking enable (VI_TRUE) or disable (VI_FALSE). |

## hp4156b_errorQueryDetect_Q

This function indicates if automatic instrument error detection is enabled or disabled.

**Syntax**

ViStatus _VI_FUNC hp4156b_errorQueryDetect_Q(ViSession vi, ViPBoolean pErrDetect);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| pErrDetect | Error checking enable (VI_TRUE) or disable (VI_FALSE). |

## hp4156b_esr_Q

This function returns the contents of the ESR register. The driver returns the equivalent messages:

**Syntax**

ViStatus _VI_FUNC hp4156b_esr_Q(ViSession vi, ViChar _VI_FAR errstr[ ] );

**Parameters**

vi — Instrument handle returned from hp4156b_init( ).

errstr[ ] — Response from instrument.

| Bit Value | Message |
|---|---|
| 1 | "ESR_OPC" |
| 2 | "ESR_RQL" |
| 4 | "ESR_QYE" |
| 8 | "ESR_DDE" |
| 16 | "ESR_EXE" |
| 32 | "ESR_CME" |
| 64 | "ESR_URQ" |
| 128 | "ESR_PON" |

## hp4156b_execCal

This function executes the calibration and returns the calibration result. The parameter "result" returns the calibration result.

**Syntax**

ViStatus _VI_FUNC hp4156b_execCal(ViSession vi, ViPInt32 result);

**Parameters**

vi — Instrument handle returned from hp4156b_init( ).

result — Calibration result. Numeric number.
0: No error (calibration succeed).

# hp4156b_execOffsetCancel

This function measures the zero offset data, and sets the zero offset function to ON.

The parameter 'channel' specifies the measurement channel (SMU or VMU).
If you define SMU for 'channel', the SMU must be set to the voltage force mode by using the hp4156b_force function, before executing this function.

If you define VMU for 'channel', the VMU must be set to the differential voltage measurement mode by using the hp4156b_setVm function, before executing this function.

**Syntax**

ViStatus _VI_FUNC hp4156b_execOffsetCancel(ViSession vi, ViInt32 channel, ViInt32 range);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the unit to measure the zero offset data.. |
| | 1 to 6 (SMU1 to SMU6), 23 (VMU1), or 24 (VMU2). |
| range | Measurement range to measure the zero offset data |
| | 0 (10 pA range for SMU), 1 (100 pA range for SMU),<br>2 (1 nA range for SMU), or 3 (0.2 V range for VMU). |

# hp4156b_force

This function specifies the dc current source (SMU) or dc voltage source (SMU, VSU, or PGU), and forces the output immediately. To stop the output, use the hp4156b_force function with 0 (zero) output.

**Syntax**

ViStatus _VI_FUNC hp4156b_force(ViSession vi, ViInt32 channel, ViInt32 mode, ViReal64 range, ViReal64 value, ViReal64 comp, ViInt32 polarity);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the source unit.<br>1 to 6 (SMU1 to SMU6), 21 (VSU1), 22 (VSU2), 27 (PGU1), or 28 (PGU2) |
| mode | Output mode. 1 (current output, only for SMU) or 2 (voltage output). |
| range | Output range. 0 (auto ranging) or positive value (limited auto ranging). See below.<br>For current output: 1E-11 to 1.0 A, or 0.<br>For voltage output: 2.0 to 200.0 V, or 0. |
| value | Output value. -1.0 to 1.0 A for current output, -200.0 to 200.0 V for SMU voltage output, -40 to 40 V for PGU dc voltage output, -20 to 20 V for VSU output. |
| comp | Compliance value (only for SMU). -200.0 V to 200.0 V for voltage compliance, -1.0 to 1.0 A for current compliance. |
| polarity | Compliance polarity (only for SMU). 0 (auto) or 1 (manual). If you select 1, polarity is set to the same polarity as comp value you enterd. |

## hp4156b_forcePulse

This function specifies the pulse source (PGU) settings and forces the voltage pulse immediately. To stop the pulse output, use hp4156b_abortMeasure function.

**Syntax**

ViStatus _VI_FUNC hp4156b_forcePulse(ViSession vi, ViInt32 channel, ViInt32 count, ViReal64 base, ViReal64 peak, ViReal64 width, ViReal64 period, ViReal64 delay, ViReal64 rise, ViReal64 fall);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the pulse generator unit.<br>27 (PGU1) or 28 (PGU2) |
| count | Pulse count (number of pulses). 1 to 65535, or 0 (free run mode). |
| base | Pulse base value. -40.0 to 40.0 V. |
| peak | Pulse peak value. -40.0 to 40.0 V. |
| width | Pulse width. 1E-6 to 9.99 seconds. |
| period | Pulse period. 1E-6 to 10.0 seconds. |
| delay | Pulse delay time. 0.0 to 10.0 seconds. |
| rise | Pulse leading time. 0.1E-6 to 10E-3 seconds. |
| fall | Pulse trailling time. 0.1E-6 to 10E-3 seconds. |

# hp4156b_init

This function initializes the software connection to the instrument and optionally verifies that instrument is in the system. In addition, it may perform any necessary actions to place the instrument in its reset state.

If the hp4156b_init function encounters an error, then the value of the vi output parameter will be VI_NULL.

**Syntax**

ViStatus _VI_FUNC hp4156b_init(ViRsrc InstrDesc, ViBoolean id_query, ViBoolean do_reset, ViPSession vi);

**Parameters**

| | |
|---|---|
| InstrDesc | Instrument description. Examples; GPIB0::1::INSTR. |
| id_query | VI_TRUE (to perform system verification), or VI_FALSE (do not perform system verification). |
| do_reset | VI_TRUE (to perform reset operation), or VI_FALSE (do not perform reset operation). |
| vi | Instrument handle. This is VI_NULL if an error occurred during the init. |

## hp4156b_measureM

This function executes a multi channel spot measurement by the specified units, and returns the measured value and the measurement status.

The array size of all arrays should be the same together. Then the order of the array data is important. For example, the measurement setup for the unit specified by channel[1] must be entered into mode[1] and range[1]. And the measured data and status data of the units specified by channel[1] will be returned by value[1] and status[1], respectively.

**Syntax**

ViStatus _VI_FUNC hp4156b_measureM(ViSession vi, ViInt32 channel[ ], ViInt32 mode[ ], ViReal64 range[ ], ViReal64 value[ ], ViInt32 status[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel[ ] | Channel number of the measurement unit. Enter 0 (zero) at the end of the unit definition for channel[ ]. For example, if you use two units, the first and second elements of channel[ ] must specify the units, and the third element must be 0.<br>1 to 6 (SMU1 to SMU6), 23 (VMU1), or 24 (VMU2). |
| mode[ ] | Measurement mode.<br>1 (current measurement) or 2 (voltage measurement). |
| range[ ] | Measurement range. 0 (auto ranging), positive value (limited auto ranging), or negative value (fixed range). See below.<br>For current measurement: -1E-11 to -1.0 A, 1E-11 to 1.0 A, or 0.<br>For voltage measurement: -2.0 to -200.0 V, 2.0 to 200.0 V (-0.2 and 0.2 are available for VMU in differential mode), or 0. |
| value[ ] | Measurement data. |
| status[ ] | Measurement status. 0 (no error), or 1 to 255 (error status). |

## hp4156b_measureP

This function executes a pulsed spot measurement by the specified channel, and returns the measured value and the measurement status.

**Syntax**

ViStatus _VI_FUNC hp4156b_measureP(ViSession vi, ViInt32 channel, ViInt32 mode, ViReal64 range, ViPReal64 value, ViPInt32 status);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the measurement unit.<br>1 to 6 (SMU1 to SMU6), 23 (VMU1), or 24 (VMU2). |
| mode | Measurement mode. 1 (current measurement, only for SMU) or 2 (voltage measurement). |
| range | Measurement range. 0 (auto ranging), positive value (limited auto ranging), or negative value (fixed range). See below.<br>For current measurement: -1E-11 to -1.0 A, 1E-11 to 1.0 A, or 0.<br>For voltage measurement: -2.0 to -200.0 V, 2.0 to 200.0 V (-0.2 and 0.2 are available for VMU in differential mode), or 0. |
| value | Measurement data. |
| status | Measurement status. 0 (no error), or 1 to 255 (error status). |

## hp4156b_offsetCancel

This function enables or disables the zero offset cancel function.

**Syntax**

ViStatus _VI_FUNC hp4156b_offsetCancel(ViSession vi, ViInt32 channel, ViInt32 state);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the unit to set the offset cancel function.<br>1 to 6 (SMU1 to SMU6), 23 (VMU1), or 24 (VMU2). |
| state | 0 (Function OFF), or 1 (Function ON). |

## hp4156b_opc_Q

This function does the *OPC? common command.

**Syntax** ViStatus _VI_FUNC hp4156b_opc_Q(ViSession vi, ViPBoolean result);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| result | VI_TRUE (Operation complete), or<br>VI_FALSE (Operation is pending). |

## hp4156b_readData

This function reads and returns the source setup data or the data measured by the hp4156b_startMeasure function.

**Syntax** ViStatus _VI_FUNC hp4156b_readData(ViSession vi, ViPInt32 eod, ViPInt32 data_type, ViPReal64 value, ViPInt32 status, ViPInt32 channel);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| eod | End of data flag. 0 (not end of data), or 1 (end of data). |
| data_type | Data type of the value. 0 (Voltage setup data),<br>1 (Current setup data), 3 (Time setup data),<br>8 (Voltage measurement data), 9 (Current measurement data),<br>11 (Time measurement data), 14 (Sampling index data), or<br>15 (Stress status data). |
| value | Measurement data or source setup data. |
| status | Measurement status or source status. |
| channel | Channel number of the unit for measurement or output.<br><br>1 to 6 (SMU1 to SMU6), 21 (VSU1), 22 (VSU2), 23 (VMU1), 24 (VMU2), 27 (PGU1) or 28 (PGU2). |

## hp4156b_readStatusByte_Q

This function returns the contents of the status byte register.

**Syntax**

```
ViStatus _VI_FUNC hp4156b_readStatusByte_Q(ViSession vi,
ViPInt16 statusByte);
```

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| statusByte | The contents of the status byte are returned in this parameter. |

## hp4156b_recoverOutput

This function returns the unit to the settings that are stored by the hp4156b_zeroOutput function, and clears the stored unit settings.

**Syntax**

```
ViStatus _VI_FUNC hp4156b_recoverOutput(ViSession vi, ViInt32 channel);
```

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the unit to return the settings. 1 to 6 (SMU1 to SMU6), 21 (VSU1), 22 (VSU2), 27 (PGU1) or 28 (PGU2). |

## hp4156b_reset

This function places the instrument in a default state. Before issuing this function, it may be necessary to send a device clear to ensure that the instrument can execute a reset. A device clear can be issued by invoking hp4156b_dcl function.

**Syntax**

```
ViStatus _VI_FUNC hp4156b_reset(ViSession vi);
```

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |

## hp4156b_revision_query

This function returns the driver revision and the instrument firmware revision.

**Syntax**

ViStatus _VI_FUNC hp4156b_revision_query(ViSession vi,
ViChar_VI_FAR driver_rev[ ] , ViChar _VI_FAR instr_rev[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| driver_rev[ ] | Instrument driver revision. This is limited to 256 characters. |
| instr_rev[ ] | Instrument firmware revision. This is limited to 256 characters. |

## hp4156b_sample

This function executes a sampling measurement by the specified channels, and returns the number of measurement points, measurement data index, measurement data and the measurement status.

Before executing this function, set the sampling timing by using the hp4156b_setSample function. The synchronous dc sources used with the sampling measurement units are defined by using the hp4156b_addSampleSyncIv function. And the synchronous pulsed sources used with the sampling measurement units are defined by using the hp4156b_addSampleSyncPulse function.

**Syntax**

ViStatus _VI_FUNC hp4156b_sample(ViSession vi, ViInt32 channel[ ], ViInt32 mode[ ], ViReal64 range[ ], ViPInt32 point, ViInt32 index[ ], ViReal64 value[ ], ViInt32 status[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel[ ] | Channel number of the measurement unit.<br>1 to 6 (SMU1 to SMU6), 23 (VMU1), or 24 (VMU2). |
| mode[ ] | Measurement mode. 1 (current measurement, only for SMU) or 2 (voltage measurement). |
| range[ ] | Measurement range. 0 (auto ranging), positive value (limited auto ranging), or negative value (fixed range). See below.<br>For current measurement: -1E-11 to -1.0 A, 1E-11 to 1.0 A, or 0.<br>For voltage measurement: -2.0 to -200.0 V, 2.0 to 200.0 V (-0.2 and 0.2 are available for VMU in differential mode), or 0. |
| point | Number of measurement points. 1 to 10001. |
| index[ ] | Measurement data index. |
| value[ ] | Measurement data. |
| status[ ] | Measurement status. 0 (no error), or 1 to 255 (error status). |

**Remarks**

The array size of the parameters should be as shown below.

ViInt32 channel[N]

ViInt32 mode[N]

ViReal64 range[N]

ViInt32 point

ViInt32 index[M]

ViReal64 value[M][N]

ViReal64 status[M][N]

where,

N: Number of channels used for the measurements plus 1, or more.

M: Number of sweep points ('point' parameter value of hp4156b_setSample function), or more.

For the parameter definition, the order of the array data is important. For example, the measurement setup for the unit specified by channel[1] must be entered into mode[1] and range[1]. And measurement data and status data of the unit specified by channel[1] will be returned by value[M][1] and status[M][1], respectively.

## hp4156b_self_test

This function causes the instrument to perform a self-test and returns the result of that self-test. This is used to verify that an instrument is operating properly. A failure may indicate a potential hardware problem.

**Syntax**

ViStatus _VI_FUNC hp4156b_self_test(ViSession vi, ViPInt16 test_result, ViChar_VI_FAR test_message[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| test_result | Numeric result from self-test operation. 0: No error. |
| test_message[ ] | Self-test status message. This is limited to 256 characters. |

## hp4156b_setFilter

This function sets the output filter of the specified channel.

**Syntax**

ViStatus _VI_FUNC hp4156b_setFilter(ViSession vi, ViInt32 channel, ViInt32 state);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the unit. 1 (SMU1), 2, 3, 4, 5, or 6 (SMU6). |
| state | 0 (Filter OFF) or 1 (Filter ON). |

## hp4156b_setInteg

This function sets the integration time, and sets the number of samples that are taken and averaged for the measurement.

**Syntax**

ViStatus _VI_FUNC hp4156b_setInteg(ViSession vi, ViInt32 table, ViReal64 time, ViInt32 average);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| table | Integration time table. 1 (short), 2 (medium), or 3 (long). |
| time | Integration time. in seconds. 80E-6 to 10.16E-3 for table=1, or 16.7E-3 to 2.0 for table=3. Ignore this parameter for table=2. |
| average | Number of samples for averaging. 1 to 1023, or 0. If you do not want to change the value from previous value, enter 0. |

## hp4156b_setIv

This function specifies the sweep source channel for the staircase sweep measurements and the staircase sweep with pulsed bias measurements, and sets the parameters. For the staircase sweep with pulsed bias measurements, the sweep output synchronizes with the pulse output by the hp4156b_setPbias function.

**Syntax**

ViStatus _VI_FUNC hp4156b_setIv(ViSession vi, ViInt32 channel, ViInt32 mode, ViReal64 range, ViReal64 start, ViReal64 stop, ViInt32 point, ViReal64 hold, ViReal64 delay, ViReal64 s_delay, ViReal64 comp, ViReal64 p_comp);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the sweep source.<br>1 to 6 (SMU1 to SMU6), 21 (VSU1), or 22 (VSU2). |
| mode | Output mode. 1 (single linear), 2 (single log), 3 (double linear), or 4 (double log). Use positive value for voltage output, use negative value for current output (only for SMU). |
| range | Output range. 0 (auto ranging) or positive value (limited auto ranging). See below.<br>For current output: 1E-11 to 1.0 A, or 0.<br>For voltage output: 2.0 to 200.0 V, or 0. |
| start | Sweep start value. -1.0 to 1.0 A, or -200.0 to 200.0 V. |
| stop | Sweep stop value. -1.0 to 1.0 A, or -200.0 to 200.0 V. |
| point | Number of sweep steps. 1 to 1001. |
| hold | Hold time. 0 to 655.35 seconds. |
| delay | Delay time. 0 to 65.535 seconds. |
| s_delay | Step delay time. 0 to 1.0 second. |
| comp | Compliance value. -200.0 V to 200.0 V for voltage compliance, -1.0 to 1.0 A for current compliance. |
| p_comp | Power compliance. 1.0 to 20.0. |

## hp4156b_setPbias

This function specifies the pulse output channel for the pulsed spot measurements and the staircase sweep with pulsed bias measurements, and sets the parameters.

For the staircase sweep with pulsed bias measurements, the pulse output synchronizes with the staircase sweep output by the hp4156b_setIv function.

**Syntax**

ViStatus _VI_FUNC hp4156b_setPbias(ViSession vi, ViInt32 channel, ViInt32 mode, ViReal64 range, ViReal64 base, ViReal64 peak, ViReal64 width, ViReal64 period, ViReal64 hold, ViReal64 comp);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the pulse source. |
| | 1 to 6 (SMU1 to SMU6), 21 (VSU1), or 22 (VSU2). |
| mode | Pulse output mode. 1 (current output, only for SMU), or 2 (voltage output). |
| range | Output range. 0 (auto ranging) or positive value (limited auto ranging). See below. |
| | For current output: 1E-11 to 1.0 A, or 0. |
| | For voltage output: 2.0 to 200.0 V, or 0. |
| base | Pulse base value. -1.0 to 1.0 A, or -200.0 to 200.0 V. |
| peak | Pulse peak value. -1.0 to 1.0A, or -200.0 to 200.0 V. |
| width | Pulse width. 0.5E-3 to 100E-3 seconds. |
| period | Pulse period. 5E-3 to 1.0 seconds. |
| hold | Hold time. 0.0 to 655.35 seconds. |
| comp | Compliance value. -200.0 V to 200.0 V for voltage compliance, -1.0 to 1.0 A for current compliance. |

## hp4156b_setPguR

This function sets the PGU output impedance.

**Syntax**

ViStatus _VI_FUNC hp4156b_setPguR(ViSession vi, ViInt32 channel, ViInt32 state);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of PGU.<br>27 (PGU1) or 28 (PGU2). |
| state | PGU output impedance.<br>0 (approx. 0 ohm low impedance) or 1 (50 ohm). |

# hp4156b_setPiv

This function specifies the pulsed sweep source channel for the pulsed sweep measurements, and sets the parameters.

**Syntax**

ViStatus _VI_FUNC hp4156b_setPiv(ViSession vi, ViInt32 channel, ViInt32 mode, ViReal64 range, ViReal64 base, ViReal64 start, ViReal64 stop, ViInt32 point, ViReal64 hold, ViReal64 width, ViReal64 period, ViReal64 comp);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the pulse sweep source.<br>1 to 6 (SMU1 to SMU6), 21 (VSU1), or 22 (VSU2). |
| mode | Output mode. 1 (single linear), 2 (single log), 3 (double linear), or 4 (double log). Use positive value for voltage output, use negative value for current output (only for SMU). |
| range | Output range. 0 (auto ranging) or positive value (limited auto ranging). See below.<br>For current output: 1E-11 to 1.0 A, or 0.<br>For voltage output: 2.0 to 200.0 V, or 0. |
| base | Pulse sweep base value. -1.0 to 1.0 A, or -200.0 to 200.0 V. |
| start | Pulse sweep start value. -1.0 to 1.0A, or -200.0 to 200.0 V. |
| stop | Pulse sweep stop value. -1.0 to 1.0A, or -200.0 to 200.0 V. |
| point | Number of sweep steps. 1 to 1001. |
| hold | Hold time. 0.0 to 655.35 seconds. |
| width | Pulse width. 0.5E-3 to 100E-3 seconds. |
| period | Pulse period. 5E-3 to 1.0 seconds. |
| comp | Compliance value. -200.0 V to 200.0 V for voltage compliance, -1.0 to 1.0 A for current compliance. |

## hp4156b_setSample

This function specifies the measurement timing of the sampling measurements. The sampling measurement units are defined by the hp4156b_sample function.

**Syntax**

ViStatus _VI_FUNC hp4156b_setSample(ViSession vi, ViReal64 hold, ViReal64 interval, ViInt32 point);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| hold | Hold time. -30E-3 to 655.35 seconds. |
| interval | Sampling interval. 60E-6 to 65.534 seconds. |
| point | Number of sampling points. 1 to 10001. |

## hp4156b_setStress

This function sets the timing parameters of the stress. See “hp4156b_stress” on page 41 for the setting of period parameter.

**Syntax**

ViStatus _VI_FUNC hp4156b_setStress(ViSession vi, ViReal64 hold, ViInt32 mode, ViReal64 duration, ViReal64 period);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| hold | Hold time. 0 to 655.35 seconds. |
| mode | Stress mode. 1 (pulse count mode) or 2 (duration mode). |
| duration | Number of pulse count (1 to 65535) for mode=1, or<br>Duration time (500E-6 to 655.0 seconds) for mode=2. |
| period | Pulse period. 2E-6 to 10.0 seconds. |

## hp4156b_setSweepSync

This function specifies the synchronous sweep source channel for the staircase sweep measurements, the pulsed sweep measurements and the staricase sweep with pulsed bias measurements, and sets the parameters. Synchronous sweep source is used for the staircase sweep.

For the staircase sweep measurements, the output synchronizes with the staircase sweep output by the hp4156b_setIv function.

For the pulsed sweep measurements, the output synchronizes with the pulsed sweep output by the hp4156b_setPiv function.

For the staircase sweep with pulsed bias measurements, the output synchronizes the staircase sweep output by the hp4156b_setIv function and the pulse output by the hp4156b_setPbias function.

**Syntax**

ViStatus _VI_FUNC hp4156b_setSweepSync(ViSession vi, ViInt32 channel, ViInt32 mode, ViReal64 range, ViReal64 start, ViReal64 stop, ViReal64 comp, ViReal64 p_comp);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the sweep source.<br>1 to 6 (SMU1 to SMU6), 21 (VSU1), or 22 (VSU2). |
| mode | Output mode. 1 (current output, only for SMU) or 2 (voltage output). |
| range | Output range. 0 (auto ranging) or positive value (limited auto ranging). See below.<br>For current output: 1E-11 to 1.0 A, or 0.<br>For voltage output: 2.0 to 200.0 V, or 0. |
| start | Sweep start value. -1.0 to 1.0 A, or -200.0 to 200.0 V. |
| stop | Sweep stop value. -1.0 to 1.0 A, or -200.0 to 200.0 V. |
| comp | Compliance value. -200.0 V to 200.0 V for voltage compliance, -1.0 to 1.0 A for current compliance. |
| p_comp | Power compliance. 1.0 to 20.0. |

## hp4156b_setSwitch

This function sets the output switch of the specified channel.

**Syntax**

ViStatus _VI_FUNC hp4156b_setSwitch(ViSession vi, ViInt32 channel, ViInt32 state);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the unit.<br>1 to 6 (SMU1 to SMU6), 21 (VSU1), 22 (VSU2), 23 (VMU1), 24 (VMU2), 26 (GNDU), 27 (PGU1) or 28 (PGU2). |
| state | Output switch setting.<br>0 (output switch OFF) or 1 (output switch ON). |

## hp4156b_setVm

This function sets the VMU measurement mode.

**Syntax**

ViStatus _VI_FUNC hp4156b_setVm(ViSession vi, ViInt32 mode);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| mode | VMU measurement mode.<br>1 (grounded mode) or 2 (differential mode). |

## hp4156b_spotMeas

This function executes a high speed spot measurement by the specified channel, and returns the measured value and the measurement status.

**Syntax**

ViStatus _VI_FUNC hp4156b_spotMeas(ViSession vi, ViInt32 channel, ViInt32 mode, ViReal64 range, ViPReal64 value, ViPInt32 status);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the measurement unit.<br>1 to 6 (SMU1 to SMU6), 23 (VMU1), or 24 (VMU2). |
| mode | Measurement mode.<br>1 (current measurement, only for SMU) or<br>2 (voltage measurement). |
| range | Measurement range.<br>0 (auto ranging), positive value (limited auto ranging), or negative value (fixed range). See below.<br>For current measurement: -1E-11 to -1.0 A, 1E-11 to 1.0 A, or 0.<br>For voltage measurement: -2.0 to -200.0 V, 2.0 to 200.0 V (-0.2 and 0.2 are available for VMU in differential mode), or 0. |
| value | Measurement data. |
| status | Measurement status. 0 (no error), or 1 to 255 (error status). |

## hp4156b_startMeasure

This function starts the specified measurement by the specified channels. You can read the measured data by using the hp4156b_readData function. The measurement data is entered to the 4155/4156 output buffer in the measurement order. If you want to abort the measurement, use the hp4156b_abortMeasure function.

The array size of all arrays should be the same together. Then the order of the array data is important. For example, the measurement setup for the unit specified by channel[1] must be entered into mode[1] and range[1].

**Syntax**

ViStatus _VI_FUNC hp4156b_startMeasure(ViSession vi, ViInt32 meas_type, ViInt32 channel[ ], ViInt32 mode[ ], ViReal64 range[ ], ViInt32 source);

**Parameters**

vi — Instrument handle returned from hp4156b_init( ).

meas_type — Measurement type. 1 (multi spot), 2 (staircase sweep), 3 (pulse spot), 4 (pulse sweep), 5 (sweep with pulsed bias), 10 (sampling), or 11 (stress force).

channel[ ] — Channel number of the measurement unit. Enter 0 (zero) at the end of the unit definition for channel[ ]. For example, if you use two units, the first and second elements of channel[ ] must specify the units, and the third element must be 0.

1 to 6 (SMU1 to SMU6), 23 (VMU1), or 24 (VMU2).

mode[ ] — Measurement mode. 1 (current measurement, only for SMU) or 2 (voltage measurement).

range[ ] — Measurement range. 0 (auto ranging), positive value (limited auto ranging), or negative value (fixed range). See below.

For current measurement: -1E-11 to -1.0 A, 1E-11 to 1.0 A, or 0.

For voltage measurement: -2.0 to -200.0 V, 2.0 to 200.0 V (-0.2 and 0.2 are available for VMU in differential mode), or 0.

source — Source data output mode.

0 (measurement data output without source data) or
1 (measurement data output with source data).

## hp4156b_stopMode

This function specifies the stop condition which enables the automatic abort function for the sweep measurement, sampling measurement, or stress force. Also this function specifies the sweep source output of the measurement unit after the sweep measurement is aborted.

**Syntax**

ViStatus _VI_FUNC hp4156b_stopMode(ViSession vi, ViInt32 occ_stop, ViInt32 tcc_stop, ViInt32 ovf_stop, ViInt32 osc_stop, ViInt32 last_mode);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| occ_stop | Automatic abort function by compliance of another unit. |
| | 0 (disables this abort mode) or 1 (enables this abort mode). |
| tcc_stop | Automatic abort function by compliance of this unit. |
| | 0 (disables this abort mode) or 1 (enables this abort mode). |
| ovf_stop | Automatic abort function by overflow of AD converter. |
| | 0 (disables this abort mode) or 1 (enables this abort mode). |
| osc_stop | Automatic abort function by oscillation of unit(s). |
| | 0 (disables this abort mode) or 1 (enables this abort mode). |
| last_mode | Source output value after abort condition. |
| | 1 (returns to start value), or 2 (keeps the value when aborted). |

# hp4156b_stress

This function forces the stress defined by the hp4156b_setStress, hp4156b_addStressSyncIv, and hp4156b_addStressSyncPulse functions.

**Syntax**

ViStatus _VI_FUNC hp4156b_stress(ViSession vi, ViPInt32 status);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| status | Stress output status. 0 (no error), or 1 to 255 (error status). |

**Remarks**

The following parameters must be set within the range shown in the following table. The period is a parameter of hp4156b_setStress function. And width and delay are parameters of hp4156b_addStressSyncPulse function.

| period | width | delay |
|---|---|---|
| 2E-6 to 100E-6 sec | 1E-6 to 99.9E-6 sec | 0 to 100E-6 sec |
| 100E-6 to 1E-3 sec | 1E-6 to 999E-6 sec | 0 to 1E-3 sec |
| 1E-3 to 10E-3 sec | 10E-6 to 9.99E-3 sec | 0 to 10E-3 sec |
| 10E-3 to 100E-3 sec | 100E-6 to 99.9E-3 sec | 0 to 100E-3 sec |
| 100E-3 to 1.0 sec | 1E-3 to 999E-3 sec | 0 to 1.0 sec |
| 1.0 to 10.0 sec | 10E-3 to 9.99 sec | 0 to 10.0 sec |

# hp4156b_sweepIv

This function executes a staircase sweep measurement by the specified channel, and returns the number of measurement points, sweep source data, measurement data and the measurement status.

Before executing this function, set the sweep source setup by using the hp4156b_setIv function. If you want to use the synchronous sweep source, execute the hp4156b_setSweepSync function.

The array size of source, value and status should be the same together, and it must be greater than or equal to the number of sweep points defined by the hp4156b_setIv function ('point' parameter).

**Syntax**

ViStatus _VI_FUNC hp4156b_sweepIv(ViSession vi, ViInt32 channel, ViInt32 mode, ViReal64 range, ViPInt32 point, ViReal64 source[ ], ViReal64 value[ ], ViInt32 status[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the measurement unit.<br>1 to 6 (SMU1 to SMU6), 23 (VMU1), or 24 (VMU2). |
| mode | Measurement mode. 1 (current measurement, only for SMU) or 2 (voltage measurement). |
| range | Measurement range. 0 (auto ranging), positive value (limited auto ranging), or negative value (fixed range). See below.<br>For current measurement: -1E-11 to -1.0 A, 1E-11 to 1.0 A, or 0.<br>For voltage measurement: -2.0 to -200.0 V, 2.0 to 200.0 V (-0.2 and 0.2 are available for VMU in differential mode), or 0. |
| point | Number of measurement points. 1 to 1001. |
| source[ ] | Sweep source setup data. |
| value[ ] | Measurement data. |
| status[ ] | Measurement status. 0 (no error), or 1 to 255 (error status). |

## hp4156b_sweepMiv

This function executes a multichannel staircase sweep measurement by the specified channels, and returns the number of measurement points, sweep source data, measurement data and the measurement status.

Before executing this function, set the sweep source setup by using the hp4156b_setIv function. If you want to use the synchronous sweep source, execute the hp4156b_setSweepSync function.

**Syntax**

ViStatus _VI_FUNC hp4156b_sweepMiv(ViSession vi, ViInt32 channel[ ], ViInt32 mode[ ], ViReal64 range[ ], ViPInt32 point, ViReal64 source[ ] , ViReal64 value[ ], ViInt32 status[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel[ ] | Channel number of the measurement unit. Enter 0 (zero) at the end of the unit definition for channel[ ]. For example, if you use two units, the first and second elements of channel[ ] must specify the units, and the third element must be 0.<br>1 to 6 (SMU1 to SMU6), 23 (VMU1), or 24 (VMU2). |
| mode[ ] | Measurement mode. 1 (current measurement, only for SMU) or 2 (voltage measurement). |
| range[ ] | Measurement range. 0 (auto ranging), positive value (limited auto ranging), or negative value (fixed range). See below.<br>For current measurement: -1E-11 to -1.0 A, 1E-11 to 1.0 A, or 0.<br>For voltage measurement: -2.0 to -200.0 V, 2.0 to 200.0 V (-0.2 and 0.2 are available for VMU in differential mode), or 0. |
| point | Number of measurement points. 1 to 1001. |
| source[ ] | Sweep source setup data. |
| value[ ] | Measurement data. Two dimentional array. |
| status[ ] | Measurement status. 0 (no error), or 1 to 255 (error status). Two dimensional array. |

**Remarks**

The array size of the parameters should be as shown below.

ViInt32 channel[N]

ViInt32 mode[N]

ViReal64 range[N]

ViInt32 point

ViReal64 source[M]

ViReal64 value[M][N]

ViReal64 status[M][N]

where,

N: Number of channels used for the measurements plus 1, or more.

M: Number of sweep points ('point' parameter value of hp4156b_setIv function), or more.

For the parameter definition, the order of the array data is important. For example, the measurement setup for the unit specified by channel[1] must be entered into mode[1] and range[1]. And measurement data and status data of the unit specified by channel[1] will be returned by value[M][1] and status[M][1], respectively.

## hp4156b_sweepPbias

This function executes a staircase sweep with pulsed bias measurement by the specified channel, and returns the number of measurement points, sweep source data, measurement data, and the measurement status. Before executing this function, set the sweep source setup and pulsed bias setup by using the hp4156b_setIv function and the hp4156b_setPbias function. If you want to use the synchronous sweep source, execute the hp4156b_setSweepSync function.

The array size of source, value and status should be the same together, and it must be greater than or equal to the number of sweep points defined by the hp4156b_setIv function ('point' parameter).

