Programming Guide

Agilent E5270 Series of Parametric Measurement Solutions

Agilent Technologies

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Edition 2

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In This Manual

This manual provides the information to control the Agilent E5270 via GPIB interface using an external computer, and consists of the following chapters:

- “Programming Basics”

  This chapter provides basic information to control the Agilent E5270.

- “Remote Mode Functions”

  This chapter explains the functions of the Agilent E5270 in the remote mode.

- “Programming Examples”

  This chapter lists the GPIB commands for each measurement mode, and provides the programming examples using the HP BASIC language.

- “Command Reference”

  This chapter provides the complete reference of the GPIB commands of the Agilent E5270.

- “Error Messages”

  This chapter lists the error codes, and explains them.

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1. Programming Basics

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1 Programming Basics

This chapter describes basic information to control the Agilent E5270, and contains the following sections:

- "Before Starting"
- "Getting Started"
- "Command Input Format"
- "Data Output Format"
- "GPIB Interface Capability"
- "Status Byte"
- "Programming Tips"

Before Starting

Before starting the programming, connect an external computer, and set the GPIB address of the Agilent E5270 as shown below.

1. Connect a GPIB cable between the GPIB interface of the external computer and the GPIB connector on the rear panel of the E5270.
2. Turn on the Agilent E5270, and set the GPIB address as shown below.
   a. Press the **Menu** key.
   b. Select the CONFIG menu, and press the **Enter** key.
   c. Select the ADDRESS menu, and press the **Enter** key.
   d. Press the arrow key to set the GPIB address of the E5270, then press the **Enter** key.
   e. Press the **Exit** key twice to close the setup menu.

If You Use HP BASIC

Example programs described in this manual use HP BASIC language to control the Agilent E5270. If you use HP BASIC, refer to the following instructions.

1. Use the ASSIGN statement to assign the I/O path for controlling the E5270.

   In the following example, the select code of the external computer is 7 and the GPIB address of the E5270 is 17.

   ```
   10 ASSIGN @E5270 TO 717
   ```

2. Use the OUTPUT statement to send commands to the E5270, as shown below.

   ```
   OUTPUT @E5270;"*RST"
   ```

   It is available to send multiple commands as shown below.

   ```
   OUTPUT @E5270;"*CN;MM2,1"
   ```

3. Use the ENTER statement to get a query response or data from the E5270.
4. Use the RED command instead of the LOCAL statement. If you execute LOCAL to the instruments on the same bus, execute the following statements. The following example is for the select code 7 and the address 17.

   ```
   LOCAL 7
   REMOTE 717
   OUTPUT 717;"RED 1"
   ```

Getting Started

This section explains the following basic operations. In this section, the HP BASIC language is used for the examples.

- “To Reset the Agilent E5270”
- “To Read Query Response”
- “To Perform Self-Test”
- “To Perform Self-Calibration”
- “To Perform Diagnostics”
- “To Enable Source/Measurement Channels”
- “To Select the Measurement Mode”
- “To Force Voltage/Current”
- “To Set the Integration Time”
- “To Set the Measurement Range”
- “To Pause Command Execution”
- “To Start Measurement”
- “To Force 0 V”
- “To Disable Source/Measurement Channels”
- “To Read Error Code/Message”
- “To Read Measurement Data”
- “To Read Time Stamp Data”
- “To Perform High Speed Spot Measurement”

To Reset the Agilent E5270

The Agilent E5270 returns to the initial settings by the *RST command.

Example

```
OUTPUT @E5270;"*RST"
```

For the initial settings, refer to *User's Guide*.

To Read Query Response

If you enter a query command such as the *TST?, ERR? and so on, the Agilent E5270 puts an ASCII format response to the query buffer that can store only one response. Read the response as soon as possible after entering a query command.

Example

```
OUTPUT @E5270;"NUB?"
ENTER @E5270;A
```

This example returns the number of data stored in the data output buffer.

To Perform Self-Test

The Agilent E5270 starts the self-test by the *TST? command. The *TST? command also returns the test result.

Example

```
OUTPUT @E5270;"*TST?"
ENTER @E5270;Code
IF Code<>0 THEN DISP "FAIL: SELF-TEST"
```

This example starts the self-test, and reads the test result code. For the test result code, refer to "*TST?" on page 4-119.

