Programmer's Guide
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Programming Overview

The HP 4155A/56A can be fully controlled from an external computer or by using built-in HP Instrument BASIC (IBASIC) controller. IBASIC is a programming environment that allows full control of HP 4155A/56A without using an external computer.

To fully control the HP 4155A/56A, you execute programs that contain SCPI commands. SCPI means Standard Commands for Programmable Instruments. SCPI is the default program language of the HP 4155A/56A, and can control all functions of the HP 4155A/56A. These programs can be run from IBASIC or an external computer.

The HP 4155A/56A has two command modes:

- **HP 4155/56 command mode** is the default mode of HP 4155A/56A. You use this mode in all cases, except when directly running an HP 4145A/B program. In this mode, you can use a program that contains SCPI commands, which allow you to control all functions of the HP 4155A/56A.
- **HP 4145 syntax command mode**, which allows you to execute HP 4145A/B programs on the HP 4155A/56A directly with little or no modification. In this command mode, you cannot control all functions of HP 4155A/56A.
How to Migrate HP 4145A/B Programs

HP 4145A/B Auto Sequence Program (ASP) programs run on the HP 4145A/B built-in programming environment and allow basic control of HP 4145A/B without using an external computer. To run the ASP programs on the HP 4155A/56A, you do one of the following and execute the program in the HP 4155/56 command mode:

- Create a program that performs the same operations as the desired ASP program by using the IBASIC editor typing aid softkeys to enter commands that correspond to each ASP command. This program can run on IBASIC only, not on an external computer. Refer to "Creating ASP-like IBASIC Programs" in Chapter 1 for details.
- Create a program using SCPI commands that performs same operations as the desired ASP program. This program can run on IBASIC or on an external computer. Refer to "Programming Example for HP 4145 Users" in Chapter 4 for details.

HP 4145A/B HP-IB programs run on an external computer and allow full control of the HP 4145A/B. To run these programs on the HP 4155A/56A, do one of the following:

- Directly run the HP 4145A/B program on the HP 4155A/56A with little or no modification. You must run this program in the HP 4145 syntax command mode from IBASIC or an external computer. Refer to Chapter 5 for details.
- Create a program using SCPI commands that performs same operations as the HP 4145A/B program. You must run this program in HP 4155/56 command mode from IBASIC or an external computer.
In This Manual

This manual describes how to control the HP 4155A/4156A by using HP-IB commands from an external computer or built-in HP Instrument BASIC.

This manual consists of the following chapters:
- Using HP Instrument BASIC
- Reference: HP Instrument BASIC
- Getting Started on Programming the HP 4155A/4156A
- HP 4155A/4156A SCPI Programming
- Running HP 4145A/B Program Directly on HP 4155A/4156A
- Sample Application Programs
- Manual Changes Depending on ROM Version

Refer to the HP 4155A/4156A HP-IB Command Reference for detailed syntax of each command.


Text Conventions.
The following text conventions are used in this manual:

- **Front-panel key**
  Represents a key physically located on HP 4155A/4156A.

- **Softkey**
  Represents a softkey that appears on screen of HP 4155A/4156A.

- **Screen Text**
  Represents text displayed on HP 4155A/4156A.

- **Italic**
  Refers to a related document, or is used for emphasis.
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Using HP Instrument BASIC
Using HP Instrument BASIC

HP Instrument BASIC (IBASIC) is a system controller built into your HP 4155A/4156A. By using IBASIC, you can run a program to control the HP 4155A/4156A and other instruments (connected via interfaces of HP 4155A/4156A) without using an external computer.

IBASIC is a subset of HP BASIC. Programs created by IBASIC can run on an HP BASIC controller with little or no modification.

This chapter consists of the following ten sections.

The following six sections provide step-by-step instructions to operate IBASIC by using examples. You can learn the basics of IBASIC programming and operations. If you are not familiar with IBASIC, we recommend to read through these sections first.

- Before Operating IBASIC
- Creating and Executing a Simple IBASIC Program
- Modifying Program by using Editor Functions
- Saving and Getting a Program
- Summary of Softkeys and Keyboard Operations for Editor
- Other Basic Features of IBASIC

The following three sections are a task oriented reference for IBASIC. You can quickly find the desired IBASIC task.

- IBASIC Basic Operation Tasks
- IBASIC Editor Tasks
- Control from External Computer

The following section introduces how to easily create a program by using the typing aid softkeys in the IBASIC editor. This method of creating a program is similar to using the ASP environment on the HP 4145A/B semiconductor parameter analyzer.

- Creating ASP-like IBASIC Programs
Before Operating IBASIC

HP 4155A/4156A provides the following three screen modes for operating IBASIC.

"All IBASIC" screen

Entire screen including softkeys is used for IBASIC, so no instrument page is displayed.

You can execute programs, but no instrument page appears in this mode.

"IBASIC Status" screen

Softkeys and bottom two lines are used for IBASIC. Rest of screen is for instrument page.

In this mode, you can start the IBASIC editor. The displayed softkeys are for IBASIC operation. You can execute IBASIC commands interactively. Characters you type are displayed at the bottom of the screen.

"All Instrument" screen

This is regular instrument screen and the default display mode at power on. Entire screen is for instrument page, and all softkeys are for interactive use of instrument. In this mode, you cannot use the IBASIC editor. Only the front-panel keys of IBASIC key group and \( \text{Ctrl} + 1 \) (Run) and \( \text{Ctrl} + \text{Pause} \) (Pause) on external keyboard are available to execute or pause program for HP Instrument BASIC from this screen mode.

For details about HP Instrument BASIC screens, refer to "IBASIC Screen" in Chapter 2.
To Switch Screen Mode

To switch the screen mode, repeat the following operation until the desired screen is displayed.

1. Press Display of IBASIC key group.

1. Press Ctrl + G

This operation toggles screen display as follows:

```
All instrument  →  I-BASIC status  →  All I-BASIC
```
To Use the Help Function

By using the built-in help function of the HP 4155A/4155A, you can easily get information (name, syntax, and description) about programming commands, and can enter the desired command into the program without typing.

To start the help function for the programming commands, press Help key while you are in the IBASIC editor.

In the help function, the programming commands are divided into the following three categories, which you can access by secondary softkeys.

<table>
<thead>
<tr>
<th>Softkey</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBASIC</td>
<td>IBASIC commands.</td>
</tr>
<tr>
<td>PAGE IMAGE COMMAND</td>
<td>SCPI commands specific for HP 4155A/4155A. These are the help commands associated with the instrument setup pages that begin with PAGE.</td>
</tr>
<tr>
<td>SCPI COMMAND</td>
<td>Standard SCPI commands.</td>
</tr>
</tbody>
</table>

The upper part of the help screen displays a list of the command names. The lower part displays a description of the selected (by field pointer) command.
To Move the Field Pointer.
To move the field pointer, refer to the following table:

<table>
<thead>
<tr>
<th>Rotary knob or Arrow keys</th>
<th>Basically, you move the field pointer by using the rotary knob or arrow keys.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAGE CONTROL keys</td>
<td>Field pointer moves to first PAGE IMAGE command that is associated with the pressed key. PAGE CONTROL keys are [Chan], [Meas], [Display], [Graph/List], [Stress], and [System].</td>
</tr>
<tr>
<td>MEASUREMENT keys</td>
<td>Field pointer moves to the PAGE IMAGE command that is associated with the pressed key. MEASUREMENT keys are [Single], [Repeat], and [Append].</td>
</tr>
<tr>
<td>Get, Save</td>
<td>Field pointer moves to the associated SCPI command.</td>
</tr>
<tr>
<td>Alphabetical keys</td>
<td>Field pointer moves to next command that has a keyword that begins with same letter as the pressed key.</td>
</tr>
</tbody>
</table>

If you are in the PAGE IMAGE command category, search is only within the instrument page group of the currently selected command.

To Search for a Command.
To search for a command:

1. Press **SEARCH** secondary softkey.
2. Type in command string that you want to search for, then press **Enter**.

To Enter a Command into the Editor.
The command specified by the field pointer is displayed on the entry line. If you press **Enter**, the command is entered into the editor.

If command specified by the field pointer is a PAGE IMAGE or SCPI command, first select the **OUTPUT @Hp415x** secondary softkey. The entry line becomes **OUTPUT @Hp415x; "command"**, where **command** is command specified by field pointer. Then, press **Enter**.

**OUTPUT @Hp415x; "command"** is entered into the editor.
Creating and Executing a Simple IBASIC Program

In this section, let’s try to create and execute a simple program.

Before creating a program in the IBASIC editor, first change the screen display mode to IBASIC Status screen mode or All IBASIC screen mode by pressing IBASIC (Display) key as described in “To Switch Screen Mode”. In following sections, the All IBASIC screen display mode is used.

Step 1. Editing

Select **EDIT** secondary softkey or type EDIT, then press **Enter**.

To start the editor at a specific program line or label

Type EDIT line_num or EDIT label.

For example, if you type EDIT 30, the cursor appears at line 30. If you do not specify a line number or label, the cursor will appear at line 10.

The following program prints the numbers from 1 to 10. Type as follows:

```
10 FOR I=1 TO 10
20 PRINT I
30 NEXT I
40 END
```
Using HP Instrument BASIC

Creating and Executing a Simple IBASIC Program

Always Insert Mode
Editor is always in insert mode, and cannot be changed to overwrite mode. If you mistyped, use [Backspace] to move back a character, or move cursor using arrow key [4], then use [Delete] to delete a character. Then type correct characters.

Program End
In IBASIC, [END] must be at end of main program. In above example, line 40 is the last line of the program.
Using HP Instrument BASIC
Creating and Executing a Simple IBASIC Program

Step 2. Exiting from Editor

Select [End edit] primary softkey to exit from the editor.

Step 3. Executing Program

To execute the program, press [Run] of the IBASIC key group, select [RUN] primary softkey, or type RUN and press [Enter]. The following should be displayed on the screen:

1
2
::
9
10

If an error message appears

If an error message appears, you probably mistyped. The error message indicates the line number where the error occurs. You need to modify the line.
Modifying Program by using Editor Functions

In this section, you can learn the following editor functions:
1. Inserting lines
2. Deleting a line
3. Renumbering
4. Inserting characters
5. Recalling deleted line
6. Indenting
7. Changing line numbers
Step 1. Inserting Lines

Type EDIT 20, then press Enter. Cursor appears at line 20.

```
10 FOR I=1 TO 10
20 PRINT I
30 NEXT I
40 END
```

Select Insert line or press Insert to insert a line above line 20.

```
10 FOR I=1 TO 10
11
20 PRINT I
30 NEXT I
40 END
```

Type as follows:

```
10 FOR I=1 TO 10
11 PRINT I^2
12
20 PRINT I
30 NEXT I
40 END
```

I^2 means the second power of I. The above program increments I from 1 to 10, and displays second power of I and I for each step.

Select End edit to exit editor, then press Run to execute the program. The following is displayed:

```
1
4
2
9
3
81
9
100
10
```
Step 2. Deleting a Line

Type EDIT 20 to start editor at line 20.

```
10  FOR I=1 TO 10
11  PRINT I^2
20  PRINT I
30  NEXT I
40  END
```

Then, select Delete line or press Shift + Delete to delete line 20. The result is as follows:

```
10  FOR I=1 TO 10
11  PRINT I^2
30  NEXT I
40  END
```

The above program increments I from 1 to 10, and displays the second power of I at each step.

If you exit editor and execute the program, the following is displayed:

```
1
4
9
...
81
100
```
Step 3. Renumbering

In above example, line numbers are not in equal increments. To change the line number increment to 10, select Re-number softkey. Line numbers will be changed as follows:

```
10 FOR I=1 TO 10
20 PRINT I^2
30 NEXT I
40 END
```

If you use the Re-number softkey, the renumbering is always as follows: first line is 10 and the increment is 10.

If you desire other numbering, you need to exit the editor, and use the REN command. For example, if you want first line number to be 100 and increment to be 20, type as follows:

```
REN 100, 20 (Enter)
```
Using HP Instrument BASIC

Modifying Program by using Editor Functions

Step 4. Inserting Characters

Type EDIT 20, then press Enter.

```
10 FOR I=1 TO 10
20 PRINT I^2
30 NEXT I
40 END
```

Move the cursor by using ▶ key.

```
10 FOR I=1 TO 10
20 PRINT I^2
30 NEXT I
40 END
```

Then type I, as follows:

```
10 FOR I=1 TO 10
20 PRINT I, I^2
30 NEXT I
40 END
```

Above program increments I from 1 to 10, and displays I and the second power of I on one line at each step. Exit editor, then execute the program. The following is displayed:

```
1   1
2   4
3   9
  ...
9   81
10  100
```
Step 5. Recalling Deleted Line

To restore the most recently deleted line, press [Recall] front-panel key.

Step 6. Indenting

Move to desired line, then select [Indent] to indent the line. Indenting makes the program flow easier to understand.

```
10 FOR I=1 TO 10
20 PRINT I,I^2
30 NEXT I
40 END
```
Saving and Getting a Program

The created program can be saved to a diskette. So, you can get the saved program from the diskette, then execute it.

In this section, you can learn the following file operation tasks:

1. Saving a Program
2. Listing Contents of Diskette
3. Clearing a Program
4. Getting a Program
Step 1. Saving a Program

Insert a diskette into the built-in drive. Then, type SAVE "filename", then press Enter. For this example, we will type SAVE "PROG1".

Step 2. Listing Contents of Diskette

Type CAT to list contents of the diskette.

If you are using an MS-DOS format diskette, the display is similar to the following example:

DIRECTORY : \:INTERNAL,4
LABEL: HP4156
FORMAT: DOS
AVAILABLE SPACE : 5692

<table>
<thead>
<tr>
<th>FILE NAME</th>
<th>TYPE</th>
<th>NUM</th>
<th>RECS</th>
<th>LEN</th>
<th>MODIFIED</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROG1</td>
<td>DOS</td>
<td>65</td>
<td>1</td>
<td>27-Jun-94 14:30</td>
<td>RW-RW-RW-</td>
</tr>
</tbody>
</table>

Filer

You can also check the contents of the diskette by using the filer (SYSTEM: FILER page) of the HP 4155A/4156A. But you cannot save and get the I BASIC programs by using the filer.
Using HP Instrument BASIC

**Saving and Getting a Program**

---

**Step 3. Clearing a Program**

To clear the program, enter the editor, then select **Scratch** softkey. Then, select **Yes** secondary softkey.

Existing program will be cleared, and following is displayed:

```plaintext
10 COM @Hp415X
20 ASSIGN @Hp415X TO 800
30 !
9990 END
```

COM @Hp415x and ASSIGN @Hp415x TO 800 are used to control the HP 4155A/4156A. For details, please refer to "Step 1. Getting the Setup File and Making a Measurement" in Chapter 3, and refer to "Subprograms and COM Blocks".

---

**Step 4. Getting a Program**

Type **GET "PROG1"**, then press **Enter**. When the LED turns off, enter the editor if you want to display the program.
Summary of Softkeys and Keyboard Operations for Editor

**Front-panel keys**

- Arrow keys (↑, ↓, ←, →) Move the cursor
- Delete Delete character
- Recall Recall most recently deleted line

**External Keyboard**

- Esc Exit editor
- F1 to F8 Primary softkeys
- Shift + F1 to F8 Secondary softkeys
- F9 Toggle screen mode
- Ctrl Clear to end
- Insert Insert line
- Delete Delete character at cursor
- Shift + Delete Delete line
- Home Beginning of line
- End End of line
- Page Up or Page Down Scroll pages

**Primary Softkeys**

- Back space Delete character before cursor
- Insert line Insert line
- Delete line Delete line
- Re-number Renumber the lines
- Indent Indent the line
- Scratch Clear program
- End edit Exit editor
Other Basic Features of IBASIC

This section describes the following:

- Branching/Repeating
- Subprograms and COM Blocks
Branching/Repeating

Table 1-1. Branch and Repeat Keywords of IBASIC

<table>
<thead>
<tr>
<th>IBASIC Keyword</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOR, NEXT</td>
<td>Repeat specified number of times.</td>
</tr>
<tr>
<td>IF THEN, ELSE, END IF</td>
<td>Branch.</td>
</tr>
<tr>
<td>WHILE, END WHILE</td>
<td>Repeat until specified condition is false.</td>
</tr>
<tr>
<td>REPEAT, UNTIL</td>
<td>Repeat until specified condition is true.</td>
</tr>
</tbody>
</table>

Following program tests 1000 devices, and judges them pass or fail.

```basic
1  COM Data(I:1000)
2  DIM Id(I:1000)
10 EXECUTE ("GETSETUP 'SAMPL.MES'")
20 FOR I=1 TO 1000
30   EXECUTE ("SINGLE")
40   EXECUTE ("READDATAVAR 'Id'"
50   IF Id(I)<1E-6 THEN
60       PRINT "FAIL LOWER"
70       Data(I)=1
80   ELSE
90       IF Id(I)>1E-4 THEN
100      PRINT "FAIL HIGHER"
110      Data(I)=2
120     ELSE
130      PRINT "PASS"
140      Data(I)=0
150   END IF
160 END IF
170 NEXT I
180 CALL Save_data
190 END
200 !
210 SUB Save_data
220 COM Data(*)
230 CREATE "data_file",1
240 ASSIGN @file TO "data_file";FORMAT ON
250 OUTPUT @file;Data(*)
260 ASSIGN @file TO *
270 SUBEND
```
Subprograms and COM Blocks

One of the most powerful constructs available is the subprogram. A subprogram has its own "context" or state that is distinct from the main program and all other subprograms. There are several benefits of subprograms.

- The subprogram allows you to take advantage of the "top-down design" method of programming.
- You can remove all subtasks from the overall logic flow of the main program.
- You can debug the program by testing each subprogram independently.
- The subprograms can be used to reduce the overall size of the program.
- Libraries of commonly used subprograms can be assembled for widespread use.

Refer to the example program in the previous section. Line 180 calls a subprogram to store data into a DOS file.

```
  160    END IF
  170    NEXT I
  180    CALL Save_data
  190    END
  200    !
  210    SUB Save_data
  220    COM Data(*)
  230    CREATE "data_file",1
  240    ASSIGN @File TO "data_file";FORMAT ON
  250    OUTPUT @File;Data(*)
  260    ASSIGN @File TO *
  270    SUBEND
```
COM Blocks.
COM blocks are used by the subprogram to communicate with the main
program or with other subprograms.

If you create subprograms and want to use common variables between main
program and subprograms, you should use COM blocks.

Refer to the above example.

In the main program, line 1 declares that the Data array will be a COM array.
Then, the main program assigns values to this array. Line 220 specifies that
the subprogram Save_data will also use the Data array. So, Data array of
main program can be operated on in the Save_data subprogram.
IBASIC Basic Operation Tasks

This section describes the following basic operations to use HP Instrument BASIC.

- Executing HP Instrument BASIC commands
- Executing program
- Listing files
- Retrieving program
- Saving program
To Execute HP Instrument BASIC Commands

1. Confirm your HP 4155A/4156A is in the following status:
   - a program is not executing.
   - another command is not executing.
   - Editor is not running.
   - the screen is "All IBASIC" screen or "IBASIC Status" screen. For "All Instrument" screen, (Run) and (Pause) front-panel keys and (Ctrl)+U (Run) and (Ctrl)+P (Pause) on external keyboard are available.

2. Type in commands by using front-panel keys in the ENTRY key group or external keyboard.

3. Press (Enter) front-panel key or (Enter) key on external keyboard.

To Execute Program

Front Panel

1. Press (Run) front-panel key in the IBASIC key group.

External Keyboard

1. Press (Ctrl)+U on external keyboard.
To List Files

1. Confirm your HP 4155A/4156A is in the following status:
   - the screen is "All IBASIC" screen.
   - a program is not executing.
   - another command is not executing.
   - Editor is not running.

2. Insert a 3.5 inch diskette (that contains the files you want to list) into the built-in diskette drive.

3. Select CAT secondary softkey, then press (Enter) front-panel key.

The file names on diskette are listed on the screen.
To Retrieve Program

1. Confirm your HP 4155A/4156A is in the following status:
   - the screen is “All IBASIC” screen or “IBASIC Status” screen.
   - a program is not executing.
   - another command is not executing.
   - Editor is not running.

2. Insert the 3.5 inch diskette (that contains the program you want to retrieve) into the built-in diskette drive.


4. Type in file name to be retrieved. Typed name is inserted after first “.

5. Press `Enter` front-panel key, or `Enter` key on external keyboard.

**External disk drive**

An external disk drive cannot be connected to HP 4155A/4156A. For using a disk drive connected to external controller, see “Control from External Computer”.

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To Save Program

1. Confirm your HP 4155A/4156A is in the following status:
   • the screen is “All IBASIC” screen or “IBASIC Status” screen.
   • a program is not executing.
   • another command is not executing.
   • Editor is not running.

2. Insert a 3.5 inch diskette into the built-in diskette drive.


4. Type in name of file to which you want to save program.
   If the file already exists on the diskette, SAVE cannot be used. If you want to overwrite an existing file, select RE-SAVE secondary softkey instead of SAVE secondary softkey in the previous step.

5. Press Enter front-panel key or Enter key on the external keyboard.

---

External disk drive
An external disk drive cannot be connected to HP 4155A/4156A. For using a disk drive connected to external controller, see “Control from External Computer”.

---

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IBASIC Editor Tasks

This section describes the following tasks to use built-in editor of HP Instrument BASIC.

- Starting the editor
- Quitting the editor
- Moving the cursor
- Inserting characters
- Deleting character
- Inserting line
- Deleting line
- Scrolling pages
- Recalling most recently deleted line
To Start the Editor

1. Confirm the screen is “All IBASIC” screen or “IBASIC Status” screen.
2. Select EDIT secondary softkey.
3. Press \text{Enter} front-panel key or \text{Enter} key on the external keyboard.
   
   If you want to start the editor to edit a specific program line, type in the line number or label of the program line, then press \text{Enter} front-panel key.
   
   The editor starts, and cursor is displayed on specified line.
4. If a program is loaded into the HP 4155A/4156A, the program is displayed.
   
   If no program is loaded, 10 is automatically displayed and rest of screen is empty.

If you start the editor from the “IBASIC Status” screen, the screen switches to “All IBASIC” screen, and the editor starts.

To Quit the Editor

1. Select \text{End edit} primary softkey.

If you started the editor from the “IBASIC Status” screen, the screen returns from “All IBASIC” screen to the “IBASIC Status” screen after you quit the editor.
To Move the Cursor

To move the cursor, use the following keys.

<table>
<thead>
<tr>
<th>Direction</th>
<th>Front-panel</th>
<th>Keyboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up</td>
<td>▲ of MARKER/_CURSOR group</td>
<td>▲</td>
</tr>
<tr>
<td></td>
<td>Rotate rotary knob counter-clockwise</td>
<td></td>
</tr>
<tr>
<td>Down</td>
<td>▼ of MARKER/_CURSOR group</td>
<td>▼</td>
</tr>
<tr>
<td></td>
<td>Rotate rotary knob clockwise</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>→ of ENTRY group</td>
<td>→</td>
</tr>
<tr>
<td></td>
<td>→ of MARKER/_CURSOR group</td>
<td>Ctrl+→</td>
</tr>
<tr>
<td>Left</td>
<td>← of ENTRY group</td>
<td>←</td>
</tr>
<tr>
<td></td>
<td>← of MARKER/_CURSOR group</td>
<td>Ctrl+←</td>
</tr>
<tr>
<td>Beginning of Line</td>
<td>[FAST]+← of MARKER/_CURSOR group</td>
<td>Home</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shift+←</td>
</tr>
<tr>
<td>End of Line</td>
<td>[FAST]+→ of MARKER/_CURSOR group</td>
<td>End</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shift+→</td>
</tr>
</tbody>
</table>

To Insert Characters

1. Move the cursor to character you want to insert before.
2. Characters you type will be automatically inserted.
3. After you insert characters, you must select the Enter key to enter the line with inserted characters into the program.

Editor is always in insert mode, and cannot be changed to overwrite mode.
To Delete Character

1. Move the cursor to character you want to delete.
2. Press key according to the following table:

<table>
<thead>
<tr>
<th>Front-panel</th>
<th>Keyboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delete of ENTRY</td>
<td>Delete</td>
</tr>
<tr>
<td>group</td>
<td></td>
</tr>
</tbody>
</table>

3. After you delete characters, you must select the Enter key to enter the line with deleted characters into the program.

To Insert Line

1. Move the cursor to the line that you want to insert a new line before.
2. Press key or softkey according to following table:

<table>
<thead>
<tr>
<th>Front-panel</th>
<th>Keyboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>insert line primary</td>
<td>Shift + Insert</td>
</tr>
<tr>
<td>softkey</td>
<td>1</td>
</tr>
</tbody>
</table>

3. After you type in a new line, you must select the Enter key to enter the new line into the program.
To Delete Line

1. Move the cursor to line you want to delete.
2. Press key or softkey according to the following table:

<table>
<thead>
<tr>
<th>Front-panel</th>
<th>Keyboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delete line</td>
<td>Shift + (Delete)</td>
</tr>
<tr>
<td>primary softkey</td>
<td>(Alt + D)</td>
</tr>
</tbody>
</table>

To Scroll Pages

To scroll the editor by one-half screen, use the following keys:

<table>
<thead>
<tr>
<th>Direction</th>
<th>Front-panel</th>
<th>Keyboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up</td>
<td>n.a.</td>
<td>Page Up</td>
</tr>
<tr>
<td>Down</td>
<td>n.a.</td>
<td>Page Down</td>
</tr>
</tbody>
</table>
To Recall Most Recently Deleted Line

To display the line most recently deleted line, use the following keys.

<table>
<thead>
<tr>
<th>Front-panel</th>
<th>Keyboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recall</td>
<td>(Shift) + (Page Up)</td>
</tr>
</tbody>
</table>

If you want to enter the line into the program, you must select the Enter key.
Control from External Computer

This section describes how to control the HP 4155A/4156A from a program that is running on an external computer:

- Downloading a program to HP 4155A/4156A.
- Uploading a program from HP 4155A/4156A.
- Controlling execution of a HP 4155A/4156A program.

Before executing a program on external computer to control HP 4155A/4156A, do as follows:

1. Set the "HP 4155A/4156A i.s" field on the SYSTEM: MISCELLANEOUS page to NOT SYSTEM CONTROLLER.

2. Connect an HP-IB cable from the external computer to the HP-IB connector on rear panel of HP 4155A/4156A.
To Download a Program to HP 4155A/4156A

To download a program from the external computer to HP 4155A/4156A, you need to use the :PROGram[:SELected]:DEFine command.