**Syntax**

ViStatus _VI_FUNC hp4156b_sweepPbias(ViSession vi, ViInt32 channel, ViInt32 mode, ViReal64 range, ViPInt32 point, ViReal64 source[ ] , ViReal64 value[ ], ViInt32 status[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the measurement unit.<br>1 to 6 (SMU1 to SMU6), 23 (VMU1), or 24 (VMU2). |
| mode | Measurement mode. 1 (current measurement, only for SMU) or 2 (voltage measurement). |
| range | Measurement range. 0 (auto ranging), positive value (limited auto ranging), or negative value (fixed range). See below.<br>For current measurement: -1E-11 to -1.0 A, 1E-11 to 1.0 A, or 0.<br>For voltage measurement: -2.0 to -200.0 V, 2.0 to 200.0 V (-0.2 and 0.2 are available for VMU in differential mode), or 0. |
| point | Number of measurement points. 1 to 1001. |
| source[ ] | Sweep source setup data. |
| value[ ] | Measurement data. |
| status[ ] | Measurement status. 0 (no error), or 1 to 255 (error status). |

## hp4156b_sweepPiv

This function executes a pulsed sweep measurement by the specified channel, and returns the number of measurement points, sweep source data, measurement value and the measurement status.

Array size of source, value and status should be the same together, and it must be greater than or equal to the number of sweep points defined by the hp4156b_setPiv function ('point' parameter).

Before executing this function, set the pulsed sweep source setup by using the hp4156b_setPiv function. If you want to use the synchronous sweep source, execute the hp4156b_setSweepSync function.

**Syntax**

ViStatus_VI_FUNC hp4156b_sweepPiv(ViSession vi, ViInt32 channel, ViInt32 mode, ViReal64 range, ViPInt32 point, ViReal64 source[ ], ViReal64 value[ ], ViInt32 status[ ] );

**Parameters**

| | | | |
|---|---|---|---|
| vi | Instrument handle returned from hp4156b_init( ). | | |
| channel | Channel number of the measurement unit. | | |
| | 1 to 6 (SMU1 to SMU6), 23 (VMU1), or 24 (VMU2). | | |
| mode | Measurement mode. 1 (current measurement, only for SMU) or 2 (voltage measurement). | | |
| range | Measurement range. 0 (auto ranging), positive value (limited auto ranging), or negative value (fixed range). See below. | | |
| | For current measurement: | -1E-11 to -1.0 A, 1E-11 to 1.0 A, or 0. | |
| | For voltage measurement: | -2.0 to -200.0 V, 2.0 to 200.0 V (-0.2 and 0.2 are available for VMU in differential mode), or 0. | |
| point | Number of measurement points. 1 to 1001. | | |
| source[ ] | Sweep source setup data. | | |
| value[ ] | Measurement data. | | |
| status[ ] | Measurement status. 0 (no error), or 1 to 255 (error status). | | |

# hp4156b_timeOut

This function sets a minimum timeout value for driver I/O transactions in milliseconds. The default timeout period is 5 seconds.

**Syntax**

ViStatus_VI_FUNC hp4156b_timeOut(ViSession vi, ViInt32 timeOut);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| timeOut | I/O timeout value for all functions in the driver. in milliseconds. 0 to 2147483647. |

# hp4156b_timeOut_Q

This function returns the timeout value for driver I/O transactions in milliseconds.

**Syntax**

ViStatus_VI_FUNC hp4156b_timeOut_Q(ViSession vi, ViPInt32 pTimeOut);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| pTimeOut | Minimum timeout period that the driver can be set to, in milliseconds. |

# hp4156b_zeroOutput

This function stores the measurement setup of the units, and sets the units to 0 V output. To recover the setup, execute hp4156b_recoverOutput function.

**Syntax**

ViStatus_VI_FUNC hp4156b_zetoOutput(ViSession vi, ViInt32 channel);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hp4156b_init( ). |
| channel | Channel number of the unit to set to the zero output.<br>0 (all unit), 1 to 6 (SMU1 to SMU6), 21 (VSU1), 22 (VSU2), 27 (PGU1), or 28 (PGU2). |

# Driver Functions for the E5250A

Table 2-2 lists all the functions for the E5250A. You will see a brief description of the functions in the table.

For the description, syntax and parameters of the function, refer to the reference section following this table. The driver functions in the reference section will appear in the alphabetical order.

**Table 2-2** **E5250A Driver Function Lists**

| Category | Function | Description |
|---|---|---|
| Miscellaneous | hpe5250a_init | Initializes the E5250A. |
| | hpe5250a_close | Closes the connection with the E5250A. |
| | hpe5250a_reset | Executes the E5250A reset. |
| | hpe5250a_self_test | Executes the E5250A self-test. |
| | hpe5250a_error_query | Queries for the E5250A error code/message. |
| | hpe5250a_error_message | Queries for the driver error. |
| | hpe5250a_revision_query | Queries for the E5250A firmware/driver revisions. |
| | hpe5250a_timeOut | Sets the timeout. |
| | hpe5250a_timeOut_Q | Queries for the timeout setting. |
| | hpe5250a_errorQueryDetect | Sets the automatic error checking. |
| | hpe5250a_errorQueryDetect_Q | Queries for the automatic error checking setting. |
| | hpe5250a_dcl | Sends the Device Clear. |
| | hpe5250a_esr_Q | Queries for the ESR status. |
| | hpe5250a_readStatusByte_Q | Reads the E5250A status byte. |
| | hpe5250a_opc_Q | Checks the E5250A operation completion status. |
| Mode Control | hpe5250a_func | Sets the configuration mode. |
| | hpe5250a_connRuleSeq | Sets the connection rule/sequence. |
| Bias Mode | hpe5250a_biasPort | Selects the input bias port. |
| | hpe5250_biasChanCard | Selects the card for bias mode. |
| | hpe5250_biasChanList | Selects the channel list for bias mode. |
| | hpe5250a_biasState | Sets the bias port state. |
| | hpe5250a_biasChanList_Q | Queries for the bias channel list. |

| Category | Function | Description |
|---|---|---|
| Couple Port | hpe5250a_couplePort | Selects the couple port. |
| | hpe5250a_coupleState | Sets the couple port state. |
| Route Control | hpe5250a_closeList | Closes the channel list. |
| | hpe5250a_openList | Opens the channel list. |
| | hpe5250a_openCard | Opens all output on the card. |
| | hpe5250a_closeList_Q | Queries for the channel list status. |
| | hpe5250a_openList_Q | |
| | hpe5250a_closeCard_Q | Queries for the closed channel list on the card. |
| C/G Compensation | hpe5250a_CompenC | Executes the C/G compensation. |
| | hpe5250a_selectCompenFile | Selects the compensation data file. |
| Diagnostics | hpe5250a_testExec_Q | Executes the relay/front-panel/controller test. |
| | hpe5250a_testClear | Clears the test result. |
| Passthrough Functions | hpe5250a_cmd | Sends a command. |
| | hpe5250a_cmdInt | Sends a command with an integer parameter. |
| | hpe5250a_cmdReal | Sends a command with a real parameter. |
| | hpe5250a_cmdData_Q | Sends a command to read any data. |
| | hpe5250a_cmdString_Q | Sends a command to read string response. |
| | hpe5250a_cmdInt16_Q | Sends a command to read 16 bit integer response. |
| | hpe5250a_cmdInt16Arr_Q | Sends a command to read 16 bit integer array response. |
| | hpe5250a_cmdInt32_Q | Sends a command to read 32 bit integer response. |
| | hpe5250a_cmdInt32Arr_Q | Sends a command to read 32 bit integer array response. |
| | hpe5250a_cmdReal64_Q | Sends a command to read 64 bit real response. |
| | hpe5250a_cmdReal64Arr_Q | Sends a command to read 64 bit real array response. |

## hpe5250a_biasChanCard

This function will enable or disable bias on all the output ports of the specified card.

**Syntax**

ViStatus _VI_FUNC hpe5250a_biasChanCard(ViSession vi,
ViInt16 disable_enable, ViInt16 bias_cardno);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| disable_enable | Bias status.<br>0 : sets bias enabled card.<br>1 : sets bias disabled card. |
| bias_cardno | Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the automatic configuration mode). For the configuration mode, see hpe5250a_func. |

## hpe5250a_biasChanList

This function will enable or disable bias on all the output ports specified by the biaschan_list.

The parameter 'biaschan_list' is an array of integers with each integer representing one channel. The last number of the 'biaschan_list' should be "0" (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

**Syntax**

ViStatus _VI_FUNC hpe5250a_biasChanList(ViSession vi,
ViInt16 biaschan_disen, ViInt32 _VI_FAR biaschan_list[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| biaschan_disen | Bias status.<br>0 : sets bias enabled port.<br>1 : sets bias disabled port. |
| biaschan_list[ ] | Channel numbers. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number.<br>Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101. |

## hpe5250a_biasChanList_Q

This function will query the instrument for the bias status for the channels given in the list.

The parameter ’biaschan_list’ is an array of integers with each integer representing one channel. The last number of the ’biaschan_list’ should be "0" (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

The ’bias_status’ parameter is an array of integers containing the return values of the query. The ’bias_status’ array returned will correspond one to one with ’biaschan_list’ parameter.

**Syntax**

ViStatus _VI_FUNC hpe5250a_biasChanList_Q(ViSession vi, ViInt16 bias_disen, ViInt32 _VI_FAR biaschan_list[ ], ViInt32 _VI_FAR bias_status[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| bias_disen | Bias status for the query.<br>0 : confirms if the port is the bias enabled.<br>1 : confirms if the port is the bias disabled. |
| biaschan_list[ ] | Channel numbers to know the bias status. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101. |
| bias_status[ ] | Bias status of the channels given in the biaschan_list. Returned value depends on the setting of bias_disen as shown below:<br>when bias_disen=0, 0 means bias disabled, 1 means enabled.<br>when bias_disen=1, 0 means bias enabled, 1 means disabled. |

## hpe5250a_biasPort

This function will select which input port is the bias port on the specified card. For each card, you can specify the same or different Bias Port. This function applies only to the E5252A card.

**Syntax**

ViStatus _VI_FUNC hpe5250a_biasPort(ViSession vi, ViInt16 biasport_cardno, ViInt16 bias_port);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| biasport_cardno | Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the automatic configuration mode). For the configuration mode, see hpe5250a_func. |
| bias_port | Input port number to be set to the bias port. 1 to 10 (input port 1 to input port 10). |

## hpe5250a_biasState

This function controls the bias mode for the specified card. When Bias Mode is ON, the input Bias Port is connected to all bias enabled output ports that are not connected to any other input ports. Bias disabled output ports are never connected to the input Bias Port when Bias Mode is ON.

**Syntax**

ViStatus _VI_FUNC hpe5250a_biasState(ViSession vi, ViInt16 biasstate_cardno, ViInt16 state);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| biasstate_cardno | Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the automatic configuration mode). For the configuration mode, see hpe5250a_func. |
| state | Bias mode. 0 (OFF) or 1 (ON). |

## hpe5250a_close

This function terminates the software connection to the instrument and deallocates system resources. It is generally a good programming habit to close the instrument handle when the program is done using the instrument.

**Syntax** ViStatus _VI_FUNC hpe5250a_close(ViSession vi);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |

## hpe5250a_closeCard_Q

This function will query the card for the channels closed of the specified card.

The parameter 'closechan_list' contains the channel numbers returned by the instrument. This will be an array of integers terminated by 'zero' to identify the end of the list. Array of enough length should be passed to the function.

**Syntax** ViStatus _VI_FUNC hpe5250a_closeCard_Q(ViSession vi, ViInt16 close_card, ViInt32 _VI_FAR closechan_list[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| close_card | Card number. 1 (card 1), 2 (card 2), 3 (card 3), or 4 (card 4) in the normal configuration mode, or 0 (all card in the automatic configuration mode). For the configuration mode, see hpe5250a_func. |
| closechan_list[ ] | Channels closed of the specified card. |

## hpe5250a_closeList

This function will connect the input ports to the output ports specified by the channel list.

The parameter 'closechan_list' is an array of integers with each integer representing one channel. The last number of the 'closechan_list' should be "0" (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

**Syntax**

```
ViStatus _VI_FUNC hpe5250a_closeList(ViSession vi,
ViInt32_VI_FAR closechan_list[ ] );
```

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| closechan_list[ ] | Channel numbers to connect. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101. |

## hpe5250a_closeList_Q

This function will query the instrument for the channels closed given in the ’closechan_list’.

The parameter ’closechan_list’ is an array of integers with each integer representing one channel. The last number of the ’closechan_list’ should be "0" (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

The ’close_status’ parameter is an array of integers containing the return values of the query. The ’close_status’ array returned will correspond one to one with ’closechan_list’ parameter.

**Syntax**

ViStatus _VI_FUNC hpe5250a_closeList_Q(ViSession vi,
ViInt32_VI_FAR closechan_list[ ], ViInt32 _VI_FAR close_status[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| closechan_list[ ] | Channel numbers to know the close status. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101. |
| close_status[ ] | Status of the channels given in the closechan_list.<br>0 (opened) or 1 (closed). |

## hpe5250a_cmd

This function passes the cmd_str string to the instrument. Must be a NULL terminated C string.

**Syntax**

ViStatus _VI_FUNC hpe5250a_cmd(ViSession vi, ViString cmd_str);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |

## hpe5250a_cmdData_Q

This function passes the cmd_str string to the instrument. This entry point will wait for a response which may be any data. You specify the cmd_str and size parameters, and get result[ ].

**Syntax**

ViStatus _VI_FUNC hpe5250a_cmdData_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViChar _VI_FAR result[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| size | Length of result in bytes. 2 to 32767. |
| result[ ] | Response from instrument. |

## hpe5250a_cmdInt

This function passes the cmd_str string to the instrument. This entry point passes the string in cmd_str followed by a space and then the integer in value. Note that either an Int16 or 32 can be passed as the Int16 will be promoted.

**Syntax**

ViStatus _VI_FUNC hpe5250a_cmdInt(ViSession vi, ViString cmd_str, ViInt32 value);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| value | Parameter for command. -2147483647 to 2147483647. |

## hpe5250a_cmdInt16Arr_Q

This function passes the cmd_str string to the instrument. This command expects a response that is a definite arbitrary block of 16 bit integers. You specify the cmd_str and size parameters, and get result[ ] and count.

**Syntax**

ViStatus _VI_FUNC hpe5250a_cmdInt16Arr_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViInt16 _VI_FAR result[ ], ViPInt32 count);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| size | Size of result[ ] (number of items in the array).<br>1 to 2147483647. |
| result[ ] | Response from instrument. |
| count | Count of valid items in result[ ]. |

## hpe5250a_cmdInt16_Q

This function passes the cmd_str string to the instrument. This command expects a response that can be returned as a 16 bit integer.

**Syntax**

ViStatus _VI_FUNC hpe5250a_cmdInt16_Q(ViSession vi, ViString cmd_str, ViPInt16 result);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| result | Response from instrument. |

## hpe5250a_cmdInt32Arr_Q

This function passes the cmd_str string to the instrument. This command expects a response that is a definite arbitrary block of 32 bit integers. You specify the cmd_str and size parameters, and get result[ ] and count.

**Syntax**

ViStatus _VI_FUNC hpe5250a_cmdInt32Arr_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViInt32 _VI_FAR result[ ], ViPInt32 count);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| size | Size of result[ ] (number of items in the array).<br>1 to 2147483647. |
| result[ ] | Response from instrument. |
| count | Count of valid items in result[ ]. |

## hpe5250a_cmdInt32_Q

This function passes the cmd_str string to the instrument. This command expects a response that can be returned as a 32 bit integer.

**Syntax**

ViStatus _VI_FUNC hpe5250a_cmdInt32_Q(ViSession vi, ViString cmd_str, ViPInt32 result);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| result | Response from instrument. |

## hpe5250a_cmdReal

This function passes the cmd_str string to the instrument. This entry point passes the string in cmd_str followed by a space and then the real in value. Note that either an Real32 or 64 can be passed as the Real32 will be promoted.

**Syntax** ViStatus _VI_FUNC hpe5250a_cmdReal(ViSession vi, ViString cmd_str, ViReal64 value);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| value | Parameter for command. -1E+300 to 1E+300. |

## hpe5250a_cmdReal64Arr_Q

This function passes the cmd_str string to the instrument. This command expects a response that is a definite arbitrary block of 64 bit reals. You specify the cmd_str and size parameters, and get result[ ] and count.

**Syntax** ViStatus _VI_FUNC hpe5250a_cmdReal64Arr_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViReal64 _VI_FAR result[ ], ViPInt32 count);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| size | Size of result[ ] (number of items in the array).<br>1 to 2147483647. |
| result[ ] | Response from instrument. |
| count | Count of valid items in result[ ]. |

## hpe5250a_cmdReal64_Q

This function passes the cmd_str string to the instrument. This command expects a response that can be returned as a 64 bit real.

**Syntax** ViStatus _VI_FUNC hpe5250a_cmdReal64_Q(ViSession vi, ViString cmd_str, ViPReal64 result);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| result | Response from instrument. |

## hpe5250a_cmdString_Q

This function passes the cmd_str string to the instrument. This entry point will wait for a response which must be a string (character data). You specify the cmd_str and size parameters, and get result[ ].

**Syntax** ViStatus _VI_FUNC hpe5250a_cmdString_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViChar _VI_FAR result[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cmd_str | Instrument command (cannot exceed 256 bytes in length). |
| size | Length of result in bytes. 2 to 32767. |
| result[ ] | Response from instrument. |

## hpe5250a_compenC

This function compensates capacitance/conductance data measured by using Agilent 4284A C meter, and returns compensation results. If you change the compensation data, create the compensation data file, and specify the data file using hpe5250a_selectCompenFile function before executing this function.

**Syntax**

ViStatus _VI_FUNC hpe5250a_compenC(ViSession vi,ViReal64 frequency, ViReal64 len_hptrx, ViReal64 len_usrtrx_h, ViReal64 len_usrtrx_l, ViReal64 len_usrcoax_h, ViReal64 len_usrcoax_l, ViReal64 raw_c, ViReal64 raw_g, ViPReal64 compen_c, ViPReal64 compen_g);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| frequency | Measurement frequency. 1E3 to 1E6 Hz. |
| len_hptrx | Agilent 16494A triaxial cable. 1.5 or 3.0 m. |
| len_usrtrx_h | Triaxial cable length (in m) between connector plate and DUT high terminal. If you do not use triaxial cable, enter 0 (zero). |
| len_usrtrx_l | Triaxial cable length (in m) between connector plate and DUT low terminal. If you do not use triaxial cable, enter 0 (zero). |
| len_usrcoax_h | Coaxial cable length (in m) between connector plate and DUT high terminal. If you do not use coaxial cable, enter 0 (zero). |
| len_usrcoax_l | Coaxial cable length (in m) between connector plate and DUT low terminal. If you do not use coaxial cable, enter 0 (zero). |
| raw_c | Capacitance value (in F) measured by the 4284A. |
| raw_g | Conductance value (in S) measured by the 4284A. |
| compen_c | Capacitance compensation result (in F). |
| compen_g | Conductance compensation result (in S). |

## hpe5250a_connRuleSeq

The function sets connection rule and connection sequence for the specified card.

**Syntax**

```
ViStatus _VI_FUNC hpe5250a_connRuleSeq(ViSession vi,
ViInt16 cardno_ruleseq, ViInt16 rule, ViInt16 sequence);
```

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| cardno_ruleseq | Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the automatic configuration mode). For the configuration mode, see hpe5250a_func. |
| rule | Connection rule. 0 (free route) or 1 (single route). |
| sequence | Connection sequence. 0, 1, or 2. See below.<br>0 (no sequence)<br>1 (break before make)<br>2 (make before break) |

# hpe5250a_couplePort

This function sets the couple ports which are used for making kelvin connections on the specified card. The specified input port number will be coupled with the next input port and two output ports. For each card, you may setup the same or different couple ports. This command overwrites the previous couple port setting for the card. This command applies only to the E5252A card.

The couple port mode is controlled by the hpe5250a_coupleState function.

**Syntax**

ViStatus _VI_FUNC hpe5250a_couplePort(ViSession vi,
ViInt16 coupleport_cardno, ViInt16 port1, ViInt16 port3, ViInt16 port5,
ViInt16 port7, ViInt16 port9);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| coupleport_cardno | Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the automatic configuration mode). For the configuration mode, see hpe5250a_func. |
| port1 | Couple port by the input ports 1 and 2.<br>0 (disable) or 1 (enable). |
| port3 | Couple port by the input ports 3 and 4.<br>0 (disable) or 1 (enable). |
| port5 | Couple port by the input ports 5 and 6.<br>0 (disable) or 1 (enable). |
| port7 | Couple port by the input ports 7 and 8.<br>0 (disable) or 1 (enable). |
| port9 | Couple port by the input ports 9 and 10.<br>0 (disable) or 1 (enable). |

## hpe5250a_coupleState

This function controls the couple port mode for the specified card. This function applies only to the E5252A card.

**Syntax**

ViStatus _VI_FUNC hpe5250a_coupleState(ViSession vi,
ViInt16 couplestate_cardno, ViInt16 couple_state);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| couplestate_cardno | Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the automatic configuration mode). For the configuration mode, see hpe5250a_func. |
| couple_state | Couple port mode. 0 (OFF) or 1 (ON). |

## hpe5250a_dcl

This function sends a device clear (DCL) to the instrument.

A device clear will abort the present operation and enable the instrument to accept a new command or query.

This is particularly useful in situations where it is not possible to determine the instrument state. In this case, it is customary to send a device clear before issuing a new instrument driver function. The device clear ensures that the instrument will be able to begin processing the new commands.

**Syntax**

ViStatus _VI_FUNC hpe5250a_dcl(ViSession vi);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |

## hpe5250a_error_message

This function translates the error return value from an instrument driver function to a readable string.

**Syntax**

ViStatus _VI_FUNC hpe5250a_error_message(ViSession vi, ViStatus error_number, ViChar _VI_FAR message[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| error_number | Error return value from the driver function. |
| message[ ] | Error message string. This is limited to 256 characters. |

## hpe5250a_error_query

This function returns the error numbers and corresponding error messages in the error queue of a instrument. See Agilent E5250A *User's Guide* for a listing of the instrument error numbers and messages.

Instrument errors may occur when you places the instrument in a bad state such as sending an invalid sequence of coupled commands. Instrument errors can be detected by polling. Automatic polling can be accomplished by using the hpe5250a_errorQueryDetect function.

**Syntax**

ViStatus _VI_FUNC hpe5250a_error_query(ViSession vi, ViPInt32 error_number, ViChar _VI_FAR error_message[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| error_number | Instrument's error code. |
| error_message[ ] | Instrument's error message. This is limited to 256 characters. |

## hpe5250a_errorQueryDetect

This function enables or disables automatic instrument error checking.

If automatic error checking is enabled then the driver will query the instrument for an error at the end of each function call.

**Syntax**

ViStatus _VI_FUNC hpe5250a_errorQueryDetect(ViSession vi,
ViBoolean errorQueryDetect);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| errorQueryDetect | Error checking enable (VI_TRUE) or disable (VI_FALSE). |

## hpe5250a_errorQueryDetect_Q

This function indicates if automatic instrument error detection is enabled or disabled.

**Syntax**

ViStatus _VI_FUNC hpe5250a_errorQueryDetect_Q(ViSession vi,
ViPBoolean pErrDetect);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| pErrDetect | Error checking enable (VI_TRUE) or disable (VI_FALSE). |

## hpe5250a_esr_Q

This function returns the contents of the ESR register. The driver returns the equivalent messages (see Parameters).

**Syntax** ViStatus _VI_FUNC hpe5250a_esr_Q(ViSession vi, ViChar _VI_FAR errstr[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| errstr[ ] | Response from instrument. |

| Bit Value | Message |
|---|---|
| 1 | "ESR_OPC" |
| 2 | "ESR_RQL" |
| 4 | "ESR_QYE_ERROR" |
| 8 | "ESR_DEVICE_DEPENDENT_ERROR" |
| 16 | "ESR_EXECUTION_ERROR" |
| 32 | "ESR_COMMAND_ERROR" |
| 64 | "ESR_URQ" |
| 128 | "ESR_PON" |
| OTHERS | "ESR_MULTI_EVENT" |

## hpe5250a_func

This function is used to set the channel configuration to the auto configuration mode or the normal configuration mode.

**Syntax** ViStatus _VI_FUNC hpe5250a_func(ViSession vi, ViInt16 channel_config);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| channel_config | Configuration mode. 0 (auto) or 1 (normal). |

## hpe5250a_init

This function initializes the software connection to the instrument and optionally verifies that instrument is in the system. In addition, it may perform any necessary actions to place the instrument in its reset state.

If the hpe5250a_init function encounters an error, then the value of the vi output parameter will be VI_NULL.

**Syntax**

```
ViStatus _VI_FUNC hpe5250a_init(ViRsrc InstrDesc, ViBoolean id_query,
ViBoolean do_reset, ViPSession vi);
```

**Parameters**

| | |
|---|---|
| InstrDesc | Instrument description. Examples; GPIB0::1::INSTR. |
| id_query | VI_TRUE (to perform In-System Verification), or VI_FALSE (do not perform In-System Verification). |
| do_reset | VI_TRUE (to perform reset operation), or VI_FALSE (do not perform reset operation). |
| vi | Instrument handle. This is VI_NULL if an error occurred during the init. |

## hpe5250a_opc_Q

This function does the *OPC? common command.

**Syntax**

```
ViStatus _VI_FUNC hpe5250a_opc_Q(ViSession vi, ViPBoolean result);
```

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| result | VI_TRUE (Operation complete), or VI_FALSE (Operation is pending). |

## hpe5250a_openCard

This function will disconnect all input ports from all output ports for the specified card. Then if bias mode is ON, connects the input bias port to all bias enabled output ports.

**Syntax**

ViStatus _VI_FUNC hpe5250a_openCard(ViSession vi, ViInt16 open_cardno);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| open_cardno | Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the automatic configuration mode). For the configuration mode, see hpe5250a_func. |

## hpe5250a_openList

This function will disconnect the input ports from the output ports specified by the channel list.

The parameter 'openchan_list' is an array of integers with each integer representing one channel. The last number of the 'openchan_list' should be "0" (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

**Syntax**

ViStatus _VI_FUNC hpe5250a_openList(ViSession vi,
ViInt32_VI_FAR openchan_list[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| openchan_list[ ] | Channel numbers to disconnect. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101. |

## hpe5250a_openList_Q

This function will query the instrument for the channels open given in the 'openchan_list'.

The parameter 'openchan_list' is an array of integers with each integer representing one channel. The last number of the 'openchan_list' should be "0" (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

The 'open_status' parameter is an array of integers containing the return values of the query. The 'open_status' array returned will correspond one to one with 'openchan_list' parameter.

**Syntax**

ViStatus _VI_FUNC hpe5250a_openList_Q(ViSession vi,
ViInt32_VI_FAR openchan_list[ ], ViInt32 _VI_FAR open_status[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| openchan_list[ ] | Channel numbers to know the open status. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101. |
| open_status[ ] | Status of the channels given in the openchan_list.<br>1 (opened) or 0 (closed). |

## hpe5250a_readStatusByte_Q

This function returns the contents of the status byte register.

**Syntax**

ViStatus _VI_FUNC hpe5250a_readStatusByte_Q(ViSession vi,
ViPInt16 statusByte);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| statusByte | The contents of the status byte are returned in this parameter. |

## hpe5250a_reset

This function places the instrument in a default state. Before issuing this function, it may be necessary to send a device clear to ensure that the instrument can execute a reset. A device clear can be issued by invoking hpe5250a_dcl function.

**Syntax**

ViStatus _VI_FUNC hpe5250a_reset(ViSession vi);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |

## hpe5250a_revision_query

This function returns the driver revision and the instrument firmware revision.

**Syntax**

ViStatus _VI_FUNC hpe5250a_revision_query(ViSession vi,
ViChar_VI_FAR driver_rev[ ] , ViChar _VI_FAR instr_rev[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| driver_rev[ ] | Instrument driver revision. This is limited to 256 characters. |
| instr_rev[ ] | Instrument firmware revision. This is limited to 256 characters. |

## hpe5250a_selectCompenFile

This function specifies capacitance/conductance compensation data file used to compensate C/G by using hpe5250a_compenC.

**Syntax**

ViStatus _VI_FUNC hpe5250a_selectCompenFile(ViSession vi, ViString file_name);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| file_name | Compensation data file name. Use absolute path. If the value is NULL string, the default data is used. |

**Remarks**

If you change the compensation data, copy the default data shown below, and modify the data for your measurement cable. You will need to change the data for DATA05 and 06, and/or DATA07 and 08 corresponding to your cables. To measure and change the compensation data, refer to Agilent E5250A *User's Guide*. To get the R, L, and C value, measure R, L, and C of the cable using the 4284A, and divide them by cable length (in m). Compensation data must be the value for 1 m length. Do not change the data format in the file.

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

## hpe5250a_self_test

This function causes the instrument to perform a self-test and returns the result of that self-test. This is used to verify that an instrument is operating properly. A failure may indicate a potential hardware problem.

**Syntax**

ViStatus _VI_FUNC hpe5250a_self_test(ViSession vi, ViPInt16 test_result, ViChar_VI_FAR test_message[ ] );

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| test_result | Numeric result from self-test operation. 0: No error. |
| test_message[ ] | Self-test status message. This is limited to 256 characters. |

## hpe5250a_testClear

This function clears the test result for the specified relay card or the front panel or the controller.

**Syntax**

ViStatus _VI_FUNC hpe5250a_testClear(ViSession vi, ViInt16 framecard_clear);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| framecard_clear | Test result to be cleared. 0, 1, 2, 3, 4, 5, 6, or 7. See below. |
| | 0 (test result of all test) |
| | 1 (card 1 relay test result) |
| | 2 (card 2 relay test result) |
| | 3 (card 3 relay test result) |
| | 4 (card 4 relay test result) |
| | 5 (relay test result of all card) |
| | 6 (front panel test result) |
| | 7 (controller test result) |

## hpe5250a_testExec_Q

This function executes the controller test, the front panel test, or the relay test for the specified card. You must attach the relay test adapter before executing the relay test. The Front Panel test requires the key to be pressed within 10 seconds else the test will fail.

**Syntax**

ViStatus _VI_FUNC hpe5250a_testExec_Q(ViSession vi, ViInt16 framecard_exec, ViPInt16 exec_result);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| framecard_exec | Test to be executed. 1 (card 1 relay test) to 4 (card 4 relay test), 5 (relay test for all card), 6 (front panel test), or 7 (controller test). |
| exec_result | Test result. 0: No error. |

## hpe5250a_timeOut

This function sets a minimum timeout value for driver I/O transactions in milliseconds. The default timeout period is 2 seconds.

**Syntax**

ViStatus_VI_FUNC hpe5250a_timeOut(ViSession vi, ViInt32 timeOut);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| timeOut | I/O timeout value for all functions in the driver. in milliseconds. 0 to 2147483647. |

## hpe5250a_timeOut_Q

This function returns the timeout value for driver I/O transactions in milliseconds.

**Syntax**

ViStatus_VI_FUNC hpe5250a_timeOut_Q(ViSession vi, ViPInt32 pTimeOut);

**Parameters**

| | |
|---|---|
| vi | Instrument handle returned from hpe5250a_init( ). |
| pTimeOut | Minimum timeout period that the driver can be set to, in milliseconds. |

# 3 Programming Examples Using Agilent VEE

This chapter describes how to create measurement programs using Agilent VEE and the VXI*plug&play* driver for Agilent 4155/4156, and provides programming examples.

This chapter contains the following sections:

- "Programming Basics"
- "High-Speed Spot Measurements"
- "Multi-Channel Spot Measurements"
- "Staircase Sweep Measurements"
- "Synchronous Sweep Measurements"
- "Multi-Channel Sweep Measurements"
- "Pulsed Spot Measurements"
- "Multi-Channel Pulsed Spot Measurements"
- "Pulsed Sweep Measurements"
- "Multi-Channel Pulsed Sweep Measurements"
- "Staircase Sweep with Pulsed Bias Measurements"
- "Sampling Measurements"
- "Stress Force"

# Programming Basics

This section covers the following topics.