To Perform Self-Calibration

The Agilent E5270 starts the self-calibration by the *CAL? command.

Example

```
OUTPUT @E5270;"*CAL?"
ENTER @E5270;Result
IF Result<>0 THEN DISP "FAIL: CALIBRATION"
```

This example starts the self-calibration, and reads the result, pass or fail. For details, refer to "*CAL?" on page 4-41.

To Perform Diagnostics

The Agilent E5270 starts the diagnostics by the DIAG? command, and returns the result. You must specify the diagnostics item by using the first parameter. Available parameter values are:

1: Trigger In/Out diagnostics

2: Front panel key diagnostics

3: High voltage LED diagnostics

4: Digital I/O diagnostics

5: Beeper diagnostics

To perform diagnostics 1, connect a BNC cable between the Ext Trig In terminal and the Ext Trig Out terminal before starting the diagnostics.

To perform diagnostics 4, disconnect any cable from the digital I/O port.

For diagnostics 1 and 4, the second parameter is available. Available parameter values are:

0: Agilent E5270 starts diagnostics immediately.

1: Agilent E5270 starts diagnostics when the **Enter** key is pressed.

Example

```
OUTPUT @E5270;"DIAG? 1,0"
ENTER @E5270;Result
IF Result<>0 THEN DISP "FAIL: DIAGNOSTICS"
```

This example starts the Trigger In/Out diagnostics, and reads the result, pass or fail. For details, refer to “DIAG?” on page 4-48.

To Enable Source/Measurement Channels

The measurement channels or source channels can be enabled by closing the output switch. To close the switch, send the CN command. The Agilent E5270 closes the output switch of the specified channels.

Example

```
OUTPUT @E5270;"CN 1"
```

This example enables channel 1 (the module installed in slot 1 of the Agilent E5270). If you do not specify the channel, the CN command enables all channels.

To Select the Measurement Mode

The Agilent E5270 provides the following measurement modes. To select the measurement mode, send the MM command.

Measurement Mode	Mode No.
Spot Measurement	1
Staircase Sweep Measurement	2
Pulsed Spot Measurement	3
Pulsed Sweep Measurement	4
Staircase Sweep with Pulsed Bias Measurement	5
Quasi-Pulsed Spot Measurement	9
Linear Search Measurement	14
Binary Search Measurement	15
Multi Channel Sweep Measurement	16
High Speed Spot Measurement	NA

In the table, Mode No. means a command parameter of the MM command.

Syntax

```
MM Mode#,Ch#[,Ch#] ...
```

where, Mode# specifies the Mode No., and Ch# specifies the measurement channel. The available number of measurement channels depends on the measurement mode. For details, refer to "MM" on page 4-81.

Example

```
OUTPUT @E5270;"MM 2,1"
```

This example sets the staircase sweep measurement, and assigns channel 1 (the module installed in slot 1 of the Agilent E5270) as the measurement channel.

NOTE

The Mode No. is not assigned for the high speed spot measurement. Refer to "To Perform High Speed Spot Measurement" on page 1-15. The high speed spot measurement does not need the MM command.

For the source output commands available for each measurement mode, see Table 1-1 on page 1-9.

To Force Voltage/Current

The Agilent E5270 provides the following commands to enable the voltage/current output. For the commands available for each measurement mode, see Table 1-1.

Command	Description
DV	Forces the constant voltage immediately.
DI	Forces the constant current immediately.
WV	Sets the staircase sweep voltage source.
WSV	Sets the synchronous sweep voltage source.
WI	Sets the staircase sweep current source.
WSI	Sets the synchronous sweep current source.
PV / PT	Sets the pulsed voltage source.
PI / PT	Sets the pulsed current source.
PWV / PT	Sets the pulsed sweep voltage source.
PWI / PT	Sets the pulsed sweep current source.
WNX	Sets a sweep source for the multi sweep measurement.
BDV	Sets the quasi-pulsed voltage source.
LSV	Sets the linear search voltage source.
LSSV	Sets the linear search synchronous voltage source.
LSI	Sets the linear search current source.
LSSI	Sets the linear search synchronous current source.
BSV	Sets the binary search voltage source.
BSSV	Sets the binary search synchronous voltage source.
BSI	Sets the binary search current source.
BSSI	Sets the binary search synchronous current source.

where, the PT command is used to set the timing parameters of the pulsed bias source or pulsed sweep source.