The following is an example of an HP BASIC program (running on external computer) that reads an HP Instrument BASIC program file (from a disk drive connected to external computer) and downloads it to HP 4156A.

```
10 OPTION BASE 1
20   !
30  DIM Line$(1024)
40   !
50  ASSIGN @Hp4156 TO 717
60   !
70  OUTPUT @Hp4156;"PROG:DEL:ALL"  ! Clears program in HP 4156A
80  File_name$="prog"
90  ASSIGN @File TO File_name$      ! Opens file and assigns data path
100 OUTPUT @Hp4156;"PROG:DEF #0"    ! Sends header to 4156A
110 ON ERROR GOTO Done
120 LOOP
130   Line$=""
140  ENTER @File;Line$               ! Reads one program line
150  OUTPUT @Hp4156;Line$           ! Downloads line to HP 4156A
160 END LOOP
170 Done:  !
180 UFF ERROR
190 OUTPUT @Hp4156;Line$
200 OUTPUT @Hp4156;" END"
210 ASSIGN @File TO *
220 END
```
Using HP Instrument BASIC
Control from External Computer

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>assigns I/O path to control HP 4155A/4155A.</td>
</tr>
<tr>
<td>70</td>
<td>delete existing HP Instrument BASIC program in HP 4155A/4155A.</td>
</tr>
<tr>
<td>80</td>
<td>name of file (in disk drive of external computer) that contains desired HP Instrument BASIC program</td>
</tr>
<tr>
<td>90</td>
<td>opens file and assigns data path</td>
</tr>
<tr>
<td>100</td>
<td>#0 indicates that an indefinite length of parameters (program lines) will be downloaded</td>
</tr>
<tr>
<td>110 to 160</td>
<td>reads program lines from the file and downloads them until EOE</td>
</tr>
<tr>
<td>210</td>
<td>closes file.</td>
</tr>
</tbody>
</table>
To Upload a Program from HP 4155A/4156A

To upload a program from the HP 4155A/4156A to external computer, you need to use the :PROGرام[:SElected]:DEFine? command.

The following is an example of an HP BASIC program (running on external computer) that uploads an HP Instrument BASIC program from HP 4156A and stores the program on a disk drive that is connected to external computer.

```
10 OPTION BASE 1
20 !
30 DIM Num_dig$(2)
40 INTEGER Byte
50 !
60 ASSIGN @Hp4156 TO 717
70 !
80 OUTPUT @Hp4156;":PROG:DEF?"
90 ENTER @Hp4156 USING ",,2A";Num_dig$
100 PRINT Num_dig$
110 !
120 Byte=VAL(Num_dig$(2))
130 !
140 ALLOCATE Data_byt$(Byte)
150 !
160 FOR I=1 TO Byte
170 ENTER @Hp4156 USING ",A";Data_byt$(I;1) ! Enter length of program
180 NEXT I
190 !
200 D=VAL(Data_byt$)
210 PRINT D
220 ALLOCATE Prog$(D)
230 PRINTER IS CRT;WIDTH D
240 ENTER @Hp4156 USING ";K";Prog$ ! Enter the program into Prog$
250 PRINT Prog$
260 ENTER @Hp4156;B$
270 PRINT B$
280 !
290 CREATE "prog",1
300 ASSIGN @File TO "prog";FORMAT ON
310 OUTPUT @File;Prog$
320 ASSIGN @File TO *
330 !
340 END
```
<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>90</td>
<td>Reads first two characters of response. These two bytes indicate how many bytes are used to specify length of program.</td>
</tr>
<tr>
<td>160 to 160</td>
<td>Reads the bytes that specify length of program.</td>
</tr>
<tr>
<td>200</td>
<td>Calculates length of program.</td>
</tr>
<tr>
<td>220</td>
<td>Allocates string variables for program.</td>
</tr>
<tr>
<td>240</td>
<td>Reads program.</td>
</tr>
<tr>
<td>260</td>
<td>Reads terminator.</td>
</tr>
<tr>
<td>290</td>
<td>Creates file “prog”</td>
</tr>
<tr>
<td>300</td>
<td>Assigns I/O path to “prog”</td>
</tr>
<tr>
<td>310</td>
<td>Stores program into “prog” file.</td>
</tr>
<tr>
<td>320</td>
<td>Closes file.</td>
</tr>
</tbody>
</table>
To Control State of HP 4155A/4156A Program

:PRogram[:SELection]:STATe command from external computer can control HP Instrument BASIC program in the HP 4155A/4156A as follows:

- To run the program:
  OUTPUT @Hp4155;";:PRogram[:SELection]:STATe RUN"

- To continue the program:
  OUTPUT @Hp4155;";:PRogram[:SELection]:STATe CONT"

- To stop the program:
  OUTPUT @Hp4155;";:PRogram[:SELection]:STATe STOP"

- To pause the program:
  OUTPUT @Hp4155;";:PRogram[:SELection]:STATe PAUSE"
Creating ASP-like IBASIC Programs

In the IBASIC editor of the HP 4155A/4156A, there are several typing aid softkeys that allow you to easily create a program.

When you press the softkey, the corresponding IBASIC command is entered into the program, so you do not have to type it, but you may need to type in some parameters.

For HP 4145A/B users, this environment is very familiar because it is similar to the Auto Sequence Program (ASP) programming environment of the HP 4145A/B. For most of the HP 4145 ASP commands, the IBASIC editor has a softkey to enter a corresponding IBASIC command.

These programs can run in IBASIC only, not on an external computer.

Step 1. Creating Programs by using the Typing Aid Softkeys

In the IBASIC editor, you can easily create programs that perform the same operations as a desired HP 4145 ASP program by using the typing aid softkeys. These are secondary softkeys. To display more softkeys, select More softkey.

For the ASP program shown below, let’s create the corresponding IBASIC program:

```
! ASP Program:                           Corresponding IBASIC Program:
!                                            
1 GET P ICBVBE                           10 EXECUTE ("GETSETUP 'ICBVBE.PRO'")
2 SINGLE                                20 EXECUTE ("SINGLE")
3 SAVE D BV1                            30 EXECUTE ("SAVEDATA 'BV1.DAT'")
    40 END
```

1. Select the GET SETUP secondary softkey. The following appears:

```
10 EXECUTE ("GETSETUP ")
```
Using HP Instrument BASIC
Creating ASP-like IBASIC Programs

You need to specify a filename in this command. At bottom of screen, enter fileName[,msus] is displayed, where msus means the mass storage unit specifier. You can specify ,DISK or ,MEMORY. Default is ,DISK.

2. Type a setup file name.

   10    EXECUTE ("GETSETUP 'ICBVBE.PRO'"")

   File name must be in single quotations ('). Then press [Enter].

3. Select SINGLE secondary softkey.

   10    EXECUTE ("GETSETUP 'ICBVBE.PRO'"")
   20    EXECUTE ("SINGLE")
   30    -

4. Select SAVEDATA secondary softkey.

   10    EXECUTE ("GETSETUP 'ICBVBE.PRO'"")
   20    EXECUTE ("SINGLE")
   30    EXECUTE ("SAVEDATA ")

5. Specify file name to which you want to save the measurement setup and result data.

   10    EXECUTE ("GETSETUP 'ICBVBE.PRO'"")
   20    EXECUTE ("SINGLE")
   30    EXECUTE ("SAVEDATA 'BVI.DAT'"")
   40    END

Finally, type END as above.

**Setup File**

In EXECUTE ("GETSETUP "), you can specify a .PRO or .MES file:
- .PRO files are setup files created by the HP 4145B. The HP 4155A/4156A can read .PRO files.
- .MES files are setup files created by the HP 4155A/4156A.

In EXECUTE ("SAVEDATA "), you specify a .DAT file, which is a file for storing the setup and measurement result data.
Step 2. Executing the Program

To execute the program, exit editor, then press **Run**.

The HP 4155A/4156A gets the setup file from the diskette, performs measurement, then saves setup and results to specified file on the diskette. However, in All IBASIC mode, no graphics results are displayed. To display results graphically, the display mode must be All Instrument mode or IBASIC Status mode.

To execute the program and display the results graphically, change the display mode to All Instrument or IBASIC Status mode, then press **Run**.

Step 3. Creating a Longer Program

In the program below, the left side is an ASP program example from the HP 4145B manual.

The right side shows a program that was created by using the typing aid softkeys to enter the ASP-like commands (of the HP 4155A/4156A) that correspond to the original ASP commands. These softkeys allow you to easily create a program that runs on the HP 4155A/4156A and performs the same operations as the original ASP program.

```
1 GET P ICBVBE
2 SINGLE
3 WAIT 3
4 GET P HFE1
5 SINGLE
6 WAIT 3
7 GET P VCESAT
8 SINGLE
9 WAIT 3
10 GET P COLR
11 SINGLE
12 WAIT 3
13 PAUSE
14 GET P NPW1

10 EXECUTE ("GETSETUP 'ICBVBE.PRO'")
20 EXECUTE ("SINGLE")
30 WAIT 3
40 EXECUTE ("GETSETUP 'HFE1.PRO'")
50 EXECUTE ("SINGLE")
60 WAIT 3
70 EXECUTE ("GETSETUP 'VCESAT.PRO'")
80 EXECUTE ("SINGLE")
90 WAIT 3
100 EXECUTE ("GETSETUP 'COLR.PRO'")
110 EXECUTE ("SINGLE")
120 WAIT 3
130 PAUSE
140 EXECUTE ("GETSETUP 'NPW1.PRO'")
```
Using HP Instrument BASIC

Creating ASP-like IBASIC Programs

<table>
<thead>
<tr>
<th>Line</th>
<th>Code</th>
<th>Line</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>SINGLE</td>
<td>150</td>
<td>EXECUTE</td>
</tr>
<tr>
<td>16</td>
<td>PAUSE</td>
<td>160</td>
<td>PAUSE</td>
</tr>
<tr>
<td>17</td>
<td>PLOT 100,100,7000,7000</td>
<td>170</td>
<td>EXECUTE</td>
</tr>
<tr>
<td>18</td>
<td>GET P BV</td>
<td>180</td>
<td>EXECUTE</td>
</tr>
<tr>
<td>19</td>
<td>SINGLE</td>
<td>190</td>
<td>EXECUTE</td>
</tr>
<tr>
<td>20</td>
<td>PLOT 100,100,7000,7000</td>
<td>200</td>
<td>EXECUTE</td>
</tr>
<tr>
<td>21</td>
<td>PAUSE</td>
<td>210</td>
<td>PAUSE</td>
</tr>
<tr>
<td>22</td>
<td>SINGLE</td>
<td>220</td>
<td>EXECUTE</td>
</tr>
<tr>
<td>23</td>
<td>CPGLOT 100,100,7000,7000</td>
<td>230</td>
<td>EXECUTE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>240</td>
<td>END</td>
</tr>
</tbody>
</table>

**Print/Plot**

EXECUTE ("PRINTPLOT") prints/plots the information of the present instrument page, not the IBASIC screen. If present page is GRAPH/LIST: GRAPHICS page, the graph is printed/plotted.

EXECUTE ("CURVEPLOT") changes to the GRAPH/LIST: GRAPHICS page, then prints/plots the graph.

You need to set the desired settings on the SYSTEM: PRINT/ PLOT SETUP page before EXECUTE ("PRINTPLOT") and EXECUTE ("CURVEPLOT") are performed.
Programming Tips

This section describes features and tips of IBASIC programs in relation to ASP programs. Some examples use an example measurement setup file named "VTH.MES". Before executing these examples, you need to save setup data to a file named "VTH.MES" on the diskette. For an example setup, see "Example Application Setup for Vth Measurement" in Chapter 3.

**File Name Variables.**
You can specify a string variable for the file name in `SAVEDATA` as follows:

```plaintext
Filename$="DATA1.DAT"
EXECUTE ("SAVEDATA Filename$")
```

This feature allows you to create a more simple program as follows.

**Example ASP Program**
Following ASP program gets a setup file, makes measurements, and saves results to following files: VTH1, VTH2, ..., VTH10. Program is 21 lines.

1. GET P VTH
2. SINGLE
3. SAVE D VTH1
4. SINGLE
5. SAVE D VTH2
6. SINGLE
7. SAVE D VTH3
   ...
21. SAVE D VTH10

**Corresponding IBASIC Program.**
The following HP Instrument BASIC (IBASIC) program does the same operation as the above ASP program. The program is simplified by using a filename variable `Filename$` and the `FOR NEXT` keyword.

```plaintext
10 EXECUTE ("GETSETUP 'VTH.PRO'")
20 FOR I=1 TO 10
30   EXECUTE ("SINGLE")
40   Filename$="VTH"&VAL$(I)&".DAT"
50 EXECUTE ("SAVEDATA Filename$")
60 NEXT I
```

In line 40, the `Filename$` is defined. For example, `Filename$ = "VTH1.DAT"` when I = 1. So, the 21-line ASP program can be converted to a 6-line IBASIC program.
Reading HP 4155/56 Data to IBASIC Variables

You can transfer read-out function values or data variable values (output data, measurement data, and user function values) from the HP 4155/56 to HP Instrument BASIC (IBASIC) variables.

**Transferring Multiple Data.**
You can transfer multiple data (such as sweep measurement data) to an array variable of IBASIC by using `EXECUTE ("READDATAVAR ")` as follows:

```basic
EXECUTE ("READDATAVAR 'ID',Id_data""
```

The above example transfers the drain current data ID of a sweep measurement to the array variable previously defined as `Id_data`.

Following example program gets `VTH MES` setup file, performs measurement, then transfers ID data to an array. In this example, the array `Id_data` is defined in line 10, and it has elements 1 to 51.

```basic
10 DIM Id_data(1:51)
20 EXECUTE ("GETSETUP 'VTH.MES'")
30 EXECUTE ("SINGLE")
40 EXECUTE ("READDATAVAR 'ID',Id_data")
50 FOR I=1 TO 51
60 PRINT "Id(";I;")=";Id_data(I);"A"
70 NEXT I
80 END
```

Result with example measurement data is as follows:

- \( \text{Id(1)} = 0.00031 \text{ A} \)
- \( \text{Id(2)} = 0.00282 \text{ A} \)
- \( \text{Id(3)} = 0.00614 \text{ A} \)
- \( \text{Id(4)} = 0.01017 \text{ A} \)
- \( \text{Id(51)} = 0.08274 \text{ A} \)

**Transferring a Single Data.**
In the following example, a single data is to transferred to a variable. For example, `VTH` is a single data point calculated by a user function that was defined by the user.

```basic
EXECUTE ("READDATAVAR 'VTH',Vthdata")
```
Using HP instrument BASIC
Creating ASP-like IBASIC Programs

In following example, EXECUTE ("READDATAVAR") is used to transfer the VTH value to the IBASIC variable Vthdata. And for example, VTH.MES is a setup file that includes auto analysis setup to extract a threshold voltage VTH.

```
10 EXECUTE ("GETSETUP 'VTH.MES'")
20 EXECUTE ("SINGLE")
30 EXECUTE ("READDATAVAR 'VTH',Vthdata")
40 PRINT "Vthdata =";Vthdata;"V"
50 END
```

Result will be for example:

```
Vthdata = 1.2345 V
```

You can also specify a read out function as the item to be transferred:

```
EXECUTE ("READDATAVAR 'OMX',Vthdata")
```

OMX is the read out function that reads X-axis value of point where marker is located.

---

Auto Scaling

Auto scaling can be done by using the following:

```
EXECUTE ("AUTOSCALE").
```

In the following example, the image dumps will be scaled for best fit to the printer or plotter even if the measurement results vary greatly.

```
10 EXECUTE ("GETSETUP 'VTH.MES'")
11 FOR I=1 TO 100
20 EXECUTE ("SINGLE")
30 EXECUTE ("AUTOSCALE")
40 EXECUTE ("PRINTPLOT")
41 NEXT I
50 END
```
Using HP Instrument BASIC

Creating ASP-like IBASIC Programs

HP 4145 ASP and HP 4155A/4156A Corresponding Keywords

Following shows HP 4145A/B’s ASP keywords and corresponding HP 4155A/4156A keywords. In IBASIC editor, there are typing aid softkeys to help you quickly enter the related HP 4155A/4156A keyword, which must be used in the EXECUTE( ) directive:

Table 1-2. Corresponding HP 4145 ASP and HP 4155A/4156A Keywords

<table>
<thead>
<tr>
<th>4145A/B</th>
<th>4155A/4156A</th>
<th>Function</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>GET P</td>
<td>GETSETUP</td>
<td>Gets setup .MES or .PRO file</td>
<td></td>
</tr>
<tr>
<td>SINGLE</td>
<td>SINGLE</td>
<td>Initiates single measurement</td>
<td></td>
</tr>
<tr>
<td>SAVE D</td>
<td>SAVE DATA</td>
<td>Saves data to .DAT file</td>
<td></td>
</tr>
<tr>
<td>PLOT</td>
<td>PRINTPLOT</td>
<td>Prints/plots present instrument page.</td>
<td></td>
</tr>
<tr>
<td>CPlot</td>
<td>CURVEPLOT</td>
<td>Prints/plots measurement graph.</td>
<td></td>
</tr>
<tr>
<td>PRINT</td>
<td>PRINTPLOT</td>
<td>Prints/plots present instrument page.</td>
<td></td>
</tr>
<tr>
<td>PAUSE</td>
<td></td>
<td>Use BASIC keyword PAUSE</td>
<td></td>
</tr>
<tr>
<td>WAIT</td>
<td></td>
<td>Use BASIC keyword WAIT</td>
<td></td>
</tr>
<tr>
<td>PAGE</td>
<td></td>
<td>Set in the Print/Plot setup</td>
<td></td>
</tr>
<tr>
<td>STANDBY</td>
<td></td>
<td>Sets Standby status on or off</td>
<td></td>
</tr>
<tr>
<td>STRESS</td>
<td></td>
<td>Initiates stress force</td>
<td></td>
</tr>
<tr>
<td>AUTOSCALE</td>
<td></td>
<td>Scales data for best fit.</td>
<td></td>
</tr>
<tr>
<td>READDATAVAR</td>
<td></td>
<td>Gets data variable from 4155A/56A</td>
<td></td>
</tr>
<tr>
<td>DEFUSERVAR</td>
<td></td>
<td>Defines user variable</td>
<td></td>
</tr>
</tbody>
</table>

For WAIT and PAUSE of HP 4145’s ASP, there are no related typing aid softkeys. You type in the IBASIC keywords (WAIT and PAUSE).

For more information about IBASIC Keywords, use help functions described in the next chapter or refer to the *HP Instrument BASIC Users Handbook*. 

1-48
Reference:
HP Instrument BASIC
Reference: HP Instrument BASIC

This chapter provides following reference information for HP Instrument BASIC:

- IBASIC Screen
- Front-panel keys
- External Keyboard
- Softkeys for Operating IBASIC
- Softkeys for IBASIC Editor
- HP 4155A/4156A Specific IBASIC Commands
- Available I/O Resources
- ASP-like Commands
IBASIC Screen

HP 4155A/4156A provides the following three screen modes for operating IBASIC.

“All IBASIC” screen
Entire screen including softkeys is used for IBASIC, so no instrument page is displayed.
You can execute programs, but no instrument page appears in this mode.

“IBASIC Status” screen
Softkeys and bottom two lines are used for IBASIC. Rest of screen is for instrument page.
In this mode, you can start the IBASIC editor. The displayed softkeys are for IBASIC operation. You can execute IBASIC commands interactively. Characters you type are displayed at the bottom of the screen.

“All Instrument” screen
This is regular instrument screen and the default display mode at power on. Entire screen is for instrument page, and all softkeys are for interactive use of instrument. In this mode, you cannot use the IBASIC editor. Only the front-panel keys of IBASIC key group and Ctrl+U (Run) and Ctrl+F (Pause) on external keyboard are available to execute or pause program for IBASIC from this screen mode.

Display front-panel key or Ctrl+5 (or F9) on external keyboard are used to toggle the screen display mode as shown in the following figure:

```
  All Instrument → I-BASIC status → All I-BASIC
```
All IBASIC Screen

For the "All IBASIC" screen, the entire screen including softkeys is used for
IBASIC. The following describes each part of this screen:

IBASIC Output Area

CRT output commands of IBASIC (such as PRINT and
OUTPUT 1;) display characters in this area. This area has 24 lines and 60
columns.

Command Entry Line

IBASIC command you type is displayed on this line. The length of this line is
60 characters.

System Message and Display Line

For displaying IBASIC error messages and other system messages, and DISP
and INPUT commands of IBASIC.
Blue Key & Green Key
Shift Status

This field displays the shift status of ENTRY front-panel keys. The shift status is controlled by using the blue and green front-panel keys:

The following statuses are displayed:

- Non-shift status: B, b, or G is not displayed. You can enter numeric values.
- Uppercase shift status: B is displayed, G is not displayed. You can enter uppercase alphabet characters.
- Lowercase shift status: b is displayed, G is not displayed. You can enter lowercase alphabet characters.
- Non-alphanumeric status: G is displayed. You can enter one non-alphanumeric character. So, you must press green key before entering each alphanumeric character.

Basically, you can change between these states as follows:

- To toggle between non-shift and shift status: press blue key,
- To toggle between uppercase and lowercase shift status: press green key, then blue key,
- To enter one non-alphanumeric character: press green key, then character.

Execution Status

This field displays the execution status of IBASIC:

**Idle**
IBASIC program is stopped. IBASIC commands can be executed.

**Run**
IBASIC program or command is being executed.

**Pause**
IBASIC program is paused.

**Input?**
IBASIC program is waiting for input from front-panel keys or external keyboard.

**Edit**
IBASIC editor is running.
IBASIC Status Screen

For the "IBASIC Status" screen, the two bottom lines are used to display the status of IBASIC. These two lines are the same as in "All IBASIC" screen. Refer to "All IBASIC Screen". Also, the softkeys are for IBASIC.

The other part of the screen is the normal 4155A/4156A screen. This is useful if you want to view a graph of the measurement results while executing IBASIC program.
Keys for IBASIC

This section provides information about the following keys for IBASIC:

- Front-panel Keys
- Primary Softkeys
- Secondary Softkeys
- External Keyboard Keys
Front-panel Keys for IBASIC

PAGE CONTROL key group
- In “IBASIC Status” screen:
  Changes to “All Instrument” screen and displays the specified page.
- In “All IBASIC” screen:
  All front-panel keys in this group are ignored.

MARKER/CURSOR key group
- In “IBASIC Status” screen:
  When you operate MARKER/CURSOR front-panel keys, the screen changes
to “All Instrument” screen and function of operated key is executed.
- In all IBASIC screen:
  Rotary Knob  □ When the editor is running, the rotary knob moves the
cursor vertically in the edit area.
  □ When the editor is not running, the rotary knob scrolls
  the IBASIC output area.
  □ When the editor is running, these keys move the cursor
evertically.
  □ When the editor is not running, these keys scroll the
  IBASIC output area.
  □ Moves the cursor horizontally on the IBASIC Editor or
  Command Entry line.

If you hold down the (Fast) key, the arrow keys move the cursor faster.
MEASUREMENT key group

- In "IBASIC Status" screen:
  
  Single, Repeat, Append

  Changes the displayed page to GRAPH/List:
  GRAPHICS or GRAPH/List: LIST page and executes
  the measurement.

  Standby

  Toggles the operation state of the standby channels
  between the standby state and the idle state.

  Stop

  Stops the measurement or stress forcing.

  Stress

  Changes the displayed page to the STRESS: STRESS
  FORCE page and starts to force stress.

  Short, Medium, Long

  Changes the measurement integration time.

- In "All IBASIC" screen:

  Standby

  Toggles the operation state of the standby channels
  between the standby state and the idle state.

  Stop

  Stops the measurement or stress forcing.

  Other front-panel keys in this group are ignored.

IBASIC key group

The following front-panel keys of IBASIC key group are available to control
IBASIC in any display mode.

Run

Executes IBASIC program that is loaded into internal
memory of HP 4155A/4156A.

Pause

Pauses program execution until CONT command is
executed or Continue primary softkey is pressed. If the
program is modified while paused, RUN command must
be used to restart program execution.

Display

Toggles the display mode in the following sequence.
Reference: HP Instrument BASIC

Keys for IBASIC

ENTRY key group

- When the editor is running, this key displays the last deleted line. To enter this displayed line as part of the program, press (Enter) front-panel key.

- When the editor is not running, this key cycles through the 10 commands that were most recently entered on the Command Entry line.

- When the editor is running, this key is same as Recall.

- When the editor is not running, this key is same as (Recall), but cycles through commands in opposite order.

These keys are ignored.

Other front-panel keys in ENTRY group are available to enter characters on the Command Entry line or Editor. For the usage of the blue and green front-panel keys to enter characters, see "All IBASIC Screen".

Other Keys

Help

Displays information about IBASIC. And can be used to select and enter SCPI and IBASIC commands into Editor or Command Entry line.

Plot/Print

If present screen is "All IBASIC", dumps "All IBASIC" screen image to the printer or plotter.

If present screen is "IBASIC Status", prints/plots instrument part of screen.
Primary Softkeys in Idle, Pause, Run, or Input? execution status

This section describes the primary softkeys that are displayed during the Idle, Pause, Run, or Input? execution status.

Refer to “Primary Softkeys in Edit execution status” for primary softkeys that are displayed when the editor is running.

Step

1. Executes the paused program line of paused program or the first program line of stopped (idle) program.
2. Displays next program line on system message line of the screen.
3. Pauses program again.

Continue

Starts execution of paused program from paused program line.

RUN

Starts program execution immediately from first program line.

Pause

Pauses program execution immediately. And displays line at which execution was paused.

Stop

Stops program execution after current line executes.

Clear

Stops I/O operation of program.

I/O

Reset

Stops program execution immediately.
Secondary Softkeys in Idle or Pause execution status

This section describes the secondary softkeys that are displayed during the Idle or Pause execution status.

For the secondary softkeys that are displayed during the Run or Input? status, refer to "Secondary Softkeys in Run or Input? execution status".

For the secondary softkeys that are displayed when the editor is running, refer to "Secondary Softkeys in Edit execution status".

CAT

Clears the Command Entry line, and types in CAT.
To list file names on the disk, press Enter.

SAVE

1. Clears the Command Entry line.
2. Types in SAVE " ".
3. Positions the cursor after first ".
To save program to diskette, type name of file to which you want to save program, then press Enter.
If file already exists on diskette, program will not be saved.

RE-SAVE

1. Clears the Command Entry line.
2. Types in RE-SAVE " ".
3. Positions the cursor after first ".
To save program to diskette, type name of file to which you want to save program, then press Enter.
If file already exists on diskette, file will be overwritten, so previous data in file is lost.
1. Clears the Command Entry line.
2. Types in GET " ".
3. Positions the cursor after first ".
To get a program from diskette, type name of file to get, then press Enter.

1. Clears the Command Entry line.
2. Types in PURGE " ".
3. Positions the cursor after first ".
To delete a file from diskette, type in the file name to be deleted, then press Enter.

EDIT
Clears the Command Entry line and types in EDIT. To start the editor, press Enter front-panel key.

REN number
Clears the Command Entry line and types in REN.
To re-number lines of a program, type in appropriate parameters, then press Enter. For more details about REN command, refer to the HP Instrument BASIC User’s Handbook.

Secondary Softkeys in Run or Input? execution status

When the execution status is Run or Input?, user-defined softkeys, which are defined by using ON KEY command in the program, are displayed in the secondary softkey area.
Primary Softkeys in Edit execution status

This section describes the primary softkeys that are displayed when the IRASIC editor is running (Edit execution status is displayed).

- **Backspace**
  Deletes the character before the cursor.

- **Insert line**
  Inserts a line between the cursor line and the previous line.