- "Registrating the Driver on Agilent VEE"
- "Basic Objects to Control the Instrument"
    - "To display the To/From object"
    - "To define transactions in the To/From object"
    - "To set input parameters"
    - "To use the Help function"
    - "To use input variables"
    - "To create output terminals in the To/From object"
    - "To display/connect the Data object"
    - "To display/connect the Display object"
- "Debugging Your Program"
- "Restrictions When Using the Driver with Agilent VEE"

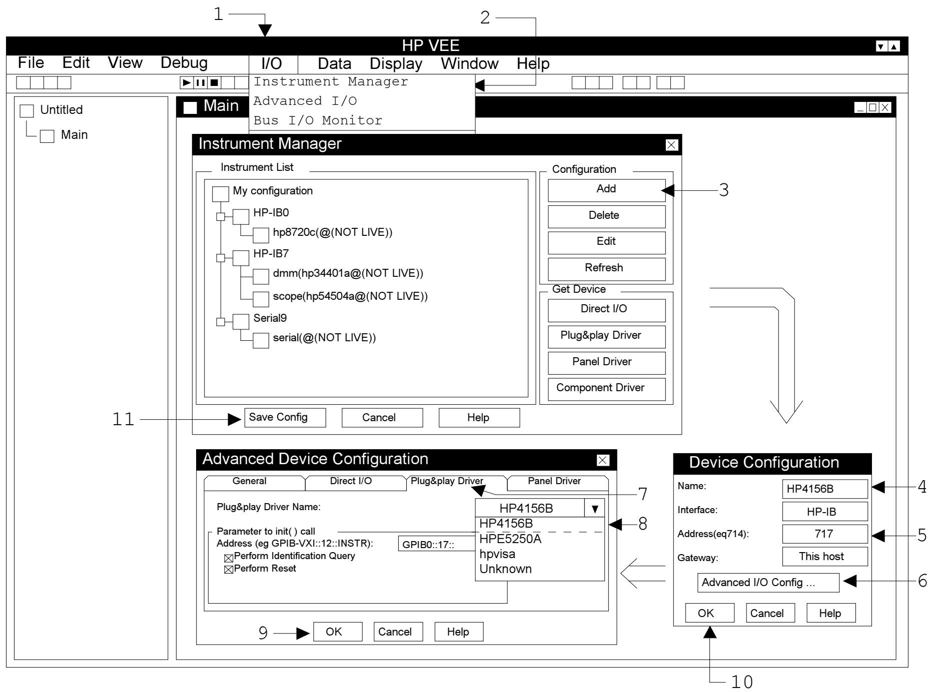
## Registrating the Driver on Agilent VEE

To use the VXI*plug&play* driver on Agilent VEE, register the driver as described below and as shown in Figure 3-1 on page 3-5.

1. Click the I/O menu.
2. Select Instrument Manager from the I/O menu. The Instrument Manager dialog box is displayed. The dialog box lists the available devices (instruments). If this is the first time using Agilent VEE, only off-line (NOT LIVE) devices are shown in the Instrument List.
3. Click Add. The Device Configuration dialog box is displayed.
4. Enter the device name in the Name field. The example shown in Figure 3-1 sets "HP4156B".
5. Enter the GPIB address for the device in the Address field. The example shown in Figure 3-1 sets "717".
6. Click Advanced I/O Config. The Advanced Device Configuration dialog box is displayed.
7. Click the Plug&play Driver tab.
8. Select HP4156B in the Plug&play Driver Name field to configure the 4155/4156 driver. If the driver is not installed properly, "HP4156B" is not available in this field. Install the driver properly at this time.
9. Click OK to close the Advanced Device Configuration dialog box.
10. Click OK to close the Device Configuration dialog box.
11. Click Save Config to save the configuration of the drivers. The Instrument Manager dialog box is closed.

You can now use the VXI*plug&play* driver for the 4155/4156.

**Figure 3-1 Registering the Driver on Agilent VEE**

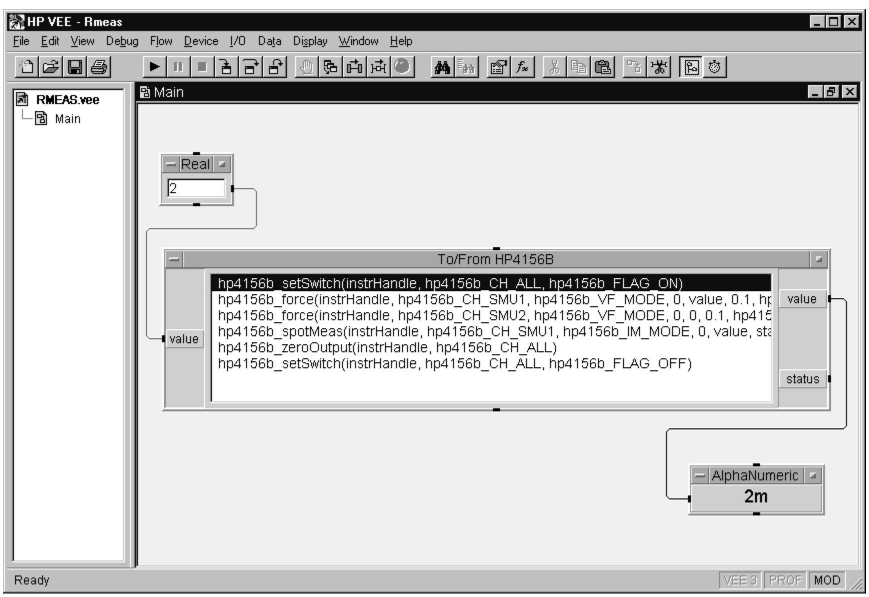


## Basic Objects to Control the Instrument

You can create programs using Agilent VEE and the VXI*plug&play* driver, as shown in the following steps. In this procedure you use only three objects; To/From, Data, and Display, shown in Figure 3-2.

1. Display the To/From object for the VXI*plug&play* driver.
2. Define the transactions (functions of the driver) in the To/From object.
3. Set the input parameters for the transaction.
4. (Optional: Use a variable for the input parameter.)
5. Repeat steps 2, 3, and 4 to complete the To/From object.
6. Connect the input terminals of the To/From object to the Data object.
7. Connect the output terminals of the To/From object to the Display object.
8. Complete the Agilent VEE program.

**Figure 3-2** **Basic Objects of Agilent VEE**



The To/From HP4156B object, in Figure 3-2, defines the following transactions (functions of the *plug&play* driver) to measure the current flow to a resistor.

| | |
|---|---|
| hp4156b_setSwitch | This function controls the 4155/4156 output switch. |
| hp4156b_force | This function forces dc voltage or current. |
| hp4156b_spotMeas | This function executes a spot measurement. |
| hp4156b_zeroOutput | This function disables the 4155/4156 output. |

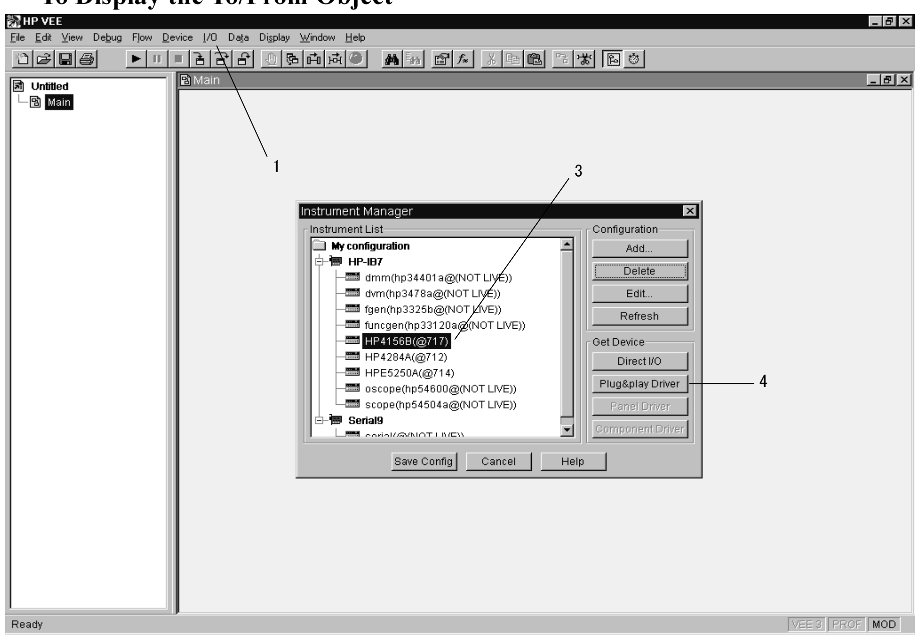
## To display the To/From object

You can display the To/From object as shown below.

1. Click I/O menu.
2. Select Instrument Manager to display the Instrument Manager dialog box.
3. Select HP4156B in the Instrument List.
4. Click Plug&play Driver.

The Instrument Manager dialog box is then closed, and the To/From HP4156B object will be displayed by moving the mouse pointer to the appropriate point, then clicking the left mouse button.

**Figure 3-3** **To Display the To/From Object**

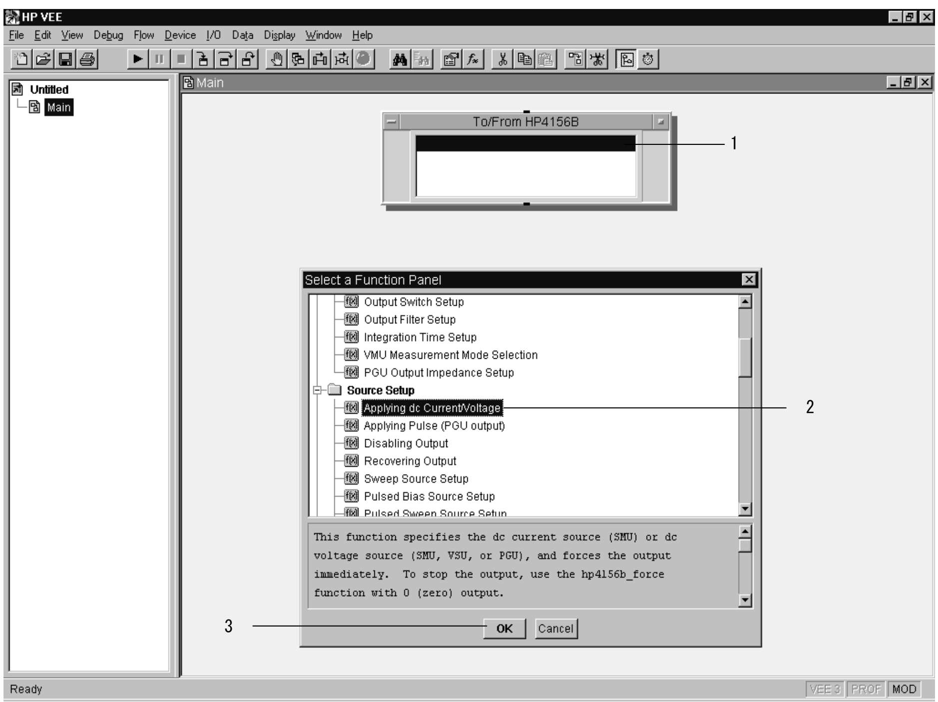


## To define transactions in the To/From object

You can define transactions (functions of *plug&play* driver) as shown in the following example.

1. Double click the blue stripe on the To/From object. The Select a Function Panel dialog box is displayed. The dialog box lists the functions available for the instrument, and displays the Help message for the selected function.
2. Select the function you want to add to the To/From object. Figure 3-4 selects the "Applying dc Current/Voltage" function, and displays the Help message for that function.
3. Click OK. The Select a Function Panel dialog box is closed, and the Edit Function Panel dialog box is displayed. See Figure 3-5 on page 3-9.

**Figure 3-4** **To Define Transactions**




**NOTE**

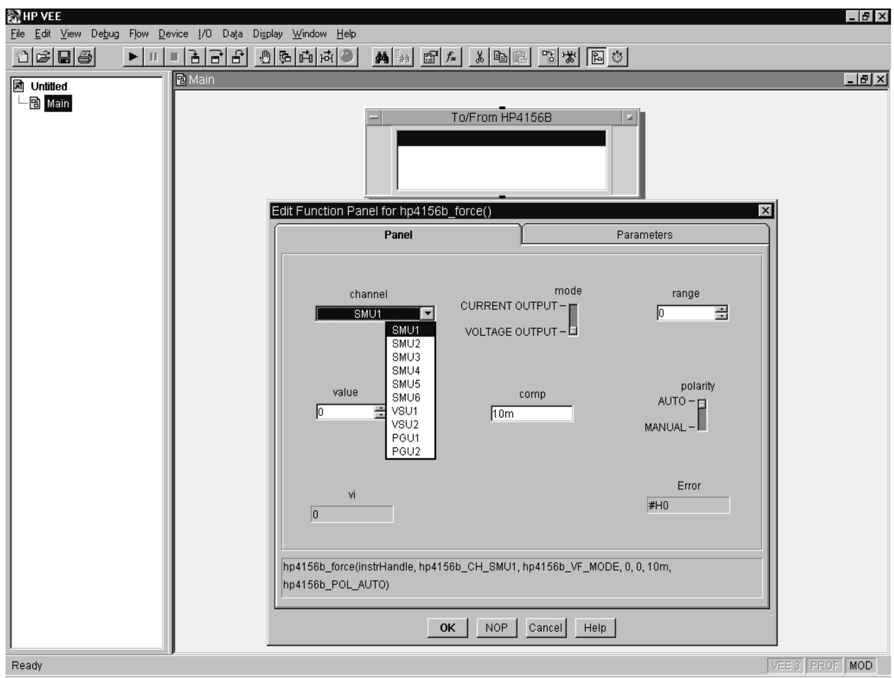
To add, insert, cut, copy, or paste the transaction, click the right mouse button on the To/From object, then select Add Trans, Insert Trans, Cut Trans, Copy Trans, or Paste Trans.

## To set input parameters

You can set the input parameter value using the Edit Function Panel dialog box. Figure 3-5 sets the following values for the input parameters of the hp4156b_force function, which forces dc current or voltage.

| | |
|---|---|
| channel | SMU1 |
| mode | VOLTAGE OUTPUT |
| range (output range) | 0 (auto range) |
| value | 0 V |
| compliance | 10 mA |
| polarity | AUTO |

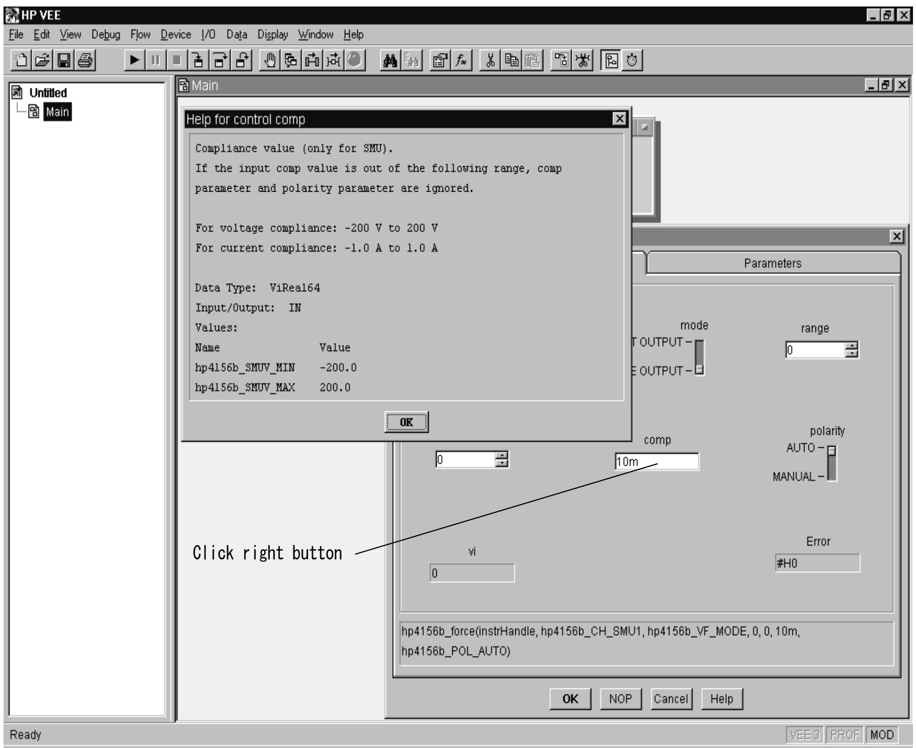
**Figure 3-5** **To Set Input Parameters**



## To use the Help function

If you need to know the details for each parameter in order to enter the parameter value, move the mouse pointer to the appropriate entry field, then click the right mouse button. The context-based Help function will be displayed. Figure 3-6 shows the Help message for the *comp* entry field.

**Figure 3-6** **Help Function**




**NOTE**

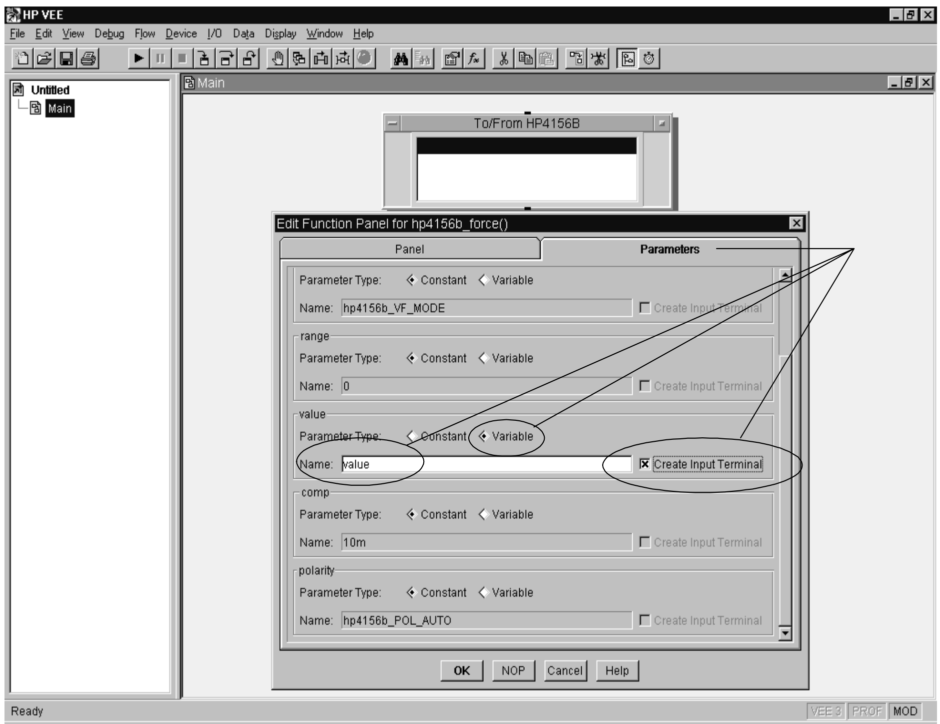
To open on-line Help for the *plug&play* driver, click the right mouse button in the To/From object, then select "Instrument Help".

### To use input variables

Most of the Edit Function Panel dialog boxes have two tabs, Panel and Parameters. To change the value, enter the value in the Panel tab.

If you pass the value from another object, such as Data-Real object, click the Parameters tab, and use Variable (not Constant). See Figure 3-7.

**Figure 3-7 To Use Input Variables**




**NOTE**

You can add terminals, after closing the dialog box, by placing the mouse pointer on the terminal area in the object and pressing Ctrl-A. You can also delete terminals by placing the mouse pointer on the terminal name you want to delete, and pressing Ctrl-D.

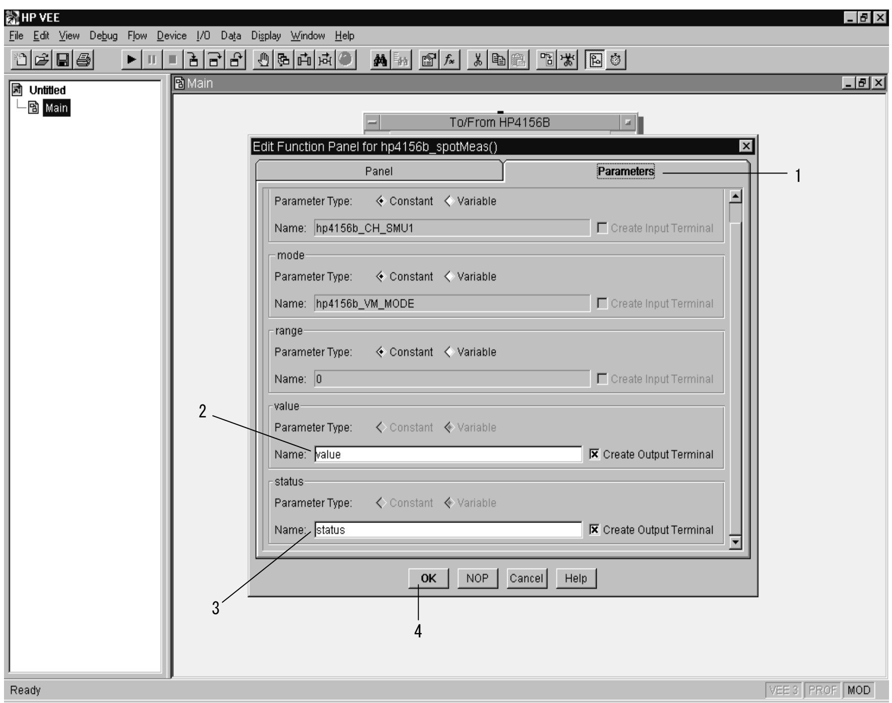
## To create output terminals in the To/From object

Figure 3-8 shows the Edit Function Panel dialog box of the hp4156b_spotMeas function. These measurement transactions need the output terminals in the To/From object. You can create the output terminal as shown in the following example.

1. Click the Parameters tab.
2. Enter the Name (output terminal name) for the output variable *value*.
3. Enter the Name (output terminal name) for the output variable *status*.
4. Click OK. The dialog box is closed, the transaction is added to the To/From object, and the output terminals are created in the object.

The output terminal will be created with the default name if steps 2 and 3 are omitted.

**Figure 3-8** **To Create Output Terminals**



## To display/connect the Data object

In Figure 3-9, the Data-Real object is used to pass the input parameter value to the *value* input variable of the hp4156b_force transaction.

You can display the Data-Real object by clicking the Data menu, selecting Constant, and then selecting Real. To pass the value, connect the output terminal of the Data-Real object to the input terminal of the To/From HP4156B object.

**NOTE**

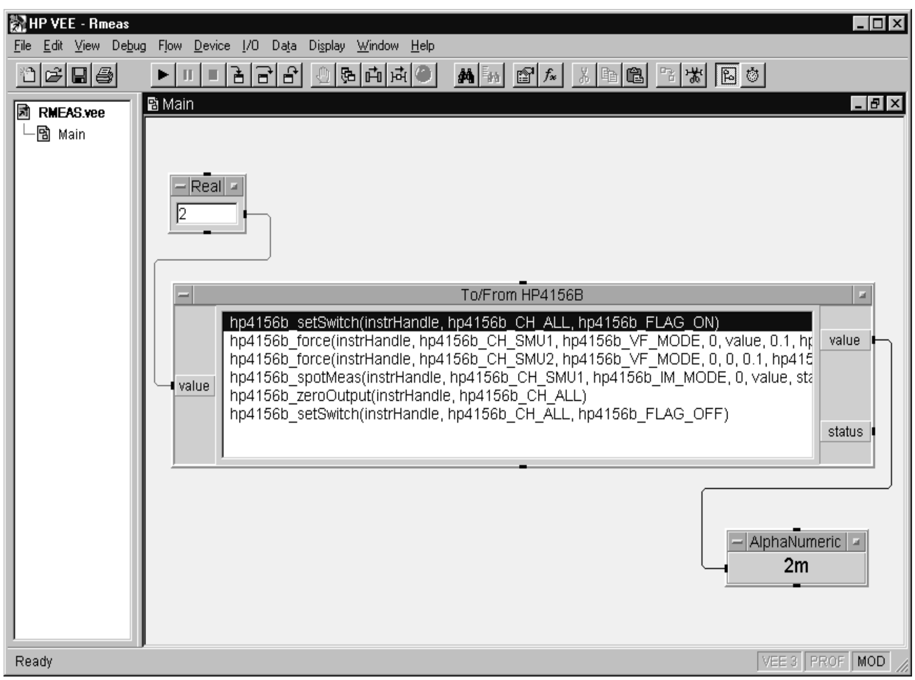
Confirm the data type of the input variable. The data type of the Data object must be the same as the data type for the input parameter.

## To display/connect the Display object

In Figure 3-9, the Display-AlphaNumeric object is used to display the measurement data (*result* output variable) from the hp4156b_spotMeas transaction.

You can display the Display-AlphaNumeric object by clicking the Display menu, and selecting AlphaNumeric. To display the value, connect the output terminal of the To/From HP4156B object to the input terminal of the Display-AlphaNumeric object.

**Figure 3-9** **To Connect Input/Output Terminals**



## Debugging Your Program

You may encounter problems when creating programs to control the 4155/4156. In the program development or debugging phase, insert the following transactions (functions of the driver) in the To/From object. Do not forget to remove the functions after completing the program. These functions will cause increased program execution time.

- hp4156b_cmd(instrHandle,”US”)
- hp4156b_errorQueryDetect

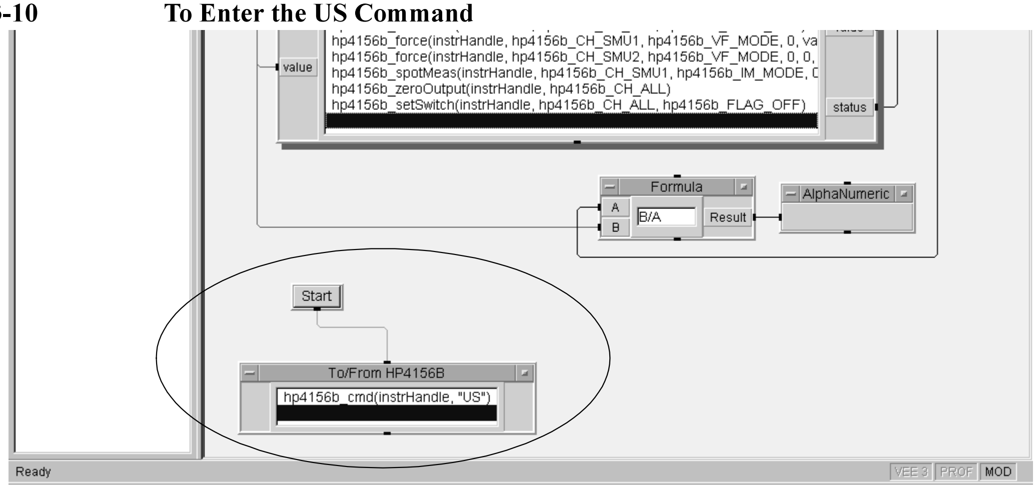
### To recover control mode

When using Agilent VEE, the 4155/4156 control mode is controlled by the hp4156b_init function, which is automatically called and executed by Agilent VEE when the program first runs after loading.

However, if you press any PAGE CONTROL key or LOCAL softkey on the 4155/4156 front panel after program execution, the control mode is changed. Also, if an unexpected I/O error has occurred, you may need to do a hardware reset which changes the control mode. Once the control mode is changed, the program cannot run without reloading it.

To recover the control mode without reloading the program, enter the US command using the hp4156b_cmd function as shown in Figure 3-10. The command recovers the effective control mode for the *plug&play* driver.

**Figure 3-10** **To Enter the US Command**



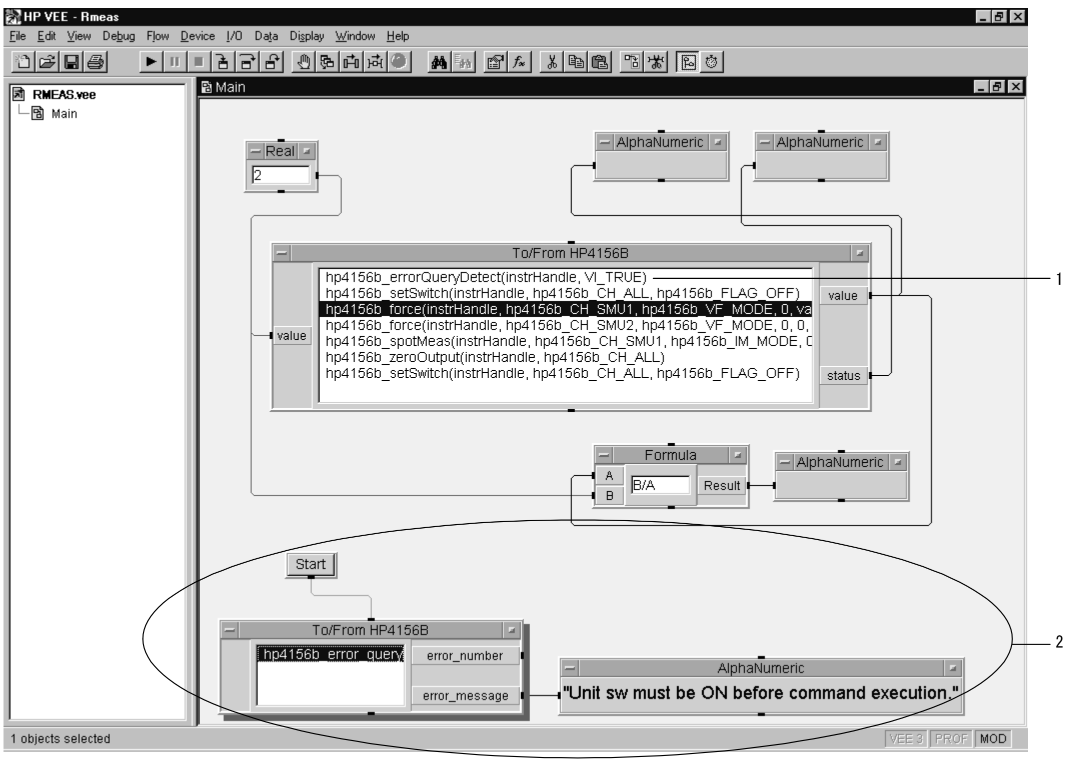
## To check for instrument error

The hp4156b_errorQueryDetect function enables or disables automatic instrument error checking. If automatic error checking is enabled, the driver will query the instrument for an error at the end of each function call.

If this function is enabled (1 of Figure 3-11) and if an error occurs in the function call, Agilent VEE stops the program execution and displays an error dialog box. You must then enter the hp4156b_error_query function (see 2 of Figure 3-11). The hp4156b_error_query function returns the instrument error code and error message.

In this example, an error occurred in the hp4156b_force function call. The cause of the error was an improper parameter setting for the hp4156b_setSwitch function.

**Figure 3-11** **To Use the hp4156b_error_query Function**



## Restrictions When Using the Driver with Agilent VEE

When using Agilent VEE and any of the following functions for Agilent 4155/4156 and Agilent E5250A, certain restrictions will apply.

### Invalid functions in the VEE program

- hp4156b_init, hpe5250a_init

  Agilent VEE calls and executes these functions automatically when the program first runs after loading. These functions cannot be called in a program using Agilent VEE.

- hp4156b_close, hpe5250a_close

  Agilent VEE calls and executes these functions automatically when you close the program or Agilent VEE. These functions cannot be called in a program using Agilent VEE.

- hp4156b_error_message, hpe5250a_error_message

  These functions receive the error status of the plug&play driver function, and returns the error message. However, these functions are invalid in a program using Agilent VEE, because Agilent VEE does not pass the error status to the function.

### Invalid use of the NULL pointer

The measurement functions listed below allow you to use the NULL pointer to restrict the number of parameters returned from the function. However, the NULL pointer is not available for Agilent VEE programming.

- hp4156b_spotMeas
- hp4156b_sweepIv
- hp4156b_sweepMiv
- hp4156b_sweepPiv
- hp4156b_sweepPbias
- hp4156b_measureM
- hp4156b_measureP
- hp4156b_sample
- hp4156b_readData

# High-Speed Spot Measurements

To make high-speed spot measurements, use the following functions.

**Table 3-1 Functions for High-Speed Spot Measurements**

| Description | Function | Parameters |
|---|---|---|
| Output Switch Setup | hp4156b_setSwitch | channel,state |
| Output Filter Setup | hp4156b_setFilter | channel,state |
| Integration Time Setup | hp4156b_setInteg | table,time,average |
| Forces dc bias | hp4156b_force | channel,mode,range,value,compliance,polarity |
| Executes measurement | hp4156b_spotMeas | channel,mode,range,value,status |
| Disables output | hp4156b_zeroOutput | channel |

A program example is shown in Figure 3-13 on page 3-18. This program measures MOSFET drain current. The measurement setup is shown in Figure 3-12.