Table 1-1 **Measurement Mode and Available Source Output Commands**

Measurement Mode	Command
Spot Measurement	DV, DI
Staircase Sweep Measurement	DV, DI, and WV(/WSV) or WI(/WSI)
Pulsed Spot Measurement	DV, DI, and PV/PT or PI/PT
Pulsed Sweep Measurement	DV, DI, and PWV/PT(/WSV) or PWI/PT(/WSI)
Staircase Sweep with Pulsed Bias Measurement	DV, DI, and WV(/WSV) or WI(/WSI), and PV/PT or PI/PT
Quasi-Pulsed Spot Measurement	DV, DI, BDV
Linear Search Measurement	DV, DI, and LSV(/LSSV) or LSI(/LSSI)
Binary Search Measurement	DV, DI, and BSV(/BSSV) or BSI(/BSSI)
Multi Channel Sweep Measurement	DV, DI, WNX, and WV or WI
High Speed Spot Measurement	DV, DI

The DV and DI commands start to force the voltage or current immediately when the command is executed. The other commands just set the source channel condition, and the source channel starts the output by the start trigger, such as the XE command. For more details of the commands, refer to Chapter 4, “Command Reference.”

Example

```
OUTPUT @E5270;"DV 1,0,5"
```

This example just forces 5 V using channel 1 (the module installed in slot 1 of the Agilent E5270) with auto ranging.

To Set the Integration Time

To adjust the balance of the measurement accuracy and the measurement speed, change the integration time or the number of averaging samples of the A/D converter (ADC) by using the AAD command and the AIT or AV command.

The AAD command selects the type of ADC, and the AIT and AV commands set the integration time or the number of samples as shown below.

Type of ADC	Description
High-speed ADC	Effective for the high speed measurement. In the multi channel sweep measurement mode (MM16), multiple measurement channels can perform synchronous measurements. The number of averaging samples must be set by the AIT or AV command. The AV command is compatible with the AV command of the Agilent 4142B.
High-resolution ADC	Effective for accurate measurement. The integration time must be set by the AIT command. The AV command cannot set the high-resolution ADC.

For accurate and reliable measurement, set the integration time longer or set the number of samples larger.

Example

The following example sets the power line cycle mode (PLC) for both the high-speed ADC and the high-resolution ADC. And channel 1 uses the high-resolution ADC and other channels use the high-speed ADC.

```
OUTPUT @E5270;"*RST"
OUTPUT @E5270;"AIT 0,2,1"
OUTPUT @E5270;"AIT 1,2"
OUTPUT @E5270;"AAD 1,1"
```

The following example sets the number of samples to 10 for the high-speed ADC.

```
OUTPUT @E5270;"AV 10,1"
```

For details about the integration time settings, refer to Chapter 4, “Command Reference.”

To Set the Measurement Range

To set the measurement range, send the following command:

Command	Description
RI	Sets the current measurement range. Available for measurement except for the high speed spot measurement.
RV	Sets the voltage measurement range. Available for measurement except for the high speed spot measurement.
TI, TTI	Sets the current measurement channel and the measurement range, and performs the high speed spot measurement.
TV, TTV	Sets the voltage measurement channel and the measurement range, and performs the high speed spot measurement.

For the current measurement with the auto ranging mode, you can specify the coverage of each measurement range. To specify the coverage, send the RM command.

For details, refer to Chapter 4, “Command Reference.”

Example

This example sets the voltage measurement ranging mode of channel 1 to auto.

```
OUTPUT @E5270;"RV 1,0"
```

This example sets the current measurement ranging mode of channel 1 to auto, and specifies coverage between 9 % and 90 % of the range value or between 90 mA and 180 mA for the 200 mA range.

```
OUTPUT @E5270;"RI 1,0"
OUTPUT @E5270;"RM 1,3,90"
```

To Pause Command Execution

To pause command execution until the specified wait time has elapsed, send the PA command.

Example

```
OUTPUT @E5270;"PA 5"
```

If this command is sent, the Agilent E5270 waits 5 seconds before executing the next command.

To Start Measurement

To start measurement other than the high speed spot measurement, send the XE command.

Example

```
OUTPUT @E5270;"XE"
```

This starts the measurement specified by the MM command.