- **Delete line**
  Deletes the cursor line.

- **Re-number**
  Changes the program line numbers so that first line is 10 and line number increment is 10.

- **Indent**
  Indents so that all program lines begin at the same position.

- **Scratch**
  Clears the program and all variables not in COM. Before clearing, **YES** and **NO** secondary softkeys are displayed for confirmation.

- **End edit**
  Exits the editor.
Secondary Softkeys in Edit execution status

This section describes the secondary softkeys that are displayed when the IBASIC editor is running (Edit execution status is displayed).

These softkeys help you enter program commands. For commands that require you to type in some parameters, these softkeys display the command. You must enter the parameters, then you must press Enter key to enter the command into the program. For commands that do not have parameters, the commands are entered directly into the program. Commands are entered at the cursor line.

For the EXECUTE command, refer to “EXECUTE” for details.

For secondary softkeys that are displayed during Idle or Pause execution status, refer to “Secondary Softkeys in Idle or Pause execution status”.

For secondary softkeys that are displayed during Run or Input? execution status, refer to “Secondary Softkeys in Run or Input? execution status”.

In Edit execution status, there are three pages of secondary softkeys. To move to next page, press MORE secondary softkey.

1. Displays the following program line for loading a setup file:

   \texttt{EXECUTE("GETSETUP ")}

2. Positions cursor at second double quotes. You enter the file name to be loaded, then select Enter key.

Enters the following program line for triggering a single measurement:

\texttt{EXECUTE("SINGLE")}

1. Displays the following program line for changing the operation state of the standby channels:

   \texttt{EXECUTE("STANDBY ")}

2. Positions the cursor at the second double quote. You enter ON or OFF, then select Enter key.
Reference: HP Instrument BASIC

Keys for IBASIC

**STRESS**

Enters the following program line for triggering stress force:

```
EXECUTE("STRESS")
```

**AUTOSCALE**

Enters the following program line for autoscaling:

```
EXECUTE("AUTOSCALE")
```

**SAVE DATA**

1. Displays the following program line for saving measurement data to a file:

```
EXECUTE("SAVEDATA ")
```

2. Positions the cursor at the second double quote. You enter file name to which you want to save measurement data, then select (Enter) key.

**READ DATA VARIABLE**

1. Displays the following program line for reading the values of an HP 4155A/4156A data variable, then storing the values into an IBASIC program variable:

```
EXECUTE("READDATAVAR ,")
```

2. Positions the cursor at the comma. You enter names of HP 4155A/4156A data variable and IBASIC program variable, then select (Enter) key.

**DEFINE USER VARIABLE**

1. Displays the following program line for defining a user variable:

```
EXECUTE("DEFUSERVAR,,,")
```

2. Positions the cursor at the first comma. You enter the user variable name, number of data, name of IBASIC program variable that contains desired data, and user variable unit, then select (Enter) key.

**PRINT/ PLOT**

Enters following program line for printing/plotting the instrument window:

```
EXECUTE("PRINTPLOT")
```

**CURVE PLOT**

Enters following program line for printing/plotting a graphics plot of measurement results:

```
EXECUTE("CURVEPLOT")
```
1. Displays the following program line for outputting a command to the HP 4155A/4156A:

```
OUTPUT @Hp415x;"
```

2. Positions the cursor at the second double quotes. You enter desired command, then select (Enter) key.

```
ENTER @Hp415x;
```

2. Positions the cursor after the semicolon. You enter desired variable, then select (Enter) key.

```
PAUSE
```

Enters the following program line for pausing a program:

```
PAUSE
```

1. Displays the following program line for displaying a message:

```
DISP ""
```

2. Positions the cursor at the second double quotes. You enter the message that you want to display, then select (Enter) key.

```
INPUT "",
```

2. Positions the cursor at the second double quote. Enter string that you want to be displayed on CRT, and name of variable in which you want to store keyboard input, then select (Enter) key.

```
IF THEN
ELSE
END IF
```

1. Displays the following program lines for conditional branching:

2. Positions the cursor before THEN. Fill in as desired, then select (Enter) key.
Reference: HP Instrument BASIC

Keys for IBASIC

1. Displays the following program lines for defining a loop:

   WHILE
   END WHILE

2. Positions the cursor after WHILE. Fill in as desired, then select Enter key.

1. Displays the following program lines for defining a loop:

   FOR = TO STEP
   NEXT

2. Positions the cursor at =. Fill in as desired, then select Enter key.
External Keyboard

You can connect an external keyboard to the HP 4155A/4156A and use to enter text.

Also, you can use the keyboard for other tasks as described in this chapter.

In this section, the notation "[KeyA]+[KeyB]" means to hold down [KeyA] and press [KeyB].

Esc
Exits the editor

F1 through F8
Primary softkeys
Corresponds to the primary softkeys.

Shift + F1 through F7
Secondary softkeys
Corresponds to the secondary softkeys.

F9
Screen mode
Toggles the screen mode as follows:

```
All instrument  ---  I-BASIC status  ---  All I-BASIC
```

Same as Ctrl)+(.

F11
Clear to end
Deletes characters from cursor to end of line.
Same as Ctrl)+(Delete

Shift+(F11)
Clear line
When editor is running, same as F11.
When editor is not running, deletes characters on the Command Entry line.
Reference: HP Instrument BASIC

**Keys for IBASIC**

**F12**
Clear display  Clears the display for IBASIC. When the editor is running, exits from the editor, and clears the display for IBASIC.

**Print Screen**
Clear I/O  Stops I/O operation of program.

**Scroll Lock**
Stop  Stops program execution after executing the current line.
Same as **Shift + Pause**

**Shift + Scroll Lock**
Reset  Stops program execution immediately.

**Pause**
Pause  Pauses program execution until **CONT** is executed or **Continue** primary softkey is pressed. If the program is modified while paused, **RUN** must be used to restart program execution.
Same as **Ctrl + P**.

**Shift + Pause**
Stop  Stops program execution after executing the current line.
Same as **Scroll Lock**.

**Insert**
Insert  When the editor is running, opens a new line before the current line.
When the editor is not running, inserts text at the cursor (press **Insert** again to end insert mode).
Same as **Alt + I**.

**Shift + Insert**
Insert  Same as **Insert**.

**Delete**
Delete  Deletes character at the cursor.

**Shift + Delete**
Delete line  When the editor running, deletes the current line.
When the editor is not running, deletes character at cursor.
Same as **Alt + D**.

2-20
Ctrl + Delete
Clear to end
Deletes characters from cursor to end of line.
Same as (Fill).

Home
Beginning of line
Moves the cursor to beginning of the line.
Same as (Shift) + (4).

Shift + Home
Page move
When the editor is running, same as (Page Up). Also, same as (Shift) + (A).
When the editor is not running, jumps to the top of the IBASIC output area. Also, same as (Shift) + (7).

End
End of line
Moves cursor to end of line.
Same as (Shift) + (6).

Shift + End
Page move
When the editor is running, same as (Page Down). Also, same as (Shift) + (7).
When the editor is not running, jumps to the bottom of the IBASIC output area. Same as (Shift) + (A).

Page Up
Page move
When the editor is running, moves the cursor one-half display page toward the beginning of the program. Same as (Shift) + (Home). Also same as (Shift) + (A).
When the editor is not running, moves display down one page.

Shift + Page Up
Recall
When the editor is running, displays last deleted line. To enter line into program, press (Enter).
When the editor is not running, cycles through the 10 commands that were most recently entered on the Command Entry line.
Reference: HP Instrument BASIC

**Keys for IBASIC**

- **Page Down**
  - Page move
  - When the editor is running, moves the cursor one-half display page toward the end of the program. Same as \( \text{Shift} + \text{End} \). Same as \( \text{Shift} + \uparrow \).
  - When the editor is not running, moves display up one page.

- **Shift + Page Down**
  - Recall backward
  - When the editor is running, same as \( \text{Shift} + \text{Page Up} \).
  - When the editor is not running, cycles through the 10 commands that were most recently entered on the Command Entry line in reverse order of \( \text{Shift} + \text{Page Up} \).

- **Previous line**
  - When the editor is running, moves cursor up one line.
  - When the editor is not running, display on the IBASIC output area moves one line toward the end.

- **Shift + Previous line**
  - Page move
  - When the editor is running, same as \( \text{Page Up} \). Also, same as \( \text{Shift} + \text{Home} \).
  - When the editor is not running, jumps to the bottom of the IBASIC output area. Same as \( \text{Shift} + \text{End} \).

- **Alt + Previous line**
  - Recall backward
  - When the editor is running, same as \( \text{Shift} + \text{Page Up} \).
  - When the editor is not running, same as \( \text{Shift} + \text{Page Down} \).

- **Next line**
  - When the editor is running, cursor moves down one line.
  - When editor is not running, display on IBASIC output area moves one line toward beginning.

- **Shift + Next line**
  - Page move
  - When the editor is running, same as \( \text{Page Down} \). Also, same as \( \text{Shift} + \text{End} \).
  - When the editor is not running, jumps to the top of the IBASIC output area. Same as \( \text{Shift} + \text{Home} \).

- **Alt + Next line**
  - Recall
  - Same as \( \text{Shift} + \text{Page Up} \).
Move cursor  
Moves the cursor one character in indicated direction.

Shift + 
Beginning of line  
Moves the cursor to beginning of line.
Same as Home.

Shift + 
End of line  
Moves the cursor to end of line.
Same as End.

Backspace  
When the editor is running, deletes the character before cursor. 
When the editor is not running, deletes the character before cursor (if mode is insert mode). If mode is not 
insert move, moves cursor to left by one character.

Alt + Delete line  
When the editor is running, deletes the current line. 
When the editor is not running, deletes the character at the cursor.
Same as Shift + Delete.

Alt + Insert line  
When the editor is running, opens a new line before the 
current line. 
When the editor is not running, inserts text at the cursor 
(press insert again to end insert mode).
Same as Insert.

Ctrl + U  
Run  
Executes the program.

Ctrl + P  
Pause  
Pauses program execution until CONT is executed or 
Continue: primary softkey is pressed. If the program 
is modified while paused, RUN must be used to restart 
program execution.
Same as Pause.
Screen mode  

Toggles the screen mode as follows:

```
All instrument  →  I-BASIC status  →  All I-BASIC
```

Same as (F9)
The following keywords are not standard IBASIC keywords, or are standard keywords, but with a difference. These keywords are specific to HP 4155A/4156A.

**EXECUTE**
Not standard IBASIC keyword. Refer to “ASP-like Commands” for details.

**ON KEY**
Standard IBASIC keyword, except the range of *key selector* is 1 to 7.
1 to 7 of *key selector* corresponds to secondary softkeys 1 to 7, respectively.

**PEN**
Standard IBASIC keyword, except the range of *pen selector* is 7. The following table shows the corresponding color for each *pen selector*.

<table>
<thead>
<tr>
<th>pen selector</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>color defined for Foreground on SYSTEM: COLOR SETUP page.</td>
</tr>
<tr>
<td>2</td>
<td>color defined for Y1 Axis on SYSTEM: COLOR SETUP page.</td>
</tr>
<tr>
<td>3</td>
<td>color defined for Y2 Axis on SYSTEM: COLOR SETUP page.</td>
</tr>
<tr>
<td>4</td>
<td>color defined for Marked/Cursor/Line on SYSTEM: COLOR SETUP page.</td>
</tr>
<tr>
<td>5</td>
<td>color defined for Active Mark/Line on SYSTEM: COLOR SETUP page.</td>
</tr>
<tr>
<td>6</td>
<td>color defined for Advisory on SYSTEM: COLOR SETUP page.</td>
</tr>
<tr>
<td>7</td>
<td>color defined for Title on SYSTEM: COLOR SETUP page.</td>
</tr>
</tbody>
</table>
The following IBASIC keywords are not implemented in HP 4155A/4156A's Instrument BASIC.

- ALPHA ON/OFF
- AREA
- CLIP
- CONTROL
- DUMP
- EDGE
- FILL
- FRAME
- GESCAPE
- GLOAD
- GRAPHICS
- GRID
- GSTORE
- LINE TYPE
- PLOTTER IS
- POLYGON
- POLYLINE
- RATIO
- RECTANGLE
- SET PEN
- SHOW
- STATUS
- VIEWPORT
- WINDOW
Available I/O Resources for IBASIC

This section provides information about available I/O resources for IBASIC of HP 4155A/4156A.

The following I/O resources are available for IBASIC.

- CRT Display
- External keyboard and front-panel keyboard
- HP-IB Interface on rear panel
- Internal pseudo HP-IB Interface (to control HP 4155A/4156A itself)
- Serial Interface
- Built-in Disk Drive (no select code)

Table 2-1 shows available I/O interfaces and their select codes.

<table>
<thead>
<tr>
<th>Select Code</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CRT</td>
</tr>
<tr>
<td>2</td>
<td>External and front-panel keyboard</td>
</tr>
<tr>
<td>7</td>
<td>HP-IB Interface on rear panel</td>
</tr>
<tr>
<td>8</td>
<td>Internal pseudo HP-IB Interface</td>
</tr>
<tr>
<td>9</td>
<td>Serial Interface</td>
</tr>
</tbody>
</table>
CRT Display

IBASIC can display text or graphics on the CRT display of the HP 4155A/4156A.

**Text display.**
Text can be displayed in the IBASIC output area of "All IBASIC" screen.

**Graphics display.**
In "All IBASIC" screen, you can display a graphical plot.

The x and y coordinate values are as follows:
- lower left corner of screen: (0,0)
- upper right corner of screen: (545,400).

HP-IB Interfaces

- **Internal pseudo HP-IB**
  By using select code 8, you can control HP 4155A/4156A via internal pseudo HP-IB interface. The HP-IB address of HP 4155A/4156A has no meaning, so you can use any address (0 through 30).

- **HP-IB on rear panel**
  You can access HP-IB interface on rear panel by using select code 7.
Serial Interface

You can access serial interface on rear panel by using select code 9.

Receiving data

To receive data from serial interface successfully, be sure to do the following:

- Use `ASSIGN IBASIC command to open I/O path. Refer to the following example:

  ```
  ASSIGN @Serial TO 9
  ENTER @Serial;A$
  ```

  Do not use `ENTER 9;A$` because every time it is executed, the I/O path is opened, which may cause errors.

- If you receive multiple lines of data (such as by a loop of `ENTER` statements), make sure no other operation or statement occurs between receptions. It may cause an overrun error. If overrun error is caused, use a slower baud rate for receiving.
Built-in Diskette Drive

If you specify optional volume specifier when accessing the built-in diskette drive, the volume specifier must be ":INTERNAL,4".

Available diskettes.
You can use the following types of 3.5 inch diskettes:
- 2HD 1.44 MB
- 2DD 720 KB

Diskette must be formatted as L1F or the following DOS format:
- 80 tracks/side
- 18 sectors/track (2HD)
  9 sectors/track (2DD)
- 512 bytes/sector
ASP-like Commands

EXECUTE is an IBASIC keyword for executing function directives, which allow you to easily create simple programs in a way similar to creating Auto Sequence Programs (ASP) on the HP 4145A/B Semiconductor Parameter Analyzer.

Compatibility Consideration
EXECUTE is not a standard IBASIC or HP BASIC keyword. So, if you use this keyword in your program, it will not execute on another IBASIC or HP BASIC system.

EXECUTE

Keyboard Executable: Yes
Programmable: Yes
In an IF ... THEN ...: Yes

This keyword can execute the function directives that are described on the following pages.

Syntax

```
EXECUTE ("directive_keyword [,parameter]")
```

directive

Some directives require parameters. There must be one or more spaces between `directive_keyword` and `parameter`.

The following pages describe the directives that can be used in the EXECUTE command.
GET SETUP Directive

This directive loads the specified HP 4155A/4156A setup file.

Directive syntax

```
GETSETUP file_name [,DISK|MEMORY]
```

Directive parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>file_name</td>
<td>string</td>
<td>name of setup file with extension (.MES or .STR) to be loaded. You must enclose the name with single quotes or double-double quotes.</td>
</tr>
<tr>
<td>DISK</td>
<td>character</td>
<td>(default) loads setup data from internal diskette.</td>
</tr>
<tr>
<td>MEMORY</td>
<td>character</td>
<td>loads setup data from internal memory.</td>
</tr>
</tbody>
</table>

Example

```
EXECUTE("GETSETUP 'Sweep.MES'")
EXECUTE("GETSETUP "Sweep.MES"")
EXECUTE("GETSETUP File$,DISK")
EXECUTE("GETSETUP 'MEM1.MES',MEMORY")
```

SINGLE Directive

This directive executes measurement.

Directive syntax

```
SINGLE
```

Example

```
EXECUTE("SINGLE")
```
STANDBY directive

This directive changes STBY ON channels to standby state or idle state.

Directive syntax

STANDBY ON | OFF

Directive parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>character</td>
<td>changes STBY ON channels from idle state to standby state.</td>
</tr>
<tr>
<td>OFF</td>
<td>character</td>
<td>changes STBY ON channels from standby state to idle state.</td>
</tr>
</tbody>
</table>

Example

EXECUTE("STANDBY ON")

EXECUTE("STANDBY OFF")

STRESS Directive

This directive forces stress.

Directive syntax

STRESS

Example

EXECUTE("STRESS")
AUTO-SCALE Directive

This directive changes page to GRAPH/LIST: GRAPHICS and executes auto-scaling function.

Directive syntax

AUTOSCALE

Example

EXECUTE("AUTOSCALE")

SAVE DATA Directive

This directive stores measurement data file to internal diskette or internal memory.

Directive syntax

SAVEDATA file_name [,DISK|MEMORY]

Directive parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>file_name</td>
<td>string</td>
<td>name of measurement data file with extension [.DAT] to be stored. You must enclose the name with single quotes or double-double quotes.</td>
</tr>
<tr>
<td>DISK</td>
<td>character</td>
<td>(default) stores measurement data to internal diskette.</td>
</tr>
<tr>
<td>MEMORY</td>
<td>character</td>
<td>stores measurement data to internal memory.</td>
</tr>
</tbody>
</table>

Example

EXECUTE("SAVEDATA 'Sweep.DAT'")
EXECUTE("SAVEDATA ""Sweep.DAT"")
EXECUTE("SAVEDATA File\$,DISK")
EXECUTE("SAVEDATA 'MEM1.DAT',MEMORY")
READ DATA VARIABLE Directive

This directive gets values of specified HP 4155A/4156A data variable, and stores the values in an IBASIC variable.

Directive syntax

```
READDATAVAR data_variable_name,ibasic_variable_name)
```

Directive parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>data_variable_name</td>
<td>string</td>
<td>name of the data variable of HP 4155A/4156A. You must enclose the name with single quotes or double-double quotes. Name is case sensitive.</td>
</tr>
<tr>
<td>ibasic_variable_name</td>
<td>string</td>
<td>Name of numeric variable or numeric array of IBASIC program. ibasic_variable_name is not case sensitive.</td>
</tr>
</tbody>
</table>

Example

```
EXECUTE("READDATAVAR 'V1',V")

EXECUTE("READDATAVAR "'V1'",V")
```
DEFINE USER VARIABLE Directive

This directive defines an HP 4155A/4156A user variable, and transfers values from an IBASIC variable to the user variable.

**Directive syntax**

```
DEFUSERVAR user_variable_name, no_of_points, ibasic_variable_name
[ , unit ]
```

**Directive parameter**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>user_variable_name</td>
<td>string</td>
<td>user variable name that you want to define. You must enclose the name</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with single quotes or double-double quotes.</td>
</tr>
<tr>
<td>no_of_points</td>
<td>numeric</td>
<td>number of data for the user variable</td>
</tr>
<tr>
<td>ibasic_variable_name</td>
<td>string</td>
<td>name of numeric variable or numeric array of IBASIC program. The data in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>this variable will be transferred to the user variable.</td>
</tr>
<tr>
<td>unit</td>
<td>string</td>
<td>unit of user variable. You must enclose the unit with single quotes or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>double-double quotes.</td>
</tr>
</tbody>
</table>

**Example**

```
EXECUTE("DEFUSERVAR 'U_var',101,Vth,'V'")
```
PRINT/PLOT Directive

This directive prints/plots the information of the present instrument page, not the IBASIC screen. If present page is GRAPH/LIST: GRAPHICS page, the graph is printed/plotted.

**Directive syntax**

```
PRINTPLOT
```

**Example**

```
EXECUTE("PRINTPLOT")
```

---

CURVE PLOT Directive

This directive changes to GRAPH/LIST: GRAPHICS page, then prints/plots the graph.

**Directive syntax**

```
CURVEPLOT
```

**Example**

```
EXECUTE("CURVEPLOT")
```
Reference: HP Instrument BASIC

ASP-like Commands
Getting Started on Programming the HP 4155A/4156A
Getting Started on Programming the HP 4155A/4156A

This chapter provides step-by-step tutorials for programming to control the HP 4155A/4156A along with programming examples.

This chapter consists of the following sections:

- Creating a Simple Measurement Program
  This section introduces how to create a measurement program.

- Programming for Data Extraction
  This section provides the programming tutorials for data extraction.

- Complete Example Program for Vth Measurement
  This section shows complete example program based on the parts described in the other sections.

- Example Application Setup for Vth Measurement
  This section describes an example application setup that you should save to the file named \texttt{VTH.MES} on diskette before executing program examples (that use \texttt{VTH.MES}) described in this chapter.

In addition to this chapter, Chapter 6 provides some application examples which are helpful to increase your understanding.
Creating a Simple Measurement Program

This section introduces how to create a measurement program.

A simple measurement program created by using built-in IBASIC controller is provided as an example and you learn step-by-step how to create a measurement program.

This section consists of the following:

1. Getting a setup file and making a measurement
2. Changing the sweep setup parameters
3. Changing the display setup parameters
4. Saving the measurement results to a diskette
5. Printing the measurement results
Before Creating a Program

This section assumes that you have already saved a measurement setup file for Vth measurement to diskette.

Before starting this section, prepare the diskette and save the measurement setup (described in “Example Application Setup for Vth Measurement”) to the file named "VTH.MES" on the diskette.

Step 1. Getting the Setup File and Making a Measurement

In this step, you can create a program to get a setup file from the diskette and execute a measurement.

1. Press IBASIC (Display) key until screen display mode is All IBASIC mode.
2. Select EDIT softkey, then press Enter key to start the IBASIC editor.
3. If there is an existing program, save it if necessary.
4. Delete existing program and assign I/O path to control HP 4155A/56A.

   Type SCRATCH, then Enter. Or select Scratch primary softkey to delete the program.

   Existing program is deleted and the following program lines are entered automatically. These lines are for assigning HP 4155A/56A control I/O path.

   10 COM @Hp415x
   20 ASSIGN @Hp415x 70 800
   30 !
   9990 END
## Creating a Simple Measurement Program

<table>
<thead>
<tr>
<th>Line number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Declares COM so that subprograms can access the I/O path (that is assigned in line 20) for controlling the HP 4155A/456A. Refer to the HP Instrument BASIC Users Handbook for details.</td>
</tr>
<tr>
<td>20</td>
<td>Assigns the I/O path for controlling the HP 4155A/456A. 800 means built-in IBASIC controller.</td>
</tr>
</tbody>
</table>

### To ASSIGN I/O path

- Built-in IBASIC controller

  Specify select code 8. For the HP-IB address, you can use any number between 0 to 31. Refer to the following example:

  ```
  10 ASSIGN @Hp4155 TO 800
  ```

- HP BASIC on an external computer

  Specify the select code of the external computer. And specify the HP-IB address that you entered into the HP-IB ADDRESS field on the SYSTEM: MISCELLANEOUS page. In the following example, the select code of the external computer is 7 and HP-IB address of HP 4155A/456A is 17:

  ```
  10 ASSIGN @Hp4155 TO 717
  ```

5. Select `OUTPUT @Hp415x` secondary softkey.

   The following characters are automatically entered:

   ```
   30 OUTPUT @Hp415x:"
   ```

   Do not press `Enter` yet.

6. Use the help function to find the command for getting a setup file:

   a. Press `Help`.
   b. Press `Get`.
Creating a Simple Measurement Program

The cursor in help window automatically jumps to the command (:MMEM:LOAD:STAT) for getting a setup file.

7. Press Enter to insert the command into the program line.

Now line 30 is as follows:

```
30 OUTPUT @hp415x;"":MMEM:LOAD:STAT"
```

8. Type in the command parameters as in following example:

```
30 OUTPUT @hp415x;"":MMEM:LOAD:STAT 0,'VTH.MES','DISK"
```

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No meaning (dummy parameter).</td>
</tr>
<tr>
<td>'VTH.MES'</td>
<td>File name to be loaded.</td>
</tr>
<tr>
<td>'DISK'</td>
<td>Source mass storage is diskette.</td>
</tr>
</tbody>
</table>

Then press Enter. Then select the Insert line softkey.

9. Select OUTPUT @hp415x secondary softkey.

```
40 OUTPUT @hp415x;""
```

10. Press Help, then press Single, Append, or Repeat to find the command for executing a measurement.

<table>
<thead>
<tr>
<th>Execution Key</th>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>:PAGE:SCON:MEAS:SING</td>
</tr>
<tr>
<td>Append</td>
<td>:PAGE:SCON:MEAS:APP</td>
</tr>
<tr>
<td>Repeat</td>
<td>:PAGE:SCON:MEAS:REP</td>
</tr>
</tbody>
</table>

11. Press Enter to insert the found command into the program line.

```
10 COM @hp415x
20 ASSIGN @hp415x TD 800
30 OUTPUT @hp415x;"":MMEM:LOAD:STAT 0,'VTH.MES','DISK"
40 OUTPUT @hp415x;"":PAGE:SCON:MEAS:SING"
9999 END
```

Then press Enter
12. Press **End edit** to exit from the editor.

Now you have created a measurement program.

To execute the program, do as follows:

1. Press IBASIC *(Display)* key until screen display mode is All Instrument or IBASIC Status mode. This allows you to monitor the measurement on GRAPH/LIST: GRAPHICS page.