**Figure 3-12 Device Connection and Source Setup for Example Program**

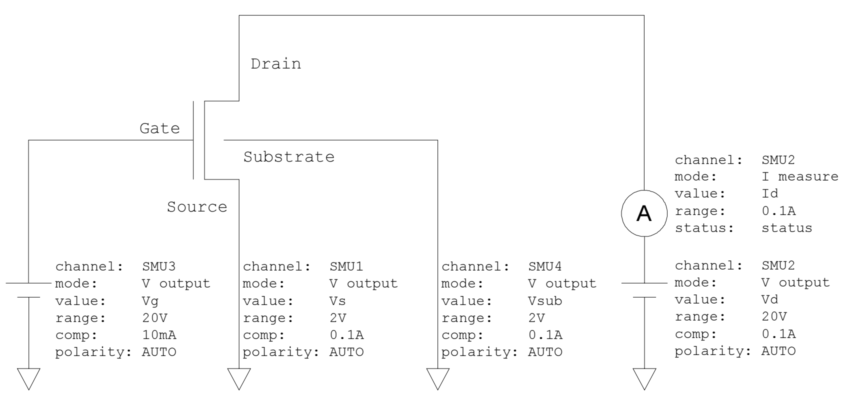


**Figure 3-13** **Program Example of High-Speed Spot Measurement**

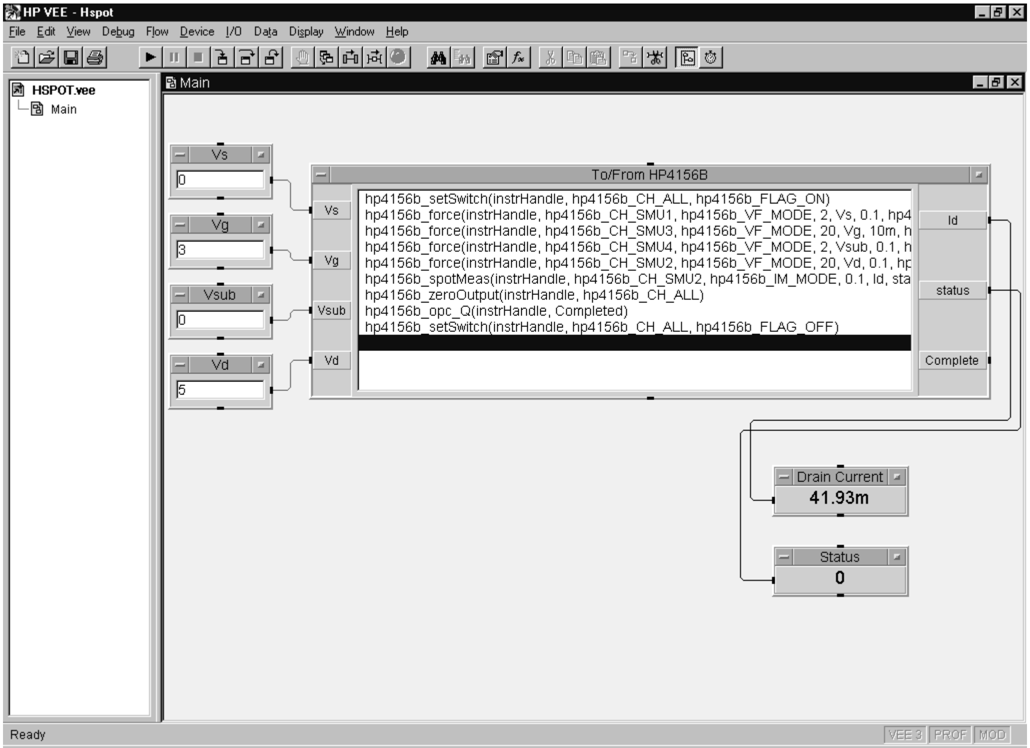



**Table 3-2** **Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Vs,Vg,Vsub,Vd | Data-Constant-Real | Enters input parameters of hp4156b_force. |
| To/From HP4156B | I/O-InstrumentManager-Plug&play | Executes measurement. |
| Drain Current | Display-AlphaNumeric | Displays Id. (hp4156b_spotMeas value parameter) |
| Status | Display-AlphaNumeric | Displays status. (hp4156b_spotMeas status parameter) |

# Multi-Channel Spot Measurements

To make multi-channel spot measurements, use the following functions.

**Table 3-3 Functions for Multi-Channel Spot Measurements**

| Description | Function | Parameters |
|---|---|---|
| Output Switch Setup | hp4156b_setSwitch | channel,state |
| Output Filter Setup | hp4156b_setFilter | channel,state |
| Integration Time Setup | hp4156b_setInteg | table,time,average |
| Forces dc bias | hp4156b_force | channel,mode,range,value,compliance,polarity |
| Executes measurement | hp4156b_measureM | channel[ ],mode[ ],range[ ],value[ ],status[ ] |
| Disables output | hp4156b_zeroOutput | channel |

A program example is shown in Figure 3-15 on page 3-20. This program measures bipolar transistor collector current and base current. The example uses the User object of the Agilent VEE. See Figure 3-16 on page 3-21. The measurement setup is shown in Figure 3-14.

**Figure 3-14 Device Connection and Source Setup for Example Program**

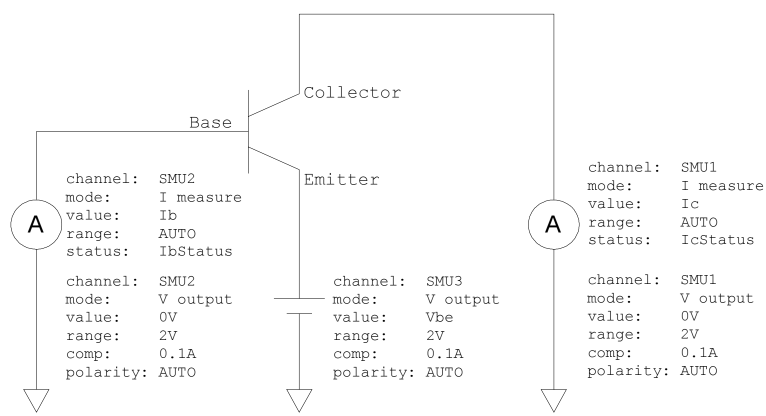


**Figure 3-15 Program Example of Multi-Channel Spot Measurement**

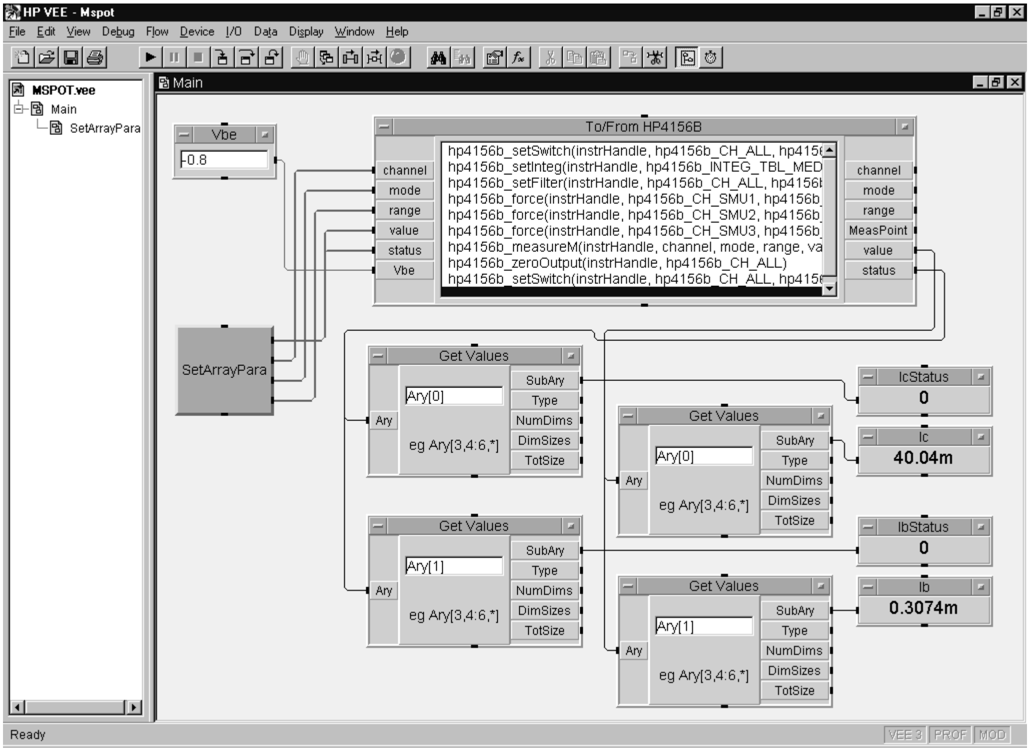



**Table 3-4 Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Vbe | Data-Constant-Real | Enters input parameters of hp4156b_force. |
| To/From HP4156B | I/O-InstrumentManager-Plug&play | Executes measurement. |
| GetValues | Data-AccessArray-GetValues | Gets data from Array (value[ ], status[ ]). |
| IcStatus,Ic, IbStatus,Ib | Display-AlphaNumeric | Displays measurement data/status. (hp4156b_measureM output parameters) |

**Figure 3-16 SetArrayPara User Object**

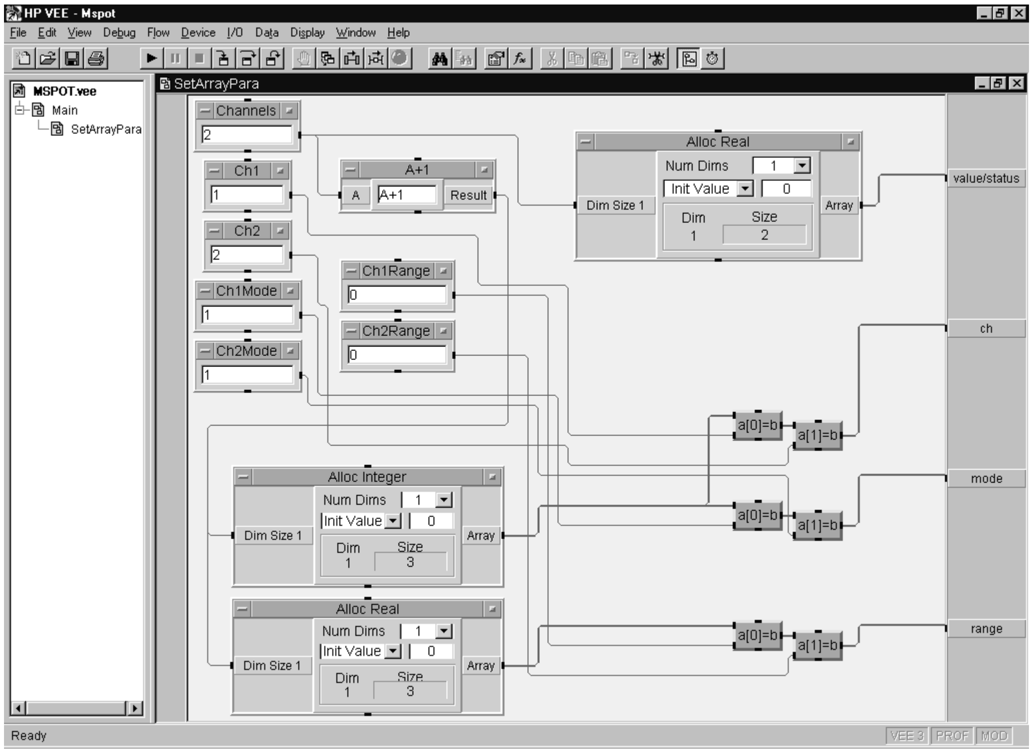



**Table 3-5 Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Channels,Ch1,Ch2, Ch1Mode,Ch2Mode, Ch1Range,Ch2Range | Data-Constant-Integer<br>Data-Constant-Real | Enters data to allocate array, and array element for channel[ ], mode[ ], range[ ] of hp4156b_measureM. |
| A+1 | Device-Formula | Calculates A+1 to allocate array. |
| AllocReal, AllocInteger | Data-AllocateArray-Real<br>Data-AllocateArray-Integer | Allocates array for channel[ ], mode[ ], range[ ] of hp4156b_measureM. |
| a[0]=b, a[1]=b | Data-AccessArray-SetValues | Sets data of array (array element). |

# Staircase Sweep Measurements

To make staircase sweep measurements, use the following functions.

**Table 3-6 Functions for Staircase Sweep Measurements**

| Description | Function | Parameters |
|---|---|---|
| Output Switch Setup | hp4156b_setSwitch | channel,state |
| Output Filter Setup | hp4156b_setFilter | channel,state |
| Integration Time Setup | hp4156b_setInteg | table,time,average |
| Forces dc bias | hp4156b_force | channel,mode,range,value,compliance,polarity |
| Sweep Source Setup | hp4156b_setIv | channel,mode,range,start,stop,point,hold,delay, s_delay,comp,p_comp |
| Executes measurement | hp4156b_sweepIv | channel,mode,range,point,source[ ],value[ ], status[ ] |
| Disables output | hp4156b_zeroOutput | channel |

A program example is shown in Figure 3-18 on page 3-23. This program measures MOSFET Id-Vd characteristics. The measurement setup is shown in Figure 3-17.

**Figure 3-17 Device Connection and Source Setup for Example Program**

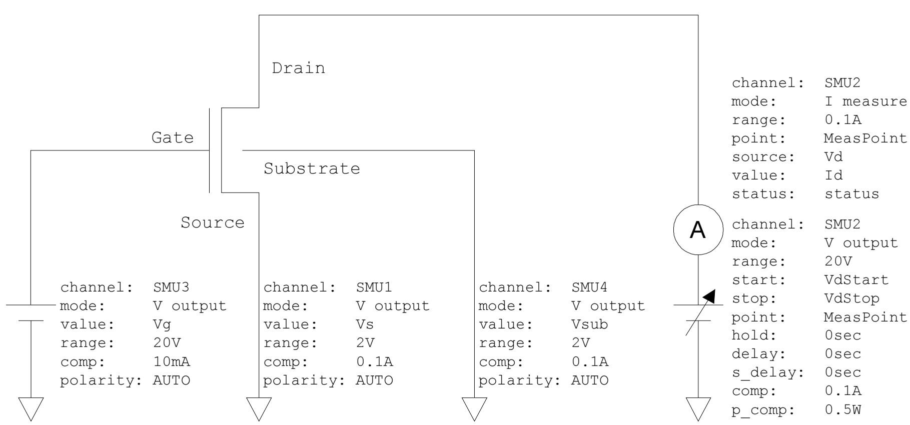


**Figure 3-18 Program Example of Staircase Sweep Measurement**

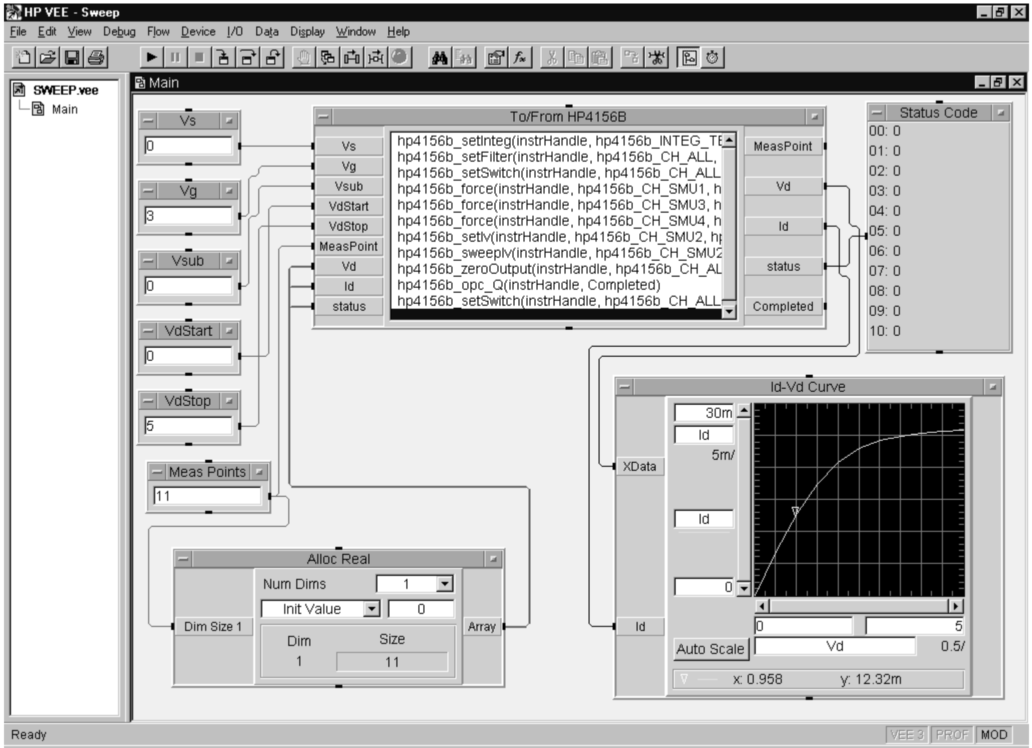



**Table 3-7 Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Vs,Vg,Vsub<br>VdStart,VdStop<br>MeasPoints | Data-Constant-Real<br>Data-Constant-Integer | Enters input parameters of hp4156b_force, hp4156b_setIv, and hp4156b_sweepIv. |
| To/From HP4156B | I/O-InstrumentManager- Plug&play | Executes measurement. |
| AllocReal | Data-AllocateArray-Real | Allocates array for Vd[ ],Id[ ],status[ ] of hp4156b_sweepIv. |
| Status Code | Display-AlphaNumeric | Displays status[ ]. |
| Id-Vd Curve | Display-XvsYPlot | Plots Id-Vd curve. |

# Synchronous Sweep Measurements

To make synchronous sweep measurements, use the following function with the functions shown in “Staircase Sweep Measurements” on page 22, or “Pulsed Sweep Measurements” on page 34.

The hp4156b_setSweepSync function must be placed after the hp4156b_setIv function or the hp4156b_setPiv function in the To/From object.

**Table 3-8 Function for Synchronous Sweep Measurements**

| Description | Function | Parameters |
|---|---|---|
| Synchronous Source Setup | hp4156b_setSweepSync | channel,mode,range,start,stop,comp, p_comp |

A program example is shown in Figure 3-20 on page 3-25. This program measures MOSFET Id-Vg characteristics. The measurement setup is shown in Figure 3-19.

**Figure 3-19 Device Connection and Source Setup for Example Program**

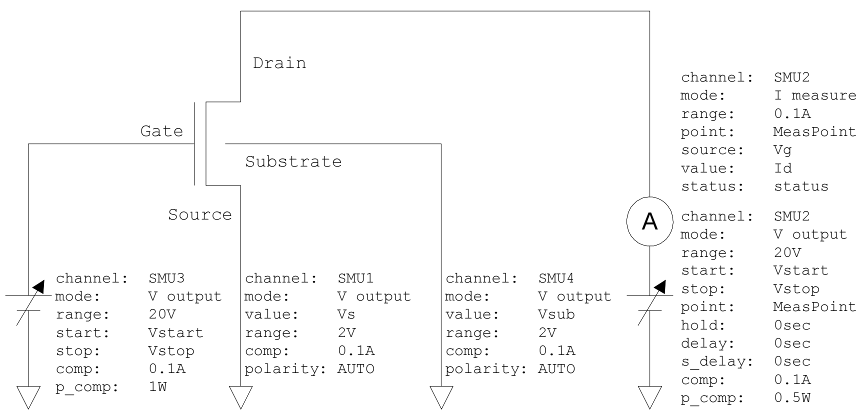


**Figure 3-20 Program Example of Synchronous Sweep Measurement**

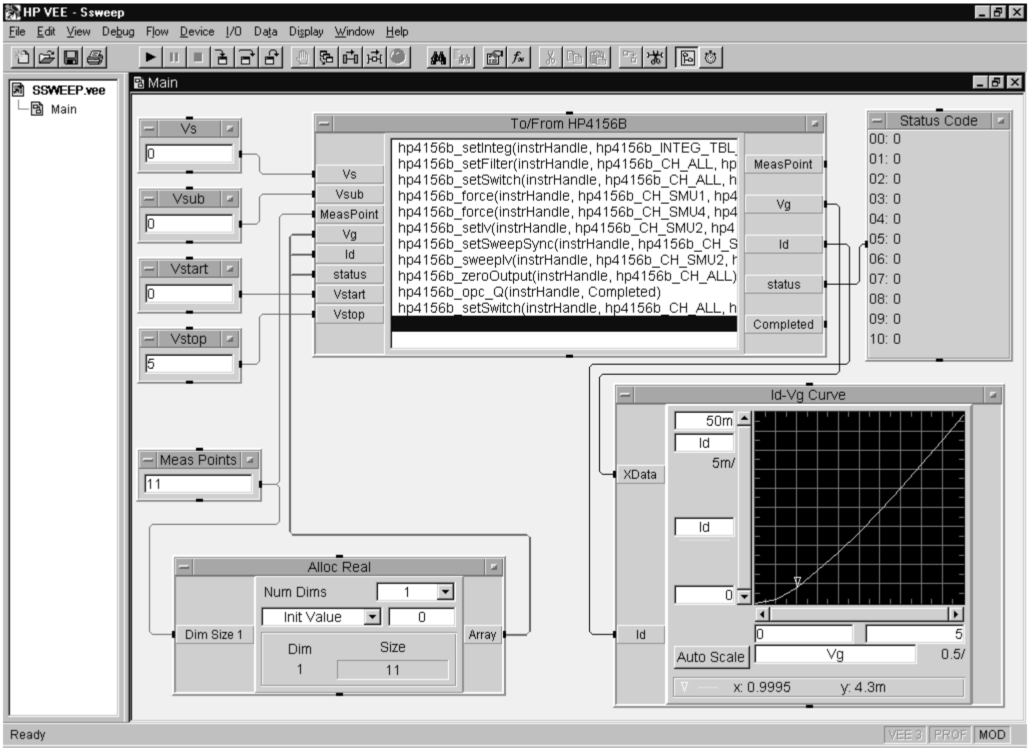



**Table 3-9 Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Vs,Vsub<br>Vstart,Vstop<br>MeasPoints | Data-Constant-Real<br>Data-Constant-Integer | Enters input parameters of hp4156b_force, hp4156b_setIv, and hp4156b_setSweepSync. |
| To/From HP4156B | I/O-InstrumentManager- Plug&play | Executes measurement. |
| AllocReal | Data-AllocateArray-Real | Allocates array for Vg[ ],Id[ ],status[ ] of hp4156b_sweepIv. |
| Status Code | Display-AlphaNumeric | Displays status[ ]. |
| Id-Vg Curve | Display-XvsYPlot | Plots Id-Vg curve. |

# Multi-Channel Sweep Measurements

To make multi-channel sweep measurements, use the following functions.

**Table 3-10** **Functions for Multi-Channel Sweep Measurements**

| Description | Function | Parameters |
|---|---|---|
| Output Switch Setup | hp4156b_setSwitch | channel,state |
| Output Filter Setup | hp4156b_setFilter | channel,state |
| Integration Time Setup | hp4156b_setInteg | table,time,average |
| Forces dc bias | hp4156b_force | channel,mode,range,value,compliance,polarity |
| Sweep Source Setup | hp4156b_setIv | channel,mode,range,start,stop,point,hold,delay, s_delay,comp,p_comp |
| Executes measurement | hp4156b_sweepMiv | channel[ ],mode[ ],range[ ],point,source[ ], value[ ], status[ ] |
| Disables output | hp4156b_zeroOutput | channel |

A program example is shown in Figure 3-22 on page 3-27. This program measures bipolar transistor Ic, Ib-Vbe characteristics. The example uses the User Object of the Agilent VEE. See Figure 3-23 on page 3-28 and Figure 3-24 on page 3-29. The measurement setup is shown in Figure 3-21.

**Figure 3-21** **Device Connection and Source Setup for Example Program**

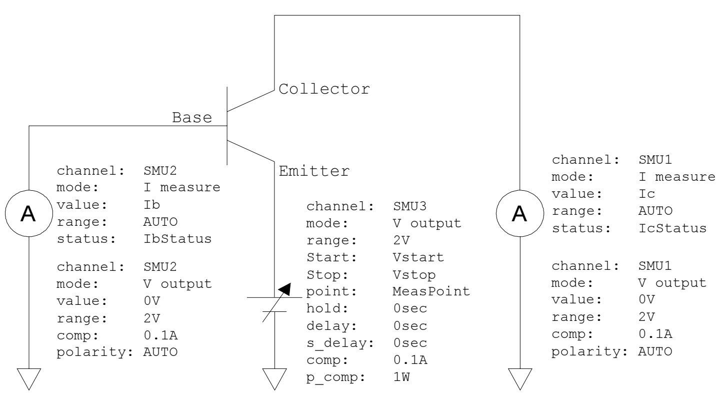


**Figure 3-22 Program Example of Multi-Channel Sweep Measurement**

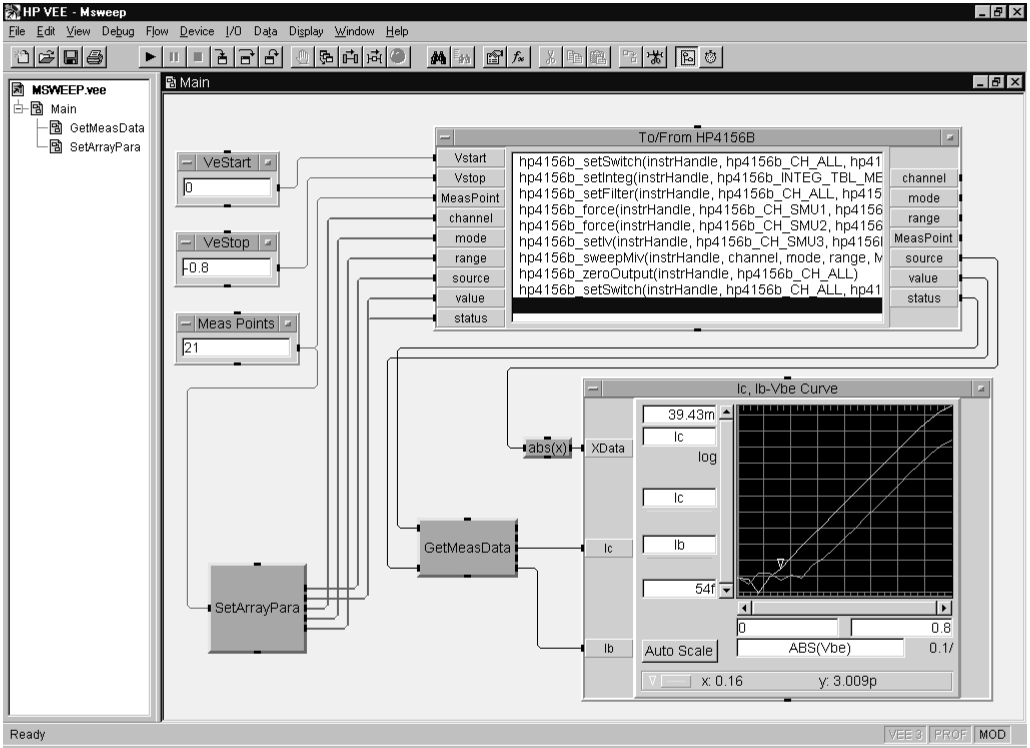



**Table 3-11 Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| VeStart,VeStop<br>MeasPoints | Data-Constant-Real<br>Data-Constant-Integer | Enters input parameters of hp4156b_setIv and hp4156b_sweepMiv. |
| To/From HP4156B | I/O-InstrumentManager-Plug&play | Executes measurement. |
| abs(x) | Device-Formula | Calculates absolute value of Vbe (source). |
| Ic,Ib-Vbe Curve | Display-XvsYPlot | Plots Ic-Vbe and Ib-Vbe curves. |

**Figure 3-23 SetArrayPara User Object**

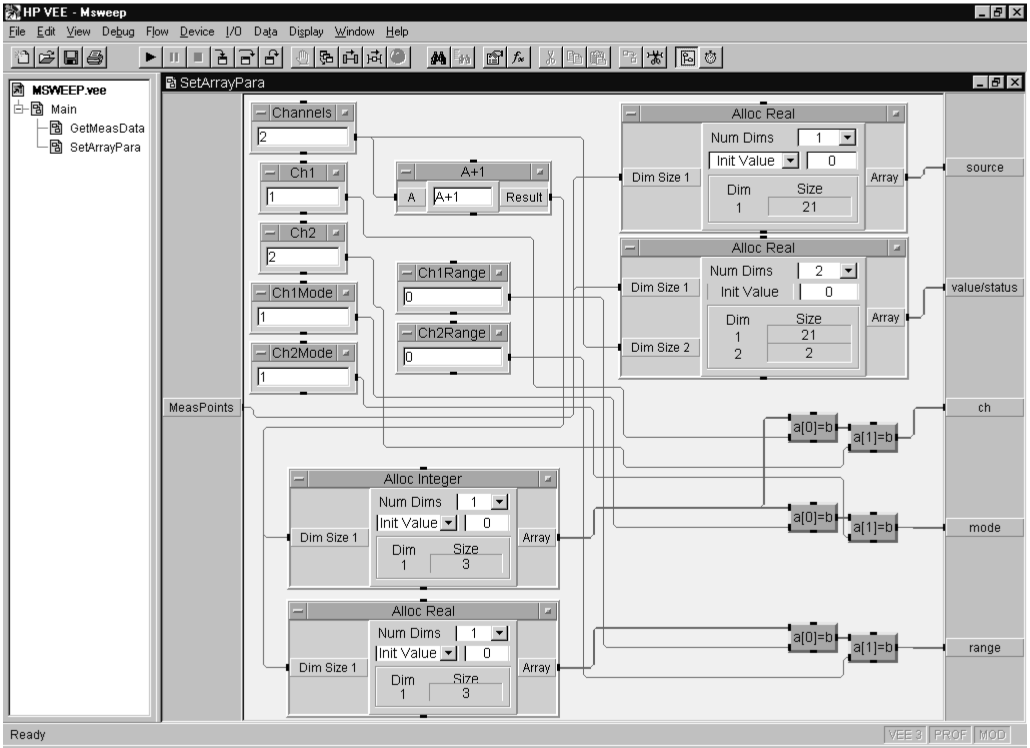



**Table 3-12 Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Channels,Ch1,Ch2, Ch1Mode,Ch2Mode, Ch1Range,Ch2Range | Data-Constant-Integer Data-Constant-Real | Enters data to allocate array, and array element for channel[ ], mode[ ], range[ ] of hp4156b_sweepMiv. |
| A+1 | Device-Formula | Calculates A+1 to allocate array. |
| AllocReal, AllocInteger | Data-AllocateArray-Real Data-AllocateArray-Integer | Allocates array for channel, mode, range, source,value,status of hp4156b_sweepMiv. |
| a[0]=b, a[1]=b | Data-AccessArray-SetValues | Sets data of array (array element). |

**Figure 3-24 GetMeasData User Object**

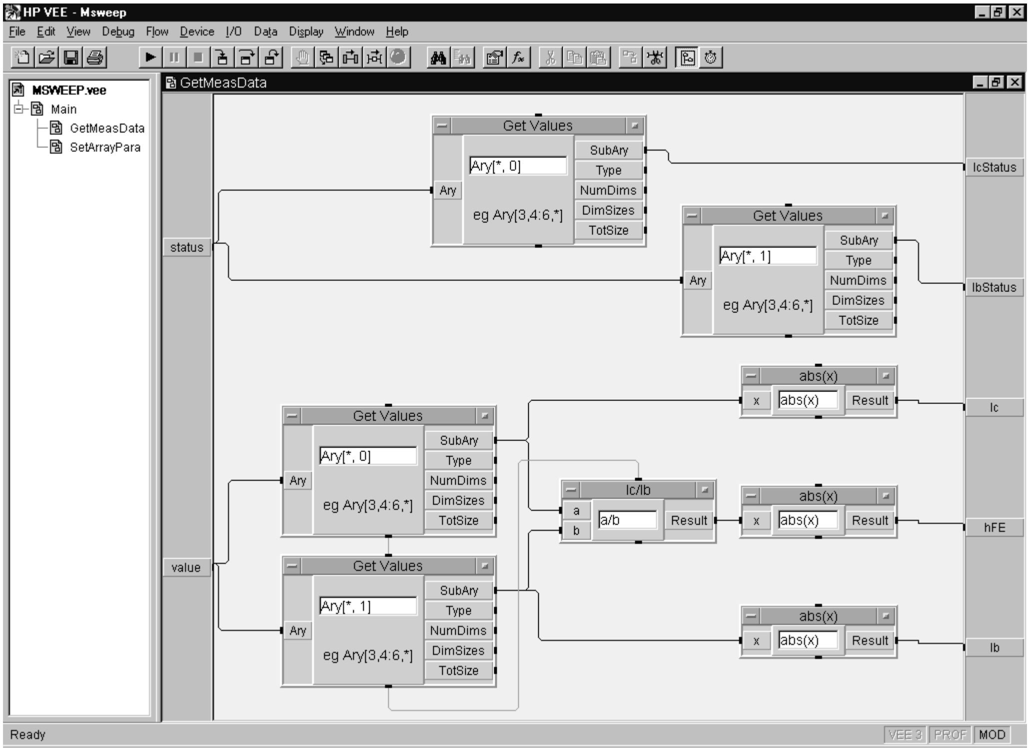



**Table 3-13 Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| GetValues | Data-AccessArray-GetValues | Gets data from array (value[ ],status[ ]). |
| Ic/Ib | Device-Formula | Calculates a/b to get hFE value. |
| abs(x) | Device-Formula | Calculates absolute value of Ic,Ib,hFE. |

# Pulsed Spot Measurements

To make pulsed spot measurements, use the following functions.