For the high speed spot measurement, refer to “To Perform High Speed Spot Measurement” on page 1-15.

To Force 0 V

To force 0 V immediately, send the DZ command. The Agilent E5270 memorizes the present source output settings of the specified channel, and changes the specified channel output to 0 V. If you do not specify the channel, the DZ command function is effective for all channels.

Example

```
OUTPUT @E5270;"DZ 1"
```

If this command is sent, the Agilent E5270 memorizes the current settings of channel 1 (the module installed in slot 1 of the Agilent E5270), and changes channel 1 output to 0 V.

To restore the settings stored by the DZ command, send the RZ command. For details, refer to Chapter 4, “Command Reference.”

To Disable Source/Measurement Channels

To disable the channels, send the CL command. The Agilent E5270 opens the output switch of the specified channels. Opening the output switch disables the channel.

Example

```
OUTPUT @E5270;"CL 1"
```

This example disables channel 1 (the module installed in slot 1 of the Agilent E5270). If you do not specify the channel, the CL command disables all channels.

To Read Error Code/Message

If any error occurs, the E5270 will not put the measurement data into the data output buffer. Hence, confirm that no error has occurred before reading the measurement data. To read the error code, enter the ERR? command, and to read the error message, enter the EMG? command.

Example

```
OUTPUT @E5270;"ERR? 1"
ENTER @E5270;Code
IF Code<>0 THEN
  OUTPUT @E5270;"EMG? ";Code
  ENTER @E5270;Msg$
  PRINT "ERROR: ";Msg$
ELSE
 :   :
```

This example checks the error buffer, and prints the error message on the computer screen if any error code is stored in the error buffer.

To Read Measurement Data

After measurement, the Agilent E5270 puts the measurement data into its output data buffer. Then you can read the measurement data by using the HP BASIC ENTER statement.

Example

If the data output format is ASCII format with a header set by the FMT5 command, send the following statements.

```
ENTER @E5270 USING "#,3A,12D,X";Head$,Data
```

This example stores the header information into the Head$ variable, and stores the measurement data into the Data variable. For the data output format, refer to "Data Output Format" on page 1-19.

To Read Time Stamp Data

NOTE

This function is *not* available for the quasi-pulsed spot measurement (MM 9), search measurement (MM 14 or 15), and the binary data output format (FMT 3 or 4).

To read the time data with the best resolution (100 µs), clear the timer every 100 s or less (for FMT 1, 2, or 5), or 1000 s or less (for FMT 11, 12, 15, 21, 22, or 25).

The time stamp function records the time from when the timer count is cleared until the measurement is started. This function is enabled by the TSC command.

For example, in the staircase sweep measurement, the output data will be as follows:

Block1 [,*Block2*] . . . . <terminator>

where, *BlockN* (*N*: integer) = *Time1*,*Data1* [,*Time2*,*Data2*] ... [,*Source_data*], then *TimeN* (*N*: integer) is the time when the *DataN* measurement is started.

Without the TSC command, you can get the time data by the following commands:

- TSR: Resets the timer count (*Time*=0 s).
- TDV (for voltage output), TDI (for current output):

  Applies DC voltage or current, and returns the output start time.

  Example:

  ```
  OUTPUT @E5270;"TDV 1,0,20"
  ENTER @E5270 USING "#,5X,13D,X";Time
  PRINT "Time=";Time;"sec"
  ```

- TTV (for voltage measurement), TTI (for current measurement):

  Executes the high speed spot measurement, and returns the measurement data and the time data for the time from when the timer count is cleared until the measurement is started.

  Example:

  ```
  OUTPUT @E5270;"TTV 1,0"
  ENTER @E5270 USING "#,5X,13D,X";Time
  ENTER @E5270 USING "#,5X,13D,X";Mdata
  PRINT "Data=";Mdata;" at ";Time;"sec"
  ```

- TSQ: Returns the time when this command is entered.

  Example:

  ```
  OUTPUT @E5270;"TSR"            !Resets count
        :
  OUTPUT @E5270;"TSQ"            !Returns time data
  ENTER @E5270 USING "#,5X,13D,X";Time
  PRINT "Time=";Time;"sec"
  ```

To Perform High Speed Spot Measurement

The high speed spot measurement does not need the MM and XE commands to set the measurement mode and start measurement. To start and perform the high speed spot measurement immediately, send the TI command for the current measurement, or the TV command for the voltage measurement. The following example program measures current by using the TI command, and displays the measurement result data on the computer screen.