2. Press *(Run)* front-panel key. The measurement program is executed.

---

**Controlling from External Computer**

You must do as follows before controlling HP 4155A/4156A from an external computer:

1. Connect the HP-IB interface of external computer to HP-IB interface on rear panel of HP 4155A/4156A.

2. Set the HP 4155A/56A is field on the SYSTEM: MISCELLANEOUS page to NOT SYSTEM CONTROLLER.

3. Enter the HP-IB address of your HP 4155A/4156A into the HP-IB ADDRESS field.
Step 2. Changing the Sweep Setup Parameters

Modify measurement program created in previous step so that you can enter new sweep start and stop values while program is running:

1. Press IBASIC (Display) key until the screen display mode is All IBASIC mode.
2. Select EDIT softkey, then press (Enter) key to start the IBASIC editor
3. Insert program lines that allow you to enter the sweep start and stop values from the keyboard during program running.
   a. Move the cursor to program line 30.
   b. Select Insert line primary softkey.
   c. Type the following program lines:
      
      ```
      21 !
      22 INPUT "Sweep Start (V)?",Start_v
      23 INPUT "Sweep Stop (V)?",Stop_v
      24 !
      ```

4. If you do not know the SCPI commands for changing the sweep start and stop parameters, do as follows:
   a. Press IBASIC (Display) key until screen display mode is All Instrument mode.
   b. Press (Meas) to change to MEASURE: SWEEP SETUP page.
   c. Move the field pointer to the parameter that you want to change.
   d. Press (Help) key. The corresponding command is displayed at the bottom of the help window:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>:PAGE:MEAS:SWE:VAR1:STAR</td>
<td>VAR1 sweep start</td>
</tr>
<tr>
<td>:PAGE:MEAS:SWE:VAR1:STOP</td>
<td>VAR1 sweep stop</td>
</tr>
</tbody>
</table>

You need to remember the commands, so that you can enter them in the next step.

   e. Select the EXIT HELP softkey.
5. Press IBASIC [Display] key until screen display mode is All IBASIC mode. Then, do the following to insert the program lines for changing the sweep start and stop values.
   a. Move the cursor to the program line 40.
   b. Select [Insert line] primary softkey.
   c. Select the [OUTPUT @Hp415x] softkey.
   d. Type in the SCPI command. Or you can use the help function to enter the command. For the help function, see "To Use the Help Function" in Chapter 1.

   After you finish, the program lines should look as follows:
   
   ```
   31 OUTPUT @Hp415x;"*:PAGE:MEAS:SWE:VAR1:STAR";Start_v
   32 OUTPUT @Hp415x;"*:PAGE:MEAS:SWE:VAR1:STOP";Stop_v
   ```

   Now the program is as follows:

   ```
   10 COM @Hp415x
   20 ASSIGN @Hp415x TO 800
   21 !
   22 INPUT "Sweep Start (V)?",Start_v
   23 INPUT "Sweep Stop (V)?",Stop_v
   24 !
   30 OUTPUT @Hp415x;"*:MEMORY:LOAD:STAT 0,'VTH.MES', 'DISK'"
   31 OUTPUT @Hp415x;"*:PAGE:MEAS:SWE:VAR1:STAR";Start_v
   32 OUTPUT @Hp415x;"*:PAGE:MEAS:SWE:VAR1:STOP";Stop_v
   40 OUTPUT @Hp415x;"*:PAGE:SCAN:MEAS:SING"
   9990 END
   ```

6. Select [End edit] to exit from the editor.

7. Press IBASIC [Display] key until screen display mode is IBASIC Status mode.

8. Press [Run] to execute the program.

9. **Sweep Start (V)?** is displayed on the display line. Enter the desired sweep start voltage.

10. **Sweep Stop (V)?** is displayed on the display line. Enter the desired sweep stop voltage.
Step 3. Changing the Display Setup Parameters

In this step, change X-axis range of display setup parameters to match the sweep start and stop values.

1. Press IBASIC (Display) key until screen display mode is All IBASIC mode.
2. Select EDIT softkey, then press Enter key to start the IBASIC editor.
3. If you do not know the SCPI commands for changing the X-axis parameters, do as follows:
   a. Press IBASIC (Display) key until screen display mode is All Instrument mode.
   b. Press PAGE CONTROL (Display) key to change to DISPLAY: DISPLAY SETUP page.
   c. Move the field pointer to the parameter that you want to change.
   d. Press Help key. The corresponding commands are displayed at the bottom of the help window. You need to remember the commands, so that you can enter them in the next step.
   e. Select the EXIT HELP softkey.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
</table>
4. Press IBASIC (Display) key until screen display mode is All IBASIC mode. Then, do the following to insert the program lines for changing the X-axis display parameters:

a. Move the cursor to the program line 40.
b. Select Insert line primary softkey.
c. Select the OUTPUT @Hp415x softkey.
d. Type in the SCPI command. Or you can use the help function to enter the command. For the help function, see "To Use the Help Function" in Chapter 1. After you finish, the program lines should look as follows:

33 OUTPUT @Hp415x;"PAGE:DISP:SET:GRAP:X:MIN";Start_v
34 OUTPUT @Hp415x;"PAGE:DISP:SET:GRAP:X:MAX";Stop_v

Now the program is as follows:

10 COM @Hp415x
20 ASSIGN @Hp415x TO 800
21 !
22 INPUT "Sweep Start (V)?",Start_v
23 INPUT "Sweep Stop (V)?",Stop_v
24 !
30 OUTPUT @Hp415x;"MMEM:LOAD:STAT 0,'VTH,MES','DISK'"
31 OUTPUT @Hp415x;"PAGE:MEAS:SWE:VAR1:STAR";Start_v
32 OUTPUT @Hp415x;"PAGE:MEAS:SWE:VAR1:STOP";Stop_v
33 OUTPUT @Hp415x;"PAGE:DISP:SET:GRAP:X:MIN";Start_v
34 OUTPUT @Hp415x;"PAGE:DISP:SET:GRAP:X:MAX";Stop_v
40 OUTPUT @Hp415x;"PAGE:SCN:MEAS:SEND"
9999 END

5. Select End edit to exit from the editor.

6. Press IBASIC (Display) key until screen mode is IBASIC Status mode.

7. Press (run) to execute the program.

8. Enter the desired sweep start and stop values as prompted. The minimum and maximum X-axis values of the graph will be the same as these entered values.
Step 4. Saving All Measurement Results to a Diskette.

In this step, add program lines that save the setup data and measurement results to the diskette.

1. Press IBASIC (Display) key until screen display mode is All IBASIC mode.
2. Select EDIT softkey, then press Enter key to start the IBASIC editor
3. Move the cursor to program line 9990.
4. Select Insert line primary softkey.
5. Insert the following program lines, which wait until the measurement is completed.

```
50 OUTPUT @Hp415x;"#OPC?"
60 ENTER @Hp415x;Complete
```

When measurement is completed, HP 4155A/56A returns 1 to the Complete variable.

6. Insert the following program line, which saves the measurement setup and results to a file named VTH.DAT:

```
70 OUTPUT @Hp415x;"MEM:STOR:TRAC DEF,'VTH.DAT'
```

Now the program is as follows:

```
10  Command @Hp415x
20  Assign @Hp415x TO 800
21  !
22  Input "Sweep Start (V)?",Start_v
23  Input "Sweep Stop (V)?",Stop_v
24  !
30  OUTPUT @Hp415x;"MEM:LOAD:STAT 0,'VTH.MES','DISK"
31  OUTPUT @Hp415x;"PAGE:MEAS:SWEP:VAR1:STAR":Start_v
32  OUTPUT @Hp415x;"PAGE:MEAS:SWEP:VAR1:STOP":Stop_v
33  OUTPUT @Hp415x;"PAGE:DISP:SET:GRAPH:X:MIN":Start_v
34  OUTPUT @Hp415x;"PAGE:DISP:SET:GRAPH:X:MAX":Stop_v
40  OUTPUT @Hp415x;"PAGE:SCON:MEAS:SMAN"
50  OUTPUT @Hp415x;"#OPC?"
60  ENTER @Hp415x;Complete
70  OUTPUT @Hp415x;"MEM:STOR:TRAC DEF,'VTH.DAT'"
9990 END
```

7. Select End editor to exit from the editor.
8. Press IBASIC [Display] key until screen display mode changes to IBASIC Status mode.

9. Press [Run] to execute the program.

The measurement setup and results are automatically saved to the diskette after measurement is performed.
Step 5. Printing the Measurement Results

**Printing from IBASIC**

If you use built-in IBASIC controller to control HP 4155A/4156A, you do not need to prepare before controlling HP 4155A/4156A because built-in IBASIC controller is always connected to HP 4155A/4156A via internal HP-IB.

However, to print plot from built-in IBASIC controller, set "HP 4155A/56A is" field on the SYSTEM: MISCELLANEOUS page to SYSTEM CONTROLLER.

In this step, add program lines that print the measurement results.

1. Press **Display** key until screen display mode is All IBASIC mode.
2. Select **EDIT** softkey, then press **Enter** key to start the IBASIC editor.
3. Move the cursor to the program line 70.
4. Select **Insert line** primary softkey.
5. Insert the following program lines, which print a screen dump of the results:

   ```
   61 OUTPUT @Hp415x:"HCOP:SDUM"
   62 DISP "Printing"
   63 OUTPUT @Hp415x:"*0PC?"
   64 ENTER @Hp415x:Complete
   65 DISP "Done"
   ```

HCOP immediately initiates the plot or print according to the current setup. After printing is finished, HP 4155A/56A returns 1 to the Complete variable, then "Done" is displayed on the screen.

Now the program is as follows:
10 COM @Hp415x
20 ASSIGN @Hp415x TO 800
21 !
22 INPUT "Sweep Start (V)?",Start_v
23 INPUT "Sweep Stop (V)?",Stop_v
24 !
30 OUTPUT @Hp415x;";MNUM:LOAD:STAT 0,'VTH.MES',DISK"
31 OUTPUT @Hp415x;";PAGE:MEAS:SWE:VAR1:STAR";Start_v
32 OUTPUT @Hp415x;";PAGE:MEAS:SWE:VAR1:STOP";Stop_v
33 OUTPUT @Hp415x;";PAGE:DISP:SET:GRAP:X:MIN";Start_v
34 OUTPUT @Hp415x;";PAGE:DISP:SET:GRAP:X:MAX";Stop_v
35 OUTPUT @Hp415x;";PAGE:SCN:MEAS:SIG"
50 OUTPUT @Hp415x;";OPC?"
60 ENTER @Hp415x;Complete
61 OUTPUT @Hp415x;";HOP:SDUM"
62 DISP "Printing"
63 OUTPUT @Hp415x;";OPC?"
64 ENTER @Hp415x;Complete
65 DISP "Done"
70 OUTPUT @Hp415x;";MNUM:STOR:TRAC DEF,'VTH.DAT'"
9990 END
Programming for Data Extraction

This section provides the following programming tutorials for data extraction:

• Reading HP 4155/56 setup data
• Reading values of data variables (measurement results)
• Transferring data into a file

Reading HP 4155/56 Setup Data

To read setup data from HP 4155/56 into an IBASIC variable, use the query form of the corresponding setting command. To make the query form of a command, simply add a question mark (?) to the end of the command.

Refer to the following program lines of example program:

```
60  OUTPUT #0p415x;".PAGE:MEAS:SWE:VAR1:START?"
70  ENTER #0p415x;Vd_start
80  OUTPUT #0p415x;".PAGE:MEAS:SWE:VAR1:STOP?"
90  ENTER #0p415x;Vd_stop
100 OUTPUT #0p415x;".DISP:ALL BAS"
110 CLEAR SCREEN
120 PRINT TABXY(1,1);"Vd_START=";Vd_start;"(V)"
130 PRINT TABXY(1,2);"Vd_STOP =";Vd_stop;"(V)"
```

Line 60
This query command tells the HP 4155A/56A to put the VAR1 start value in its output buffer.

`.PAGE:MEAS:SWE:VAR1:START` is the command for setting the VAR1 start value. By adding ?, the command becomes the query command for reading the VAR1 start value.

Line 70
This gets the start value from the output buffer, then enters it in the Vd_start variable.

Line 80 to 90
These lines tell the HP 4155A/56 to put VAR1 stop value in its output buffer, then the value is entered into the Vd_stop variable.

3-16
Reading HP 4155/56 Measurement Data

To read read-out function values or data variable values (output data, measurement data, and user function values) from HP 4155/56 to IBASIC variables, use the :DATA? command.

Refer to the following program lines in the example program:

```
410   OUTPUT @Hp415x;";PAGE:SCON:MEAS:SING"
420   OUTPUT @Hp415x;";0PC?"
430   ENTER @Hp415x;Complete
440   OUTPUT @Hp415x;";DATA? 'VTH'"
450   ENTER @Hp415x;Vth
```

Line 410   Execute single measurement.
Line 420 to 430   Wait for measurement completion.
Line 440   Send :DATA? query command to read the result value of user function "VTH".
Line 450   Store the result value into Vth variable.

**NOTE**

Be aware that data variable names, such as user functions and user variables, are case sensitive. For example, if you set up user function name VTH on the CHANNEL: USER FUNCTION DEFINITION page, then to read it, you must use :DATA? 'VTH', not :DATA? 'Vth'.

---

3-17
Transferring Specific HP 4155/56 Data to a File

To transfer data from the HP 4155A/56A to a file, do as follows:

1. Create a data file.

You can create three types of data files: DOS, LIF ASCII, or BDAT as follows:

```
CREATE "data_file",1
! Creates a DOS file.
CREATE ASCII "ascii_file",100
! Creates a LIF ASCII file.
CREATE BDAT "binary_file",100
! Creates a BDAT file.
```

DOS files are compatible with MS-DOS, which are easy to transfer to PCs and other computers.

LIF ASCII files are compatible with HP computers that support this file type, so this type is best if you are transferring files among HP computers that support this file type.

BDAT (binary data) files provide more flexibility (can specify both number of records and record length) and faster transfer rate. But BDAT files cannot be interchanged with as many other systems.

The first parameter of each statement specifies the file name to create.

The second parameter specifies number of records to allocate for the file as follows:

**DOS**

Second parameter specifies how many records are to be *initially* allocated for the file. A DOS file system automatically allocates additional space for the file as new data is written to it, so you can always specify 1 for this parameter.

**LIF ASCII**

Second parameter specifies *total* number of records to allocate for the file, so you must specify a sufficient number of records. The length of one record is 256 bytes.

For example, the following statement would create a file with 100 records (each record is 256 bytes):

```
CREATE ASCII "File",100
```
460  OUTPUT @File;Vth
630  UNTIL Stop$="S" OR Stop$="s"

The above program repeats appending Vth variable value to a DOS file in ASCII format.

In addition to numeric data, array data and string data can be stored to a file as in following examples:

- Array data:

  1    DIM Vth(1:100)
  340  INPUT "Enter file name to store data",File$
  350  CREATE File$,1
  360  ASSIGN @File TO File$;FORMAT ON
  390  FOR I=1 TO 100
  440  OUTPUT @Hp415x;";DATA? 'VTH';"
  450  ENTER @Hp415x;Vth(I)
  460  NEXT I
  470  OUTPUT @File;Vth(*)

- String data:

  10   DIM Data$[10](1:100)
  20   CREATE "DATFILE";1
  30   ASSIGN @File TO "DATFILE";FORMAT ON
  40   FOR I=1 TO 100
  50   Data$(I)="ABC"
  60   NEXT I
  70   OUTPUT @File;Data$(*)

4. Close the I/O path.

To close an I/O path to a file, ASSIGN the path name to an * (asterisk) as in the following example:

  340  INPUT "Enter file name to store data",File$
  350  CREATE File$,1
  360  ASSIGN @File TO File$;FORMAT ON
  460  OUTPUT @File;Vth

  590  ASSIGN @File TO *

In this program, line 590 closes the I/O path that was opened by line 360.
BDAT

Second parameter specifies total number of records to allocate for the file, so you must specify a sufficient number of records. You can specify a record length by using an optional third parameter (default length is 256 bytes).

For example, the following statement creates a file with 7 records (each record is 128 bytes):

```
CREATE BDAT "B_file",7,128
```

The following statement creates a file with 7 records (each record is 256 bytes):

```
CREATE BDAT "B_file",7
```

2. Open an I/O path for transferring data into the file.

To open an I/O path to the file, assign an I/O path name to the file by using an ASSIGN statement as in the following example:

```
340 INPUT "Enter file name to store data",File$
350 CREATE File$,1
360 ASSIGN &File TO File$;FORMAT ON
```

Line 350 creates a DOS file, then line 360 opens an I/O path to the file.

For DOS and BDAT files, ASSIGN statement can also specify the following:

- **FORMAT ON**: ASCII data representations are used. Specify this if you need to transport data between IBASIC and other machines.
- **FORMAT OFF**: IBASIC internal data representations are used. Specify this if you need a faster transfer rate and space efficiency.

3. Store data into the file.

To store data into a file, use OUTPUT and ENTER statements as in the following examples:

```
340 INPUT "Enter file name to store data",File$
350 CREATE File$,1
360 ASSIGN &File TO File$;FORMAT ON
390 REPEAT ...
440 OUTPUT @Hp415x:"DATA? 'VTH"'
450 ENTER @Hp415x;Vth
```
Complete Example Program for Vth Measurement

The example program shown below uses the measurement setup file described in "Example Application Setup for Vth Measurement". This is a complete example program based on the parts described in the previous sections.

10   COM @Hp415x
20   ASSIGN @Hp415x TO 800
30   OUTPUT @Hp415x;"\"MEM:LOAD:STAT 0,\'VTH\'.MES\',\'DISK\'\""
40   !
50   ! Read and Disp. Measurement Conditions
60   OUTPUT @Hp415x;"\"PAGE:MEAS:SWE:VAR1:STAR?\""
70   ENTER @Hp415x;Vd_start
80   OUTPUT @Hp415x;"\"PAGE:MEAS:SWE:VAR1:STOP?\""
90   ENTER @Hp415x;Vd_stop
100  OUTPUT @Hp415x;"\"DISP:ALL BAS\""
110  CLEAR SCREEN
120  PRINT TABXY(1,1);"\"Vd START\":\";Vd_start;\"(V)\"
130  PRINT TABXY(1,2);"\"Vd STOP\":\";Vd_stop;\"(V)\"
140  !
150  ! Parameter Change
160  Change$="n"
170  Change:  !
180  INPUT "Change these parameters? (y/n default=n)\",Change$
190  SELECT Change$
200  CASE \"Y\",\"y\"
210    INPUT "New Vd START (V)?\",Vd_start
220    INPUT "New Vd STOP (V)?\",Vd_stop
230    OUTPUT @Hp415x;"\"PAGE:MEAS:SWE:VAR1:STAR\":\";Vd_start
240    OUTPUT @Hp415x;"\"PAGE:MEAS:SWE:VAR1:STOP\":\";Vd_stop
250    PRINT TABXY(1,1);"\"Vd START\":\";Vd_start;\"(V)\"
260    PRINT TABXY(1,2);"\"Vd STOP\":\";Vd_stop;\"(V)\"
270  CASE \"n\",\"n\"
280    GOTO Store_file
290  CASE ELSE
300    GOTO Change
310  END SELECT
320  !
330  Store_file:  !
340  INPUT "Enter file name to store data\",File$
350  CREATE File$,1
360  ASSIGN @File TO File$;FORMAT ON
370  !
380  No_of_data=0
390  REPEAT
Getting Started on Programming the HP 41C/15A/416A
Complete Example Program for Vth Measurement

400  OUTPUT @Hp415x;":DISP:ALL BST"
410  OUTPUT @Hp415x;":PAGE:SCON:MEAS:SING"
420  OUTPUT @Hp415x;"#GPC?"
430  ENTER @Hp415x;Complete
440  OUTPUT @Hp415x;":DATA? 'VTH'"
450  ENTER @Hp415x;Vth
460  OUTPUT @File;Vth
470  No_of_data=No_of_data+1
480  OUTPUT @Hp415x;":DISP:ALL BASIC"
490  PRINT TABXY(1,10);"Last measured Vth =";Vth;"(V)
500  PRINT TABXY(1,11);"Total number of die tested=";No_of_data
510  Stop_query:INPUT "Continue to next die or Stop test? (c/a)";Stop$
520  SELECT Stop$
530  CASE "C", "c"
540    DISP "Move to the next die, then press [Continue]"
550    PAUSE
560    DISP ""
570  CASE "S", "s"
580    PRINT TABXY(1,24);"Test Stopped!!"
590    ASSIGN @File TO *
600  CASE ELSE
610    GOTO Stop_query
620  END SELECT
630  UNTIL Stop$="S" OR Stop$="a"
640  END
Example Application Setup for Vth Measurement

This section describes an example application setup that you should save to the file named \texttt{VTH.MES} on diskette before executing program examples (that use \texttt{VTH.MES}) described previously in this chapter.

A frequently used method of measuring \(Vth\) is to synchronously sweep the exact same voltage to gate and drain, and measure the characteristics in the saturation region.

The theoretical value of drain current in the saturation region is calculated as follows:

\[
I_d = \beta \cdot (V_g - V_{th})^2
\]

Where \(\beta\) is the gain factor, which is \(-1/2 \cdot (\mu_C W/L) \cdot t_ox\). Therefore, if you take the square root of both sides of the equation:

\[
\sqrt{I_d} = \sqrt{\beta \cdot (V_g - V_{th})}
\]

\(\sqrt{I_d}\) is proportional to \(V_g\), and the slope is \(\sqrt{\beta}\). At the point where \(\sqrt{I_d}\) is equal 0, \(V_{th}\) is equal to \(V_g\). So, to know \(V_{th}\), we need to find that point.

The measurement conditions are as follows:

- **Channel Definition**

<table>
<thead>
<tr>
<th>Measurement Mode</th>
<th>Sweep</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNIT</strong></td>
<td><strong>VNAME</strong></td>
</tr>
<tr>
<td>SMU1</td>
<td>Vd</td>
</tr>
<tr>
<td>SMU2</td>
<td>Vg</td>
</tr>
<tr>
<td>SMU3</td>
<td>Vs</td>
</tr>
<tr>
<td>SMU4</td>
<td>Veb</td>
</tr>
</tbody>
</table>
Getting Started on Programming the HP 4155A/4156A

Example Application Setup for Vth Measurement

- **Sweep Setup**

<table>
<thead>
<tr>
<th></th>
<th>VAR1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNIT</strong></td>
<td>SMU2</td>
</tr>
<tr>
<td><strong>NAME</strong></td>
<td>Vg</td>
</tr>
<tr>
<td><strong>Sweep Mode</strong></td>
<td>Single</td>
</tr>
<tr>
<td><strong>LIN/LOG</strong></td>
<td>LINEAR</td>
</tr>
<tr>
<td><strong>START</strong></td>
<td>0.0000 V</td>
</tr>
<tr>
<td><strong>STOP</strong></td>
<td>5.000 V</td>
</tr>
<tr>
<td><strong>STEP</strong></td>
<td>100.0 mV</td>
</tr>
<tr>
<td><strong>NO OF STEP</strong></td>
<td>51</td>
</tr>
<tr>
<td><strong>COMPLIANCE</strong></td>
<td>100.0 mA</td>
</tr>
<tr>
<td><strong>POWER COMP</strong></td>
<td>OFF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>VAR1'</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNIT</strong></td>
<td>SMU1</td>
</tr>
<tr>
<td><strong>NAME</strong></td>
<td>Vd</td>
</tr>
<tr>
<td><strong>OFFSET</strong></td>
<td>0.0000 V</td>
</tr>
<tr>
<td><strong>RATIO</strong></td>
<td>1.000</td>
</tr>
<tr>
<td><strong>COMPLIANCE</strong></td>
<td>100.00 mA</td>
</tr>
<tr>
<td><strong>POWER COMP</strong></td>
<td>OFF</td>
</tr>
</tbody>
</table>
By this setup, Id-Vg characteristics can be measured. On the CHANNELS:
USER FUNCTION DEFINITION page shown in the following table, we defined
the square root of Id (SQRTId), and the differential coefficient (GRAD) of
SQRTId versus Vg.

Also, we defined VTH and BETA by using Read Out Functions. VTH is @L1X
(X-intercept of line 1) and BETA is @L1G2 (slope of line 1 to second power).
Line 1 is drawn according to DISPLAY: ANALYSIS SETUP page, which is
described later.

As shown in the following tables, we set the DISPLAY: DISPLAY SETUP page
to plot two curves: SQRTId versus Vg, and GRAD versus Vg. And VTH and
BETA will be displayed in the data variables display area.
Example Application Setup for Vth Measurement

<table>
<thead>
<tr>
<th></th>
<th>X-axis</th>
<th>Y1-axis</th>
<th>Y2-axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>Vg</td>
<td>SQRTId</td>
<td>GRAD</td>
</tr>
<tr>
<td>SCALE</td>
<td>LINEAR</td>
<td>LINEAR</td>
<td>LINEAR</td>
</tr>
<tr>
<td>MIN</td>
<td>0 V</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MAX</td>
<td>5 V</td>
<td>200 m</td>
<td>80 m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GRID</th>
<th>LINE PARAMETER</th>
<th>DATA VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>ON</td>
<td>VTH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BETA</td>
</tr>
</tbody>
</table>

The auto analysis functions are defined on DISPLAY: ANALYSIS SETUP page as shown below. A tangent line (line 1) is drawn to “SQRTId versus Vg” curve (Y1) at point where GRAD is maximum. VTH is the X-intercept of this line. Also, the marker is moved to point where GRAD is maximum.

*LINE1: [TANGENT] line on [Y1] at a point where [GRAD] = [MAX(GRAD)]

If you execute a single measurement, the two curves are drawn. Right after the measurement, a tangent line is drawn as specified in DISPLAY: ANALYSIS SETUP page, and resulting VTH and BETA values are displayed.
HP 4155A/4156A SCPI Programming
HP 4155A/4156A SCPI Programming

Standard Commands for Programmable Instruments (SCPI) is a universal programming language for electronic test and measurement instruments, and based on IEEE 488.1 and IEEE488.2.

This chapter describes how to create programs that contain SCPI commands to control the HP 4155A/56A. These programs can be run from an external computer or from the built-in HP Instrument BASIC (IBASIC) controller.

This chapter explains the following programming tasks along with programming examples:

- SCPI Programming Basics
- Measurement Setup
- Measurement Execution
- File Operation
- Data Transfer
- Print/Plot Operation
- Other Programming Tips
- Example for HP 4145 Users

If you are not familiar with HP 4155A/4156A programming, Chapter 3 provides step-by-step tutorials for programming and helps you to understand quickly.

In addition to this chapter, “Example Application Setup for Vth Measurement” in Chapter 3 provides some application examples which are helpful to increase your understanding.
SCPI Programming Basics

This section provides the following basic tasks to control and program the HP 4155A/4156A:

- Preparation before controlling the HP 4155A/56A via HP-IB
- SCPI Command Hierarchy
- To control HP 4155A/4156A by HP BASIC programming
Preparation before Controlling the HP 4155A/56A via HP-IB

SCPI programs to control the HP 4155A/4156A via HP-IB can be run from an external computer or from the built-in HP Instrument BASIC (IBASIC) controller.

To run these programs, the HP 4155A/56A must be set to HP 4155A/56A command mode, which is the default mode.

The HP 4155A/56A has two command modes: HP 4155A/56A command mode (default) and HP 4145 syntax command mode.

You use the HP 4145 syntax command mode if you need to execute HP 4145A/B programs on the HP 4155A/56A. For information about this, refer to Chapter 5.

**Controlling from External Computer.**

You must do as follows before controlling HP 4155A/4156A from an external computer:

1. Connect the HP-IB interface of external computer to HP-IB interface on rear panel of HP 4155A/4156A.

2. Set the HP 4155A/56A is field on the SYSTEM: MISCELLANEOUS page to NOT SYSTEM CONTROLLER.

3. Enter the HP-IB address of your HP 4155A/4156A into the HP-IB ADDRESS field.

**Controlling from built-in IBASIC controller.**

If you use built-in IBASIC controller to control HP 4155A/4156A, you do not need to prepare before controlling HP 4155A/4156A because built-in IBASIC controller is always connected to HP 4155A/4156A via internal HP-IB.