**Table 3-14 Functions for Pulsed Spot Measurements**

| Description | Function | Parameters |
|---|---|---|
| Output Switch Setup | hp4156b_setSwitch | channel,state |
| Output Filter Setup | hp4156b_setFilter | channel,state (pulse channel must be set to OFF) |
| Integration Time Setup | hp4156b_setInteg | table,time,average |
| Forces dc bias | hp4156b_force | channel,mode,range,value,compliance,polarity |
| Forces pulse bias | hp4156b_setPbias | channel,mode,range,base,peak,width,period, hold,compliance |
| Executes measurement | hp4156b_measureP | channel,mode,range,value,status |
| Disables output | hp4156b_zeroOutput | channel |

A program example is shown in Figure 3-26 on page 3-31. This program measures MOSFET drain current. The measurement setup is shown in Figure 3-25.

**Figure 3-25 Device Connection and Source Setup for Example Program**

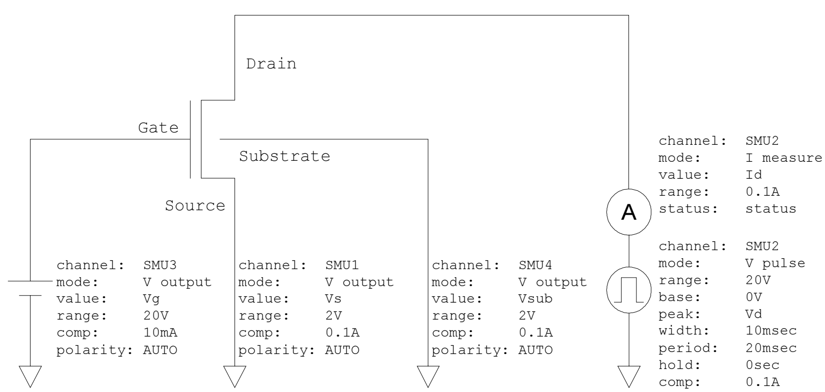


**Figure 3-26** **Program Example of Pulsed Spot Measurement**

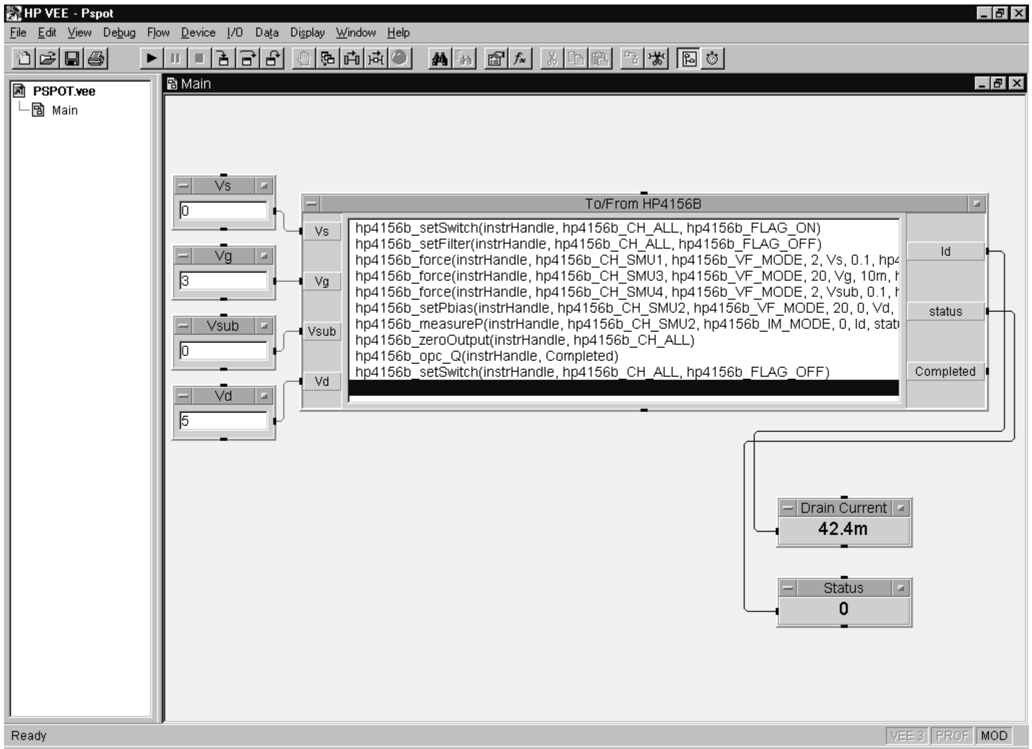



**Table 3-15** **Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Vs,Vg,Vsub,Vd | Data-Constant-Real | Enters input parameters of hp4156b_force, and hp4156b_setPbias. |
| To/From HP4156B | I/O-InstrumentManager-Plug&play | Executes measurement. |
| Drain Current | Display-AlphaNumeric | Displays Id (hp4156b_measureP value parameter). |
| Status | Display-AlphaNumeric | Displays status (hp4156b_measureP status parameter). |

# Multi-Channel Pulsed Spot Measurements

To make multi-channel pulsed spot measurements, use the following functions.

**Table 3-16 Functions for Multi-Channel Pulsed Spot Measurements**

| Description | Function | Parameters |
|---|---|---|
| Output Switch Setup | hp4156b_setSwitch | channel,state |
| Output Filter Setup | hp4156b_setFilter | channel,state (pulse channel must be set to OFF) |
| Integration Time Setup | hp4156b_setInteg | table,time,average |
| Forces dc bias | hp4156b_force | channel,mode,range,value,compliance,polarity |
| Sends Command String | hp4156b_cmd | command (PT and PV commands are sent) |
| Executes measurement | hp4156b_startMeasure | meas_type,channel[ ],mode[ ],range[ ],source |
| Disables output | hp4156b_zeroOutput | channel |
| Reads measurement data | hp4156b_readData | eod,data_type,value,status,channel |

A program example is shown in Figure 3-28 on page 3-33. This program measures bipolar transistor collector current and base current. The measurement setup is shown in Figure 3-27.

**Figure 3-27 Device Connection and Source Setup for Example Program**

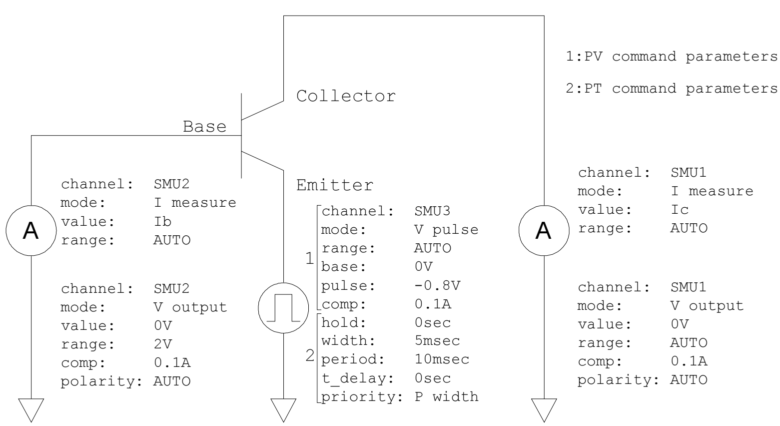


**Figure 3-28** **Program Example of Multi-Channel Pulsed Spot Measurement**

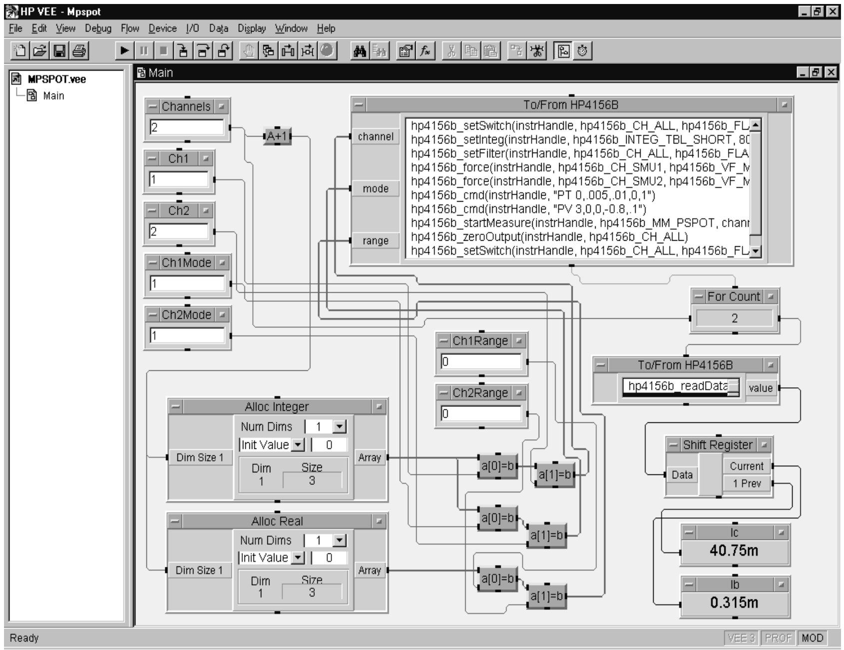



**Table 3-17** **Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Channels,Ch1,Ch2, Ch1Mode,Ch2Mode, Ch1Range,Ch2Range | Data-Constant-Integer<br>Data-Constant-Real | Enters data to allocate array, and array element for channel[ ], mode[ ], range[ ] of hp4156b_startMeasure. |
| A+1 | Device-Formula | Calculates A+1 to allocate array. |
| AllocReal, AllocInteger | Data-AllocateArray-Real<br>Data-AllocateArray-Integer | Allocates array for channel, mode, range of hp4156b_startMeasure. |
| a[0]=b, a[1]=b | Data-AccessArray-SetValues | Sets data of array (array element). |
| For Count | Flow-Repeat-ForCount | Repeats next action for specified count. |
| To/From HP4156B | I/O-InstrumentManager-Plug&play | Executes measurement or reads data. |
| Shift Register | Device-ShiftRegister | Outputs last data and 1 prev data. |
| Ic, Ib | Display-AlphaNumeric | Displays Ic and Ib. |

# Pulsed Sweep Measurements

To make pulsed sweep measurements, use the following functions.

**Table 3-18 Functions for Pulsed Sweep Measurements**

| Description | Function | Parameters |
|---|---|---|
| Output Switch Setup | hp4156b_setSwitch | channel,state |
| Output Filter Setup | hp4156b_setFilter | channel,state (pulse channel must be set to OFF) |
| Integration Time Setup | hp4156b_setInteg | table,time,average |
| Forces dc bias | hp4156b_force | channel,mode,range,value,compliance,polarity |
| Sweep Source Setup | hp4156b_setPiv | channel,mode,range,base,start,stop,point,hold, width,period,compliance |
| Executes measurement | hp4156b_sweepPiv | channel,mode,range,point,source[ ],value[ ], status[ ] |
| Disables output | hp4156b_zeroOutput | channel |

A program example is shown in Figure 3-30 on page 3-35. This program measures MOSFET Id-Vd characteristics. The measurement setup is shown in Figure 3-29.

**Figure 3-29 Device Connection and Source Setup for Example Program**

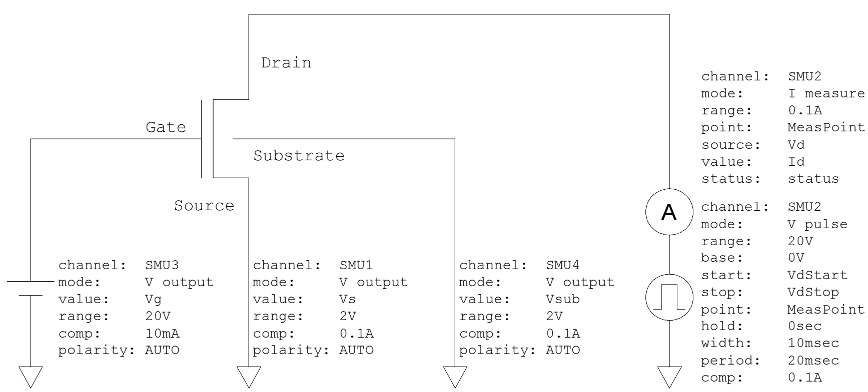


Figure 3-30 **Program Example of Pulsed Sweep Measurement**

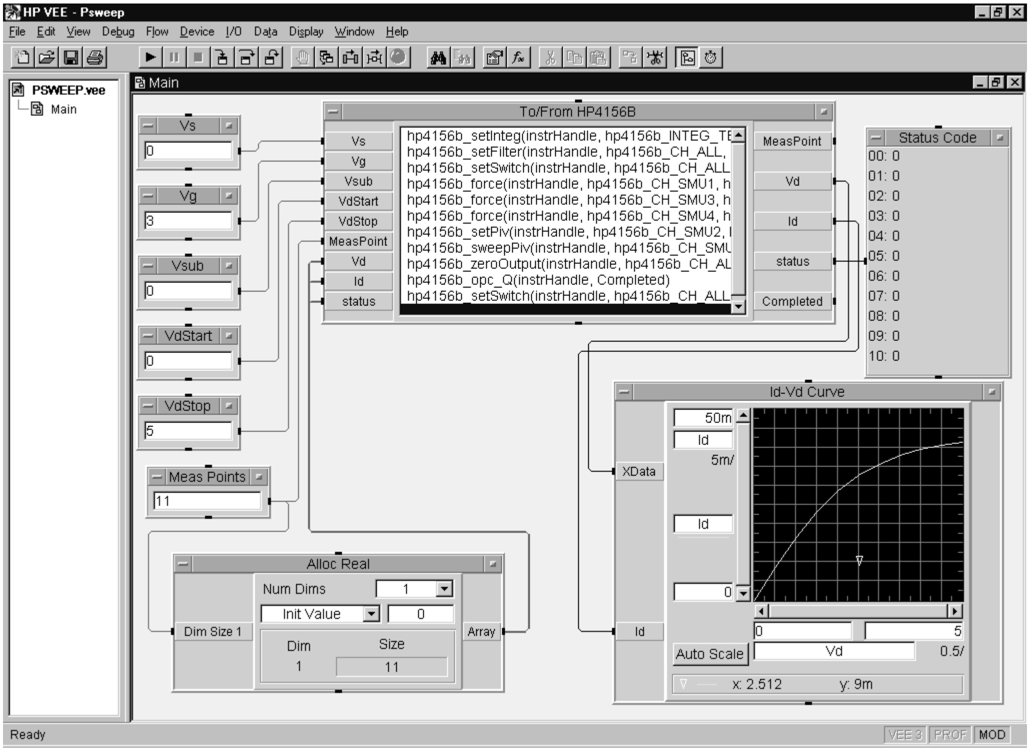



Table 3-19 **Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Vs,Vg,Vsub<br>VdStart,VdStop<br>MeasPoints | Data-Constant-Real<br>Data-Constant-Integer | Enters input parameters of hp4156b_force, hp4156b_setPiv, and hp4156b_sweepPiv. |
| To/From HP4156B | I/O-InstrumentManager- Plug&play | Executes measurement. |
| AllocReal | Data-AllocateArray-Real | Allocates array for Vd[ ],Id[ ],status[ ] of hp4156b_sweepIv. |
| Status Code | Display-AlphaNumeric | Displays status[ ]. |
| Id-Vd Curve | Display-XvsYPlot | Plots Id-Vd curve. |

# Multi-Channel Pulsed Sweep Measurements

To make multi-channel pulsed sweep measurements, use the following functions.

**Table 3-20** **Functions for Multi-Channel Pulsed Sweep Measurements**

| Description | Function | Parameters |
|---|---|---|
| Output Switch Setup | hp4156b_setSwitch | channel,state |
| Output Filter Setup | hp4156b_setFilter | channel,state (pulse channel must be set to OFF) |
| Integration Time Setup | hp4156b_setInteg | table,time,average |
| Forces dc bias | hp4156b_force | channel,mode,range,value,compliance,polarity |
| Sends Command String | hp4156b_cmd | command (PT and PWV commands are sent) |
| Executes measurement | hp4156b_startMeasure | meas_type,channel[ ],mode[ ],range[ ],source |
| Disables output | hp4156b_zeroOutput | channel |
| Reads measurement data | hp4156b_readData | eod,data_type,value,status,channel |

A program example is shown in Figure 3-32 on page 3-37. This program measures bipolar transistor Ic, Ib-Vbe characteristics. The example uses the User Function of the Agilent VEE. See Figure 3-33 on page 3-38. The measurement setup is shown in Figure 3-31.

**Figure 3-31** **Device Connection and Source Setup for Example Program**

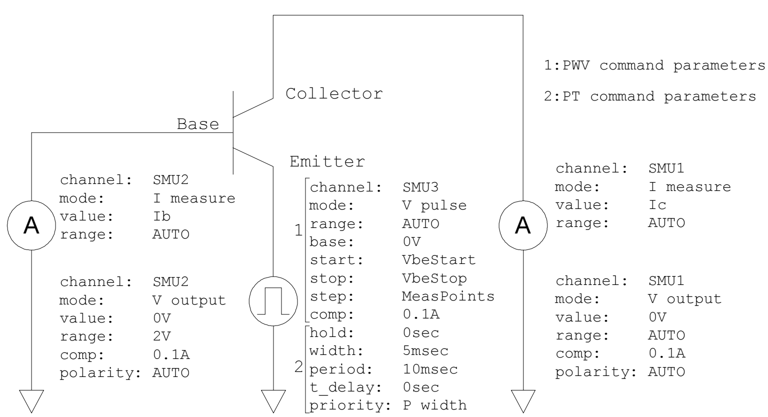


**Figure 3-32 Program Example of Multi-Channel Pulsed Sweep Measurement**

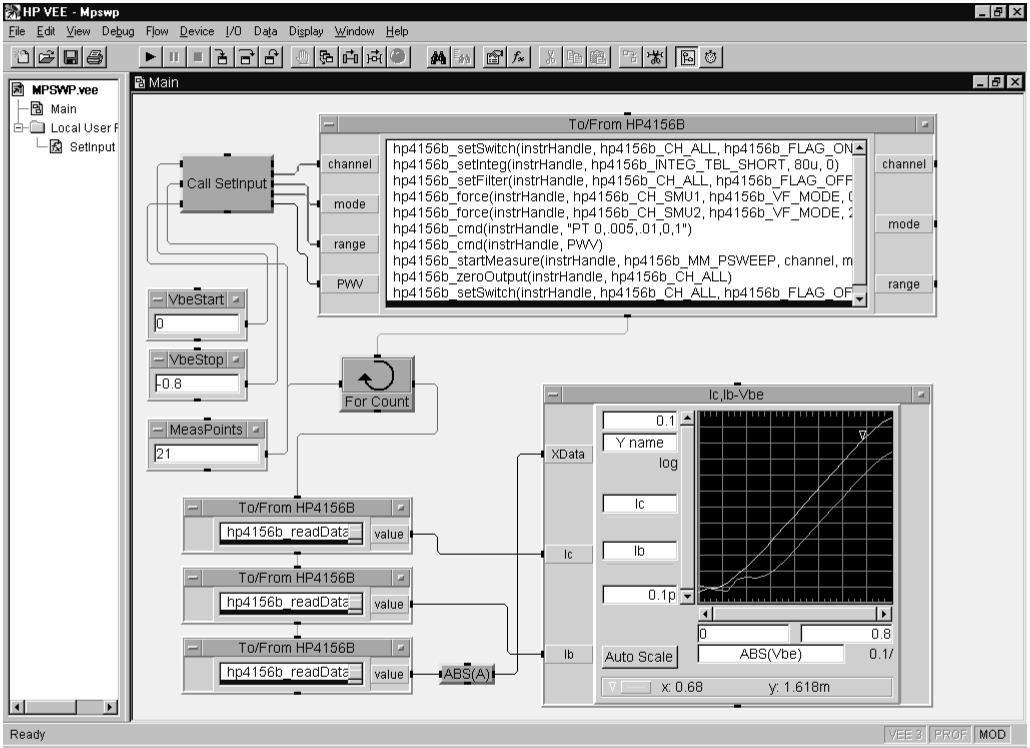



**Table 3-21 Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| VbeStart,VbeStop<br>MeasPoints | Data-Constant-Real<br>Data-Constant-Integer | Enters PWV command parameters. |
| For Count | Flow-Repeat-ForCount | Repeats next action for specified count. |
| To/From HP4156B | I/O-InstrumentManager-Plug&play | Executes measurement, or reads data. |
| ABS(A) | Device-Formula | Calculates absolute value of Vbe (source). |
| Ic,Ib-Vbe | Display-XvsYPlot | Plots Ic-Vbe and Ib-Vbe curves. |

**Figure 3-33 SetInput User Function**

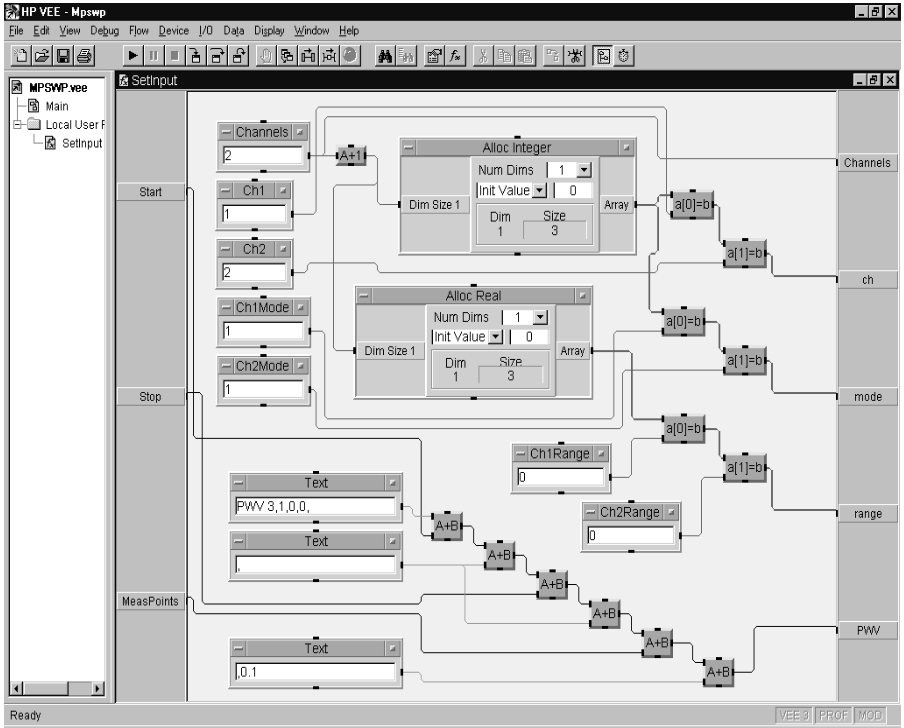



**Table 3-22 Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Channels,Ch1,Ch2, Ch1Mode,Ch2Mode, Ch1Range,Ch2Range | Data-Constant-Integer Data-Constant-Real | Enters data to allocate array, and array element for channel[ ], mode[ ], range[ ] of hp4156b_startMeasure. |
| A+1 | Device-Formula | Calculates A+1 to allocate array. |
| AllocReal, AllocInteger | Data-AllocateArray-Real Data-AllocateArray-Integer | Allocates array for channel, mode, range, of hp4156b_startMeasure. |
| a[0]=b, a[1]=b | Data-AccessArray-SetValues | Sets data of array (array element). |
| Text | Data-Constant-Text | Enters PWV command parameters. |
| A+B | Device-Formula | Calculates A+B to create PWV command. |

# Staircase Sweep with Pulsed Bias Measurements

For staircase sweep with pulsed bias measurements, use the following functions.

**Table 3-23 Functions for Staircase Sweep with Pulsed Bias Measurements**

| Description | Function | Parameters |
|---|---|---|
| Output Switch Setup | hp4156b_setSwitch | channel,state |
| Output Filter Setup | hp4156b_setFilter | channel,state (pulse channel must be set to OFF) |
| Integration Time Setup | hp4156b_setInteg | table,time,average |
| Forces dc bias | hp4156b_force | channel,mode,range,value,compliance,polarity |
| Forces pulse bias | hp4156b_setPbias | channel,mode,range,base,peak,width,period, hold,compliance |
| Sweep Source Setup | hp4156b_setIv | channel,mode,range,start,stop,point,hold,delay, s_delay,comp,p_comp |
| Executes measurement | hp4156b_sweepPbias | channel,mode,range,point,source[ ],value[ ], status[ ] |
| Disables output | hp4156b_zeroOutput | channel |

A program example is shown in Figure 3-35 on page 3-40. This program measures bipolar transistor Ic-Vc characteristics. The measurement setup is shown in Figure 3-34.

**Figure 3-34 Device Connection and Source Setup for Example Program**

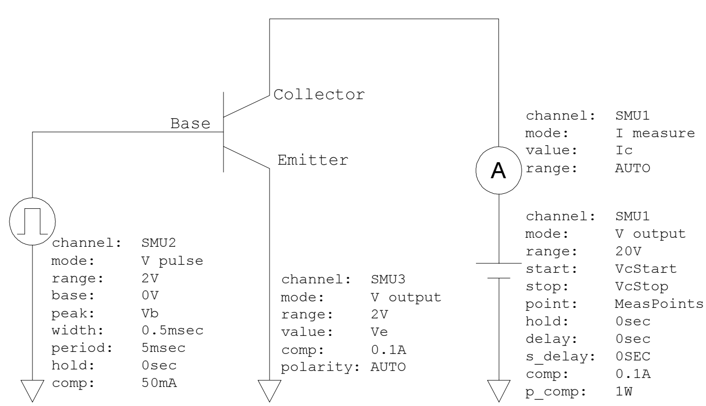


Figure 3-35 **Program Example of Staircase Sweep with Pulsed Bias Measurement**

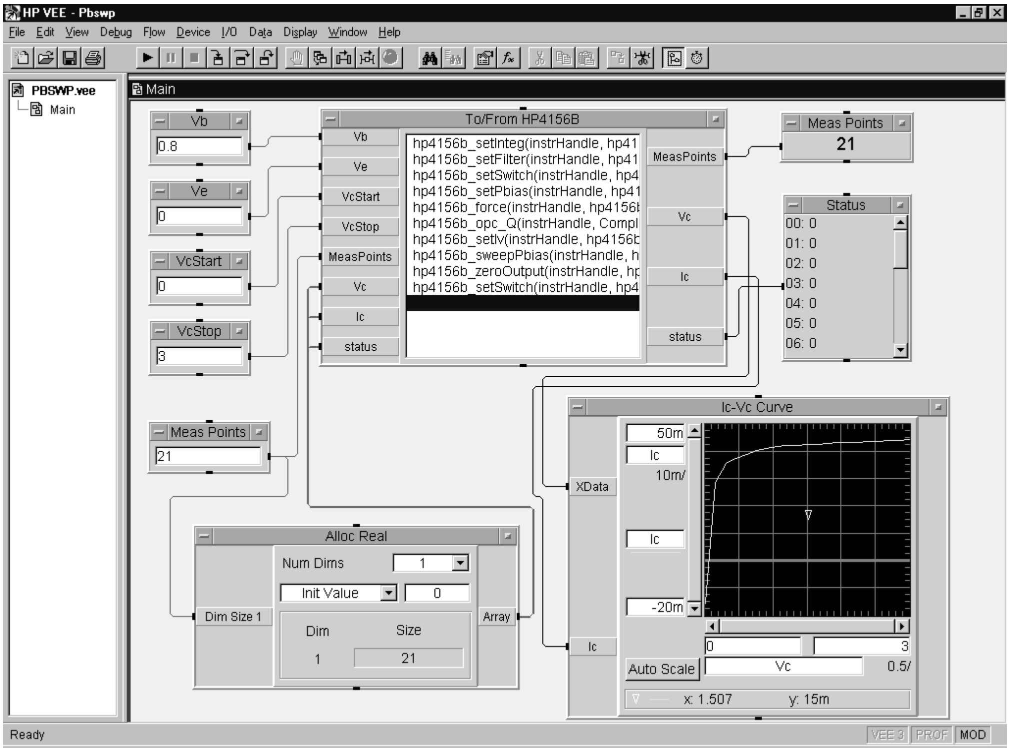



Table 3-24 **Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| VcStart, VcStop Vb,Ve,MeasPoints | Data-Constant-Real Data-Constant-Integer | Enters input parameters of hp4156b_force hp4156b_setPbias, and hp4156b_setIv. |
| To/From HP4156B | I/O-InstrumentManager- Plug&play | Executes measurement. |
| AllocReal | Data-AllocateArray-Real | Allocates array for Vc[ ],Ic[ ],status[ ] of hp4156b_sweepPbias. |
| MeasPoints | Display-AlphaNumeric | Displays number of measurement points. |
| Status | Display-AlphaNumeric | Displays status[ ]. |
| Ic-Vc Curve | Display-XvsYPlot | Plots Ic-Vc curve. |

# Sampling Measurements

To make sampling measurements, use the following functions.

**Table 3-25 Functions for Sampling Measurements**

| Description | Function | Parameters |
|---|---|---|
| Output Switch Setup | hp4156b_setSwitch | channel,state |
| Output Filter Setup | hp4156b_setFilter | channel,state |
| Integration Time Setup | hp4156b_setInteg | table,time,average |
| Forces dc bias | hp4156b_force | channel,mode,range,value, compliance,polarity |
| Sampling timing setup | hp4156b_setSample | hold,interval,point |
| Sampling dc source setup | hp4156b_addSampleSyncIv | channel,mode,range,base,bias, compliance |
| Sampling pulse source setup | hp4156b_addSampleSyncPulse | channel,base,peak,count,period, width,delay,rise,fall |
| Executes measurement | hp4156b_sample | channel[ ],mode[ ],range[ ],point, index[ ],value[ ],status[ ] |
| Clears sampling source setup | hp4156b_clearSampleSync | |
| Disables output | hp4156b_zeroOutput | channel |

A program example is shown in Figure 3-37. This program measures resistance. The example uses the User function of the Agilent VEE. See Figure 3-38 on page 3-43 and Figure 3-39 on page 3-44. The measurement setup is shown in Figure 3-36.