Example

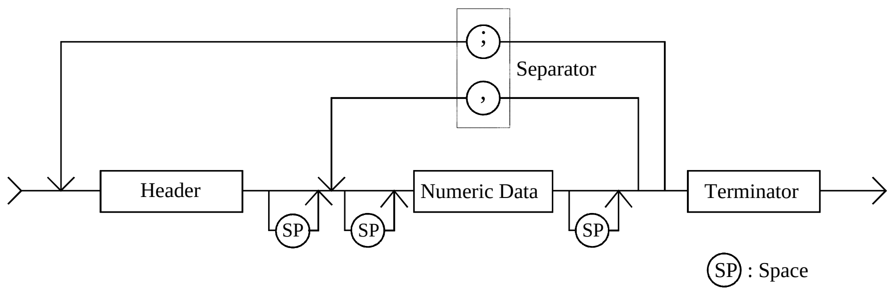
```
10    ASSIGN @E5270 TO 717
20    OUTPUT @E5270;"*RST"
30    OUTPUT @E5270;"FMT 5"
40    OUTPUT @E5270;"CN 1,2,3,4"
50    OUTPUT @E5270;"DV 1,0,0"
60    OUTPUT @E5270;"DV 2,0,0"
70    OUTPUT @E5270;"DV 3,0,2"
80    OUTPUT @E5270;"DV 4,0,5"
90    OUTPUT @E5270;"TI 4,0"
100   ENTER @E5270 USING "#,3A,12D,X";Head$,Data
110   PRINT Head$,Data
120   OUTPUT @E5270;"DZ"
130   OUTPUT @E5270;"CL"
140   END
```

Line Number	Description
10	Assigns the I/O path to control the E5270.
20	Initializes the Agilent E5270.
30	Sets the data output format (ASCII with header and <,>).
40	Enables channels 1, 2, 3, and 4.
50 to 80	Forces the DC voltage. Channel 1 and 2 force 0 V, channel 3 forces 2 V, and channel 4 forces 5 V with auto ranging.
90	Performs the high speed spot measurement using channel 4 with auto ranging.
100 to 110	Prints the header data and measurement data on the screen.
120	Forces 0 V. All channels force 0 V.
130	Disables all channels.

Command Input Format

The GPIB commands of the Agilent E5270 are composed of a header, numeric data, and terminator, as shown in the syntax diagram in the following figure.

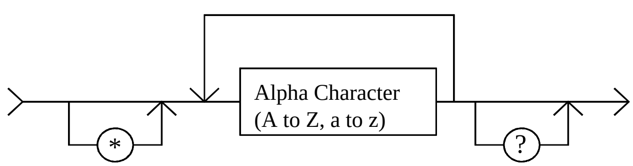
E5270 Control Command Syntax Diagram



Header

The header is the command name, always contains alpha characters, and is not upper or lowercase sensitive. Some command names also contain an asterisk (*) or question mark (?). The following figure shows the syntax diagram for a header.

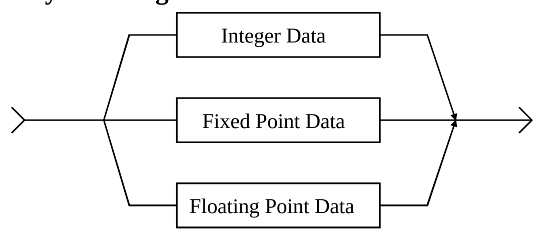
Header Syntax Diagram



Numeric Data

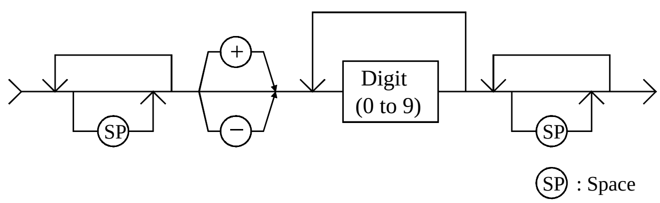
Numeric data are the command parameters. You can enter numeric data directly after the header or insert spaces between the header and numeric data. Some parameters require integer data. The following figure shows the syntax diagram for numeric data.