However, to print/plot from built-in IBASIC controller, set “HP 4155A/56A is” field on the SYSTEM: MISCELLANEOUS page to SYSTEM CONTROLLER.
SCPI Command Hierarchy

SCPI commands use a hierarchical structure for subsystem commands similar to the file system.

For example, in :PAGE:MEASURE:SWEEP command, the hierarchy is as follows:

- PAGE: root
- MEASURE: sub-level 1
- SWEEP: sub-level 2

The colon at the beginning of the command means root. The colons between two command keywords means moving down to a lower level.

---

**Using a Semicolon to Reduce Typing**

A semicolon enables two commands to be sent on the same line.

For example, :PAGE:MEAS:VAR1:START 0;STOP 5 is the same as the following two commands:

- :PAGE:MEAS:VAR1:START 0
- :PAGE:MEAS:VAR1:STOP 5

So, using a semicolon reduces typing and simplifies the program.

A command terminator (such as a `<newline>`) resets the path to root.
To Control HP 4155A/56A by HP BASIC Programming

1. Assign I/O path for controlling HP 4155A/4156A.

   Use ASSIGN command to assign I/O path:
   - Built-in IBASIC
     Specify select code 8. For the HP-IB address, you can use any number between 0 to 31. Refer to the following example:

     10 ASSIGN @Hp4155 TO 800

   - HP BASIC on an external computer
     Specify the select code of the external computer. And specify the HP-IB address that you entered into the HP-IB ADDRESS field on the SYSTEM: MISCELLANEOUS page. In the following example, the select code of the external computer is 7 and HP-IB address of HP 4155A/56A is 17:

     10 ASSIGN @Hp4155 TO 717

2. Use OUTPUT command to send commands to HP 4155A/56A.

3. Use ENTER command to get query response from HP 4155A/56A.
The following is the example program to control HP 4155A/4156A:

```
10   DIM I3(1:501)
20  
30   ASSIGN @Hp4155 TO 717
40  
50   OUTPUT @Hp4155;"*RST"
60  
70   OUTPUT @Hp4155;" :MMEM:LOAD:STAT 0,’SWP.MES’,’DISK’"
80  
90   OUTPUT @Hp4155;" :PAGE:SCON:SING"
100  OUTPUT @Hp4155;" *OPC?"
110  ENTER @Hp4155;Complete
120  
130  OUTPUT @Hp4155;"FORM:DATA ASC"
140  OUTPUT @Hp4155;" :DATA? ’I3’"
150  ENTER @Hp4155; I3(*)
160  
170  END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>50</td>
<td>Resets HP 4155A/4156A by sending *RST command.</td>
</tr>
<tr>
<td>70</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>90 to 110</td>
<td>Executes measurement</td>
</tr>
<tr>
<td>130 to 150</td>
<td>Gets the measurement data</td>
</tr>
</tbody>
</table>
Programming: Measurement Setup

To set up a measurement, you can use SCPI commands to set the setup pages of HP 4155A/4156A the same way that you can by interactive operation.

Basically, there are the following three ways to set up a measurement via SCPI programming:

- Load the measurement setup data from diskette or internal memory.

  Load the measurement setup data by SCPI programming. The data was previously defined and stored to a diskette file or internal memory interactively or by SCPI programming.

- Load the measurement setup data, then change some of the settings.

  Load the measurement setup data from diskette or internal memory, then change desired settings by SCPI programming.

- Set all settings.

  Set all settings for measurement setup by SCPI programming.

This section describes the following tasks:

- To set or change setup data values.
- To read setup data values

To load previously defined measurement setup data, refer to “Programming: File Operation”.
To Set or Change HP 4155/56 Setup Data Values

1. Send :PAGE subsystem commands that correspond to the setup data values that you want to change or set.

There is a command subsystem for each setup page as shown in Table 4-1. Each command subsystem has commands for setting the setup data of the corresponding setup page.

<table>
<thead>
<tr>
<th>Setup Page</th>
<th>Command Subsystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHANNELS: CHANNEL DEFINITION</td>
<td>:PAGE:CHANnels:CDEnition</td>
</tr>
<tr>
<td>CHANNELS: USER FUNCTION DEFINITION</td>
<td>:PAGE:CHANnels:UFUnction</td>
</tr>
<tr>
<td>CHANNELS: USER VARIABLE DEFINITION</td>
<td>:PAGE:CHANnels:UVARiable</td>
</tr>
<tr>
<td>MEASURE: SWEEP SETUP</td>
<td>:PAGE:MEAsure:SWEep</td>
</tr>
<tr>
<td>MEASURE: SAMPLING SETUP</td>
<td>:PAGE:MEAsure:SAPling</td>
</tr>
<tr>
<td>MEASURE: PGU SETUP</td>
<td>:PAGE:MEAsure:PGUSetup</td>
</tr>
<tr>
<td>MEASURE: MEASURE SETUP</td>
<td>:PAGE:MEAsure:MSetup</td>
</tr>
<tr>
<td>MEASURE: OUTPUT SEQUENCE</td>
<td>:PAGE:MEAsure:OSSequence</td>
</tr>
<tr>
<td>DISPLAY: DISPLAY SETUP</td>
<td>:PAGE:DISPLAY:SETup</td>
</tr>
<tr>
<td>DISPLAY: ANALYSIS SETUP</td>
<td>:PAGE:DISPLAY:ANALysis</td>
</tr>
<tr>
<td>STRESS: CHANNEL DEFINITION</td>
<td>:PAGE:STRes:(CDefinition)</td>
</tr>
<tr>
<td>STRESS: STRESS SETUP</td>
<td>:PAGE:STRes:SETup</td>
</tr>
</tbody>
</table>
To load measurement setup data, then change the sweep start and stop values:

```plaintext
10  ASSIGN @Hp4155 TO 800
20  !
30  OUTPUT @Hp4155;";:MMEM:LOAD:STAT 0,'SWP.MES','DISK'"!
40  !
50  Swp_start=1
60  Swp_stop=10
70  !
80  OUTPUT @Hp4155;";:PAGE:MEAS:VAR1:STAR";Swp_start
90  OUTPUT @Hp4155;";:PAGE:MEAS:VAR1:STOP";Swp_stop
100 !
110 END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>30</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>60</td>
<td>Changes start value of VAR1.</td>
</tr>
<tr>
<td>90</td>
<td>Changes stop value of VAR1.</td>
</tr>
</tbody>
</table>
To Read HP 4155/56 Setup Data Values

To read setup data from HP 4155/56 into an IBASIC variable, do as follows:

1. Send :PAGE subsystem query command that corresponds to setup data that you want to read.

Example

To load measurement setup data, then read the sweep start and stop values:

```
10    ASSIGN @Hp4155 TO 717
20    !
30    OUTPUT @Hp4155;";MEM:LOAD:STAT 0,'SWP.MES','DISK''
40    !
50    OUTPUT @Hp4155;";PAGE:MEAS:VAR1:STAR?"
60    ENTER @Hp4155;Swp_start
70    OUTPUT @Hp4155;";PAGE:MEAS:VAR1:STOP?"
80    ENTER @Hp4155;Swp_stop
90    !
100   PRINT "Sweep-start=";Swp_start,"Sweep-stop=";Swp_stop
110   !
120   END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>30</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>50 to 80</td>
<td>Reads start value of VAR1.</td>
</tr>
<tr>
<td>70 to 80</td>
<td>Reads stop value of VAR1.</td>
</tr>
</tbody>
</table>
Programming: Measurement Execution

To execute a measurement, you can use :PAGE:SCONtrol subsystem commands.

This section describes the following tasks:

- To execute a sweep or sampling measurement
- To force stress
- To start the knob sweep function
- To control standby units
To Execute a Sweep or Sampling Measurement

1. Send :PAGE:SCONtrol[:MEASurement]:SINGLE command to HP 4155A/4156A.

- If you would like to repeat measurements, send :PAGE:SCONtrol[:MEASurement]:REPeat command instead of :PAGE:SCONtrol[:MEASurement]:SINGLE command.

- If you would like to append measurement, send :PAGE:SCONtrol[:MEASurement]:APPend command instead of :PAGE:SCONtrol[:MEASurement]:SINGLE command.

Example 1.
To execute a sweep or sampling measurement after loading the measurement setup data:

```
10  ASSIGN 6Hp4155 TO 717
20  !
30  OUTPUT 6Hp4155;"MEM:LOAD:STAT 0, SEG 0, SWP.MES"
40  OUTPUT 6Hp4155;"PAGE:SCON:SING"
40  !
60  END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>30</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>40</td>
<td>Executes measurement.</td>
</tr>
</tbody>
</table>
Example 2.
To load two measurement setups from diskette and store them into internal memory, then execute the measurements sequentially:

```
10  ASSIGN @Hp4155 TO 717
20  !
30  OUTPUT @Hp4155;";MMEM:LOAD:STAT 0,'MEAS1.MES','DISK;"
40  OUTPUT @Hp4155;";MMEM:STOR:STAT 0,'MEM1.MES','MEMORY;"
50  OUTPUT @Hp4155;";MMEM:LOAD:STAT 0,'MEAS2.MES','DISK;"
60  OUTPUT @Hp4155;";MMEM:STOR:STAT 0,'MEM2.MES','MEMORY;"
70  !
80  FOR I=1 TO 5
90  OUTPUT @Hp4155;";MMEM:LOAD:STAT 0,'MEM1.MES','MEMORY;"
100 OUTPUT @Hp4155;";PAGE:SCON:SING"
110 OUTPUT @Hp4155;";*QPC?"
120 ENTER @Hp4155;Complete
130 DISP "Analyze manually then press [Continue]"
140 PAUSE
150 !
160 OUTPUT @Hp4155;";MMEM:LOAD:STAT 0,'MEM2.MES','MEMORY;"
170 OUTPUT @Hp4155;";PAGE:SCON:SING"
180 OUTPUT @Hp4155;";*QPC?"
190 ENTER @Hp4155;Complete
200 DISP "Analyze manually and then press [Continue]"
210 PAUSE
220 !
230 IF I<5 THEN
240  DISP "Move to the next TEG and then press [Continue]"
250  PAUSE
260  END IF
270 !
280 NEXT I
290 !
300 END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>30 to 60</td>
<td>Leads two measurement setups from diskette, then stores them into internal memory.</td>
</tr>
<tr>
<td>90 to 120</td>
<td>Executes first measurement, then waits for measurement completion.</td>
</tr>
<tr>
<td>160 to 190</td>
<td>Executes second measurement, then waits for measurement completion.</td>
</tr>
</tbody>
</table>
To Force Stress


Example 1.
To force stress after loading the stress setup data:

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>30</td>
<td>Loads stress setup data from diskette file STRS.STR.</td>
</tr>
<tr>
<td>40</td>
<td>Executes stress forcing.</td>
</tr>
</tbody>
</table>
Example 2.
To force stress, then execute sweep measurement:

```
  10  ASSIGN @Hp4155 TO 717
  20  !
  30  OUTPUT @Hp4155;";MEM:LOAD:STAT 0,'STRS.STR'"
  40  OUTPUT @Hp4155;";PAGE:SCON:STR"
  50  OUTPUT @Hp4155;";*OFC?"
  60  ENTER @Hp4155;Complete
  70  !
  80  OUTPUT @Hp4155;";MEM:LOAD:STAT 0,'SWP.MES'"
  90  OUTPUT @Hp4155;";PAGE:SCON:SING"
 100  !
110  END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>30</td>
<td>Loads stress setup data from diskette file STRS.STR.</td>
</tr>
<tr>
<td>40</td>
<td>Executes stress forcing.</td>
</tr>
<tr>
<td>50 to 60</td>
<td>Waits until stress forcing is completed.</td>
</tr>
<tr>
<td>80</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>90</td>
<td>Executes sweep measurement.</td>
</tr>
</tbody>
</table>
To Start the Knob Sweep Function


Example

To start the knob sweep function:

```
10    ASSIGN @hp4155 TO 717
20    !
30    OUTPUT @hp4155;:"MEM:LOAD:STAT 0, 'MEM1.MES', 'MEMORY'"
40    OUTPUT @hp4155;:"PAGE:SCON:KSW"
50    !
60    END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>30</td>
<td>Loads sweep setup data from internal memory file MEM1.</td>
</tr>
<tr>
<td>40</td>
<td>Starts knob sweep function.</td>
</tr>
</tbody>
</table>
To Control Standby Units

To change the standby units from the idle state to the standby state:

1. Send :PAGE:SCONtrol:STANdby ON.

   You cannot change which units are standby units after you execute this command. Standby units are units for which STBY is set to ON in the CHANNELS: CHANNELS DEFINITION page.

To change the standby units from the standby state to the idle state.

1. Send :PAGE:SCONtrol:STANdby OFF to stop standby units.

Example

To set standby units to standby state (so standby value will be output before and after measurements), then after final measurement, change standby units to idle state:

```
10    ASSIGN @Hp4155 TO 717
20    !
30    OUTPUT @Hp4155;";MME:M:LOAD:STAT 0,'SWP1.MES','DISK''
40    OUTPUT @Hp4155;";PAGE:SCON:STAN ON"
50    OUTPUT @Hp4155;";PAGE:SCON:SING"
60    OUTPUT @Hp4155;";#OPC?"
70    ENTER @Hp4155;Complete
80    OUTPUT @Hp4155;";MME:M:STOR:TRAC DEF,"MEAS1.DAT","DISK"
90    !
100   OUTPUT @Hp4155;";MME:M:LOAD:STAT 0,'SWP2.MES','DISK''
110   OUTPUT @Hp4155;";PAGE:SCON:SING"
120   OUTPUT @Hp4155;";#OPC?"
130   ENTER @Hp4155;Complete
140   OUTPUT @Hp4155;";PAGE:SCON:STAN OFF"
150   OUTPUT @Hp4155;";MME:M:STOR:TRAC DEF,"MEAS2.DAT","DISK"
160   END
```
<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>30</td>
<td>Loads measurement setup data from diskette file SWP1.MES.</td>
</tr>
<tr>
<td>40</td>
<td>The standby units specified in setup data start to output the standby value.</td>
</tr>
<tr>
<td>50</td>
<td>Executes measurement.</td>
</tr>
<tr>
<td>60 to 70</td>
<td>Waits for completion of measurement. After measurement, standby units output the standby value.</td>
</tr>
<tr>
<td>80</td>
<td>Stores measurement data onto a diskette.</td>
</tr>
<tr>
<td>100</td>
<td>Loads another measurement setup data from diskette file SWP2.MES. This setup data cannot change which units are the standby units.</td>
</tr>
<tr>
<td>110</td>
<td>Executes measurement.</td>
</tr>
<tr>
<td>120 to 130</td>
<td>Waits for completion of measurement. After measurement, standby units output the standby value.</td>
</tr>
<tr>
<td>140</td>
<td>Standby units stop standby output and change to idle state.</td>
</tr>
<tr>
<td>150</td>
<td>Stores measurement data onto a diskette.</td>
</tr>
</tbody>
</table>
Programming: File Operation

This section describes how to use SCPI commands to move data to and from the internal memory or diskette memory of HP 4155A/4156A.

This section covers the following basic file operations:

- To store setup data to diskette or internal memory
- To store measurement data to diskette or internal memory
- To load setup data from diskette or internal memory
- To load measurement data from diskette or internal memory
To Store Setup Data to Diskette or Internal Memory

1. Send `:MMEMory:STORe:STATe` command to HP 4155A/4156A.
   a. Specify the first parameter to be 0. This parameter has no meaning for HP 4155A/4156A, but is necessary for SCPI compatibility.
   b. Specify the second parameter:
      - For diskette:
        File name with extension: `.MES` for measurement setup data or `.STR` for stress setup data.
      - For internal memory:
        Internal memory name (MEM1, MEM2, MEM3, or MEM4) with extension: `.MES` for measurement setup data or `.STR` for stress setup data.
   c. Specify the third parameter:
      - For diskette (default): DISK
      - For internal memory: MEMORY

Example

To store measurement setup data to a diskette file:

10 !
20 Assign 4Hp4155 to 717
30 !
40 Output 4Hp4155;":\MMEM:STOR:STAT 0,'SWP.MES','DISK''
50 !
60 END

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>40</td>
<td>Stores measurement setup data to diskette file SWP.MES.</td>
</tr>
</tbody>
</table>
To Store Measurement Data to Diskette or Internal Memory

1. Send :MMEory:STORe:TRACe command to HP 4155A/4156A.
   a. Specify the first parameter to be DEFault. This parameter has no meaning for HP 4155A/4156A, but is necessary for SCPI compatibility.
   b. Specify the second parameter:
      • For diskette:
        File name with extension .DAT
      • For internal memory:
        Internal memory name (MEM1, MEM2, MEM3, or MEM4) with extension .DAT.
   c. Specify the third parameter:
      • For diskette (default): DISK
      • For internal memory: MEMORY

Example

To store measurement data to a diskette file:

```
10   !
20   ASSIGN OHp4155 TO 717
30   !
40   OUTPUT OHp4155;"::MME:STOR:TRAC DEF,'SWP.DAT','DISK''
50   !
60   END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>40</td>
<td>Stores measurement data to diskette file SWP.DAT.</td>
</tr>
</tbody>
</table>

4-22
To Load Setup Data from Diskette or Internal Memory

1. Send :MMEMorY:LOAD:STATe command to HP 4155A/4156A.
   a. Specify the first parameter to be 0. This parameter has no meaning for HP 4155A/4156A, but is necessary for SCPI compatibility.
   b. Specify the second parameter:
      • From diskette:
        File name with extension: .MES for measurement setup data or .STR for stress setup data.
      • From internal memory:
        Internal memory name (MEM1, MEM2, MEM3, or MEM4) with extension: .MES for measurement setup data or .STR for stress setup data.
   c. Specify the third parameter:
      • From diskette (default): DISK
      • From internal memory: MEMORY

Example

To load measurement setup data from a diskette file:

```
10   !
20   ASSIGN @Hp4155 TO 717
30   !
40   OUTPUT @Hp4155;";:MMEM:LOAD:STAT 0,'SWP.MES','DISK''
50   !
60   END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>40</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
</tbody>
</table>
To Load Measurement Data from Diskette or Internal Memory

1. Send :MMEMory:LOAD:TRACe command to HP 4155A/4156A.
   a. Specify the first parameter to be DEFauIt. This file has no meaning for HP 4155A/4156A, but is necessary for SCPI compatibility.
   b. Specify the second parameter:
      - From diskette:
        File name with extension .DAT
      - From internal memory:
        Internal memory name (MEM1, MEM2, MEM3, or MEM4) with extension .DAT.
   c. Specify the third parameter:
      - From diskette (default): DISK
      - From internal memory: MEMORY

Example

To load measurement data from a diskette file:

```plaintext
10 !
20 ASSIGN Hp4155 TO 717
30 !
40 OUTPUT Hp4155;"':MMEM:LOAD:TRAC DEF,'SWP.DAT','DISK'"
50 !
60 END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>40</td>
<td>Loads measurement data from diskette file SWP.DAT.</td>
</tr>
</tbody>
</table>
This section describes the data transfer between a program and HP 4155A/4156A.

The following programming tasks are described in this section:

- To read measurement data from HP 4155A/4156A
- To transfer data to HP 4155A/4156A
To Read HP 4155/56 Measurement Data

1. Send :DATA? query command to get data variable values (output data, measurement data, user function values) or read-out function values from HP 4155/56 to IBASIC variables.

Example 1.
To get measurement data, then store it in a data array:

```
10   DIM I3(1:501)
20   !
30   ASSIGN @Hp4155 TO 717
40   !
50   OUTPUT @Hp4155;"::FORM::DATA ASC"
60   !
70   OUTPUT @Hp4155;"::DATA? 'I3'"
80   ENTER @Hp4155;I3(\*)
90   !
100  END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>50</td>
<td>Specifies ASCII data transfer format.</td>
</tr>
<tr>
<td>70 to 80</td>
<td>Gets the values of data variable I3.</td>
</tr>
</tbody>
</table>

Example 2.
To get slope of LINE1 for Y2 axis curve on GRAPH/LIST: GRAPHICS page:

```
10   ASSIGN @Hp4155 TO 717
20   !
30   OUTPUT @Hp4155;"::DATA? 'GL1G2'"
40   ENTER @Hp4155;Slope
50   !
60   PRINT Slope
70   END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>30 to 40</td>
<td>Gets slope of LINE1 for Y2 axis curve on GRAPH/LIST: GRAPHICS page.</td>
</tr>
</tbody>
</table>
To Transfer Data to HP 4155A/4156A (Using User Variable)

To transfer a user variable to HP 4155A/4156A, use DATA|TRACe subsystem commands. A user variable consists of a name, unit, and numeric data.

Transferred user variable data can be used like other data variables in HP 4155A/4156A. You can perform calculations between measurement results and transferred data, plot transferred data on GRAPH/LIST: GRAPHICS page, or list transferred data on GRAPH/LIST: LIST page.

To transfer numeric data to the HP 4155A/4156A:

1. Define the data transfer format by using :FORMat[:DATA] command.
   - For ASCII data transfer format, send :FORM ASC.
   - For REAL 64-bit length data transfer format, send :FORM REAL, 64.
   - For REAL 32-bit length data transfer format, send :FORM REAL, 32.

2. For REAL data transfer format, define byte order by using :FORMat:BOReD command.
   - For normal order, send :FORM:BOReD NORM.
   - For swapped order, send :FORM:BOReD SWAP.

3. Define name of the user variable, unit (optional), and number of numeric data by using the :PAGE.CHANnels:UVARiable:DEFIne command.

   You can also define these parameters by using the :DATA:DEFIne and :DATA:UNIT command.

   If user variable is already defined, you do not have to perform this step.

**Example 1.**

To transfer data array by using ASCII data transfer format:

```plaintext
10  DIM Uvar1(1:5)
20  !
30  ASSIGN @Hp4155 TO 717
40  !
50  Uvar1(1)=1.0
60  Uvar1(2)=1.1
70  Uvar1(3)=1.2
80  Uvar1(4)=1.3
90  Uvar1(5)=1.4
100 !
110  OUTPUT @Hp4155;";FORM:DATA ASC"
120  OUTPUT @Hp4155;";PAGE:CHAN:UVAR:DEF 'UVAR1','V','S"
130  OUTPUT @Hp4155;";TRAC 'UVAR1','';Uvar1(*)
140 !
150 END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>110</td>
<td>Specifies ASCII data transfer format.</td>
</tr>
<tr>
<td>120</td>
<td>Defines user variable.</td>
</tr>
<tr>
<td>130</td>
<td>Transfers user variable.</td>
</tr>
</tbody>
</table>
Example 2.
To transfer data array by using REAL 64-bit data transfer format:

```
10  DIM Uvar1(1:101)
20  INTEGER I
30  !
40  ASSIGN @Hp4155 TO 717
50  ASSIGN @Form_off TO 717;FORMAT OFF
60  !
70  FOR I=1 TO 101
80     Uvar1(I)=SQR(I)
90  NEXT I
100  !
110  OUTPUT @Hp4155;";";FORM REAL,64"
120  OUTPUT @Hp4155;";";FORM:BORD NORM"
130  OUTPUT @Hp4155;";";PAGE:CHAN:UVAR:DEF 'UVAR1',';',101"
140  OUTPUT @Hp4155;";";TRAC 'UVAR1',';0";
150  OUTPUT @Form_off;Uvar1(*),END
160  !
170  END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>50</td>
<td>Assigns I/O path to transfer data.</td>
</tr>
<tr>
<td>110 to 120</td>
<td>Specifies REAL 64 bit data transfer format.</td>
</tr>
<tr>
<td>130</td>
<td>Defines a user variable.</td>
</tr>
<tr>
<td>140 to 150</td>
<td>Transfers user variable.</td>
</tr>
</tbody>
</table>
Example 3.
To transfer data, then display plot of transferred data and measurement results:

```plaintext
10  DIM Uvar1(1:101)
20    !
30  ASSIGN @Hp4155 TO 717
40    !
50  FOR I=1 TO 101
60    Uvar1(I)=SQRT(I)
70  NEXT I
80    !
90  OUTPUT @Hp4155;""MEM:LOAD:STAT 0,SWP.MES"
100 OUTPUT @Hp4155;""PAGE:SCON:SING"
110 OUTPUT @Hp4155;""OPC?"
120 ENTER @Hp4155;Complete
130    !
140 OUTPUT @Hp4155;""FORM ASC"
150 OUTPUT @Hp4155;""DATA:DEF 'UVAR1'.101"
160 OUTPUT @Hp4155;""DATA:UNIT 'UVAR1','V''"
170 OUTPUT @Hp4155;""DATA 'UVAR1',"",Uvar1(*)
180    !
190 OUTPUT @Hp4155;""PAGE:DISP:GRAP:Y2:NAM 'UVAR1''"
200 OUTPUT @Hp4155;""PAGE:GLIS"
210  END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>20</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>30</td>
<td>Executes measurement.</td>
</tr>
<tr>
<td>40</td>
<td>Waits for measurement completion.</td>
</tr>
<tr>
<td>50  to 120</td>
<td>Specifies ASCII data transfer format.</td>
</tr>
<tr>
<td>140</td>
<td>Defines user variable.</td>
</tr>
<tr>
<td>150</td>
<td>Defines unit of user variable.</td>
</tr>
<tr>
<td>160</td>
<td>Transfers user variable.</td>
</tr>
<tr>
<td>170</td>
<td>Sets user variable to Y2 axis of graph.</td>
</tr>
<tr>
<td>200</td>
<td>Displays GRAPH/LIST: GRAPHICS page.</td>
</tr>
</tbody>
</table>

4-30
Programming: Print/Plot Operation

For the print/plot operation, you can use :HCOPY subsystem commands. This section describes the following tasks:

- To output setup data to printer/plotter
- To output graphics result data to printer/plotter
- To output list result data to printer/plotter
- To dump screen image to printer/plotter
- To save hardcopy image to diskette

Before performing above tasks, the following print or plot settings must be set interactively or by remote commands.

We recommend that you save the following settings in a file, then load it before printing or plotting.

- Interface information

<table>
<thead>
<tr>
<th>Interface</th>
<th>Setting Parameter</th>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP-IB</td>
<td>printer address</td>
<td>:SYST:COMM:GPIB.RDEV:ADDR</td>
</tr>
<tr>
<td>Serial</td>
<td>baud rate (reception)</td>
<td>:SYST:COMM:SER:BAUD</td>
</tr>
<tr>
<td></td>
<td>parity scheme (reception)</td>
<td>:SYST:COMM:SER:PAR</td>
</tr>
<tr>
<td></td>
<td>stop bits (reception)</td>
<td>:SYST:COMM:SER:SBIT</td>
</tr>
<tr>
<td></td>
<td>software pacing scheme (reception)</td>
<td>:SYST:COMM:SER:PACE</td>
</tr>
<tr>
<td></td>
<td>baud rate (transmission)</td>
<td>:SYST:COMM:SER:TRAN:BAUD</td>
</tr>
<tr>
<td></td>
<td>parity scheme (transmission)</td>
<td>:SYST:COMM:SER:TRAN:PAR</td>
</tr>
<tr>
<td></td>
<td>stop bits (transmission)</td>
<td>:SYST:COMM:SER:TRAN:SBIT</td>
</tr>
<tr>
<td></td>
<td>software pacing scheme (transmission)</td>
<td>:SYST:COMM:SER:TRAN:PACE</td>
</tr>
</tbody>
</table>
HP 4155A/4156A SCPI Programming

Programming: Print/Plot Operation

- Printer information

<table>
<thead>
<tr>
<th>Setting Parameter</th>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>color or not</td>
<td>:HCOP:DEV:COL</td>
</tr>
<tr>
<td>control language</td>
<td>:HCOP:DEV:LANG</td>
</tr>
<tr>
<td>resolution [PCL]</td>
<td>:HCOP:DEV:RES</td>
</tr>
<tr>
<td>destination</td>
<td>:HCOP:DEST</td>
</tr>
</tbody>
</table>

- Output Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title of the print or plot out</td>
<td>:HCOP:ITEM:ANN:STAT</td>
</tr>
<tr>
<td>User defined comment for page group</td>
<td>:HCOP:ITEM:ANN:STAT</td>
</tr>
<tr>
<td>Present date and time of the built-in clock</td>
<td>:HCOP:ITEM:T0ST:STAT</td>
</tr>
<tr>
<td>Page number of the print or plot out</td>
<td>:HCOP:ITEM:PNUM:STAT</td>
</tr>
<tr>
<td>User defined comment for print or plot out</td>
<td>:HCOP:ITEM:LAB:STAT</td>
</tr>
<tr>
<td>Graphics plot curve</td>
<td>:HCOP:ITEM:TRAC:STAT</td>
</tr>
<tr>
<td>Frame and grid</td>
<td>:HCOP:ITEM:TRAC:GRAESTAT</td>
</tr>
<tr>
<td>Marker, cursor, and data variable coordinate fields, and line parameters (gradients and intercepts)</td>
<td>:HCOP:ITEM:TEXT:STAT</td>
</tr>
<tr>
<td>Names, units, and scale of the graph axis</td>
<td>:HCOP:ITEM:TEXT2:STAT</td>
</tr>
</tbody>
</table>

- For built-in IBASIC only

To print from built-in IBASIC, set "HP 4155A/56A is" field on the SYSTEM: MISCELLANEOUS page to SYSTEM CONTROLLER.
To Output Setup Data to Printer/Plotter

1. If you want to output print/plot comment, enter comment by using :HCPy:ITEM:LABel:TEXT command.

2. Specify the range of setup data to print/plot by sending :HCPy:OPAgE command.
   - To print/plot present page setup data, send :HCPy:OPAgE CURRent
   - To print/plot present page group setup data, send :HCPy:OPAgE GR0up
   - To print/plot all setup data, send :HCPy:OPAgE ALL

3. Display the page that you want to print/plot by using the appropriate command:

<table>
<thead>
<tr>
<th>Page</th>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHANNELS: CHANNEL DEFINITION</td>
<td>:PAGE:CHAN</td>
</tr>
<tr>
<td>CHANNELS: USER FUNCTION DEFINITION</td>
<td>:PAGE:CHAN:UFUN</td>
</tr>
<tr>
<td>CHANNELS: USER VARIABLE DEFINITION</td>
<td>:PAGE:CHAN:UVAR</td>
</tr>
<tr>
<td>MEASURE: SWEEP SETUP</td>
<td>:PAGE:MEAS</td>
</tr>
<tr>
<td>MEASURE: SAMPLING SETUP</td>
<td>:PAGE:MEAS:SAMP</td>
</tr>
<tr>
<td>MEASURE: PGU SETUP</td>
<td>:PAGE:MEAS:PGUS</td>
</tr>
<tr>
<td>MEASURE: MEASURE SETUP</td>
<td>:PAGE:MEAS:MSET</td>
</tr>
<tr>
<td>MEASURE: OUTPUT SEQUENCE</td>
<td>:PAGE:MEAS:OSeq</td>
</tr>
<tr>
<td>DISPLAY: DISPLAY SETUP</td>
<td>:PAGE:DISP</td>
</tr>
<tr>
<td>DISPLAY: ANALYSIS SETUP</td>
<td>:PAGE:DISP:ANAL</td>
</tr>
<tr>
<td>STRESS: CHANNEL DEFINITION</td>
<td>:PAGE:STR</td>
</tr>
<tr>
<td>STRESS: STRESS SETUP</td>
<td>:PAGE:STR:SET</td>
</tr>
<tr>
<td>STRESS: STRESS FORCE</td>
<td>:PAGE:STR:FORC</td>
</tr>
</tbody>
</table>

If you print/plot from built-in IBASIC, change display mode to All
Instrument or IBASIC Status by sending :DISPlay[:WINDow]:ALLocation
command.

4. Print/plot the setup data by sending :HCPy command.

If you print/plot from an external computer, pass Active Controller
capability to HP 4155A/4156A after sending :HCPy command because HP
4155A/4156A requires Active Controller capability to print.

Refer to the following example.

The following two examples load a sweep setup file, then print setup data of
the MEASURE: SWEEP SETUP page:

**Example 1.**
From an external computer:

```plaintext
10   ASSIGN @Hp4155 TO 717
20   CONTROL 7,3,21
30   !
40   OUTPUT @Hp4155;"*RST"
50   OUTPUT @Hp4155;"*OSet 1"
60   !
70   OUTPUT @Hp4155;"*:MMEM:LOAD:STAT 0,'SWP.MES'"
80   OUTPUT @Hp4155;"*:HCP:ITEM:PNUM:STAT OFF"
90   OUTPUT @Hp4155;"*:HCP:ITEM:LAB:TEXT 'This is an example',"
100  OUTPUT @Hp4155;"*:HCP:DISPLAY:MODE 'ADCV''
110  OUTPUT @Hp4155;"*:HCP:CPAG CURR"
120  !
130  OUTPUT @Hp4155;"*:PAGE:MEAS"
140  !
150  OUTPUT @Hp4155;"*:HCPB"
160  REPEAT
170  OUTPUT @Hp4155;"*ESR?"
180  ENTER @Hp4155;Event_status
190  UNTIL BIT(Event_status,1)
200  !
210  PASS CONTROL @Hp4155
220  DISP "Printing"
230  REPEAT
240  STATUS 7,6;Hpcb_status
250  UNTIL BIT(Hpcb_status,6)
260  DISP "Done"
270  END
```
<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A from external computer.</td>
</tr>
<tr>
<td>20</td>
<td>Sets the HP-IB address of external computer. This will be necessary to return Active Controller capability from HP 4155A/4156A back to the external computer.</td>
</tr>
<tr>
<td>40</td>
<td>Resets HP 4155A/4156A</td>
</tr>
<tr>
<td>50</td>
<td>Specifies to pass Active Controller capability back to external computer after printing is completed.</td>
</tr>
<tr>
<td>70</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>80</td>
<td>Specifies to not print the page number.</td>
</tr>
<tr>
<td>90</td>
<td>Defines a print/plot comment.</td>
</tr>
<tr>
<td>100</td>
<td>Selects HP-IB interface. If serial interface, change the parameter to &quot;SER&quot;.</td>
</tr>
<tr>
<td>110 to 130</td>
<td>Specifies to print/plot the setup data of the MEASURE: SWEEP SETUP page.</td>
</tr>
<tr>
<td>150 to 180</td>
<td>Sends print command and waits for Active Controller request from HP 4155A/4156A.</td>
</tr>
<tr>
<td>210</td>
<td>Passes Active Controller capability to HP 4155A/4156A, then HP 4155A/4156A starts printing.</td>
</tr>
<tr>
<td>230 to 250</td>
<td>Waits until printing is complete.</td>
</tr>
</tbody>
</table>
Example 2.
From built-in IBASIC:

```
10   ASSIGN @Hp4155 TO 800
20   !
30   OUTPUT @Hp4155;"*RST"
40   !
50   OUTPUT @Hp4155;"*:MEM:LOAD:STAT 0,'SWP.MES','DISK"
60   OUTPUT @Hp4155;"*:HCP:ITEM:PNUM:STAT OFF"
70   OUTPUT @Hp4155;"*:HCP:ITEM:LAB:TEXT 'This is an example'"
80   OUTPUT @Hp4155;"*:HCP:DEST RDEV"
90   OUTPUT @Hp4155;"*:HCP:OPAG CURR"
100  !
110  OUTPUT @Hp4155;"*:DISP:ALL INST"
110  OUTPUT @Hp4155;"*:PAGE:MEAS"
120  !
130  OUTPUT @Hp4155;"*:HCP"
140  DISP "Printing"
150  OUTPUT @Hp4155;"*:QPC?"
160  ENTER @Hp4155;Complete
170  DISP "Done"
180  !
190  END
```

<table>
<thead>
<tr>
<th>Line Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A from built-in IBASIC.</td>
</tr>
<tr>
<td>30</td>
<td>Resets HP 4155A/4156A</td>
</tr>
<tr>
<td>50</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>60</td>
<td>Specifies to not print the page number.</td>
</tr>
<tr>
<td>70</td>
<td>Defines a print/plot comment.</td>
</tr>
<tr>
<td>80</td>
<td>Selects HP-IB interface. If serial interface, change the parameter to &quot;SER&quot;.</td>
</tr>
<tr>
<td>90 to 110</td>
<td>Specifies to print/plot the setup data of the MEASURE: SWEEP SETUP page.</td>
</tr>
<tr>
<td>130</td>
<td>Starts printing.</td>
</tr>
<tr>
<td>150 and 160</td>
<td>Waits until printing is complete.</td>
</tr>
</tbody>
</table>
To Output Graphics Result Data to Printer/Plotter

1. If you want to output print/plot comment, enter comment by using :HCOpy:ITEM:LABEL:TEXT command.

   If you print/plot from built-in IBASIC, change display mode to All Instrument or IBASIC Status display mode by sending :DISPLAY:[WINDOW]:ALLocation command.

3. Execute print/plot by using :HCOpy command.
   If you print/plot from an external computer, pass Active Controller capability to HP 4155A/4156A after sending :HCOpy command because HP 4155A/4156A requires Active Controller capability to print.
   Refer to the following example.

The following two examples load a sweep setup file, execute measurement, then print measurement results of GRAPH/LIST: GRAPHICS page:

**Example 1.**
From an external computer:

```
10   ASSIGN @Hp4155 TO 717
20   CONTROL 7,3;21
30   !
40   OUTPUT @Hp4155;"*RST"
50   OUTPUT @Hp4155;"*PGB 21"
60   !
70   OUTPUT @Hp4155;":MMEM:LOAD:STAT 0,"SWP.MES""
80   !
90   OUTPUT @Hp4155;":PAGE;SCON:STING"
100  OUTPUT @Hp4155;":OPC?"
110  ENTER @Hp4155;Complete
120  !
130  OUTPUT @Hp4155;":HCO:DEST RDEV"
140  !
150  OUTPUT @Hp4155;":PAGE:GLIS"
160  !
170  OUTPUT @Hp4155;":HCO"
180  REPEAT
190  OUTPUT @Hp4155;":ESR?"
```
HP 4155A/4156A SCPI Programming

Programming: Print/Plot Operation

200 ENTER @hp4155:Event_status
210 UNTIL BIT(Event_status,1)
220 !
230 PASS CONTROL @hp4155
240 DISP "Printing"
250 REPEAT
260 STATUS 7,6;@pib_status
270 UNTIL BIT(@pib_status,6)
280 DISP "Done"
290 END

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A from external computer.</td>
</tr>
<tr>
<td>20</td>
<td>Sets the HP-IB address of external computer. This will be necessary to return Active Controller capability from HP 4155A/4156A back to the external computer.</td>
</tr>
<tr>
<td>40</td>
<td>Resets HP 4155A/4156A</td>
</tr>
<tr>
<td>50</td>
<td>Specifies to pass Active Controller capability back to external computer after printing is completed.</td>
</tr>
<tr>
<td>70</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>90 to 110</td>
<td>Executes measurement and waits until completed.</td>
</tr>
<tr>
<td>130</td>
<td>Selects HP-IB interface. If serial interface, change the parameter to &quot;SER&quot;.</td>
</tr>
<tr>
<td>150</td>
<td>Changes page to GRAPH/LIST: GRAPHICS page.</td>
</tr>
<tr>
<td>170 to 210</td>
<td>Sends print command and waits for Active Controller request from HP 4155A/4156A.</td>
</tr>
<tr>
<td>230</td>
<td>Passes Active Controller capability to HP 4155A/4156A, then HP 4155A/4156A starts printing.</td>
</tr>
<tr>
<td>250 to 270</td>
<td>Waits until printing is complete.</td>
</tr>
</tbody>
</table>
Example 2.
From built-in IBASIC:

10  ASSIGN @HP4155 TO 800
20  !
30  OUTPUT @HP4155;"*RST"
40  !
50  OUTPUT @HP4155;"**:MEM:LOAD:STAT 0,'SWP.MES'"
60  !
70  OUTPUT @HP4155;"**:PAGE:SCON:SING"
80  OUTPUT @HP4155;"*OPC?"
90  ENTER @HP4155;Complete
100  !
110  OUTPUT @HP4155;"**:HOP:DEST RDEV"
120  !
130  OUTPUT @HP4155;"**:DISP:ALL INST"
140  OUTPUT @HP4155;"**:PAGE:GLIS"
150  !
160  OUTPUT @HP4155;"**:HOP"
170  DISP "Printing"
180  OUTPUT @HP4155;"*OPC?"
190  ENTER @HP4155;Complete
200  DISP "Done"
210  END

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A from built-in IBASIC.</td>
</tr>
<tr>
<td>30</td>
<td>Resets HP 4155A/4156A</td>
</tr>
<tr>
<td>50</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>70 to 90</td>
<td>Executes measurement and waits until complete.</td>
</tr>
<tr>
<td>110</td>
<td>Selects HP-IB interface. If serial interface, change the parameter to &quot;SER&quot;.</td>
</tr>
<tr>
<td>130 to 140</td>
<td>Changes page to GRAPH/LIST: GRAPHICS page.</td>
</tr>
<tr>
<td>160 to 180</td>
<td>Starts printing and waits until completion.</td>
</tr>
</tbody>
</table>
To Output List Results Data to Printer/Plotter

1. Specify the range of measurement results to output by using
   :HCOPYy:LINDEX command.

2. If you want to output print/plot comment, enter comment by using
   :HCOPYy:ITEM:LABel:TEXT command.

   command.
   If you print/plot from built-in IBASIC, change display mode
   to All Instrument or IBASIC Status display mode by sending
   :DISPlay:[WINDOW]:ALLocation command.

4. Execute print/plot by using :HCOPYy command.
   If you print/plot from an external computer, pass Active Controller
   capability to HP 4155A/4156A after sending :HCOPYy command because HP
   4155A/4156A requires Active Controller capability to print.
   Refer to the following example.

The following two examples load a sweep setup file, execute measurement,
then print measurement results of GRAPH/LIST: LIST page:

**Example 1.**
From an external computer:

```
10   ASSIGN @Hp4155 TO 717
20   CONTROL 7,3,21
30   !
40   OUTPUT @Hp4155;"RST"
50   OUTPUT @Hp4155;"PWB 21"
60   !
70   OUTPUT @Hp4155;"MEM:LOAD:STAT 0,'SWP:MES''"
80   !
90   OUTPUT @Hp4155;"PAGE:SCON:SING"
100  OUTPUT @Hp4155;"GFC?"
110  ENTER @Hp4155;Complete
120   !
130  OUTPUT @Hp4155;"HCOPY:LINDEX MAX"
140   !
150  OUTPUT @Hp4155;"PAGE:GLIST:LIST"
160   !
```

4-40
170 OUTPUT @Hp4155;":"HCOP"
180 REPEAT
190 OUTPUT @Hp4155;"*:ESR?"
200 ENTER @Hp4155;Event_status
210 UNTIL BIT(Event_status,1)
220 !
230 PASS CONTROL @Hp4155
240 DISP "Printing"
250 REPEAT
260 STATUS 7,6;Hpb_status
270 UNTIL BIT(Hpb_status,6)
280 DISP "Done"
290 END

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A from external computer.</td>
</tr>
<tr>
<td>20</td>
<td>Sets the HP/IIB address of external computer. This will be necessary to return Active Controller capability from HP 4155A/4156A back to the external computer.</td>
</tr>
<tr>
<td>40</td>
<td>Resets HP 4155A/4156A</td>
</tr>
<tr>
<td>50</td>
<td>Specifies to pass Active Controller capability back to external computer after printing is completed.</td>
</tr>
<tr>
<td>70</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>90 to 110</td>
<td>Executes measurement and waits until completed.</td>
</tr>
<tr>
<td>130</td>
<td>Sets the range of list results to be output.</td>
</tr>
<tr>
<td>150</td>
<td>Changes page to GRAPH/LIST: LIST page.</td>
</tr>
<tr>
<td>170 to 210</td>
<td>Sends print command and waits for Active Controller request from HP 4155A/4156A.</td>
</tr>
<tr>
<td>230</td>
<td>Passes Active Controller capability to HP 4155A/4156A, then HP 4155A/4156A starts printing.</td>
</tr>
<tr>
<td>250 and 270</td>
<td>Waits until completion of printing.</td>
</tr>
</tbody>
</table>
Example 2.
From built-in IBASIC:

```
10    ASSIGN @Hp4155 TO 800
20    !
30    OUTPUT @Hp4155;"*RST"
40    !
50    OUTPUT @Hp4155;":*MMEM:LOAD:STAT 0,"SWP.MES""
60    !
70    OUTPUT @Hp4155;":*PAGE:SCON:SING"
80    OUTPUT @Hp4155;"*OPC?"
90    ENTER @Hp4155;Complete
100   !
110   OUTPUT @Hp4155;":*HCOP:LIND MAX"
120   !
130   OUTPUT @Hp4155;":*DISP:ALL INST"
140   OUTPUT @Hp4155;":*PAGE:CLIS:LIST"
150   !
160   OUTPUT @Hp4155;":*HCOP"
170   DISP "Printing"
180   OUTPUT @Hp4155;"*OPC?"
190   ENTER @Hp4155;Complete
200   DISP "Done"
210   END
```

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A from built-in IBASIC.</td>
</tr>
<tr>
<td>30</td>
<td>Resets HP 4155A/4156A.</td>
</tr>
<tr>
<td>50</td>
<td>Loads measurement setup data from diskette file SWP.MES.</td>
</tr>
<tr>
<td>70 to 90</td>
<td>Executes measurement and waits until completion.</td>
</tr>
<tr>
<td>110</td>
<td>Sets the range of list results to be output.</td>
</tr>
<tr>
<td>130 to 140</td>
<td>Changes page to GRAPH/LIST: LIST page.</td>
</tr>
<tr>
<td>160 to 190</td>
<td>Starts printing and waits until completion.</td>
</tr>
</tbody>
</table>
To Dump Screen Image to Printer/Plotter

1. Display the page to be dumped.
2. Execute print/plot by using :HCOPy:SDUMP command.
   If you print/plot from an external computer, pass Active Controller capability to HP 4155A/4156A after sending :HCOPy:SDUMP command because HP 4155A/4156A requires Active Controller capability to print.

   Refer to the following example.

The following two examples load a sweep setup file, execute measurement, display GRAPH/LIST: GRAPHICS page, then dump screen image of GRAPH/LIST: GRAPHICS page to printer/plotter:

**Example 1.**
From an external computer:

```
10    ASSIGN @Hp4155 TO 717
20    CONTROL 7,3;21
30    !
40    OUTPUT @Hp4155;"*RST"
50    OUTPUT @Hp4155;"*PJB 21"
60    !
70    OUTPUT @Hp4155;":MEM:LOAD:STAT 0,"SWP.MES"
80    !
90    OUTPUT @Hp4155;":PAGE;SCon:SING"
100   OUTPUT @Hp4155;"*OPC?"
110   ENTER @Hp4155;Complete
120   !
130   OUTPUT @Hp4155;":HCOP:DEST RDEV"
140   !
150   OUTPUT @Hp4155;":PAGE;GLIS"
160   !
170   OUTPUT @Hp4155;":HCOP:SDUM"
180   REPEAT
190   OUTPUT @Hp4155;"*ERR?"
200   ENTER @Hp4155;Event_status
210   UNTIL BIT(Event_status,1)
220   !
230   PASS CONTROL @Hp4155
240   DISP "Printing"
250   REPEAT
260   STATUS 7,6;Hpib_status
```
assigns I/O path to control HP 4155A/4156A from external computer.

20 Sets the HP-IB address of external computer. This will be necessary to return Active Controller capability from HP 4155A/4156A back to the computer.

40 Resets HP 4155A/4156A

50 Specifies to pass Active Controller capability back to external computer after printing is completed.

70 Loads measurement setup data from diskette file SWP.MES.

80 to 110 Executes measurement and waits until completed.

130 Selects HP-IB interface. If serial interface, change the parameter to "SER".

150 Changes page to GRAPH/List: Graphics page.

170 to 210 Sends screen dump command and waits for Active Controller request from HP 4155A/4156A.

230 Passes Active Controller capability to HP 4155A/4156A, then HP 4155A/4156A starts printing.

250 and 270 Waits until printing is complete.
**Example 2.**
From built-in IBASIC:

```
10  ASSIGN @Hp4155 TO 800
20  !
30  OUTPUT @Hp4155;"*EST"
40  !
50  OUTPUT @Hp4155;"::MEM:LOAD:STAT 0,"SWP.MES"
60  !
70  OUTPUT @Hp4155;"::PAGE:SCON:SING"
80  OUTPUT @Hp4155;"::OPC?"
90  ENTER @Hp4155;Complete
100 !
110 OUTPUT @Hp4155;"::DISP:ALL INST"
120 OUTPUT @Hp4155;"::PAGE:GLIS"
130 !
140 OUTPUT @Hp4155;"::ROP:SDUM"
150 OUTPUT @Hp4155;"::OPC?"
160 ENTER @Hp4155;Complete
170 END
```

**Line Number** | **Description** |
--- | --- |
10 | Assigns VO path to control HP 4155A/4156A from built-in IBASIC. |
30 | Resets HP 4155A/4156A. |
50 | Loads measurement setup data from diskette file SWP.MES. |
70 to 90 | Executes measurement and waits until completion. |
110 to 120 | Displays GRAPHLIST, GRAPHICS page. |
140 to 160 | Starts printing and waits until completion. |
To Save Hardcopy Image to Diskette

1. To set print/plot destination to diskette file, send :HCOPY:DESTination command with MMEMory parameter.

2. Specify the file name by using :MMEMory:NAME command.

3. Execute the print/plot operation. Refer to print/plot tasks described previously.

Example

To load sweep setup file, execute measurement, and then saves a hardcopy image of the measurement results of GRAPH/LIST: GRAPHICS page to a diskette:

```
10 ASSIGN @Hp4155 TO 717
20 !
30 OUTPUT @Hp4155;"^RST"
40 !
50 OUTPUT @Hp4155;"^MMEM:LOAD:STAT 0,'SWP.MES'"
60 !
70 OUTPUT @Hp4155;"^PAGE:SCON:RING"
80 OUTPUT @Hp4155;"^OPC?"
90 ENTER @Hp4155;Complete
100 !
110 OUTPUT @Hp4155;"^HCOPY:DEST MMEM"
120 OUTPUT @Hp4155;"^MMEM:NAME 'TEST1'"
130 !
140 OUTPUT @Hp4155;"^PAGE:GLIS"
150 !
160 OUTPUT @Hp4155;"^HCOPY"
170 OUTPUT @Hp4155;"^OPC?"
180 ENTER @Hp4155;Complete
190 END
```
<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Assigns I/O path to control HP 4155A/4156A.</td>
</tr>
<tr>
<td>30</td>
<td>Resets HP 4155A/4156A.</td>
</tr>
<tr>
<td>50</td>
<td>Loads measurement setup data from diskette file SWP:MES.</td>
</tr>
<tr>
<td>70 to 90</td>
<td>Executes measurement and waits until completion.</td>
</tr>
<tr>
<td>110</td>
<td>Specifies the destination to be diskette.</td>
</tr>
<tr>
<td>120</td>
<td>Specifies the diskette file name.</td>
</tr>
<tr>
<td>140</td>
<td>Displays GRAPH/LIST: GRAPHICS page.</td>
</tr>
<tr>
<td>160 to 180</td>
<td>Starts printing and waits until completion.</td>
</tr>
</tbody>
</table>
Other Programming Tips

This section provides the advanced programming techniques and useful tips:

- Speed Improvement
- Auto-loading of Files

Disabling Instrument Screen Update to Improve Speed

Most of the commands that control and set the HP 4155A/56A will also update the instrument screen.

For example, :PAGE:CHAN:MODE command changes the measurement mode. This command also changes the instrument screen to the CHANNELS: CHANNEL DEFINITION page and updates the MEASUREMENT MODE field setting.

This instrument screen update is useful for confirming the settings that were changed by the commands, but it takes time.

You can enable or disable this time consuming instrument screen update as follows:

:DISP OFF    Instrument screen is not updated
:DISP ON     Instrument screen is updated
Auto-loading of Files

The HP 4155A/56A can automatically load files when it is turned on.

**INIT files for Initial Settings.**

If any setup files named INIT.MES, INIT.STR, INIT.CST, or INIT.DAT are on the diskette (in the built-in drive) when the HP 4155A/56A is turned on, the HP 4155A/56A automatically loads these setup files to be the initial settings.

This function saves you the trouble of getting application files every time you turn on the HP 4155A/56A.

---

**INIT.MES and INIT.DAT files**

INIT.MES and INIT.DAT both contain measurement setup data. If both these files exist on the diskette, the HP 4155A/56A gets INIT.DAT, not INIT.MES.

---

**MEMno Files.**

If any files named MEMno.DAT, MEMno.MES, or MEMno.STR are on the diskette in the drive, the files are automatically loaded from diskette to internal memory when HP 4155A/56A is turned on. Where MEMno means MEM1, MEM2, MEM3, or MEM4, which correspond to the four internal memory areas.

If the same internal memory is specified by multiple files (for example, MEM1.MES and MEM1.DAT), the priority is as follows:

1. DAT
2. MES
3. STR

**IBASIC Program File to Auto-execute.**

If an IBASIC program is stored in a file named "AUTOST" on the diskette in the built-in drive, the program is automatically loaded and started when you turn on the HP 4155A/56A.
Programming Example for HP 4145 Users

This section shows a programming example with SCPI commands that performs the same operations as the desired HP 4145 ASP program.

Built-in iBASIC can execute ASP-like commands for controlling the HP 4155A/4156A. Refer to "Creating ASP-like iBASIC Programs" in Chapter 1 on programming this commands.

Following program is the simplest example of creating an HP BASIC program (with SCPI commands) that performs the same operations as the desired HP 4145 ASP program. The ASP program gets a setup file named "VTH" from the diskette, makes a single measurement, then saves measurement to a file named "VTH1".

1 GET P VTH
2 SINGLE
3 SAVE D VTH1

The above HP BASIC program (with SCPI commands) does as follows:

- Line 1 assigns a path named @Hp415x to 800, which is the select code/HP-IB address to use if this is an iBASIC program running in the HP 4155A/56A. If this program will run on an external computer, use the select code of the HP-IB interface and the HP-IB address of the HP 4155A/4156A instead.

- Line 10 gets a measurement setup file named "VTH.MES". So, you need to save setup data to a file named "VTH.MES" on the diskette before executing this program. For an example setup, see "Example Application Setup for Vth Measurement" in Chapter 3.

- Line 20 performs a single measurement.

- Line 50 saves measurement setup and result data to a file named VTH1.DAT.

For built-in help function, which makes it easier to enter the desired SCPI command, see the "To Use the Help Function" in Chapter 1.

4-50
Following shows HP 4145A/B's ASP keywords and corresponding SCPI commands of HP 4155A/4156A:

<table>
<thead>
<tr>
<th>4155A/B</th>
<th>SCPI Commands</th>
<th>Function</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>GET P</td>
<td>:MMEM:LOAD:STAT</td>
<td>Gets setup .MES or .PRO file</td>
<td></td>
</tr>
<tr>
<td>SINGLE</td>
<td>:PAGE:SCON:SING</td>
<td>Initiates single measurement</td>
<td></td>
</tr>
<tr>
<td>SAVE D</td>
<td>:MMEM:STOR:TRAC</td>
<td>Saves data to .DAT file</td>
<td></td>
</tr>
<tr>
<td>PLOT</td>
<td>:HCOP</td>
<td>Prints/plots present instrument page.</td>
<td></td>
</tr>
<tr>
<td>CPLOT</td>
<td>:HCOP:ITEM:TRAC</td>
<td>Prints/plots measurement graph.</td>
<td></td>
</tr>
<tr>
<td>PRINT</td>
<td>:HCOP</td>
<td>Prints/plots present instrument page.</td>
<td></td>
</tr>
<tr>
<td>PAUSE</td>
<td></td>
<td>Use BASIC keyword PAUSE</td>
<td></td>
</tr>
<tr>
<td>WAIT</td>
<td></td>
<td>Use BASIC keyword WAIT</td>
<td></td>
</tr>
<tr>
<td>PAGE</td>
<td></td>
<td>Set in the Print/Plot setup</td>
<td></td>
</tr>
</tbody>
</table>
Running HP 4145A/B
Program Directly on HP 4155A/4156A
Running HP 4145A/B Program Directly on HP 4155A/4156A

This chapter describes how to directly run an HP 4145A/B HP-IB program (non-ASP program) on the HP 4155A/4156A with little or no modification. To run these programs directly, you need to use the HP 4145 syntax command mode of the HP 4155A/4156A.

To Enter into HP 4145 Syntax Command Mode

When HP 4155A/4156A is turned on, HP 4155A/4156A is always in HP 4155A/4156A command mode.

To enter into HP 4145 syntax command mode:

- From front-panel

  Set COMMAND SET field on the SYSTEM: MISCELLANEOUS page to HP4145.

- From remote control

  Send ":SYSTem:LANGuage COMPability" command to HP 4155A/4156A.

Usually, you can run these programs with no modification. But sometimes small modifications are required due to the following, which are described in this chapter:

- Non-supported commands
- Consideration about Differences
Non-supported Commands

The following HP 4145A/B commands are not supported in HP 4145B syntax command mode:

- **GL0**: Disables HP-GL
- **GL1**: Enables HP-GL overlay graphics
- **GL2**: Enables HP-GL stand-alone graphics
- **MX**: Matrix
- **SH**: Schmoo
- **SV S**: Save ASP file
- **GT S**: Get ASP file
- **DM3**: Display mode Matrix
- **DM4**: Display mode Schmoo
- **AS1**: Auto Sequence Program Start
- **AS2**: Auto Sequence Program Continue
- **AS3**: Auto Sequence Program Stop

If you have HP 4145A/B programs that include any of the above commands, they will not work with the HP 4155A/4156A. Please refer to Chapter 2 in *HP-IB Command Reference* of HP 4155A/4156A for details.
Considerations about Differences

Spot Measurement

HP 4145A/B can execute a spot measurement by setting both start and stop of the sweep to the same value, but the HP 4155A/4156A executes the measurement twice even if you set both start and stop of the sweep to the same value.

Sweep Steps in Logarithmic Step Mode

Calculation algorithm for primary sweep steps in logarithmic step mode is slightly different between HP 4155A/4156A and HP 4145A/B, so step values and number of steps may be different between HP 4155A/4156A and HP 4145A/B.
Terminator

If you run your program on an external controller, use <CR>+<LF> as the command terminator if you execute serial polling to read a status of HP 4155A/4156A in your program.

If you use only <CR> or <LF> as command terminator, HP 4155A/4156A may respond with incorrect status.

This is due to the differences of reading and parsing commands between HP 4145A/B and HP 4155A/4156A.

The following example and explanation gives a better understanding of this.

```
10 OUTPUT @Hp415x;"ME1"
20 REPEAT
30 Status=SPOLL(@Hp415x)
40 UNTIL BIT(Status,0)
```

<table>
<thead>
<tr>
<th>line number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>triggers measurement and clears the data ready bit (bit1) of status register.</td>
</tr>
<tr>
<td>20 to 40</td>
<td>waits until the data ready bit of status register is set to 1.</td>
</tr>
</tbody>
</table>

- When the Terminator is only <CR>
  - HP 4145A/B
    - At line 10:
      1. HP 4145A/B starts reading data with RFD line set to false (data bus is halted) after each byte.
      In this example:
        \[ M \Rightarrow \text{bus halted} \Rightarrow E \Rightarrow \text{bus halted} \Rightarrow 1 \Rightarrow \text{bus halted} \]
      2. After receiving 1, HP 4145A/B recognizes valid command ME1, then executes ME1.

      At this time, the program is paused because the controller is trying to send <CR>, which is a terminator, but HP 4145A/B has halted data bus and does not receive <CR>.  

Running HP 4145A/B Program Directly on HP 4155A/4156A

Considerations about Differences

3. After HP 4145A/B triggers measurement and clears status bit1, HP 4145A/B reads <CR>, then the program proceeds to next step (line 20).

The program reads the correct status at line 30.

☐ HP 4155A/4156A

1. At line 10:
   a. HP 4155A/4156A starts and continues reading data until reading a terminator.
      In this example, HP 4155A/4156A reads ME1<CR>, then halts data bus.
   b. HP 4155A/4156A starts executing "ME1". At the same time, the external controller can proceed to the next line, because all data of this line has transferred, then program continues.

2. At line 30, controller can read status of HP 4155A/4156A even if RFD line is false. RFD holdoff is not effective for serial polling.

   However, the clearing of the status register bit by line 10 may not have been completed yet, so line 30 may get the incorrect status.

- When the Terminator is <CR> + <LF>

The example program for HP 4155A/4156A performs as follows:

1. HP 4155A/4156A starts and continues reading data until reading a terminator.
   In this example, HP 4155A/4156A reads ME1<CR>, then halts data bus.

2. HP 4155A/4156A executes "ME1".
   At this time, the program is paused because the controller is trying to send <LF>, which is part of the terminator, but HP 4155A/4156A has halted data bus and does not receive <LF>.

3. After HP 4155A/4156A triggers measurement and clears the status bit1, HP 4155A/4156A reads <LF>, then the program proceeds to next step (line 20).

The program reads the correct status at line 30.
Sample Application Programs

This chapter describes some sample application programs and setup files, which will be helpful for creating your own applications.

All programs and setup files described in this chapter are stored on a DOS formatted 3.5-inch diskette that is provided with your HP 4155A/4156A. You should copy this diskette to a diskette that you will use as your working diskette. The 3.5-inch diskette includes eight programs. This chapter provides only the following three examples:

- Flash EEPROM Test
- TDDB
- Electromigration

See Sample Application Programs' Guide Book if you want to use the other programs on the 3.5-inch diskette. All programs are written in HP Instrument BASIC and ready to run in HP 4155A/4156A's HP instrument BASIC environment.

These programs are only examples, so you may need to modify these programs and setup files for your own application before executing. If these example programs damage your devices; Hewlett-Packard is NOT LIABLE for the damage.

You can modify setup files by remote programming or interactively by front-panel keys.
Flash EEPROM Test

This program forces write and erase pulses, then measures Vth shift.

<table>
<thead>
<tr>
<th>name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
</tr>
<tr>
<td>Setup files</td>
</tr>
</tbody>
</table>

This program uses NORWRT.STR and NORERS.STR stress setup files for write and erase pulses. These setup files are for NOR type flash EEPROM.

To use this program for NAND type flash EEPROM, please modify as follows to use NANWRT.STR and NANERS.STR stress setup files:

- Modify the following two lines:
  
  1990  Wrt_file$="NORWRT.STR" ! Write Stress Setup File Name
  2000  Eras_file$="NORERS.STR" ! Erase Stress Setup File Name
  
  as follows:

  1990  Wrt_file$="NANWRT.STR" ! Write Stress Setup File Name
  2000  Eras_file$="NANERS.STR" ! Erase Stress Setup File Name
Program Overview

Device connections for NOR and NAND type flash EEPROM are different.

**Device Connection for NOR type flash EEPROM.**
As shown in Figure 6-1, one HP 16440A SMU/Pulse Generator Selector is used to switch units for forcing write pulse and erase pulse, and measuring Vth.

![Figure 6-1. Device Connection (NOR Type)](image)

The following table shows the selector’s state for each phase:

**Table 6-1. Selector’s State in Each Phase**

<table>
<thead>
<tr>
<th>Selector Channel</th>
<th>Write</th>
<th>Erase</th>
<th>Vth Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH1 (Drain)</td>
<td>PGU</td>
<td>PSU OPEN</td>
<td>SMU</td>
</tr>
<tr>
<td>CH2 (Gate)</td>
<td>PGU</td>
<td>PSU</td>
<td>SMU</td>
</tr>
</tbody>
</table>
**Device Connection for NAND type flash EEPROM.**

As shown in Figure 6-2, two HP 16440A SMU/Pulse Generator Selectors are used to switch units for forcing write pulse and erase pulse, and measuring Vth.

![Diagram of device connection](image)

**Figure 6-2. Device Connection (NAND Type)**

Table 6-2 shows the selector's state for each phase:

<table>
<thead>
<tr>
<th>Selector Channel</th>
<th>Write</th>
<th>Erase</th>
<th>Vth Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH1 (Drain)</td>
<td>PGU</td>
<td>PGU</td>
<td>SMU</td>
</tr>
<tr>
<td>CH2 (Gate)</td>
<td>PGU</td>
<td>PGU</td>
<td>SMU</td>
</tr>
<tr>
<td>CH3 (Source)</td>
<td>PGU</td>
<td>PGU</td>
<td>SMU</td>
</tr>
<tr>
<td>CH4 (Substrate)</td>
<td>PGU</td>
<td>PGU</td>
<td>SMU</td>
</tr>
</tbody>
</table>
Main Program.
The following is the main program:

1560 !--------------------------------- Main -----------------------------------!
1570 CALL Init_hp4155
1580 ON INTR 8 CALL Err_check
1590 ENABLE INTR 8:2
1600 !
1610 CALL Test_setting
1620 CALL Get_file
1630 !
1640 Str_num=1
1650 FOR I=1 TO Meas_points
1660   CALL Stress_loop(I)
1670   IF Meas_str_num(I)>4500 THEN CALL Calibration
1680 !
1690 OUTPUT @hp4155;":\:\:\:\:\:\:\:\:\:\:\:\:\\LOAD\:STAT 0,\MEM2.STR',\'MEMORY''
1700 OUTPUT @hp4155;":\:\:\:\:\:\:\:\:\:\:\:\:\\LOAD\:STAT 0,\MEM3.STR',\'MEMORY''
1710 CALL Vth_meas("Write",I)
1720 !
1730 OUTPUT @hp4155;":\:\:\:\:\:\:\:\:\:\:\:\:\\LOAD\:STAT 0,\MEM3.STR',\'MEMORY''
1740 CALL Vth_meas("Erase",I)
1750 !
1760 CALL Trans_data(I)
1770 CALL Stress_graph(I)
1780 !
1790 IF Vth_w(I)<.1 OR Vth_e(I)<.1 THEN
1800 PRINT "### The Device is broken. Test Aborted ###"
1810 PRINT "Final Stress Times : ";Str_num
1820 CALL Final_session
1830 STOP
1840 END IF
1850 Str_num=Str_num+1
1860 NEXT I
1870 !
1880 CALL Final_session
1890 !
1900 END
<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1570</td>
<td>initializes HP 4155A/4156A.</td>
</tr>
<tr>
<td></td>
<td>enables the Service Request “Enable” Register for Command, Execution,</td>
</tr>
<tr>
<td></td>
<td>Device-dependent, and Query errors to generate service requests.</td>
</tr>
<tr>
<td>1580 and 1590</td>
<td>enables service request from HP 4155A/4156A to interrupt program.</td>
</tr>
<tr>
<td>1610</td>
<td>defines names of measurement setup files for Vth measurement and device</td>
</tr>
<tr>
<td></td>
<td>setup files for write stress and erase stress, and other stress setup.</td>
</tr>
<tr>
<td>1620</td>
<td>loads measurement setup file for Vth measurement and stress setup files</td>
</tr>
<tr>
<td></td>
<td>for write and erase into internal memories.</td>
</tr>
<tr>
<td>1650</td>
<td><em>Mees-points</em> is specified in subprogram “Test-setting”.</td>
</tr>
<tr>
<td>1660</td>
<td>forces write and erase pulses. Refer to “Stress-loop” for details.</td>
</tr>
<tr>
<td>1690 and 1700</td>
<td>loads measurement setup file for Vth measurement and stress setup file</td>
</tr>
<tr>
<td></td>
<td>for write pulse from internal memories.</td>
</tr>
<tr>
<td>1710</td>
<td>forces last write pulse, then measures Vth. Refer to “Vth...meas”.</td>
</tr>
<tr>
<td>1730</td>
<td>loads stress setup file for erase pulse from an internal memory.</td>
</tr>
<tr>
<td>1740</td>
<td>forces last erase pulse, then measures Vth. Refer to “Vth...meas”.</td>
</tr>
<tr>
<td>1760</td>
<td>transfers measurement results [Vth shifts] to HP 4155A/4156A.</td>
</tr>
<tr>
<td>1770</td>
<td>displays measurement results.</td>
</tr>
<tr>
<td>1880</td>
<td>stores measurement results onto the diskette.</td>
</tr>
</tbody>
</table>
Subprogram "Stress_loop" to force write and erase stress is shown below:

```plaintext
2610 SUB Stress_loop(INTEGER i)
2620 CD# @p4155; "Form off,Start time,End time"
2630 CD# /Meas_info/ (INTEGER Meas_points,REAL Str,Str_sum,Meas_str_sum)
2640 INTEGER K
2650 REAL Str_end
2660 !
2670 OUTPUT @hp4155; "::STAT:MEAS:EVENT"
2680 ENTER @hp4155; K
2690 OUTPUT @hp4155; "::STAT:MEAS:ERAS 267"
2700 !
2710 OUTPUT @hp4155; "::PAGE:SCON:STAN Dn"
2720 Str_end=Meas_str_sum()-2
2730 FOR Str=Str_end TO Str_end
2740 DISP VALS(Str); "::MEAS:STR,VALS"
2750 OUTPUT @hp4155; "::MEM:LOAD:STAT 0,\"MEMR\",\"MEMORY\",::PAGE:SCON:STAN Dn"
2760 OUTPUT @hp4155; "::MEM:LOAD:STAT 0,\"MEMS\",\"MEMORY\",::PAGE:SCON:STAN Dn"
2770 OUTPUT @hp4155; "::PAGE:SCON:STAN Dn"
2780 ENTER @hp4155; A
2790 NEXT Str
2800 !
2810 Sub_end Str
2820 OUTPUT @hp4155; "::PAGE:SCON:STAN OFF"
2830 OUTPUT @hp4155; "::STAT:MEAS:ERAS 0"
2840 Sub_end
```

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2670 and 2680</td>
<td>clears the Measurement/Stress Status &quot;Event&quot; register.</td>
</tr>
<tr>
<td>2690</td>
<td>enables Bit 0 (A/D Overflow), 1 (Oscillation Status), 3 (Compliance Status), and 8 (PSU Status) of enable mask for the Measurement/Stress Status &quot;Event&quot; register.</td>
</tr>
<tr>
<td>2710</td>
<td>enables standby state so that state does not become idle between write and erase stress. If state becomes idle, the relay will switch after every write and erase stress, which will damage the relay.</td>
</tr>
<tr>
<td>2730 to 2790</td>
<td>repeats forcing write/erase pulses until one write/erase pulse before next Vth measurement.</td>
</tr>
<tr>
<td>2820</td>
<td>disables standby state.</td>
</tr>
</tbody>
</table>
Subprogram "Vth_meas" to force last write and erase pulses, then measure Vth:

2860 Vth_meas: SUB Vth_meas(Str_type$, INTEGER 1)
2870 "CON &h4155 &Form_off,Start_time,End_time"
2880 "CON /Mes_linf/ INTEGER Mes_ploits,REAL Str,Str_sum,Mes_str_sum(4)
2890 "CON /Mes_data/ Vth_u(1),Vth_d(1)"
2900 INTEGER 1
2910 !
2920 OUTPUT &h4155: "PAGE:SCON:STR:+3PCT"
2930 ENTER &h4155:
A
2940 DISP Str_type$; "Times = "AVAL$(Str_sum)
2960 !
2980 OUTPUT &h4155: "PAGE:CHAN:COMP 'Flash ROM Vth Mes. Str_Type$' Times = "AVAL$(Str_sum)"
2990 OUTPUT &h4155: "PAGE:G150"
3000 OUTPUT &h4155: "PAGE:OFF"
3010 OUTPUT &h4155: "PAGE:SCON:SSING:0PCT"
3020 ENTER &h4155:
A
3030 OUTPUT &h4155: "DISP OFF"
3040 ENTER &h4155:
X
3050 OUTPUT &h4155: "TRAC 'VTH'"
3060 SELECT Str_type$
3070 ENTER &h4155:Vth_w(1)
3080 PRINT USING "#.AX,DEZ,10X,50,DDD":Str_sum,Vth_w(1)
3090 CASE "Write"
3100 ENTER &h4155:Vth_w(1)
3110 PRINT USING "10X,50,000,7X,50,000E":Vth_c(1),Vth_d(1)-Vth_w(1)
3120 END SELECT
3130 SUBEND

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2960</td>
<td>executes Vth measurement and waits until completion.</td>
</tr>
<tr>
<td>3040</td>
<td>gets measurement result.</td>
</tr>
</tbody>
</table>
Program Customization

This section describes how to customize program for your own application.

**Subprogram “Test_setting”**.

In this subprogram, you may need to customize the following:

- **Name of setup files.**

  If you want to use your own measurement or stress setup files, store the files on diskette, then modify the file names on the following lines:

  - Measurement setup file name for Vth measurement.
    
    1980  Vth_file$="ROMVTH.MES"   ! Vth Measurement Setup File Name
  
  - Stress setup file name for write pulse.
    
    1990  Wrt_file$="WRTWRT.STR"   ! Write Stress Setup File Name
  
  - Stress setup file name for erase pulse.
    
    2000  Ers_file$="ERASE.STR"    ! Erase Stress Setup File Name
  
- **File name for saving measurement results.**

  Following two lines create following file name for saving measurement results: *time*.DAT. To change this file name, modify these lines:

  2020  Save_file$=TIME$"(TIME.DATE)" ! File Name for saving measurement results
  2030  Save_file$=Save_file$[1,2]"Save_file$[4,8]"Save_file$[7,7]".DAT"

- **Number of times to repeat measurement (FOR loop of Main Program)**

  Following line specifies how many times to measure Vth during stress.

  2030  Meas_points=16   ! Number of times to repeat Measurement

- **Stress pulse count data.**

  For example, if *Meas_points*=4, a total of ten write/erase pulses are forced, and Vth is measured after 1st, 2nd, 5th, and 10th pulse.

  2040  Str_num: ! Stress Pulse Count data
    2070  DATA  1, 2, 5
    2080  DATA  10, 20, 50
    2090  DATA  100, 200, 600
    2100  DATA  1000, 2000, 6000
    2110  DATA  10000, 20000, 60000
    2120  DATA  200000, 200000, 600000
    2130  DATA  1000000

6-10
Measurement setup file for Vth measurement (for NOR type).
Measurement setup for Vth measurement is stored in "ROMVTH.MES" file on provided diskette. As described previously, if you use your own setup file with a different file name, change line 2000.
In the ROMVTH.MES file, the following is set up. You can modify these settings in the ROMVTH.MES file or your own file:

- Gate voltage sweep setup.

<table>
<thead>
<tr>
<th>Start voltage</th>
<th>Stop voltage</th>
<th>Sweep step</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 V</td>
<td>8 V</td>
<td>10 mV</td>
<td>1 nA</td>
</tr>
</tbody>
</table>

SMU1 is gate voltage source as shown in Figure 6-1 and Figure 6-2.

- Constant source setup.

<table>
<thead>
<tr>
<th>Units</th>
<th>Output</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU2 (Source)</td>
<td>0 V</td>
<td>100 μA</td>
</tr>
<tr>
<td>SMU3 (Drain)</td>
<td>100 mV</td>
<td>2 μA</td>
</tr>
<tr>
<td>SMU4 (Substrate)</td>
<td>0 V</td>
<td>100 μA</td>
</tr>
</tbody>
</table>

- Analysis function for Vth extraction.

In this example, Vth is extracted by moving marker to the point where Id is 1 μA, then reading the voltage at that point. Refer to the following user function and auto-analysis setup:

**User Function Definition**

<table>
<thead>
<tr>
<th>Name</th>
<th>Unit</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vth</td>
<td>V</td>
<td>@MX</td>
</tr>
</tbody>
</table>

**Analysis Setup**

<table>
<thead>
<tr>
<th>Setup</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marker</td>
<td>Id = 1 μA</td>
</tr>
<tr>
<td>Interpolate</td>
<td>ON</td>
</tr>
</tbody>
</table>
**Stress setup file for write pulse of NOR type.**

Stress setup for write pulse of NOR type is stored in "NORWRT.STR" file on provided diskette. As described previously, if you use your own setup file with a different file name, change line 2010.

In the NORWRT.STR file, the following is set up. You can modify these settings in the NORWRT.STR file or your own file:

- PGUs

<table>
<thead>
<tr>
<th>Unit</th>
<th>Period</th>
<th>Width</th>
<th>Delay Time</th>
<th>Peak Value</th>
<th>Base Value</th>
<th>Leading Time</th>
<th>Trailing Time</th>
<th>Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGU1 (Gate)</td>
<td>1.03 ms</td>
<td>1.02 ms</td>
<td>0.0 s</td>
<td>14 V</td>
<td>0 V</td>
<td>1 µs</td>
<td>1 µs</td>
<td>50 ohm</td>
</tr>
<tr>
<td>PGU2 (Drain)</td>
<td>1.00 ms</td>
<td>10 µs</td>
<td>7 V</td>
<td>0 V</td>
<td>1 µs</td>
<td>1 µs</td>
<td>50 ohm</td>
<td></td>
</tr>
</tbody>
</table>

- Constant source setup

<table>
<thead>
<tr>
<th>Unit</th>
<th>Source</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU2 (Source)</td>
<td>0 V</td>
<td>100 mA</td>
</tr>
<tr>
<td>SMU4 (Substrate)</td>
<td>0 V</td>
<td>100 mA</td>
</tr>
</tbody>
</table>

**Stress setup file for erase pulse of NOR type.**

Stress setup for erase pulse is stored on "NORES.STR" file on provided diskette. As described previously, if you use your own setup file with a different file name, change line 2020.

In the NORES.STR file, the following is set up. You can modify these settings in the NORES.STR file or your own file:

- Constant source setup

<table>
<thead>
<tr>
<th>Unit</th>
<th>Source</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU2 (Source)</td>
<td>11 V</td>
<td>100 mA</td>
</tr>
<tr>
<td>SMU4 (Substrate)</td>
<td>0 V</td>
<td>100 mA</td>
</tr>
</tbody>
</table>

1. Erase pulse source

- Erase pulse width

Pulse width of erase pulse is specified as stress DURATION and set to 20ms.
**Stress setup file for write pulse of NAND type.**
Stress setup for write pulse of NAND type is stored in “NANWRT.STR” file on provided diskette. As described previously, you must change line 2010 to “NANWRT.STR” or your own custom file name.
In the NANWRT.STR file, the following is set up. You can modify these settings in the NANWRT.STR file or your own file:

- **PGUs**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Period</th>
<th>Width</th>
<th>Delay Time</th>
<th>Peak Value</th>
<th>Base Value</th>
<th>Leading Time</th>
<th>Trailing Time</th>
<th>Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGU1</td>
<td>473 μs</td>
<td>400 μs</td>
<td>0.0 s</td>
<td>20 V</td>
<td>0 V</td>
<td>10 μs</td>
<td>10 μs</td>
<td>50 ohm</td>
</tr>
</tbody>
</table>

**Stress setup file for erase pulse of NAND type.**
Stress setup for erase pulse of NAND type is stored in “NANEERS.STR” file on provided diskette. As described previously, you must change line 2020 to “NANEERS.STR” or your own custom file name.
In the NANEERS.STR file, the following is set up. You can modify these settings in the NANEERS.STR file or your own file:

- **PGUs**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Period</th>
<th>Width</th>
<th>Delay Time</th>
<th>Peak Value</th>
<th>Base Value</th>
<th>Leading Time</th>
<th>Trailing Time</th>
<th>Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGU2</td>
<td>5.02 ms</td>
<td>5.00 ms</td>
<td>0.0 s</td>
<td>20 V</td>
<td>0 V</td>
<td>10 μs</td>
<td>10 μs</td>
<td>50 ohm</td>
</tr>
</tbody>
</table>

---

1. Connected to drain, source, and substrate, and set to constant source.

---

1. Connected to gate, and set to constant source.
Program Listing

1000 ****************************
1010  *= FILE:  NOR_TEST
1020  *= DESCRIPTION: Program for NOR-FLASH ROM Stress Test.
1030  *=
1040  *= AUTHOR:  Yukihisa Iwasaki, YRF
1050  *= CREATED:  12/21/1993
1060  *= MODIFIED:  01/26/1994
1070  *= PRODUCT:  HP4166A, HP4156A
1080  *= REVISION:  Rev. A.01.03
1090  *=
1100  *= (c) Copyright 1994, Hewlett-Packard Co.,
1110  *= All rights reserved.
1120  *=
1130  *=
1140  *=
1150  *= Customer shall have the personal, non-
1160  *= transferable rights to use, copy or modify
1170  *= this SAMPLE PROGRAM for customer's internal
1180  *= operations. Customer shall use the SAMPLE
1190  *= PROGRAM solely and exclusively for its own
1200  *= purpose and shall not license, lease, market
1210  *= or distribute the SAMPLE PROGRAM or modification
1220  *= or any part thereof.
1230  *=
1240  *= HP shall not be liable for the quality,
1250  *= performance or behavior of the SAMPLE PROGRAM.
1260  *= HP especially disclaims that the operation of
1270  *= the SAMPLE PROGRAM shall be uninterrupted or
1280  *= error free. This SAMPLE PROGRAM is provided
1290  *= AS IS.
1300  *=
1310  *= HP DISCLAIMS THE IMPLIED WARRANTIES OF
1320  *= MERCHANTABILITY AND FITNESS FOR A PARTICULAR
1330  *= PURPOSE.
1340  *=
1350  *= HP shall not be liable for any infringement
1360  *= of any patent, trademark, copyright or other
1370  *= proprietary rights by the SAMPLE PROGRAM or
1380  *= its use. HP does not warrant that the SAMPLE
1390  *= PROGRAM is free from infringements or such
1400  *= rights of third parties. However, HP will not
1410  *= knowingly infringe or deliver a software that
1420  *= infringes the patent, trademark, copyright or
1430  *= other proprietary right of a third party.
1440  *=
1450 ****************************
1460  = Start_time:TIME=DATE
1470  ASGN 4Hp4156 TO 800
1480  ASGN @Form_off TO 800; FORMAT OFF
1490  CDH $Hp4156, Form_off, Start_time, End_time
1500  CDH /File_name/ Vth_file(12), Vth_file(12), Err_file(12), Dev_file(12)
1510  CDH /Mesg_info/ INTEGER Mesg_points, REAL Str, Str_err, Mesg_str_err
1520  CDH /Mesg_data/ Vth_u(1:60), Vth_e(1:60)
1530  CDH /Err Err_err(60), Err_message(1:60) [80]
Sample Application Programs

Flash EEPROM Test

1540 INTEGER 1
1550 !
1560 /*------------------- Main -----------------------------*/
1570 CALL init_ap4155
1580 ON INTR 0 CALL Err_chk
1590 ENABLE INTR 8:2
1600 !
1610 CALL Test_setting
1620 CALL Get_file
1630 !
1640 STR3
1650 FOR i=1 TO Mem_str_num
1660 CALL Stress_loop(i)
1670 IF Mem_str_num(i)>4000 THEN CALL Calibration
1680 !
1690 OUTPUT #445555:">MEM:LOAD:STAT 0,'MEM2.STR',"MEMORY"
1700 OUTPUT #445555:">MEM:LOAD:STAT 0,'MEM1.STR',"MEMORY"
1710 CALL Vth_meas("Write",i)
1720 !
1730 OUTPUT #445555:">MEM:LOAD:STAT 0,'MEM3.STR',"MEMORY"
1740 CALL Vth_meas("Erase",i)
1750 !
1760 CALL Stress_data(i)
1770 CALL Stress_graph(i)
1780 !
1790 IF Vth_w(i)<.1 OR Vth_e(i)<.1 THEN
1800 PRINT " The device is broken, Test aborted 
1810 PRINT " Final Stress Times : "Str_num
1820 CALL Final_session
1830 STOP
1840 END IF
1850 Str_num=str_num+1
1860 NEXT i
1870 !
1880 CALL Final_session
1890 !
1900 END
1910 !
1920 /*------------------- Sub -----------------------------*/
1930 Test_setting:SUB Test_setting
1940 CMM /File_name/Vth_file,Wrc_file,Err_file,Save_file
1950 CMM /Mem_info/ INTEGER Mem_points,REAL Str_num,Mem_str_num()
1960 CMM /Mem_data/ Vth_w,Vth_e()
1970 !
1980 Vth_file$="ROMVTH.NEX"  ! Vth Measurement Setup File Name
1990 Wrc_file$="ROMWRT.STR"  ! Write Stress Setup File Name
2000 Err_file$="RMKRM.STR"  ! Error Stress Setup File Name
2010 Save_file$="TIME$(TIME DATE)" ! File Name for saving measurement results
2020 Save_file$=Save_file$[1,2]@Save_file$[4,6]@Save_file$[7,7]@.DAT
2030 Mem_points=1  ! Number of times to repeat Measurement
2040 RESM Mem_str_num(1:Mem_points)
2050 RESM Vth_w(1:Mem_points),Vth_e(1:Mem_points)
2060 Str_num=1  ! Stress Fize Count data
2070 DATA 1, 2, 5
2080 DATA 10, 20, 50
2090 DATA 100, 200, 500
2100 DATA 1000, 2000, 5000
2110 DATA 10000, 20000, 50000
2120 DATA 100000, 200000, 500000
2130 DATA 1000000
2140 RESTORE Str_num
Sample Application Programs

Flash EEPROM Test

2160  READ Mem_str_num(*)
2170  SUBEND
2170  !
2180  init_hp4155:SUB init_hp4155
2190  CMN hp4155,Form_off,Start_time,End_time
2200  !
2210  CLEAR SCREEN
2220  CLEAR hp4155
2230  OUTPUT hp4155:"*RST"
2240  OUTPUT hp4155:"*CLS"
2250  OUTPUT hp4155:"MEM:FREE"
2260  OUTPUT hp4155:"® // 60, +SE 34 +DPC?"
2270  ENTER hp4155:A
2280  OUTPUT hp4155:":DISP:WND:ALL BST"
2290  OUTPUT hp4155:":DISP OFF"
2300  PRINT "<< Flash ROM Stress Test >>"
2310  PRINT "Stress Times Vth Write [V] Vth Erase [V] Diff [V]"
2320  SUBEND
2330  !
2340  Get_file:SUB Get_file
2350  CMN hp4155,Form_off,Start_time,End_time
2360  CMN /File_name/ Vth_file$ WRT_file$ Errs_file$ Save_file$
2370  !
2380  OUTPUT hp4155:"MEM:COPY "\Vth_file$", "DISK", "MEM. WRT", "MEMORY"
2390  OUTPUT hp4155:"MEM:COPY "\WRT_file$", "DISK", "MEM2. STR", "MEMORY"
2400  OUTPUT hp4155:"MEM:COPY "\Errs_file$", "DISK", "MEM3. STR", "MEMORY"
2410  SUBEND
2420  !
2430  Calibration:SUB Calibration
2440  CMN hp4155,Form_off,Start_time,End_time
2450  !
2460  OUTPUT hp4155:"PAGE:SYST:CDI"
2470  OUTPUT hp4155:"DISP ON"
2480  OUTPUT hp4155:"CAL:ALL"
2490  ENTER hp4155:A
2500  SELECT A
2510  CASE 0
2520  OUTPUT hp4155:"PAGE:GLIS"
2530  OUTPUT hp4155:"DISP OFF"
2540  CASE ELSE
2550  PRINT "### Calibration Fail .Test Aborted ###"
2560  CALL Final_session
2570  STOP
2580  END SELECT
2590  SUBEND
2600  !
2610  Stress_loop:SUB Stress_loop(INTEGER i)
2620  CMN hp4155,Form_off,Start_time,End_time
2630  CMN /Mem_info/ INTEGER Mem_points,REAL Strs,Mem_str_mem_str_size()
2640  INTEGER X
2650  REAL Strs_end
2660  !
2670  OUTPUT hp4155:"MEM:LOAD:STAT 0, "MEM2", "MEMORY":PAGE:SCRN:STR:WAIT"
2680  ENTER hp4155:X
2690  OUTPUT hp4155:"MEM:LOAD:STAT 0, "MEM2", "MEMORY":PAGE:SCRN:STR:WAIT"
2700  !
2710  OUTPUT hp4155:"PAGE:SCRN:STAN ON"
2720  Strs_end=MEM_str_mem_str_size()+2
2730  FOR Str=Strs END TO Strs_end
2740  DISP VALS(Str$):"\"VALS(Mem_str_strsize())"
2750  OUTPUT hp4155:"MEM:LOAD:STAT 0, "MEM2", "MEMORY":PAGE:SCRN:STR:WAIT"
Sample Application Programs

Flash EEPROM Test

3370  OUTPUT #p4165;";"FORM: DATA ASCII"
3370  REDIM Mess_str_sum(1:Mean_points),Vth_w(1:Mean_points),Vth_d(1:Mean_points)
3380  SUBEND

3400  !
3410  Stress_graph: SUB Stress_graph(INTEGE 1)
3420  COB #p4165,Form оф,Start_time,End_time
3430  COB #Mess_info, INTEGER Mean_points,REAL Str,Str_sum,Mess_str_sum(+)
3440  !
3450  OUTPUT #p4165;";"PAGE:CHAR:COMM "Flash ROM Vth Shift(Stress="VAVSL(Mess_str_sum(1))")"
3460  OUTPUT #p4165;";"PAGE:CHAR:FUN:DEF 'DVT',',V',',VthWRT-VthEWR";
3470  !
3480  OUTPUT #p4165;";"PAGE:DISP:GRAPH:X:NAME "Stress"
3490  OUTPUT #p4165;";"PAGE:DISP:GRAPH:Y1:NAME "VthWRT"
3500  OUTPUT #p4165;";"PAGE:DISP:GRAPH:Y2:NAME "VthEWR"
3510  OUTPUT #p4165;";"PAGE:DISP:GRAPH:X:SCALE 'LOG'"
3520  OUTPUT #p4165;";"PAGE:DISP:GRAPH:X:MIN 1"
3530  OUTPUT #p4165;";"PAGE:DISP:GRAPH:X:MAX "AVAVSL(Max(Mess_str_sum(Mean_points),2))""
3540  OUTPUT #p4165;";"PAGE:DISP:GRAPH:Y1:SCALE 'LIN'"
3550  OUTPUT #p4165;";"PAGE:DISP:GRAPH:Y2:MIN 0";
3560  OUTPUT #p4165;";"PAGE:DISP:GRAPH:Y2:MAX 7";
3570  OUTPUT #p4165;";"PAGE:DISP:GRAPH:Y2:SCALE 'LIN'"
3580  OUTPUT #p4165;";"PAGE:DISP:GRAPH:Y2:MIN 0";
3590  OUTPUT #p4165;";"PAGE:DISP:GRAPH:Y2:MAX 7"
3600  !
3610  OUTPUT #p4165;";"PAGE:DISP:DRAW:DEL "VTH"
3620  OUTPUT #p4165;";"PAGE:DISP:DRAW "DVT"
3630  !
3640  OUTPUT #p4165;";"PAGE:DISP:ANAL:LINES:MODE DIS";
3650  OUTPUT #p4165;";"PAGE:DISP:ANAL:LINES:MODE DIS";
3660  OUTPUT #p4165;";"PAGE:DISP:ANAL:MARK:DIS"
3670  !
3680  OUTPUT #p4165;";"PAGE:GLIS:INT OFF";
3690  OUTPUT #p4165;";"PAGE:GLIS:LINE OFF";
3700  OUTPUT #p4165;";"PAGE:GLIS:MARK ON";
3710  OUTPUT #p4165;";"PAGE:GLIS:MARK:DIS MAX"
3720  !
3730  OUTPUT #p4165;";"DISP ON";"DISP OFF"
3740  SUBEND
3750  !
3760  Final_session: SUB Final_session
3770  COB #p4165,Form оф,Start_time,End_time
3780  COB File_name, Vth_file$,$Wt_file$,$Era_file$,Save_file$
3790  COB #Mess_info, INTEGER Mean_points,REAL Str,Str_sum,Mess_str_sum(+)
3800  COB #err/ Err_sum(2),Err_message(2)
3810  !
3820  IF Str_sum(2)=Mess_str_sum(Mean_points) THEN
3830  Save_file$=""$Save_file$;
3840  PRINT "************* Measurement Completed !!! *************"
3850  PRINT "Final Stress Times : "';Str_sum(2)
3860  ELSE
3870  Save_file$=""$Save_file$;
3880  END IF
3890  !
3900  PRINT "Save Data File Name : "';Save_file$;
3910  PRINT "Time Duration : ";
3920  End_time@ENDATE
3930  PRINT DATE(Start_time)"";""TIME([Start_time]):""""""TIME([End_time]) ;""TIME([End_time])"
3940  !
3950  !
3960  OUTPUT #p4165;";"REM: stor:TRAC DEF "$Save_file$",DISK"
3970  OUTPUT #p4165;";"DISK"
Sample Application Programs
Flash EEPROM Test

3980 ENTER $hp4165:A
3990 OUTPUT $hp4165:"Syst:ERR"
4000 ENTER $hp4165 Err_num(); Err_message();
4010 IF Err_num()<>0 THEN PRINT "$$":Err_num(); Err_message(); " $$"
4020
4030 OUTPUT $hp4165:"DISP:ALL INST"
4040 OUTPUT $hp4165:"PAGE:0015"
4050 OUTPUT $hp4165:"DISP 0M"
4060 SUBEND
4070
4080 Err_check:SUB Err_check
4090 COM $hp4165,6Form_off,Start_time,End_time
4100 COM /Err/ Err_num(), Err_message();
4110 INTEGER I,J
4120
4130 I=0
4140 REPEAT
4150 $hp4165:"Syst:ERR"
4160 ENTER $hp4165 Err_num(); Err_message();
4170 UNTIL Err_num()=0
4180
4190 IF I=1 THEN
4200 CALL Meas_stat_check
4210 ELSE
4220 FOR J=1 TO I
4230 PRINT "$$":Err_num(); Err_message();
4240 DISP "$$":Err_num(); Err_message();
4250 NEXT J
4260 CALL Meas_stat_check
4270 PRINT "": "Test Aborted $$"
4280 CALL Final_session
4290 STOP
4300 END IF
4310 SUBEND
4320
4330 Meas_stat_check:SUB Meas_stat_check
4340 COM $hp4165,6Form_off,Start_time,End_time
4350 COM Cm (Meas_str)/ INTEGER Meas_points; REAL Str,str_sum,Meas_str_sum();
4360 INTEGER K
4370
4380 IF K<00 THEN
4390 PRINT "$$": Abnormal Stress Status Event Occurred $$": K
4400 PRINT "": At Stress Number a $$":[Str] [Times]
4410 PRINT "": "Test Aborted $$"
4420 CALL Final_session
4430 STOP
4440 END IF
4440 SUBEND
Time Dependent Dielectric Breakdown (TDDDB)

This setup forces a constant voltage to the gate until the gate oxide breakdowns or a maximum time limit is reached, then calculates the total forced electric charge.

<table>
<thead>
<tr>
<th>Program</th>
<th>none</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setup file</td>
<td>TDDBMES</td>
</tr>
</tbody>
</table>

Application Overview

![Diagram of Device Connection](image)

**Figure 6-3. Device Connection**

The measurement flow is as follows:

1. Forces a constant voltage to the gate.
2. Measures gate current by sampling measurement.
3. If gate current exceeds specified threshold, measurement is stopped.
4. Calculates total electric charge that was forced by using a user function with definition \( \text{INTEG}(I_g, @TIME) \).
Customization

Measurement setup file is stored in "TDBB.MES" file on provided diskette. In the TDBB.MES file, the following is set up. You can modify these settings in the TDBB.MES file or your own file, then use the setup for your own application.

- Constant source setup

<table>
<thead>
<tr>
<th>Units</th>
<th>Output</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU1 (Gate)</td>
<td>20 V</td>
<td>1.001 μA</td>
</tr>
<tr>
<td>SMU4 (Substrate)</td>
<td>0 V</td>
<td>100 μA</td>
</tr>
</tbody>
</table>

- Sampling Parameters

<table>
<thead>
<tr>
<th>Mode</th>
<th>Initial interval</th>
<th>No. of samples</th>
<th>Total samp. time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinned-out</td>
<td>100 ms</td>
<td>1001</td>
<td>999.9 s</td>
</tr>
</tbody>
</table>

- Stop Condition

This setup is used to judge the oxide breakdown. If gate current exceeds the specified threshold, measurement is stopped.

<table>
<thead>
<tr>
<th>Enable Delay</th>
<th>Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 ms</td>
<td>1 μA</td>
</tr>
</tbody>
</table>
Electromigration

This setup forces a constant current to the DUT (metal), measures time-to-failure of DUT, then calculates the total forced electric charge.

<table>
<thead>
<tr>
<th>Program</th>
<th>none</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setup file</td>
<td>EM.MES</td>
</tr>
</tbody>
</table>

Application Overview

The measurement flow is as follows:

1. Forces constant current.
2. Monitors DUT voltage by sampling measurement.
3. If the DUT voltage reaches specified threshold, the forcing stops.
4. Calculates total electric charge that was forced by using a user function with definition INTEG(Idut1, @TIME).
Customization

Measurement setup file is stored in "EM.MES" file on provided diskette. In the EM.MES file, the following is set up. You can modify these settings in the EM.MES file or your own file, then use the setup for your own application.

- Constant source setup

<table>
<thead>
<tr>
<th>Units</th>
<th>Output</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU1</td>
<td>50 mA</td>
<td>20.002 V</td>
</tr>
</tbody>
</table>

- Sampling Parameters

<table>
<thead>
<tr>
<th>Mode</th>
<th>Initial interval</th>
<th>No. of samples</th>
<th>Total samp. time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>1 s</td>
<td>10001</td>
<td>AUTO¹</td>
</tr>
</tbody>
</table>

1 initial interval = No. of samples

- Stop Condition

If the DUT voltage exceeds the specified threshold, measurement is stopped.

<table>
<thead>
<tr>
<th>Enable Delay</th>
<th>Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 ms</td>
<td>20 V</td>
</tr>
</tbody>
</table>
Sample Application Programs

Electromigration
Manual Changes
Depending on ROM Version
Manual Changes Depending on ROM Version

HP 4155A/4156A may vary slightly, depending on the version of the ROM based firmware. The information in this manual applies to an HP 4155A/4156A with the following ROM version.

**Manual Applies to this ROM Version**

<table>
<thead>
<tr>
<th>ROM</th>
<th>ROM Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOSTC</td>
<td>01.02</td>
</tr>
</tbody>
</table>

**ROM version**

To confirm your ROM version, check the **SOFTWARE REVISION** field on the SYSTEM: CONFIGURATION page.

This chapter contains information for customizing this manual so that it is correct for the HP 4155A/4156A that you are using.

To customize this manual for your HP 4155A/4156A, refer to the following table, and make the manual changes depending on the ROM version of your HP 4155A/56A.

**Manual Changes by ROM version**

<table>
<thead>
<tr>
<th>ROM version (HOSTC)</th>
<th>Make Manual Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.00</td>
<td>1</td>
</tr>
<tr>
<td>01.01</td>
<td>1</td>
</tr>
</tbody>
</table>
Add the following section to Chapter 5.

### Timing Considerations

You may need timing considerations for synchronizing measurements with external instruments.

Following example program controls a DMM with the HP 4155A/4156A. Measurement circuit is shown below:

![Measurement Circuit Diagram](image)

The HP 4155A/4156A has an HP-IB I/O buffer and can receive commands before executing previous command. So the execution order of HP 4155A/4156A and DMM is different from the order in the program.

In the following example, the HP 3458A receives a measurement trigger command right after the HP 4155A/4156A receives a force voltage trigger.
But due to the HP-IB I/O buffer, the voltage measurement is made by HP 3458A before HP 4155A/4156A forces voltage.

```
10 ASSIGN B#hp415x TO 717
20 ASSIGN B#hp3458 TO 722
30 !
40 DIM Rec_data$[17]
50 DIM Dem_data$[100]
60 !
70 OUTPUT B#hp3458;"RESET"
80 OUTPUT B#hp3458;"TARM HOLD"
90 OUTPUT B#hp3458;"DCV 10 A"
100 OUTPUT B#hp3458;"MPLC 1"
110 OUTPUT B#hp3458;"AZERO OFF"
120 !
130 OUTPUT B#hp415x;"00"
140 OUTPUT B#hp415x;"111 CAO BC"
150 Force_vv=1.5
160 OUTPUT B#hp415x;"DVI, 3, ";Force_vv", 20E-3"
170 OUTPUT B#hp415x;"DVG, 3, 0, 20E-3"
180 !
190 OUTPUT B#hp3458;"TARM SGL"
200 ENTER B#hp3458;Dem_data$
210 !
220 OUTPUT B#hp415x;"T12"
230 ENTER B#hp415x;Rec_data$
240 !
250 PRINT Dem_data$
260 PRINT Rec_data$
270 !
280 OUTPUT B#hp415x;"DVI, DV2"
290 END
```

Following is an example of test result:

-3.870540468E-04
NAI-1.256700E-010

DMM should measure about 1.5 V, but does not because DMM measures before SMU1 forces voltage.

You can insert a WAIT command before sending trigger command to the DMM (HP 3458A). In this example, 0.1 sec should be sufficient. So, you can insert the following in the above program:

```
181 WAIT .1
```

Or maybe the following is a better way to modify the program. The measurement order is changed. First, SMU measures current, and controller enters data from HP 4155A/4156A. Then, the measurement trigger is sent to the DMM.
Manual Changes Depending on ROM Version

Change 1

10 ASSIGN #hp415x TO T17
20 ASSIGN #hp3458 TO T22
30 !
40 DIM #oe_data$[17]
50 DIM #om_data$[100]
60 !
70 OUTPUT #hp3458;"RESET"
80 OUTPUT #hp3458;"TARP HOLD"
90 OUTPUT #hp3458;"DCV 10"
100 OUTPUT #hp3458;"APL 1"
110 OUTPUT #hp3458;"ZERO OFF"
120 !
130 OUTPUT #hp415x;"VS"
140 OUTPUT #hp415x;"TV CAO BC"
150 Force_v=0.5
160 OUTPUT #hp415x;"DV1, 1, ";Force_v;", 20E-3"
170 OUTPUT #hp415x;"DV2, 1, 0, 20E-3"
180 !
190 OUTPUT #hp415x;"T11"
200 ENTER #hp415x;#oe_data$;
210 !
220 OUTPUT #hp3458;"TARP SOL" ! <<< Changed order of measurement
230 ENTER #hp3458;#om_data$;
240 !
250 PRINT #om_data$;
260 PRINT #oe_data$;
270 !
280 OUTPUT #hp415x;"DV1: DV2"
290 END

The test result should be similar to following example:

1.499301638E+00
NAI+7.150000E-011
Data Length Considerations

When one of the following commands is sent from a controller to the HP 4155A/4156A in the HP 4145 syntax command mode, the HP 4155A/4156A outputs data to the controller.

DO  Data output request in the system mode
TI  Current measurement trigger and data output request in the user mode
TV  Voltage measurement trigger and data output request in the user mode
ID  Identification output

Different Data Length in System Mode.

The following program is equivalent to sample program 1 listed in Section 3 of HP 4155B manual. This program is an example of data output in the system mode. This program controls instrument to measure the IC-VC characteristics of a bipolar transistor, then returns IC data to the controller.

10  ASSI$E @mp415x TO TI7
20  DIM A$[1100]
30  OUTPUT @mp415x:"TI CAS DBO BC"
40  OUTPUT @mp415x:"CH1, CH2, CH3, CH4"
50  OUTPUT @mp415x:"IC, IC, IC, IC"
60  OUTPUT @mp415x:"VR1, VR2, VR3, VR4"
70  OUTPUT @mp415x:"SM, SM, SM, SM"
80  OUTPUT @mp415x:"IC, IC, IC, IC"
90  AWPOLL(0)(mp415x)
100 IF BIT(4,0)=0 THEN 90
110 OUTPUT @mp415x:"
120 ENTER @mp415x:A$"
130 PRINT A$" END

You must execute this program in the HP 4145 syntax command mode of the HP 4155A/4156A. The following will be displayed on the controller’s screen. (Or you can display on HP 4155A/4156A’s screen by changing the select code/HP-IB address assigned in line 10 to 800, which will execute the program using built-in IBASIC of the HP 4155A/4156A.) As you can see, the length of data string A$ is to short, so not all the data is displayed.
This is because the length of data output from the HP 4155A/4156A and HP 4145B is different as follows:

**HP 4145B data output format in system mode:**

```
x=nn.nnnn=nn, x=nn.nnnn=nn, ... x=nn.nnnn=nn[c][f]
```

Each data consists of 13 characters (including a comma) except for the last data, which consists of 12 characters.

**HP 4155A/4156A data output format in system mode of 4145 syntax command mode:**

```
x=nn.nnnn=nn=nn, x=nn.nnnn=nn=nn, x=nn.nnnn=nn, ... x=nn.nnnn=nn=nn
```

Each data consists of 16 characters (including a comma), except for the last data, which consists of 15 characters.

- **X** Data status
- **+** or **-**
- **N** Numeric character

In this example, number of data points is 21 x 4 = 84 (21 Var1 steps and 4 Var2 steps). So, length of data string A$ should be at least 1343 (16 char x 84 points - 1). Please modify line 20 as follows:

```
20  DIM A$(1343)  ; <<< Modified 16 x 84 - 1 = 1343
```

The result display is as follows (all data is displayed):

```
$9.994700E+004, N=5.926300E+007, N=6.081000E+006, N=7.726000E-04,
N=1.107100E+003, N=1.414000E+003, N=1.825000E+003, N=1.873000E+003,
N=1.873900E+003, N=1.627700E+003, N=1.804200E+003, N=1.885200E+003,
N=1.884900E+003, N=1.887800E+003, N=1.887500E+003, N=1.887800E+003,
N=1.896900E+003, N=1.891200E+003, N=1.892300E+003, N=1.893000E+003,
N=1.893700E+003, N=1.996500E+005, N=1.678600E+006, N=1.426100E+004,
N=1.332300E+004, N=5.399400E+003, N=6.285600E+003, N=6.354900E+003,
N=7.221000E+003, N=3.796000E+003, N=7.768000E+003, N=7.714000E+003,
N=7.721000E+003, N=7.755000E+003, N=8.994000E-005, N=0.361000E+006,
```
Manual Changes Depending on ROM Version

Change 1

Different Data Length in User Mode.
The following program is equivalent to sample program 2 listed in Section 3 of the HP 4145B manual. This program is an example of data output in the user mode.

```
10  ASSIGN @Hp415x TO 717
20  DIM A$[14]
30  OUTPUT @Hp415x;"US"
40  OUTPUT @Hp415x;"IT1 CA0 BC"
50  Force_v=1.5
60  OUTPUT @Hp415x;"DV1, 1, ";Force_v", 20E-3"
70  OUTPUT @Hp415x;"DV2, 1, 0, 20E-3"
80  OUTPUT @Hp415x;"TI1"
90  ENTER @Hp415x;A$
100 PRINT A$
110 OUTPUT @Hp415x;"DV1; DV2"
120 END
```

This program displays the following for example. As you can see, the length of data string A$ is too short, so not all the data is displayed.

NAI+4.300000E-

This is because the length of data output from the HP 4155A/4156A and HP 4145B is different as follows:

**HP 4145B data output format in user mode (14 characters):**

```
XXX+NN.NNNNNN[cr][lf]
```

**HP 4155A/4156A data output format in user mode of 4145 syntax command mode (17 characters):**

```
XXX+N.NNNNN[cr][lf]
```

- **X** Data status
- **+** or **-**
- **N** Numeric character

So, you need to change line 20 as follows:

```
```

The test result will be as follows:

NAI+4.300000E-013
Manual Changes Depending on ROM Version

Change 1

**TV and ID Commands**

For "TV" command, the data length is 14 characters for HP 4145, and 17 characters for HP 4156A/4156A. For "ID" command, the data length is 18 characters for HP 4145 and 41 characters for HP 4156A/4156A. So, if these commands are used, you need to change the data string length accordingly.
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