**Figure 3-36 Device Connection and Source Setup for Example Program**

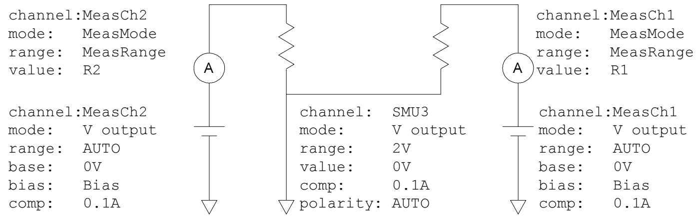


**Figure 3-37 Program Example of Sampling Measurement**

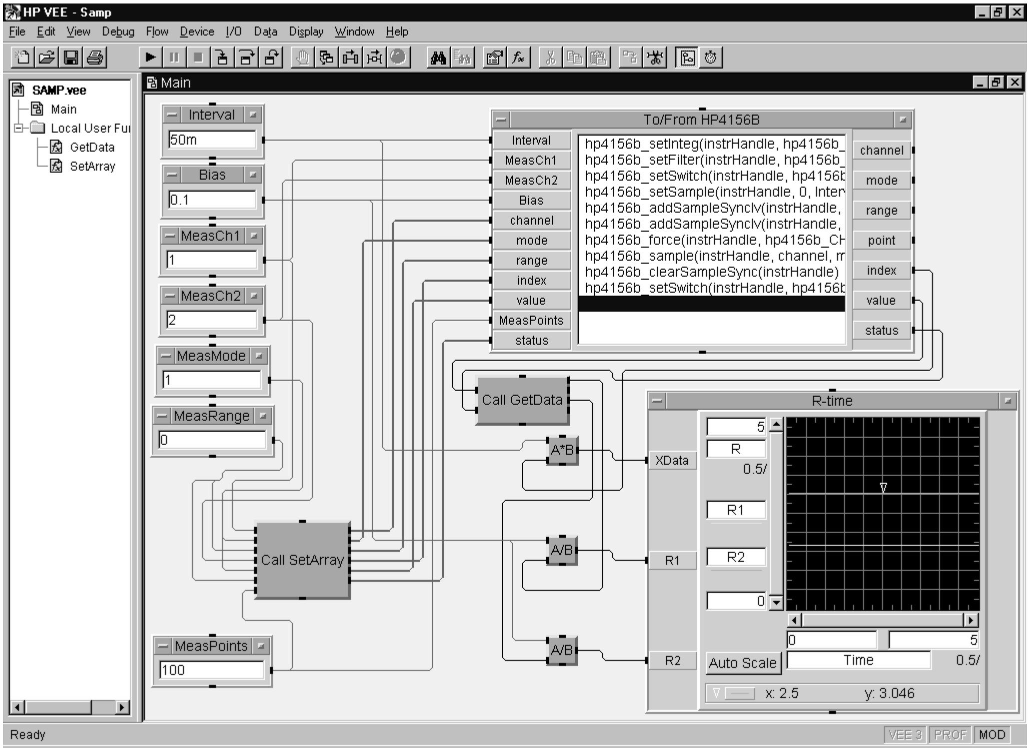



**Table 3-26 Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Interval,Bias, MeasCh1,MeasCh2 MeasMode, MeasRange, MeasPoints | Data-Constant-Integer, Data-Constant-Real | Enters input parameters of hp4156b_force, hp4156b_setSample, hp4156b_addSampleSyncIv, hp4156b_addSampleSyncPulse, hp4156b_sample |
| To/From HP4156B | I/O-InstrumentManager-Plug&play | Executes measurement. |
| A*B | Device-Formula | Calculates A*B to get Time value (X). |
| A/B | Device-Formula | Calculates A/B to get R1, R2 value (Y). |
| R-time | Display-XvsYPlot | Plots R-t curves. |

**Figure 3-38** **SetArray User Function**

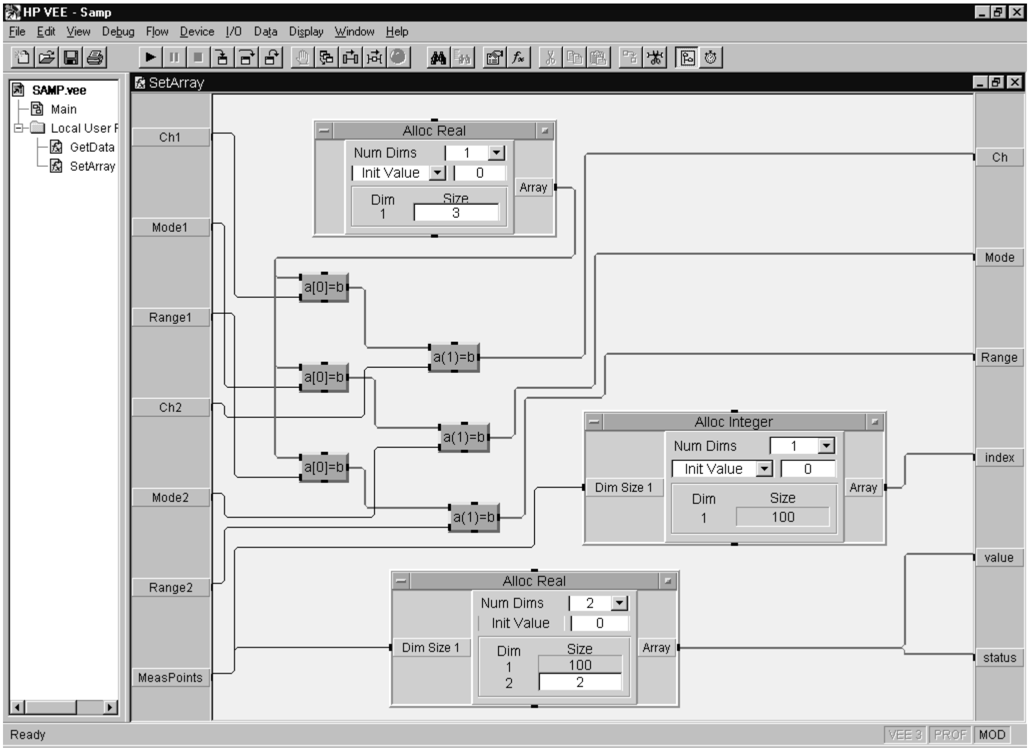



**Table 3-27** **Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| AllocReal, AllocInteger | Data-AllocateArray-Real Data-AllocateArray-Integer | Allocates array for channel, mode, range, index,value,status of hp4156b_sample. |
| a[0]=b, a[1]=b | Data-AccessArray-SetValues | Sets data of array (array element). |

**Figure 3-39** **GetData User Function**

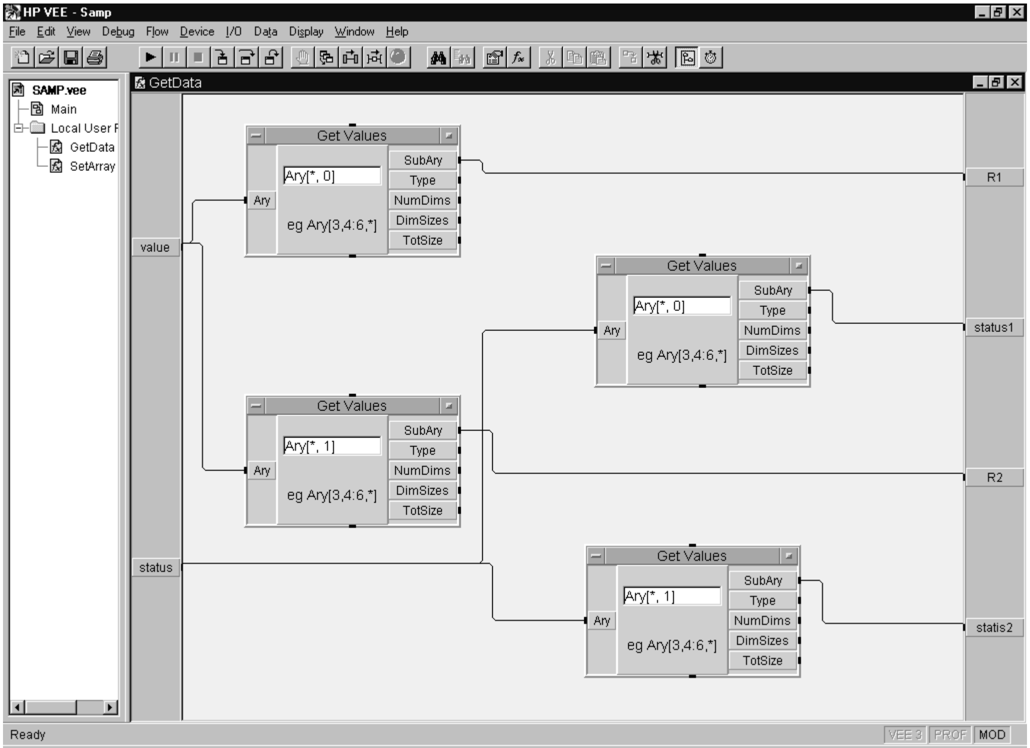



**Table 3-28** **Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| GetValues | Data-AccessArray-GetValues | Gets data from array (value[ ],status[ ]). |

# Stress Force

For stress force, use the following functions.

**Table 3-29 Functions for Stress Force**

| Description | Function | Parameters |
|---|---|---|
| Output Switch Setup | hp4156b_setSwitch | channel,state |
| PGU output impedance setup | hp4156b_setPguR | channel,state |
| Forces dc bias | hp4156b_force | channel,mode,range,value,compliance, polarity |
| Stress timing setup | hp4156b_setStress | hold,mode,duration,period |
| dc stress setup | hp4156b_addStressSyncIv | source,channel,mode,range,base,stress, compliance |
| Pulse stress setup | hp4156b_addStressSyncPulse | source,channel,base,stress,width,delay, rise,fall |
| Forces stress | hp4156b_stress | status |
| Clears stress source setup | hp4156b_clearStressSync | |
| Disables output | hp4156b_zeroOutput | channel |

A program example is shown in Figure 3-41 on page 3-46. This program forces dc stress and pulse stress to the DUTs (device under test). The measurement setup is shown in Figure 3-40.

**Figure 3-40 Device Connection and Source Setup for Example Program**

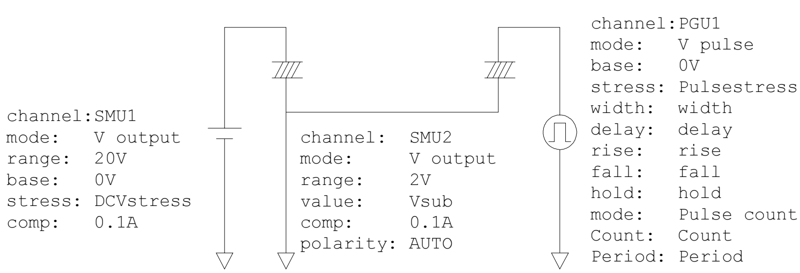


**Figure 3-41 Program Example of Stress Force**

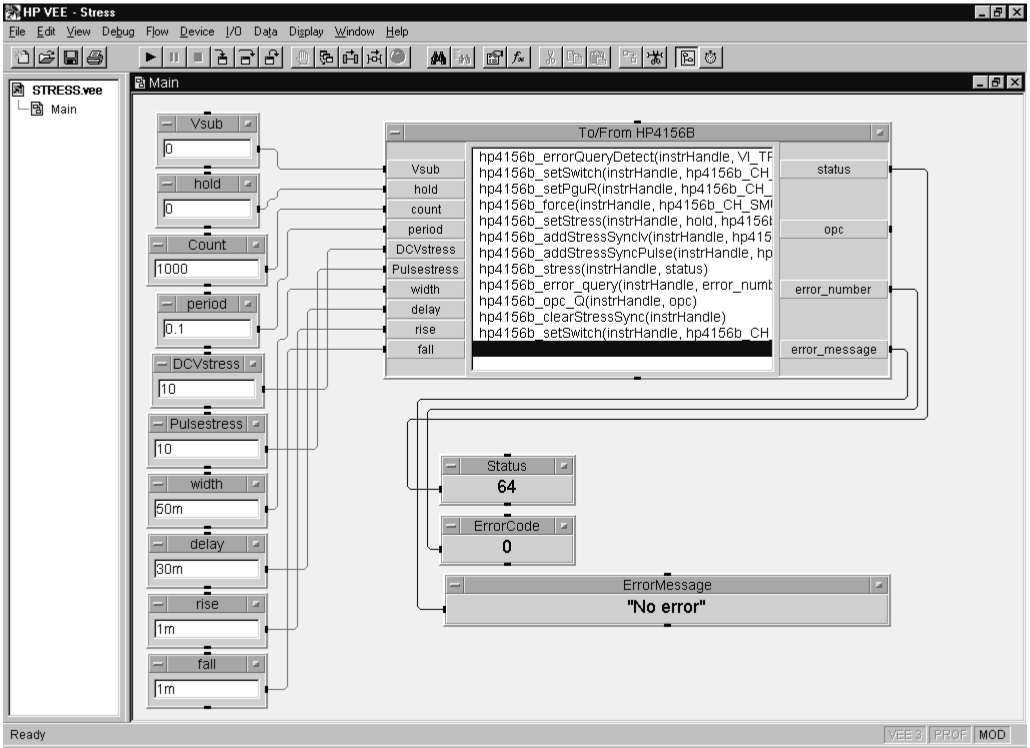



**Table 3-30 Program Explanation**

| Object Title | Menu | Explanation |
|---|---|---|
| Vsub,hold,Count,<br>period,DCVstress,<br>Pulsestress,width,<br>delay,rise,fall | Data-Constant-Real<br>Data-Constant-Integer | Enters input parameters of hp4156b_force, hp4156b_setStress, hp4156b_addStressSyncIv, hp4156b_addStressSyncPulse, hp4156b_stress. |
| To/From HP4156B | I/O-InstrumentManager-Plug&play | Forces dc stress and pulse stress. |
| Status,ErrorCode,<br>ErrorMessage | Display-AlphaNumeric | Displays measurement status, error code, error message. Ignore status code 64 which is meaningless as response of hp4156b_stress. |

# 4 Sample Application Programs for Agilent VEE

This chapter explains how to use the sample application programs stored on the Agilent VEE Sample Program Disk furnished with Agilent 4155/4156. This chapter consists of the following sections:

- "Introduction"
- "Installation"
- "Using sample1.vee"
- "Using sample2.vee"
- "Customizing Sample Programs"

**CAUTION**

The program and setup files stored on the Sample Program Disk are examples only, and may need to be customized for your specific application. Agilent Technologies is not responsible for any damage that may occur from the use of these sample programs.

**NOTE**

Copy the Agilent VEE Sample Program Disk, and keep the original disk as a backup. To store a program after modifying it, use a file name that is different than the original program name.

# Introduction

This section introduces the sample application programs for Agilent VEE that are furnished with the 4155/4156, and covers the following sections:

- "Agilent VEE Sample Program Disk"
- "What are Sample Programs?"

## Agilent VEE Sample Program Disk

The Agilent VEE Sample Program Disk stores sample application programs using Agilent VEE and VXI*plug&play* drivers for the 4155/4156 and the E5250A. The sample programs can control the 4155/4156, Agilent E5250A low leakage switch mainframe, and the Summit series semi-auto prober from Cascade Microtech, Inc.

The following files are stored on the disk.

- readme.txt

  This is a text file with a brief introduction of the sample programs, installation information, and so on.

- sample1.vee and sample2.vee

  These are program files that are executable on Agilent VEE (HP VEE version 4.0 or later). Refer to "What are Sample Programs?".

- sample.ppd

  This file is an example of data used to control the Summit series semi-auto prober from Cascade Microtech, Inc. The *.ppd files will be created and used by the prober control software (PCS) furnished with the prober or supplied from Cascade Microtech, Inc. The sample application programs require the *.ppd file and PCS to control the prober.

## What are Sample Programs?

The Sample Program Disk stores two program files, sample1.vee and sample2.vee. Both programs control the 4155/4156, E5250A low leakage switch mainframe, and Cascade Summit series semi-auto prober, and do the following:

1. Probe two MOSFETs on a die
2. Measure Id-Vg characteristics of two MOSFETs
3. Extract the threshold voltage (Vth value) for two MOSFETs
4. Store the measured data into files, and display the results

The differences between the two programs are the probing control and the display, as shown in Table 4-1.

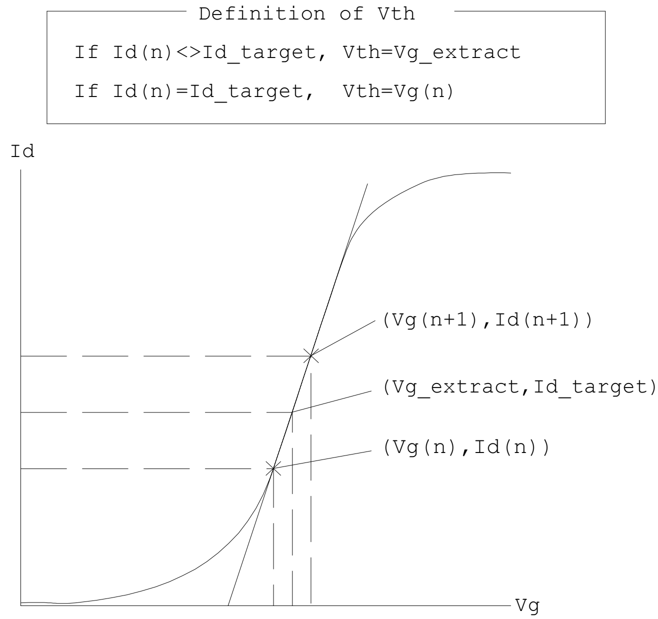
**Table 4-1 Differences Between sample1.vee and sample2.vee**

| | sample1.vee | sample2.vee |
|---|---|---|
| Probing Control | Step-by-step Measurement.<br>Probes the die where you specified the die position (x-y index) defined in the *.ppd file. | Sequential Measurement.<br>Probes sequentially for the dies defined in the *.ppd file. |
| Display | Vth value,<br>Vth pass/fail status on Wafer Map,<br>X-Y (Vg-Id) Graph of device 1,<br>X-Y (Vg-Id) Graph of device 2 | Vth value,<br>Vth pass/fail status on Wafer Map,<br>Histogram of Vth value,<br>X-Y (Vg-Id) Graph of the specified device |

## Definition of Vth

The threshold voltage (Vth) is extracted by a linear interpolation using two measurement points, which are the nearest from the targeted point for both higher and lower directions. The targeted point (Vg_extract,Id_target) is an ideal point, which indicates the Id_target value on the line through the two measurement points on the Id-Vg curve. See Figure 4-1.

**Figure 4-1** **Definition of Vth**



## Execution Mode

The sample1.vee and sample2.vee programs have five execution modes, as described below. The default is Offline mode.

**NOTE** If you do not use the Cascade Summit series semi-auto prober, use sample1.vee with Online mode, standalone, or with the E5250A. The sample2.vee program is used for sequential test, using the semi-auto prober. The test results for sample2.vee will be meaningless in the Online mode without the prober.

- Offline mode

  Select this mode if you do not use an instrument. After program execution, the demo (dummy) data is returned as the test result.

- Online mode, standalone (4155/4156 only)

  Select this mode if you use the 4155/4156 only. The test device is a single MOSFET, as the 4155/4156 has four SMUs to connect and measure a 4-terminal device simultaneously. A test fixture or manual prober is required to connect the device.

- Online mode with E5250A

  Select this mode if you use the 4155/4156 and E5250A. A test fixture or manual prober is required to connect the devices.

- Online mode with semi-auto prober

  Select this mode if you use the 4155/4156 and the Cascade Microtech Summit series semi-auto prober. The test device is a single MOSFET, as the 4155/4156 has four SMUs to connect and measure a 4-terminal device simultaneously.

- Online mode, fully automatic

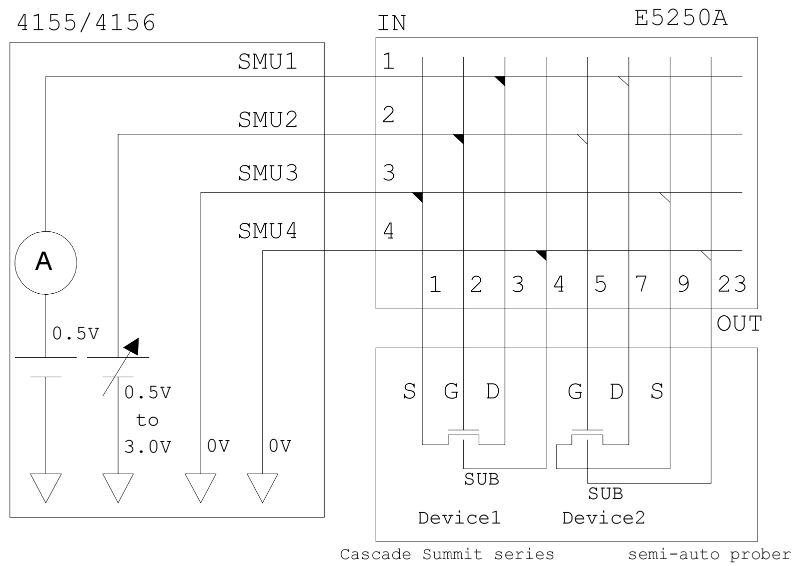
  Select this mode if you use the 4155/4156, E5250A, and the Cascade Summit series semi-auto prober.

**NOTE** The sample programs require that the E5250A be installed with two E5252A matrix cards. They must be installed in slots 1 and 2 of the E5250A mainframe.

## Measurement Connection and Source Setup

Figure 4-2 shows the measurement connection for instruments, the prober and devices. This setup is for the fully automatic Online mode. For other modes, ignore the equipment not used. This figure also shows the default source setup.

**Figure 4-2** **Measurement Connection and Source Setup**




**NOTE** To avoid misconnection, pay close attention to the die (device1 and device2) and the pin assignment of the probe card, if used.

**NOTE** In Figure 4-2, OUT 1 to 9 indicates output port 1 to 9 of the matrix card installed in slot 1 of the E5250A; OUT 23 indicates output port 11 of the card installed in slot 2 of the E5250A.

## Measurement Data Files

The sample programs create three types of data files, as shown below.

info.txt — Information file. Title, date, and comment are included.

vth*n*.txt — Vth data file. If 5 dies are tested, 5 data are included. For the file name, *n* is 1 or 2 (1 for device1, 2 for device2).

d*n*vgid*xy*.txt — Row measurement data file of Id-Vg curve. If 5 dies are tested, the program creates 10 data files (5 files/device). The file names *n*, *x*, and *y* indicate the following:

*n*: 1 or 2 (1 for device1, 2 for device2).

*x*: X-index of the die position.

*y*: Y-index of the die position.

**Figure 4-3 Example of Data Files Created by Sample Programs**

info.txt

```
Data Save Directory for HP4155B/4156B Sample Program
Mon 15/Jun/1998 14:14:30
Comment :
```

vth1.txt

```
Device 1 Vth Table
X Index     Y Index           "Vth [V]"
5           7               9.21E-01
7           5               9.19E-01
5           5               7.32E-01
3           5               9.20E-01
5           3               9.22E-01
```

vth2.txt

```
Device 2 Vth Table
X Index     Y Index           "Vth [V]"
5           7               9.10E-01
7           5               9.19E-01
5           5               9.06E-01
3           5               9.22E-01
5           3               9.09E-01
```

d1vgid55.txt

```
(5,5) Device 1 Vg-Id Data
Vg [V]        Id [A]       Id Status
-5.00E-01     8.00E-15     0
-4.13E-01     8.00E-15     0
-3.25E-01     7.06E-15     0
-2.38E-01     6.06E-15     0
-1.50E-01     6.00E-15     0
-6.25E-02     6.00E-15     0
2.50E-02      5.06E-15     0
1.13E-01      6.89E-15     0
2.00E-01      2.87E-14     0
2.88E-01      4.61E-13     0
3.75E-01      9.17E-12     0
4.63E-01      1.66E-10     0
5.50E-01      2.91E-09     0
```

d2vgid55.txt

```
(5,5) Device 2 Vg-Id Data
Vg [V]        Id [A]       Id Status
-5.00E-01     9.00E-15     0
-4.13E-01     8.00E-15     0
-3.25E-01     8.00E-15     0
-2.38E-01     8.00E-15     0
-1.50E-01     7.00E-15     0
-6.25E-02     6.00E-15     0
2.50E-02      6.00E-15     0
1.13E-01      6.00E-15     0
2.00E-01      5.00E-15     0
2.88E-01      6.99E-15     0
3.75E-01      2.99E-14     0
4.63E-01      4.85E-13     0
5.50E-01      9.67E-12     0
```

# Installation

This section explains the equipment and accessories required to use the sample programs, and how to install the programs.

## Required Equipment and Accessories

1. PC (AT-compatible) for Windows

   Agilent VEE (HP VEE version 4.0 or later) and the VXI*plug&play* drivers for the 4155/4156 and E5250A must be installed in your PC and ready for use. See Chapter 1.

   A 3.5 inch flexible disk drive must be connected to your PC to install the sample programs.

   If you use the Cascade Microtech Summit series semi-auto prober, the prober control software (PCS) supplied by Cascade Microtech, Inc. must be installed in your PC and the prober must be connected to your PC via Cascade's interface. For the interface, and the operating system supported by the PCS, contact Cascade Microtech, Inc. (PCS version 2.50 supports Windows 95 only).

2. Agilent VEE Sample Program Disk

3. Agilent 4155 or 4156 Semiconductor Parameter Analyzer

4. Agilent E5250A Low Leakage Switch Mainframe

   Two E5252A matrix cards are required and must be installed in slot 1 and 2 of the E5250A.

5. Cascade Microtech Summit Series Semi-Auto Prober

   If you do not use the semi-auto prober, prepare the manual prober or test fixture, such as Agilent 16442A, to connect the test devices.

6. Connection Cables

   Four triaxial cables are required to connect the 4155/4156 and E5250A.

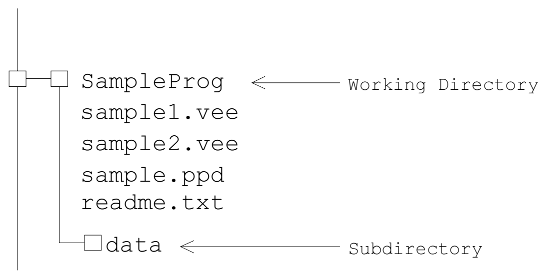
   Eight triaxial cables are required to connect the E5250A and the prober or test fixture. You will also need coaxial cables, probe card, manipulators, or wire to connect the test devices.

   Two GPIB cables are required to connect the instruments and the PC.

## Installing the Sample Programs

1. Make a working directory where you can install and execute the sample programs, using Windows Explorer.
2. Create a subdirectory in the working directory. The subdirectory will be used to save the measurement data files.
3. Insert the Agilent VEE Sample Program Disk into the flexible disk drive connected to your PC.
4. Copy all of the files on the disk to the working directory.

**Figure 4-4** **Installing Sample Programs**



# Using sample1.vee

This section covers the following topics.

- "Program Execution Flow"
- "Panel Display"
- "To Execute sample1.vee"

**NOTE**

For the wafer test using the Summit series semi-auto prober from Cascade Microtech, Inc., create your own probe plan file (*.ppd). The sample.ppd file stored on the Agilent VEE Sample Program Disk is an example only.

## Program Execution Flow

The execution flow of the sample1.vee program is shown in Figure 4-5 and Table 4-2.

**Figure 4-5** **Execution Flow of sample1.vee**

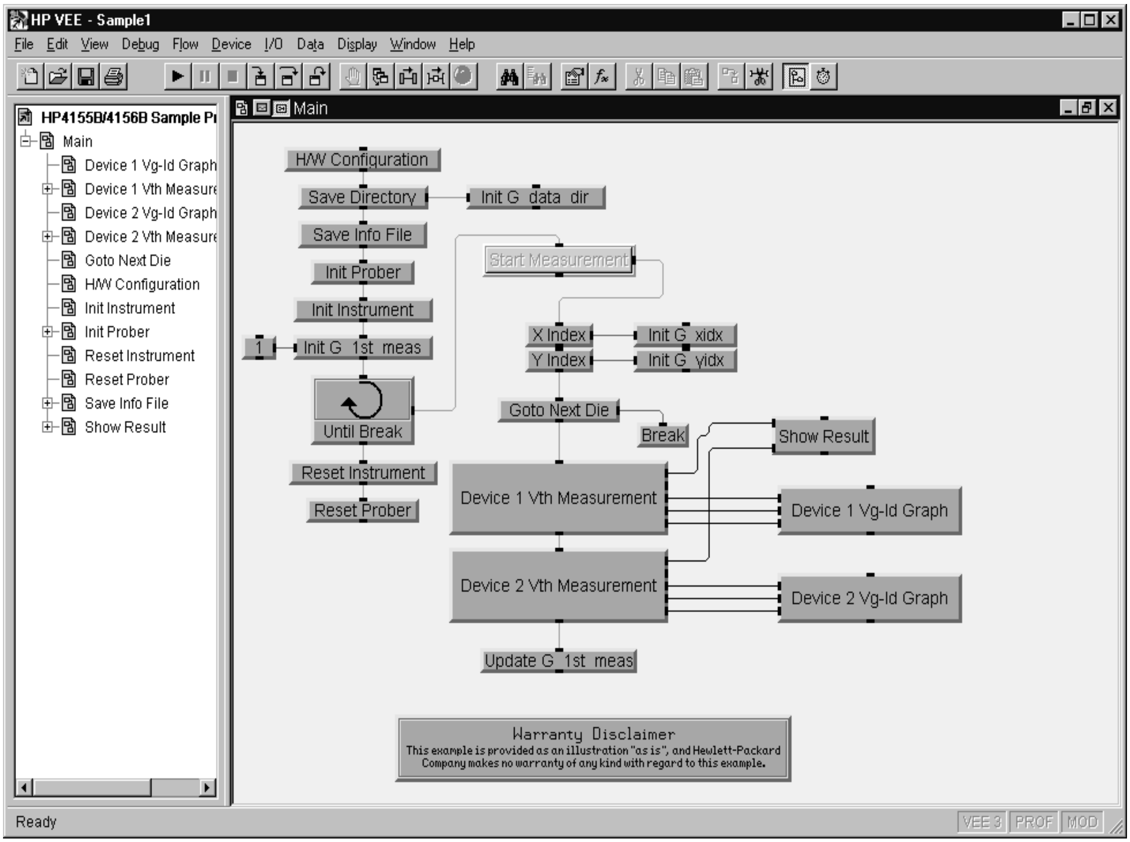


**Table 4-2 Execution Flow of sample1.vee**

| | Object | Explanation |
|---|---|---|
| 1 | H/W Configuration | Defines execution mode. Set the mode before running sample1.vee. |
| 2 | Save Directory,<br>Init G data dir | Defines name of the subdirectory to save the measurement result data. See “Installing the Sample Programs” on page 10. |
| 3 | Save Info File | Defines and saves the information file (info.txt) which contains title, date, and comments for the subdirectory. You can enter comments. See “Measurement Data Files” on page 8. |
| 4 | Init Prober | Initializes Cascade Summit series semi-auto prober, if used. |
| 5 | Init Instrument | Initializes instrument, if used. |
| 6 | 1, Init G 1st meas | Sets G_1st_meas value. If G_1st_meas=1, header lines are written in vth1.txt and vth2.txt. See “Measurement Data Files” on page 8. |
| 7 | Until Break | Repeats the following sequence until a break occurs. |
| 8 | Start Measurement | Triggers the start of the measurement. |
| 9 | X Index, Init G xidx,<br>Y Index, Init G yidx | Defines X and Y index of the die tested. The index must be defined in the *.ppd file used. |
| 10 | Goto Next Die, Break | Probes the die specified by the X-Y index. Breaks if X index < 0. |
| 11 | Device1 Vth Measurement<br>Device2 Vth Measurement | Executes Id-Vg measurement, extracts Vth, and saves measurement results. See “Measurement Data Files” on page 8. |
| 12 | Device1 Vg-Id Graph<br>Device2 Vg-Id Graph | Displays Id-Vg measurement result graphs of Device 1 and 2. See Figure 4-6. |
| 13 | Show Result | Displays Vth value and wafer map. See Figure 4-6. Dev1 Vth and Dev2 Vth show Vth value, and the field below shows wafer map. |
| 14 | Update G 1st meas | Sets G_1st_meas variable to 0. |
| 15 | Reset Instrument | Resets the instruments. |
| 16 | Reset Prober | Resets the prober. |

# Panel Display

The sample1.vee program displays the following data and graph. See Figure 4-6.

Vth — Displays Vth value of device 1 and 2. The data is in volts.

Vg-Id Graph — Displays Id-Vg curve of device 1 and 2.

X, Y Index — Displays wafer map of Vth value using the following characters.

.: Both device 1 and 2 test data are within the allowable range.

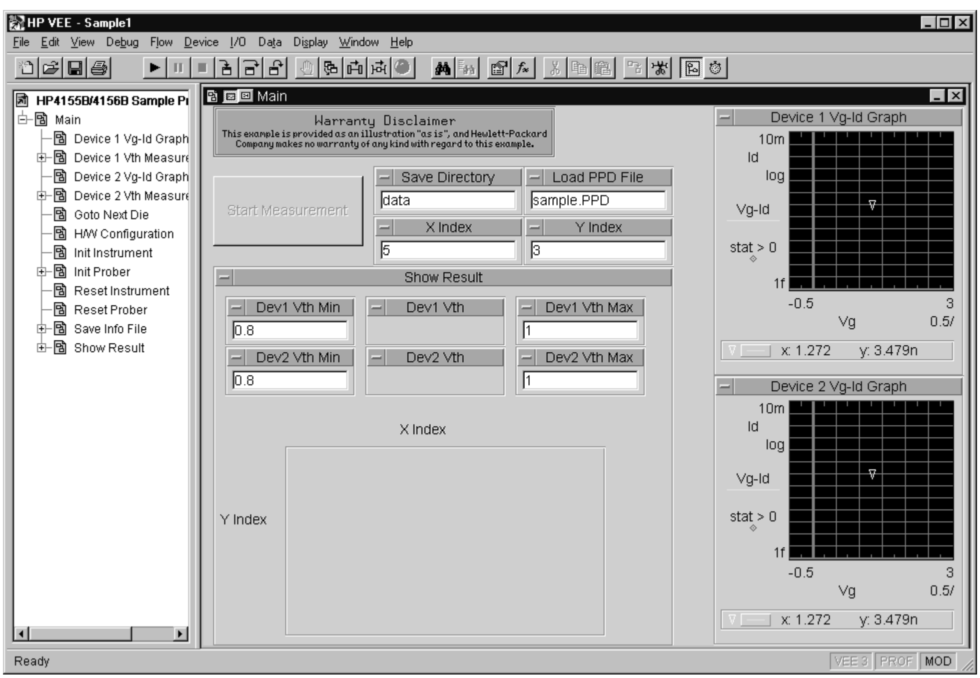
F1: Device 1 test data is out of the allowable range.

F2: Device 2 test data is out of the allowable range.

F3: Both device 1 and 2 test data are out of the allowable range.

The allowable range is specified by Dev1(2) Vth Min and Dev1(2) Vth Max input fields. Min field sets the lower limit, and Max field sets the upper limit.

**Figure 4-6 Panel Display of sample1.vee**



## To Execute sample1.vee

Before executing the sample1.vee program, do the following.