Numeric Data Syntax Diagram

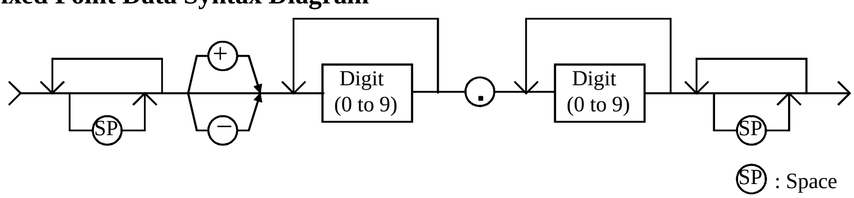


The following 3 figures show the syntax diagrams for integer, fixed point, and floating point data, respectively.

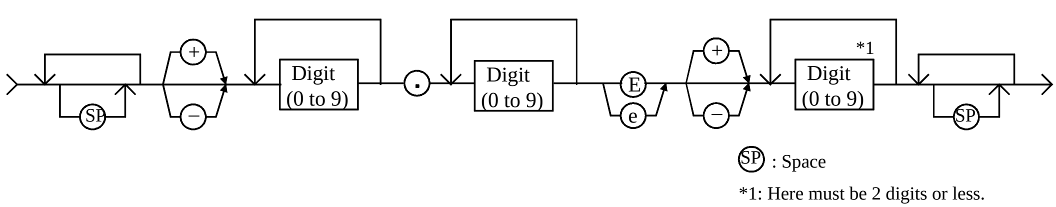
Integer Data Syntax Diagram



Fixed Point Data Syntax Diagram



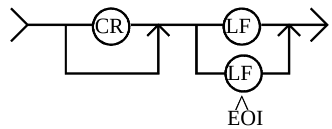
Floating Point Data Syntax Diagram



Terminator

The terminator completes the GPIB command entry and starts command execution. The following figure shows the terminator syntax diagram.

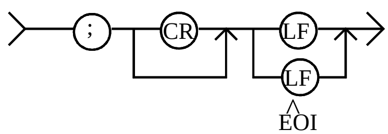
Terminator Syntax Diagram



Special Terminator

If a semicolon (;) is inserted before the terminator, as shown in the following figure, the preceding commands are not executed until the next command line is input and another terminator is input, without a preceding semicolon. The command lines are then executed together.

Special Terminator Syntax Diagram



Separator

If you enter multiple commands, use semicolons (;) to separate the commands. Spaces are allowed before and after the semicolons. Command execution starts when the terminator is received, not when the semicolon is received. You can input multiple commands of up to a total of 256 characters (including the terminator). If you input more than 256 characters, the input buffer overflows, and an error is indicated.

Use commas (,) to separate numeric data entries.

NOTE

Do not include the reset command (*RST) or the abort command (AB) in multiple command strings (example: `OUTPUT @E5270;"*RST;CN"`). If you do, the other commands in the string (example: `CN`) are not executed.

Data Output Format

Agilent E5270 provides the following data output formats:

- "ASCII Data Output Format"

  The Agilent E5270 supports ASCII format of the Agilent 4155B/4156B/4155C/4156C Parameter Analyzer in the Agilent FLEX command control mode and ASCII format of the Agilent 4142B Modular DC Source/Monitor.

  ASCII format provides better data resolution than binary format. You can read the data without calculation.

- "Binary Data Output Format"

  The Agilent E5270 supports binary format of the Agilent 4142B. Binary format enables faster data transfer time than ASCII format.

To select the data output format, use the FMT command. For details about the command, refer to Chapter 4, "Command Reference."

For the query response, the returned data is always stored in the query buffer in ASCII format, regardless of the FMT command setting.

A minimum of 17×1001×2 (34034) measurement data can be stored in the data output buffer.

Conventions

The following conventions are used in this section.

Data Output data that the E5270 sends after a measurement.

[*Data*] Optional output data sent when there are multiple output data items.

For example, source data will be sent with measurement data after the staircase sweep measurements when the source data output is enabled by the FMT command.

<terminator> Terminator.

<CR/LF^EOI> (two bytes) or <,> (one byte) for ASCII data.

<CR/LF^EOI> (two bytes) or <^EOI> (0 byte) for binary data.