**NOTE** If you execute sample1.vee in Offline mode, skip steps 1 through 5.

1. Connect GPIB cables between your PC and the instruments being used.
2. Confirm that the semi-auto prober is connected to your PC via Cascade's interface, or connect the prober to your PC, if used.
3. Connect the measurement cables between the instruments and the prober or test fixture being used. See "Measurement Connection and Source Setup" on page 7.
4. Turn on the instruments and the semi-auto prober being used, if applicable.
5. Display the SYSTEM: MISCELLANEOUS screen on the 4155/4156. Select NOT SYSTEM CONTROLLER in the *4155C/4156C is* field.
6. Run Agilent VEE. If this is the first time using Agilent VEE and VXI*plug&play* drivers for the 4155/4156 and E5250A, register the drivers at this time. See "Programming Basic" in Chapter 3.
7. Open the sample1.vee program.
8. Display the program (Figure 4-5) and double click the H/W Configuration object. The panel of this object is displayed.
9. On the panel, select the check button of the instruments being used and the semi-auto prober, if used. See Table 4-3.

**Table 4-3** **H/W Configuration Object Check Button Setup**

| Execution Mode | 4155/56 | E5250A | Semi-Auto Prober |
|---|---|---|---|
| Online, standalone | check | | |
| Online, with E5250A | check | check | |
| Online, with prober | check | | check |
| Online, fully automatic | check | check | check |
| Offline | | | |

To execute the sample1.vee program, do the following.

**NOTE** If you execute sample1.vee in Offline mode, skip steps 3, 5, and 6.

1. Create a directory (Example: C:\lot1\test1\data) to be used to save the measurement data. To create a directory, use Windows Explorer. See “Installing the Sample Programs” on page 10.
2. Display the panel (Figure 4-6) and enter the following input fields.

| | |
|---|---|
| Save Directory | Enter the name of the directory to save measurement data. Enter only the name if the directory is under the current directory which this program is stored, or enter the entire path to specify another directory, such as C:\lot1\test1\data. |
| Load PPD File | Enter the file name of the probe plan data file (*.ppd) for the Cascade Microtech Prober Control Software. Ignore this field if you do not use the semi-auto prober. |
| Dev1 Vth Min/Max | Enter the allowable range of device 1 Vth value. Min field sets the lower limit, Max field sets the upper limit. |
| Dev2 Vth Min/Max | Enter the allowable range of device 2 Vth value. Min field sets the lower limit, Max field sets the upper limit. |

3. Connect the device.

   If you use the semi-auto prober, load a wafer on the prober, and keep the platen handle up.

   If you do not use the semi-auto prober, connect devices (two MOSFETs) to a test fixture, or load a wafer on a manual prober and probe a die tested.
4. Click the run button on the Agilent VEE menu bar. If you use the semi-auto prober, the Wait the DDE Server setup dialog box is displayed, and the Cascade Microtech prober control software is called. See Figure 4-7

   If you do not use the semi-auto prober, skip steps 5 and 6.
5. Click Continue. A window for the prober control software is displayed as shown in Figure 4-8.

   This example shows the SAMPLE.PPD window of the prober control software. The title of the window will be the file name you entered in the Load PPD File input field in step 2.
6. Move the wafer to align the probes over the probe plan alignment position, then click OK in the ALIGN PROBES dialog box.

**Figure 4-7** **Running sample1.vee with Cascade Microtech Prober Control Software (1)**

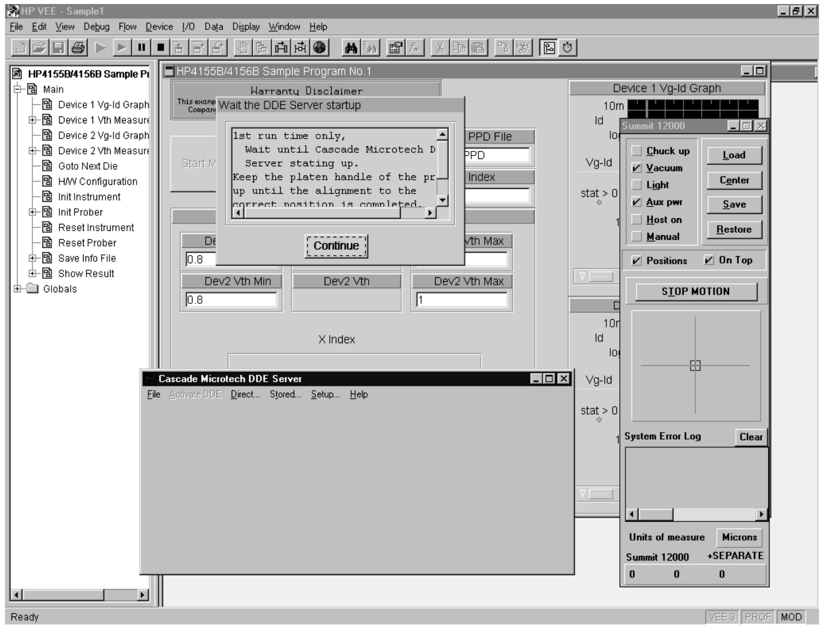
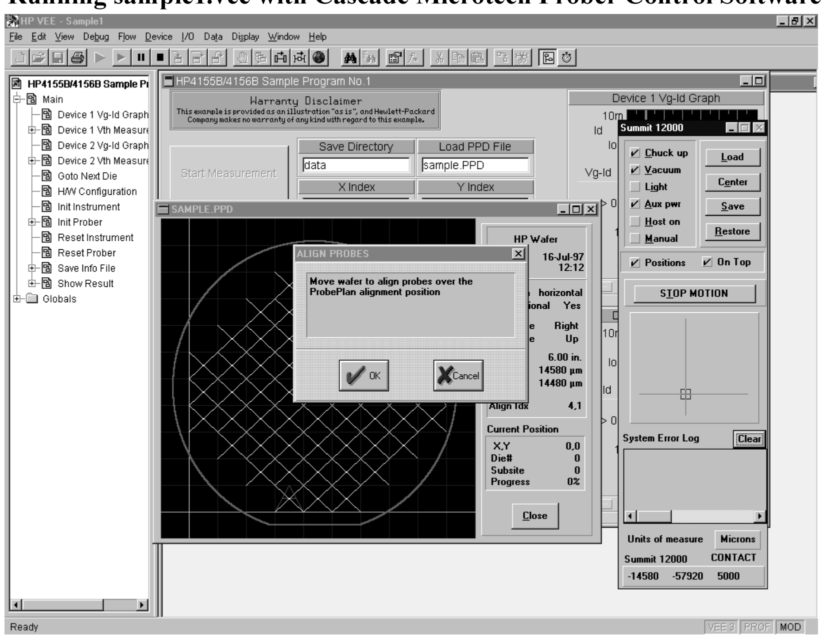


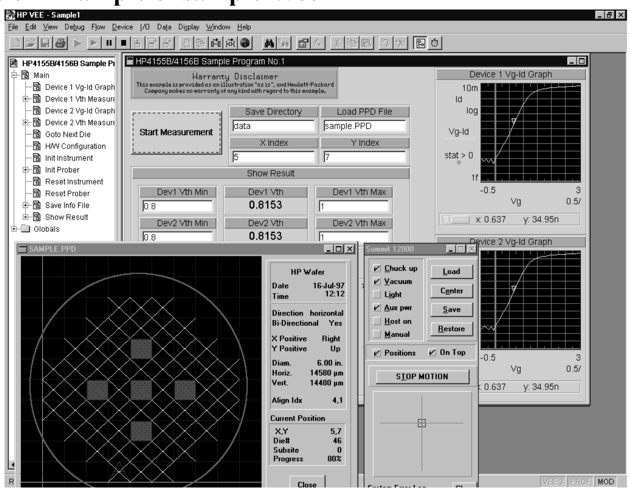
**Figure 4-8** **Running sample1.vee with Cascade Microtech Prober Control Software (2)**



7. Enter the X-Y index of the die to be tested in the X Index and Y Index input fields. Only the index defined in the *ppd file is effective for this test.

8. Click Start Measurement. The program executes the Id-Vg measurement, extracts Vth value, displays the results, and stores the data into files. The program then waits for your input.

**Figure 4-9** **Execution Example of sample1.vee**




9. Repeat steps 7 and 8 for all dies to be tested.

10. To stop the program, click the stop button on the Agilent VEE menu bar.

**NOTE**

In Offline mode, the program returns the dummy data instead of the raw measurement data in step 8.

**NOTE**

A wafer map is also displayed in the Cascade Microtech Prober Control Software *.ppd window. This window indicates results by using the following color scheme.

Green: Both device 1 and 2 test data are within the allowable range.

Yellow: Device 1 test data is out of the allowable range.

Magenta: Device 2 test data is out of the allowable range.

Red: Both device 1 and 2 test data are out of the allowable range.

**NOTE**

To exit the Cascade Microtech prober control software, select the File-Exit menu of the Cascade Microtech DDE Server window, then click Yes in the Halt Cascade DDE Server dialog box.

# Using sample2.vee

This section covers the following topics.

- "Program Execution Flow"
- "Panel Display"
- "To Execute sample2.vee"

**NOTE**

For the wafer test using the Summit series semi-auto prober from Cascade Microtech, Inc., create your probe plan file (*.ppd). The sample.ppd file stored on the Agilent VEE Sample Program Disk is an example only.

## Program Execution Flow

The execution flow of the sample2.vee program is shown in Figure 4-10 and Table 4-4.

**Figure 4-10 Execution Flow of sample2.vee**

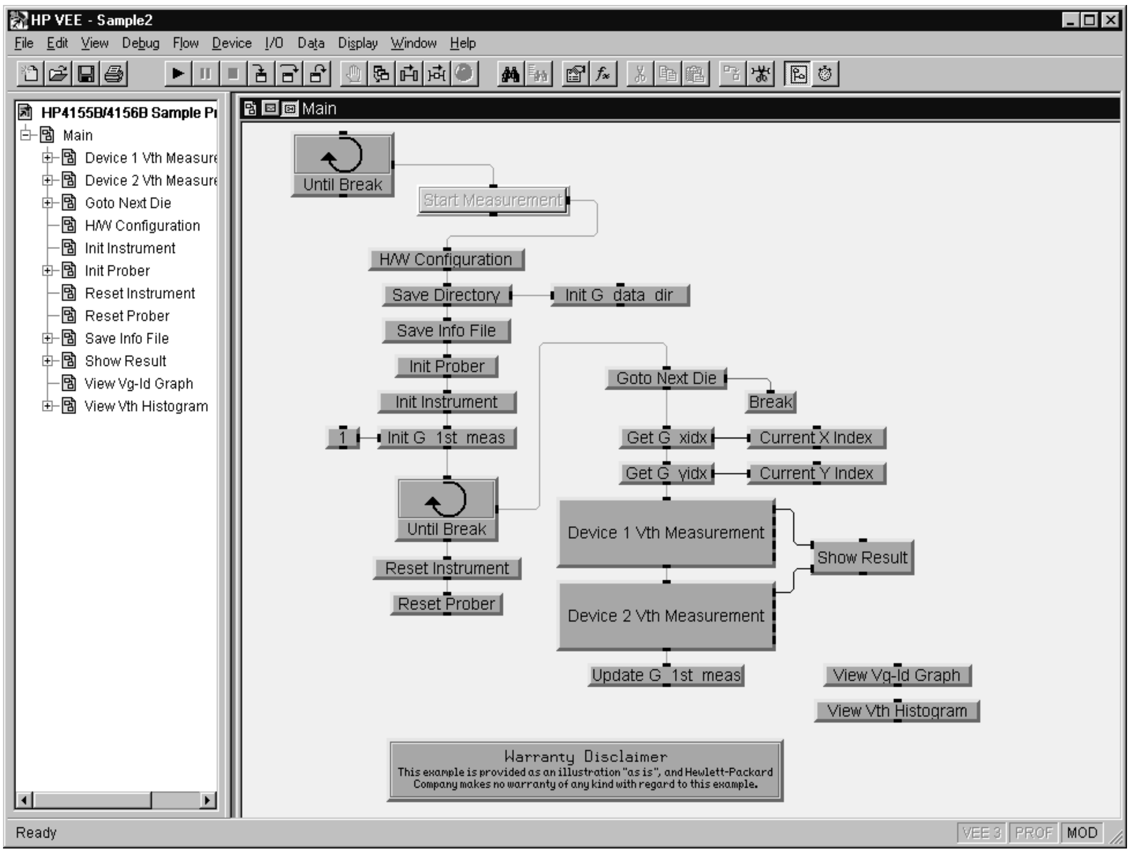


**Table 4-4 Execution Flow of sample2.vee**

| | Object | Explanation |
|---|---|---|
| 1 | Until Break | Repeats the following sequence until a break occurs. |
| 2 | Start Measurement | Triggers the start of the wafer test. |
| 3 | H/W Configuration | Defines execution mode. Set the mode before running sample2.vee. |
| 4 | Save Directory,<br>Init G data dir | Defines name of the subdirectory to save measurement result data.<br>See “Installing the Sample Programs” on page 10. |
| 6 | Save Info File | Defines and saves the information file (info.txt) which contains title, date, and comments for the subdirectory. You can enter comments.<br>See “Measurement Data Files” on page 8. |
| 7 | Init Prober | Initializes Cascade Summit series semi-auto prober, if used. |
| 8 | Init Instrument | Initializes instruments, if used. |
| 9 | 1, Init G 1st meas | Sets G_1st_meas value. If G_1st_meas=1, the prober sets the first die to probe, and header lines are written in vth1.txt and vth2.txt.<br>See “Measurement Data Files” on page 8. |
| 10 | Goto Next Die, Break | Probes the die to test. The die and probing sequence depend on the *.ppd file used. Breaks if the test was completed for all die. |
| 11 | Get G xidx, Get G yidx<br>Current X, Y Index | Gets and displays the X-Y index of the die now tested. |
| 13 | Device1 Vth Measurement<br>Device2 Vth Measurement | Executes Id-Vg measurement, extracts Vth, and saves measurement results. See “Measurement Data Files” on page 8. |
| 14 | Show Result | Displays Vth value and wafer map. See Figure 4-11. Dev1 Vth and Dev2 Vth show Vth value, and the field below shows wafer map. |
| 15 | Update G 1st meas | Sets G_1st_meas variable to 0. |
| 16 | Reset Instrument | Resets the instruments. |
| 17 | Reset Prober | Resets the prober. |
| -- | View Vg-Id Graph | Displays Id-Vg curve of the device you select. |
| -- | View Vth Histogram | Displays histogram for Vth of the device you select (device 1 or device 2). |

# Panel Display

The sample2.vee program displays the following data and graph. See Figure 4-11.

Vth — Displays Vth value of device 1 and 2. The data is in volts.

Histogram — Displays histogram of Vth value for the device selected. Enter the file name, then click View to display the histogram.

Vg-Id Graph — Displays Id-Vg curve for the device selected. Enter the file name, then click View to display the graph.

X, Y Index — Displays wafer map of Vth value using the following characters.

. : Both device 1 and 2 test data are within the allowable range.

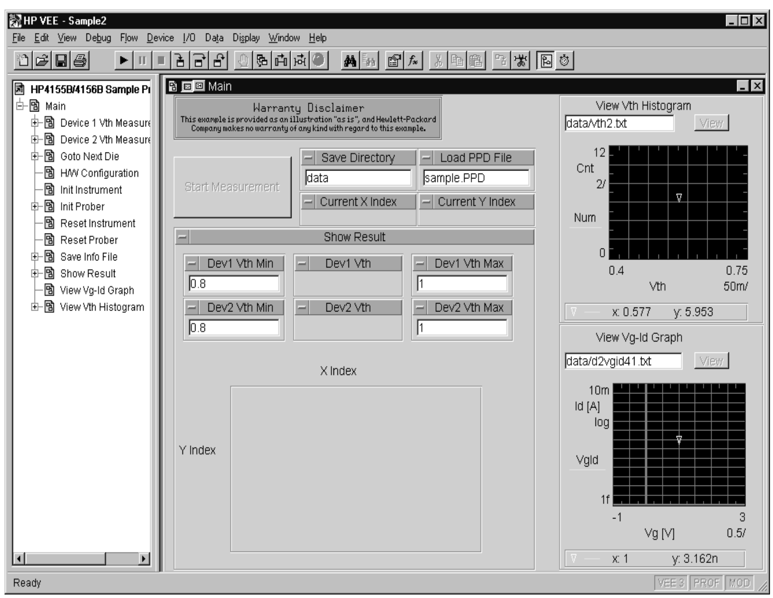
F1: Device 1 test data is out of the allowable range.

F2: Device 2 test data is out of the allowable range.

F3: Both device 1 and 2 test data are out of the allowable range.

The allowable range is specified by Dev1(2) Vth Min and Dev1(2) Vth Max input fields. Min field sets the lower limit, and Max field sets the upper limit.

**Figure 4-11** **Panel Display of sample2.vee**



## To Execute sample2.vee

Before executing the sample2.vee program, do the following.

**NOTE** If you execute sample2.vee in Offline mode, skip steps 1 through 5.

1. Connect the GPIB cables between your PC and the instruments being used.
2. Confirm that the semi-auto prober is connected to your PC via Cascade's interface, or connect the prober to your PC, if used.
3. Connect the measurement cables between the instruments and the prober or test fixture used. See "Measurement Connection and Source Setup" on page 7.
4. Turn on the instruments and the semi-auto prober being used, if applicable.
5. Display the SYSTEM: MISCELLANEOUS screen on the 4155/4156. Then select NOT SYSTEM CONTROLLER in the *4155C/4156C is* field.
6. Run Agilent VEE. If this is the first time using Agilent VEE and VXI*plug&play* drivers for the 4155/4156 and E5250A, register the drivers at this time. See "Programming Basic" in Chapter 3.
7. Open the sample2.vee program.
8. Display the program (Figure 4-10) and double click the H/W Configuration object. The panel for the object is displayed.
9. On the panel, select the check button of the instruments and the semi-auto prober being used, if applicable. See Table 4-5.

**Table 4-5** **H/W Configuration Object Check Button Setup**

| Execution Mode | 4155/56 | E5250A | Semi-Auto Prober |
|---|---|---|---|
| Online, standalone | check | | |
| Online, with E5250A | check | check | |
| Online, with prober | check | | check |
| Online, fully automatic | check | check | check |
| Offline | | | |

To execute the sample2.vee program, do the following.

**NOTE** If you execute sample2.vee in Offline mode, skip steps 4, 6, and 7.

1. Click the run button on the Agilent VEE menu bar.
2. Create a directory (Example: C:\lot1\test1\data) to save the measurement data. To create a directory, use Windows Explorer. See “Installing the Sample Programs” on page 10.
3. Enter the following input fields.

| | |
|---|---|
| Save Directory | Enter the name of the directory to save measurement data. Enter only the name if the directory is under the current directory where this program is stored, or enter the entire path to specify a different directory, such as C:\lot1\test1\data. |
| Load PPD File | Enter the file name of the probe plan data (*.ppd) file for Cascade Microtech Prober Control Software. Ignore this field if the semi-auto prober is not used. |
| Dev1 Vth Min/Max | Enter the allowable range of Vth value for device 1. Min field sets the lower limit, Max field sets the upper limit. |
| Dev2 Vth Min/Max | Enter the allowable range of Vth value for device 2. Min field sets the lower limit, Max field sets the upper limit. |

4. Connect the device.

   If you use the semi-auto prober, load a wafer on the prober, and keep the platen handle up.

   If you do not use the semi-auto prober, connect devices (two MOSFETs) to a test fixture, or load a wafer on a manual prober and probe a die tested.

5. Click Start Measurement. If you use the semi-auto prober, the Wait the DDE Server setup dialog box is displayed, and the Cascade Microtech prober control software is called. See Figure 4-12

   If you do not use the semi-auto prober, skip steps 6 and 7.

6. Click Continue. A window of the prober control software is displayed as shown in Figure 4-13.

   This example shows the SAMPLE.PPD window of the prober control software. The title of the window will be the file name you entered in the Load PPD File input field in step 3.

**Figure 4-12 Running sample2.vee with Cascade Microtech Prober Control Software (1)**

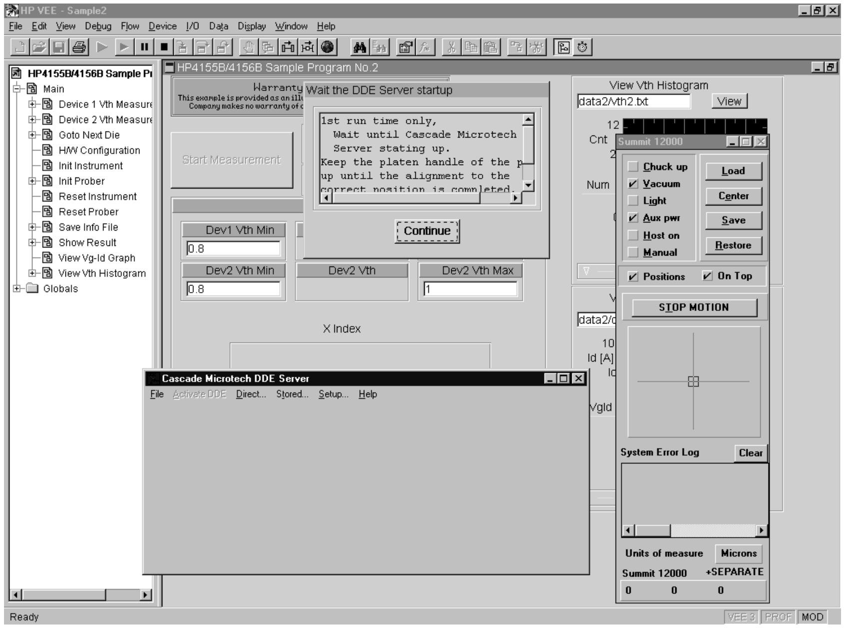
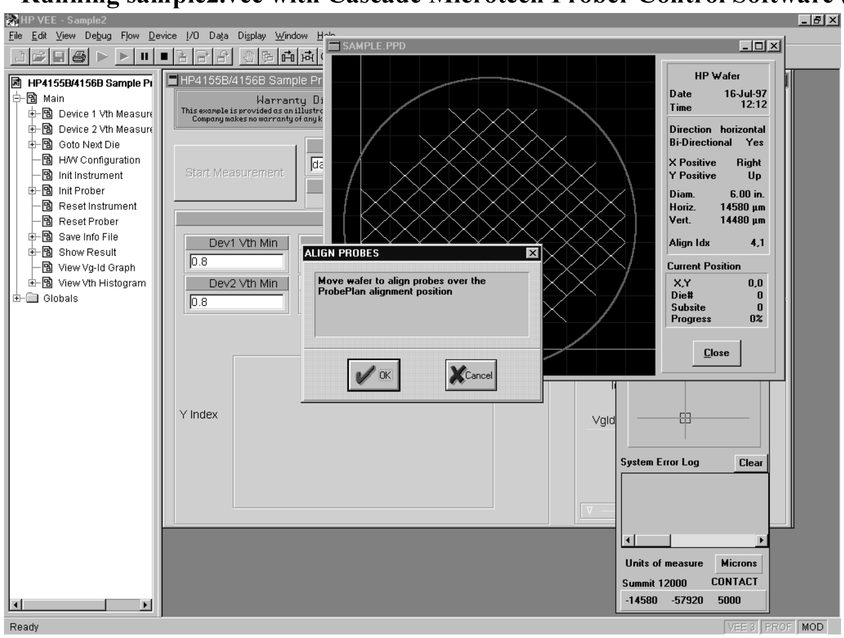


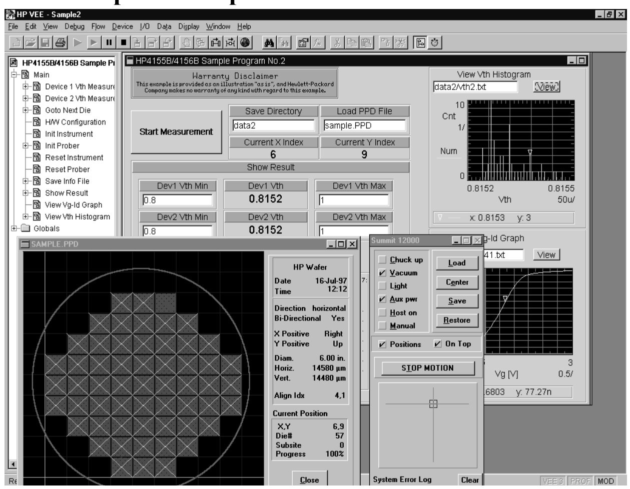

**Figure 4-13 Running sample2.vee with Cascade Microtech Prober Control Software (2)**



7. Move the wafer to align the probes over the probe plan alignment position, then click OK in the ALIGN PROBES dialog box.

8. Wait until wafer test is completed. The program executes the Id-Vg measurement, extracts Vth value, displays the results, and stores the data into files. The program then waits for your input.

**Figure 4-14** **Execution Example of sample2.vee**




9. Repeat step 2 through 8 for all wafers to be tested.

10. To stop the program, click the stop button on the Agilent VEE menu bar.

**NOTE**

In Offline mode, the program returns the dummy data instead of the raw measurement data in step 8.

**NOTE**

A wafer map is also displayed in the Cascade Microtech Prober Control Software *.ppd window. The window indicates the results by using the following color scheme.

| | |
|---|---|
| Green: | Both device 1 and 2 test data are within the allowable range. |
| Yellow: | Device 1 test data is out of the allowable range. |
| Magenta: | Device 2 test data is out of the allowable range. |
| Red: | Both device 1 and 2 test data are out of the allowable range. |

**NOTE**

To exit the Cascade Microtech Prober Control Software, select the File-Exit menu of the Cascade Microtech DDE Server window. Then click Yes in the Halt Cascade DDE Server dialog box.

# Customizing Sample Programs

This section offers examples of modifications to the sample1.vee and sample2.vee programs:

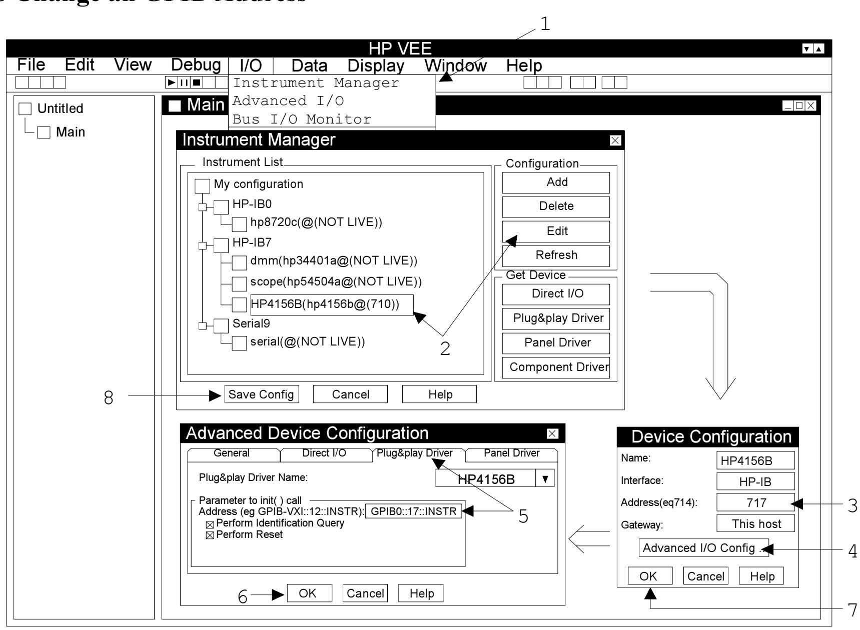
- "To Change an GPIB Address"
- "To Change the Vth Measurement Setup"
- "To Remove a Test Device"
- "To Remove a Source Output"
- "To Add a Test Device"
- "To Add a Measurement Parameter"

# To Change an GPIB Address

You can change the GPIB address of the 4155/4156 and E5250A by using the Agilent VEE Instrument Manager.

1. Select the I/O-InstrumentManager menu from the Agilent VEE menu bar. The Instrument Manager dialog box is displayed.
2. Select the instrument (Example: HP4156B) from the Instrument Manager dialog box, and then click Edit. The Device Configuration dialog box is displayed.
3. Enter the new address in the Address field. For example, enter “717”.
4. Click Advanced I/O Config. The Advanced Device Configuration dialog box is displayed.
5. Select the Plug&play Driver Tab, and then enter the new address in the Address field. For example, enter “GPIB0::17::INSTR”.
6. Click OK in the Advanced Device Configuration dialog box.
7. Click OK in the Device Configuration dialog box.
8. Click Save Config in the Instrument Manager dialog box to register the new address.

**Figure 4-15** **To Change an GPIB Address**



## To Change the Vth Measurement Setup

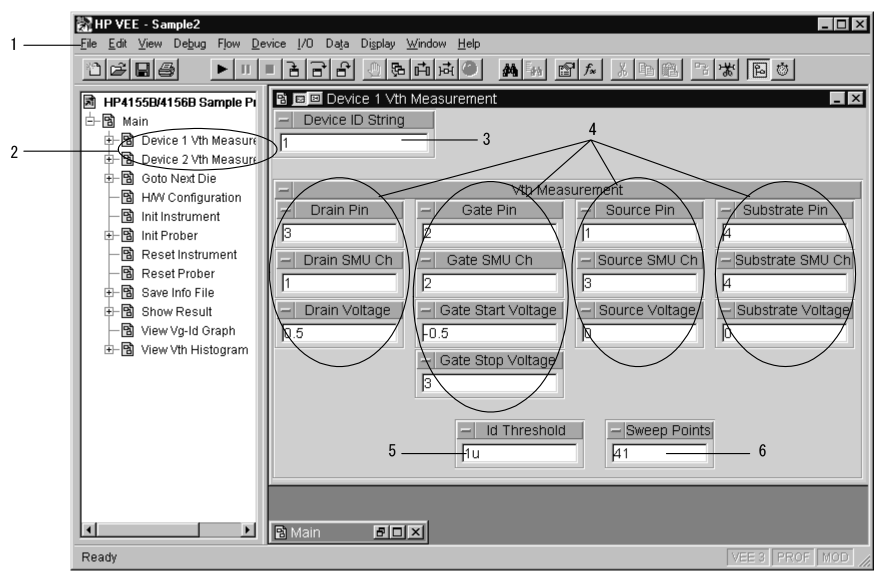
You can change the 4155/4156 source setup and the E5250A switching setup by editing the Device 1 (or 2) Vth Measurement object. See Figure 4-16.

1. Open the sample1.vee or sample2.vee program.
2. Double click Device 1 (or 2) Vth Measurement in the Agilent VEE program explorer. The Device 1 (or 2) Vth Measurement object is displayed.
3. Change the Device ID for MOSFET if needed, using a string format.
4. Change the setup for all terminals for MOSFET.

| | |
|---|---|
| Pin | E5250A output channel number; 1 to 24 are available. |
| SMU Ch | 4155/4156 SMU number; 1 to 4 are available. |
| Voltage | SMU output voltage (in volts). |
| Start,Stop Voltage | SMU output voltage for Vg sweep (in volts). |

5. Change the target Id for extracting Vth. See "Definition of Vth" on page 5.
6. Change the number of measurement points in a sweep; 2 to 256 are available.

**Figure 4-16 Vth Measurement Panel Display**



**NOTE**

If you want to change other source setup parameters, such as compliance, you will need to change the setup of the To/From object, by doing the following.

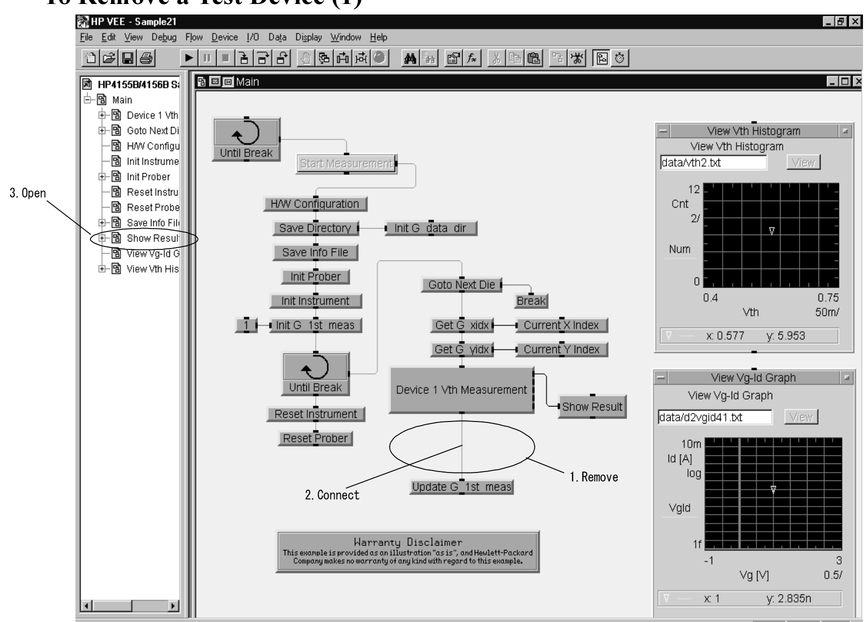
1. Display the program for the Device 1 (or 2) Vth Measurement object.
2. Open the Vth Measurement object, and display the program.
3. Open the Pre-Setup object, and then open the Setup4155 object.
4. Double click hp4156b_force and display the Edit Function Panel.
5. Change the setup value on the panel.

## To Remove a Test Device

If your test die includes only one MOSFET, modify the program as shown below. This example modifies sample2.vee, and removes objects for device 2.

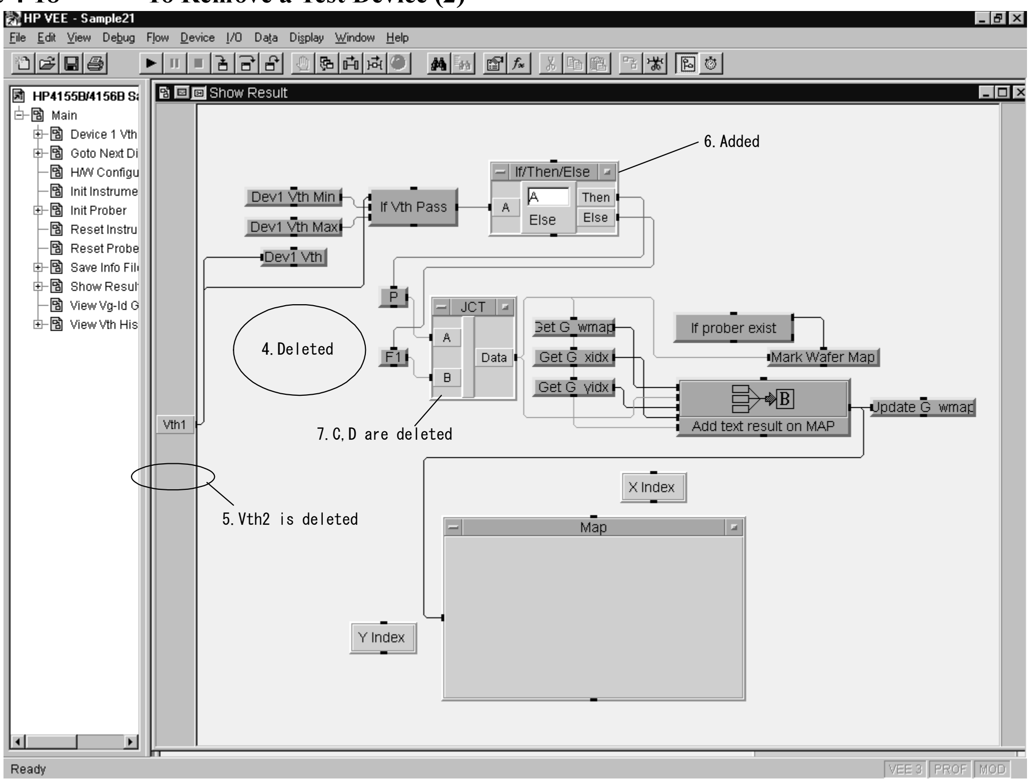
1. Cut the Device 2 Vth Measurement object from the Main program display.
2. Connect the control line between the Device 1 Vth Measurement object and the Update G 1st meas object.
3. Open the Show Result object using the Agilent VEE program explorer.

**Figure 4-17 To Remove a Test Device (1)**



4. Display the Show Result object program, and cut the following seven objects.
   - Dev2 Vth, Dev2 Vth Min, Dev2 Vth Max, If Vth Pass (for device2)
   - If/Then/Else
   - F2, F3
5. Delete the input terminal Vth2.
6. Add the Flow-If/Then/Else object, and enter A, then connect the lines:
   - between If Vth Pass and If/Then/Else A terminal
   - between If/Then/Else Then terminal and P
   - between If/Then/Else Else terminal and F1
7. Double click the JCT object, and delete the input terminals C and D.

**Figure 4-18 To Remove a Test Device (2)**



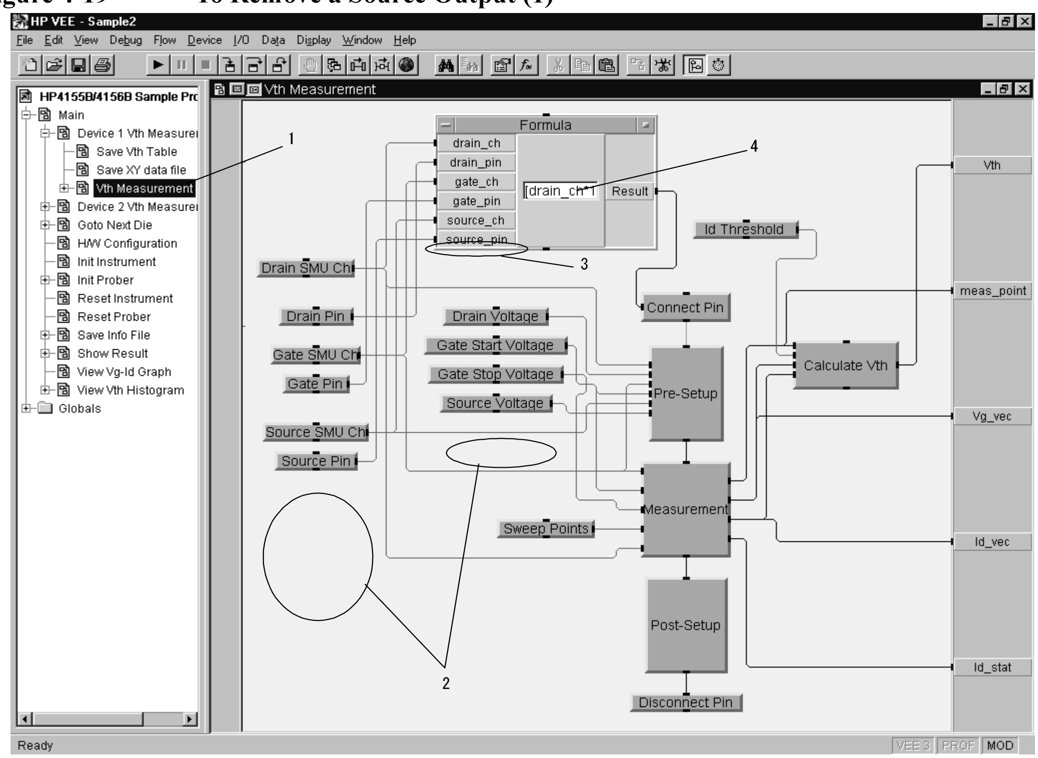
## To Remove a Source Output

If the number of terminals for your device is less than four, modify the program as shown below. This example modifies sample2.vee, and removes objects for the substrate terminal of device 1 (the example does not modify the objects for device 2).

1. Open the Vth Measurement object using the Agilent VEE program explorer.
2. Display the program, and cut the following three objects.
   - Substrate SMU Ch
   - Substrate Pin
   - Substrate Voltage
3. Open the Formula object, and delete the sub_ch and sub_pin input terminals.
4. Change the formula, defined in the Formula object, as shown below.

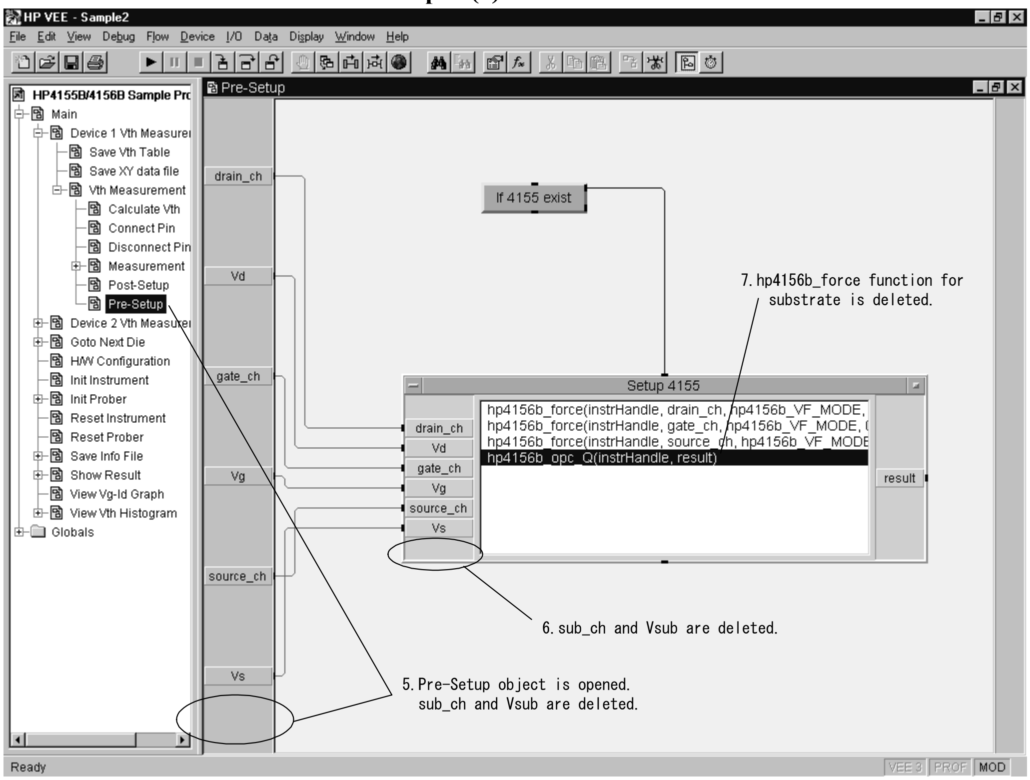
[drain_ch*100+drain_pin, gate_ch*100+gate_pin, source_ch*100+source_pin, 0]

**Figure 4-19 To Remove a Source Output (1)**



5. Open the Pre-Setup object, and delete the sub_ch and Vsub input terminals.
6. Open the Setup 4155 object, and delete the sub_ch and Vsub input terminals.
7. Delete the hp4156b_force(instrHandle,sub_ch,.....) function from the Setup 4155 object.

**Figure 4-20 To Remove a Source Output (2)**

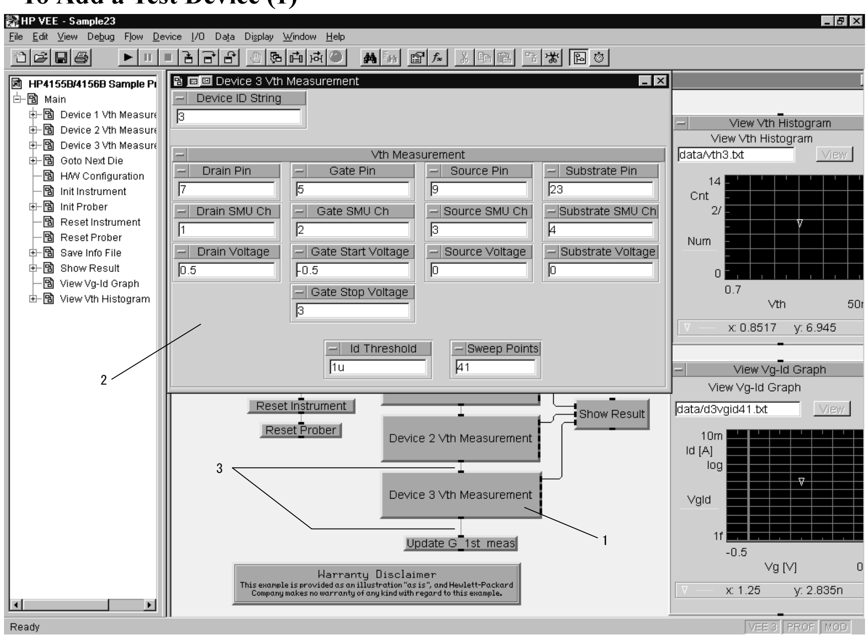


# To Add a Test Device

If your test die includes three MOSFETs, modify the program as shown below. This example modifies sample2.vee, and adds the Vth measurement and display objects for the third MOSFET.

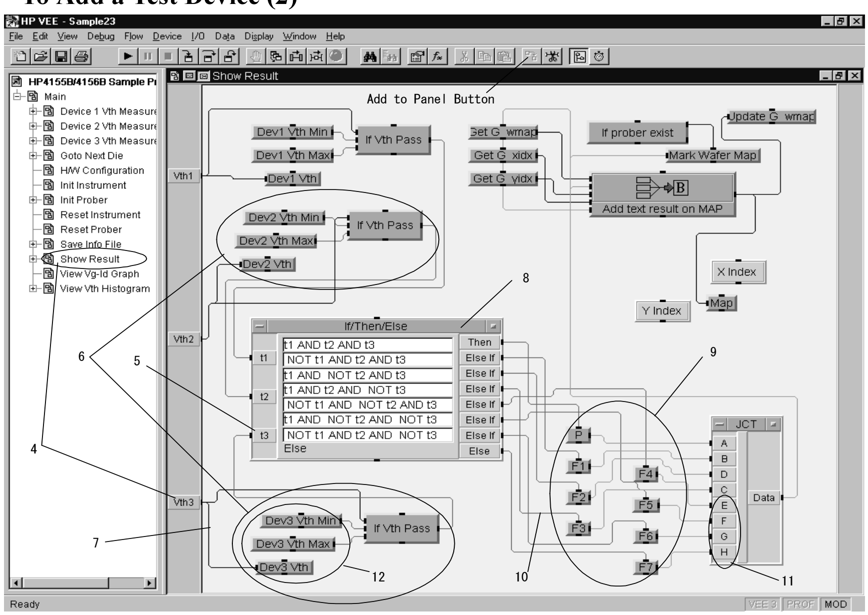
1. Copy and paste the Device 2 Vth Measurement object on the Main program display, and change the title to Device 3 Vth Measurement.
2. Change the measurement setup, Device ID String, pin, voltage, and so on, for the third device on the panel display of the Device 3 Vth Measurement object. See "To Change the Vth Measurement Setup" on page 29.
3. Cut the line between the Device 2 Vth Measurement object and Update G 1st meas object, then connect the lines as shown below.
   - between Device 2 Vth Measurement and Device 3 Vth Measurement
   - between Device 3 Vth Measurement and Update G 1st meas
4. Open the Show Result object program display, and add the Vth3 input terminal. See Figure 4-22.
5. Open the If/Then/Else object, and add the t3 input terminal.

**Figure 4-21** **To Add a Test Device (1)**



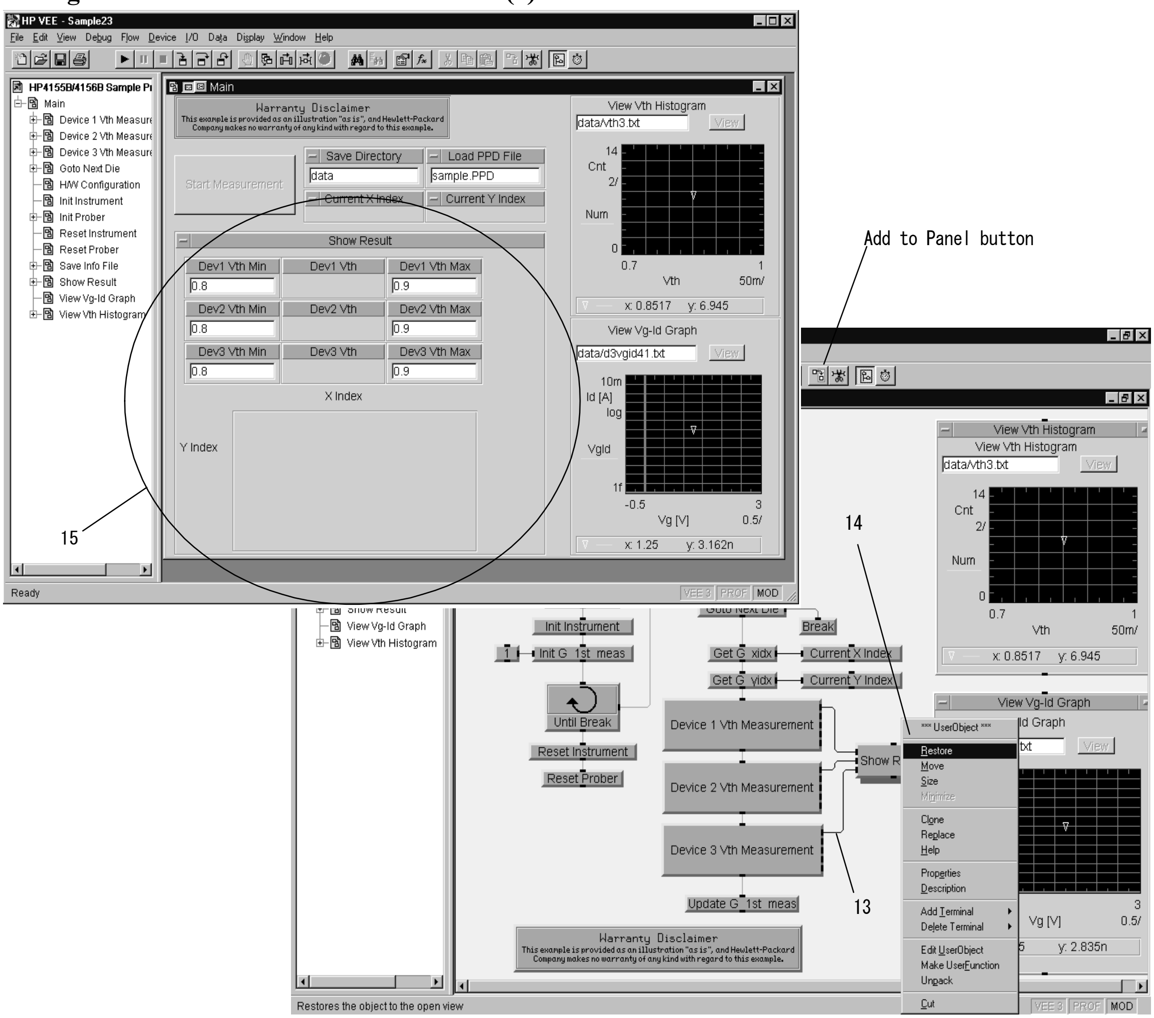
6. Copy and paste the following four objects, and change title Dev2 to Dev3.
   - Dev2 Vth Min, Dev2 Vth Max, Dev2 Vth, and If Vth Pass
7. Connect the lines shown below:
   - between Vth3 terminal and Dev3 Vth object
   - between Vth3 terminal and the data input terminal of If Vth Pass object
   - between If Vth Pass and t3 input terminal of If/Then/Else object
8. Change the definition of the If/Then/Else object as shown in Figure 4-22.
9. Copy and paste P, F1, F2 and F3 objects, and change the title and entry to F4, F5, F6, and F7, respectively.
10. Cut the line between Else and F3, and connect lines for F3, F4, F5, F6, and F7 as shown in Figure 4-22.
11. Open the JCT object, create an additional four input terminals, and connect the lines for E, F, G, and H as shown in Figure 4-22.
12. Open the Dev3 Vth, Dev3 Vth Min, and Dev3 Vth Max objects, and select them. Then click the Add to Panel button. The objects are added to the Show Result panel display. Adjust the position and size of the objects.

**Figure 4-22 To Add a Test Device (2)**



13. Open the Main program display, and connect the line between the Vth terminal of the Dev3 Vth Measurement object and the Vth3 terminal of the Show Result object.
14. Click the right mouse button on the Show Result object, and select the Restore menu. The Show Result object panel display is restored on the Main program display.
15. Select the restored Show Result object, and click the Add to Panel button. The object is added to the Main panel display. Delete the old Show Result object, and adjust the position and size of the new Show Result object.

**Figure 4-23 To Add a Test Device (3)**



**NOTE**

The modification example shown above changes the meaning of the wafer map result display as shown below.

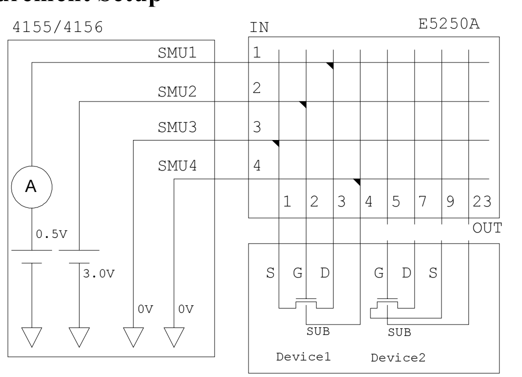
| | |
|---|---|
| P | Test results of all devices are within the allowable range. |
| F1 | Device 1 test result is out of the allowable range. |
| F2 | Device 2 test result is out of the allowable range. |
| F3 | Device 3 test result is out of the allowable range. |
| F4 | Test results of device 1 and 2 are out of the allowable range. |
| F5 | Test results of device 2 and 3 are out of the allowable range. |
| F6 | Test results of device 1 and 3 are out of the allowable range. |
| F7 | Test results of all devices are out of the allowable range. |

# To Add a Measurement Parameter

If you want to add a measurement parameter, such as drain current Id, modify the program as shown below. This example modifies sample2.vee for device 1 only (this example does not modify the objects for device 2).

- Adds the measurement function to the Measurement object.
- Adds the object to set the dummy data to the Meas 4155 (Offline) object.
- Adds the object to set the measurement source to the Vth Measurement object.
- Adds the object to save the measured data to the Device 1 Measurement object.
- Modifies the Show Result object and the Main panel display.

**Figure 4-24 Id Measurement Setup**



### To Add the Measurement Function and Dummy Data

1. Open the Measurement object using the Agilent VEE program explorer.
2. Create the Vg_spot input terminal in the Measurement object as shown in Figure 4-25.
3. Open the Meas 4155 object, and add the following three functions. Then set the parameters shown using the Edit Function Panel of each function.
   - hp4156b_opc_Q function
   - hp4156b_force function
     a. channel : Use gate_ch variable.
     b. mode : VOLTAGE OUTPUT
     c. range : 0
     d. value : Use Vg variable, and create Vg input terminal.
     e. comp : 1m
     f. polarity : AUTO
   - hp4156b_spotMeas function
     a. channel : Use drain_ch variable.
     b. mode : CURRENT MEASUREMENT
     c. range : 0
     d. value : Use spot_id variable, and create spot_id output terminal.
     e. status : Use spot_id_s variable, and create spot_id_s output terminal.
4. Connect the line between the Vg_spot input terminal and the Vg input terminal of the Meas 4155 object.
5. Add two Flow-Junction (JCT) objects.
6. Create the spot_id and spot_id_s output terminals in the Measurement object.
7. Connect the lines from the spot_id terminal of the Meas 4155 object to the spot_id terminal of the Measurement object via the JCT object.

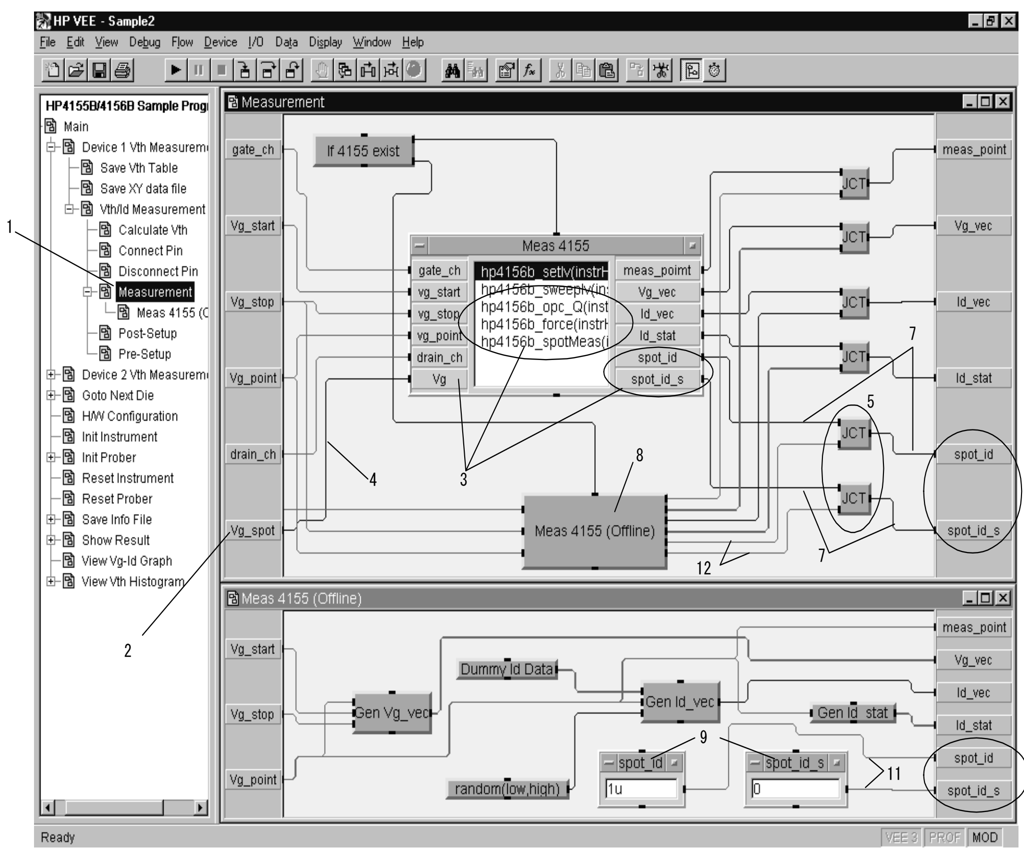
   Then connect the lines from the spot_id_s terminal of the Meas 4155 object to the spot_id_s terminal of the Measurement object via the JCT object.
8. Open the Meas 4155 (Offline) object.

9. Add the Data-Constant-Real and Data-Constant-Integer objects, and set the title to spot_id and spot_id_s, respectively. Then enter "1u" to the entry field of the spot_id object.
10. Create the spot_id and spot_id_s output terminals in the Meas 4155 (Offline) object.
11. Connect the line between the spot_id object and the spot_id terminal.

    Then connect the line between the spot_id_s object and the spot_id_s terminal.
12. Connect the line between the spot_id terminal of the Meas 4155 (Offline) object and the JCT object connected to the spot_id terminal.

    Then connect the line between the spot_id_s terminal of the Meas 4155 (Offline) object and the JCT object connected to the spot_id_s terminal.

**Figure 4-25 To Add the Measurement Function and Dummy Data**

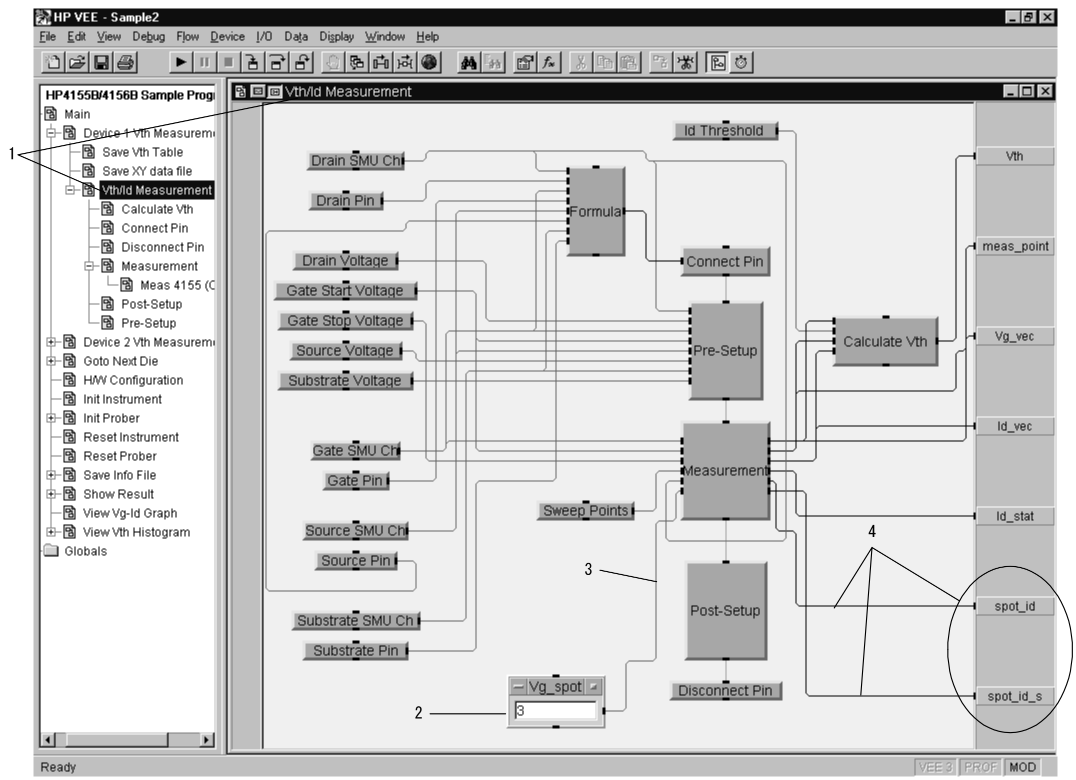


## To Set the Id Measurement Source

1. Open the Vth Measurement object program display, and change the title to Vth/Id Measurement.
2. Add the Data-Constant-Real object, set the title to Vg_spot, and enter any value for gate voltage in volts. This example enters 3.
3. Connect the line between the Vg_spot object and the Vg_spot terminal of the Measurement object.
4. Create the spot_id and spot_id_s output terminals in Vth/Id Measurement object.

   Then connect lines between the spot_id terminal of the Measurement object and the spot_id output terminal, and between the spot_id_s terminal of the Measurement object and the spot_id_s output terminal.

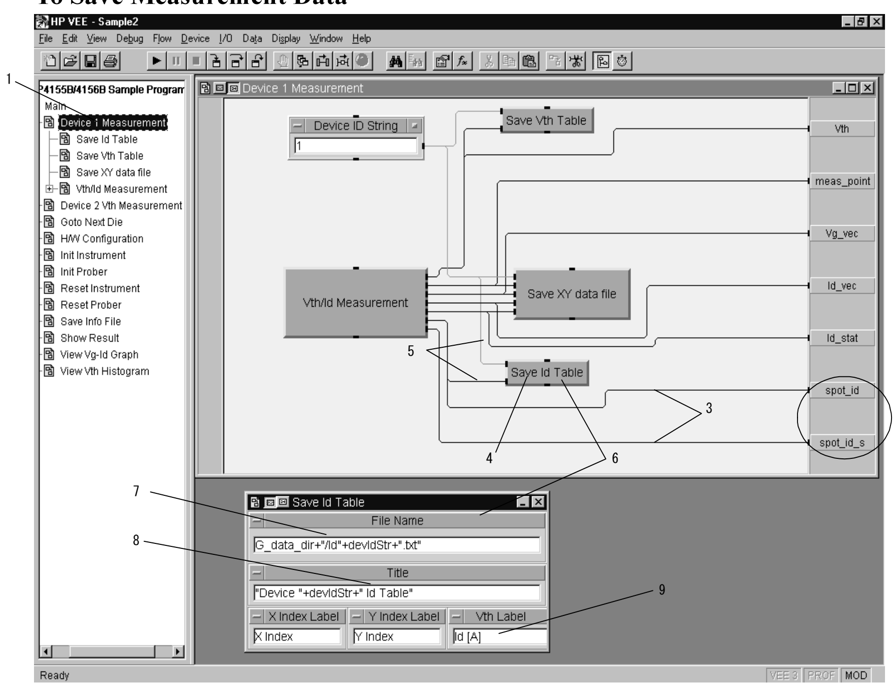
**Figure 4-26** **To Set the Id Measurement Source**



## To Save Measurement Data

1. Open the Device 1 Vth Measurement object program display, and change the title to Device 1 Measurement.
2. Create the spot_id and spot_id_s output terminals.
3. Connect the lines between the spot_id terminal of the Vth/Id Measurement object and the spot_id output terminal, and between the spot_id_s terminal of the Vth/Id Measurement object and the spot_id_s output terminal.
4. Copy and paste Save Vth Table, and change the title to Save Id Table.
5. Connect the lines between the Device Id String object and the devIdStr terminal of the Save Id Table object, and between the spot_id terminal of the Vth/Id Measurement object and the Vth terminal of the Save Id Table object.
6. Open the Save Id Table object panel display.
7. Change the characters *Vth* in the File Name entry field to *Id*.
8. Change the characters *Vth* in the Title entry field to *Id*.
9. Enter Id [A] into the Vth Label entry field.

**Figure 4-27 To Save Measurement Data**



## To Modify the Show Result and Main Panel Displays

1. Open the Show Result object program display.
2. Add the Display-Alphanumeric object, and set the title to Dev1 Id.
3. Create the spot_id input terminal.
4. Connect the line between the spot_id terminal and the Dev1 Id object.
5. Click the Dev Id object, then click the Add to Panel button. The Dev Id object is added to the panel display of the Show Result object. Adjust the position and size of the object.
6. Open the Main program display, and connect the line between the Show Result object spot_id terminal and the Device 1 Measurement object spot_id terminal.
7. Click the right mouse button on the Show Result object, and select Restore menu. The restored Show Result object is displayed.
8. Click the restored Show Result object, and click the Add to Panel button. The object is added to the Main panel display. Delete the old Show Result object from the panel, and adjust the position and size of the new Show Result object.

**Figure 4-28 To Modify Show Result and Main Panel**