You can select by using the FMT command.

ASCII Data Output Format

This section describes the ASCII data output format, and the elements of the data.

- "Data Format"
- "Time Stamp"
- "Data Elements"

Data Format

The data output format depends on the measurement mode as shown below.

High Speed Spot

Data <terminator> (by TI or TV command)

Time,*Data* <terminator> (by TTI or TTV command)

Data is the value measured by the channel you specify by using the TI, TV, TTI, or TTV command. *Time* is the time from when the timer count is cleared until the measurement is started.

Spot

Data1 [,*Data2*] . . . . <terminator>

DataN (*N*: integer) is the value measured by a channel. The order of *Data* is defined by the MM command.

Pulsed Spot, Quasi-Pulsed Spot

Data <terminator>

Data is the value measured by the channel you specify by using the MM command.

Staircase Sweep, Multi Channel Sweep

Block1 [,*Block2*] . . . . <terminator>

Block1 is the block of data measured at the first sweep step. *Block2* is the block of data measured at the second sweep step.

where *Block* consists of the following data:

Data1 [,*Data2*] . . . . [,*Source_data*]

DataN (*N*: integer) is the value measured by a channel. The order of *Data* is defined by the MM command.

Source_data is the sweep source output value. It is sent if the data output is enabled by the FMT command.

Pulsed Sweep, Staircase Sweep with Pulsed Bias

Block1 [,*Block2*] . . . . <terminator>

Block1 is the block of data measured at the first sweep step. *Block2* is the block of data measured at the second sweep step.

where *Block* consists of the following data:

Data [,*Source_data*]

Data is the value measured by the channel you specify by using the MM command.

Source_data is the sweep source output value. It is sent if the data output is enabled by the FMT command.

Linear Search, Binary Search

Data_search [,*Data_sense*]<terminator>

This is the data at the measurement point closest to the search target.

Data_search is the value forced by the search output channel.

Data_sense is the value measured by the search monitor channel. It is sent if data output is enabled by the BSVM command for the binary search, or the LSVM command for the linear search.

TDI, TDV command

Time <terminator>

Time is the time from when the timer count is cleared until the output is started.

Time Stamp

NOTE

This function is *not* available for the quasi-pulsed spot measurement (MM9) and the search measurement (MM14 and MM15).

The Agilent E5270 can record the time when the measurement is started, and sends the time data (*Time*). This function is enabled by the TSC command.

The time data will be sent just before the measurement data. For example, in the staircase sweep measurements, the data will be as shown below.

Block1 [,*Block2*] . . . . <terminator>

where, *BlockN* (*N*: integer) = *Time1*,*Data1* [,*Time2*,*Data2*] ... [,*Source_data*], then *TimeN* (*N*: integer) is the time from when the timer count is cleared until the *DataN* measurement is started.

The timer count is cleared (*Time*=0) by the TSR command.

Data Elements

The measurement data (*Data*), source output data (*Source_data*), time data (*Time*), and search data (*Data_search* and *Data_sense*) are the string as shown below.

Data	FMT command
ABCDDDDDDDDDDDD	FMT1 or FMT5
ABCDDDDDDDDDDDDD	FMT11 or FMT15
EEEFGDDDDDDDDDDDDD	FMT21 or FMT25
DDDDDDDDDDDD	FMT2
DDDDDDDDDDDDD	FMT12 or FMT22

The data elements depends on the FMT command setting. Details of the elements are described on the following pages.

A: Status. One character.

B: Channel number. One character.

C: Data type. One character.

D: Data. Twelve digits or 13 digits.

E: Status. Three digits.

F: Channel number. One character.

G: Data type. One character.

A Status. One character.

- Status for *Source_data*:

  Priority of appearance is W<E.

A	Explanation
W	Data is for the first or intermediate sweep step.
E	Data is for the last sweep step.

- Status for *Data*, *Data_search*, or *Data_sense*: See Table 1-2 on page 1-26.

  Priority of appearance is as follows:

  - For the quasi-pulsed spot measurement: N<T<C<V<X<G or S
  - For other measurement: N<G<S<T<C<V<X<F

B Channel number of the measurement/source channel. One character.

B	Explanation
A	Channel 1.
B	Channel 2.
C	Channel 3.
D	Channel 4.
E	Channel 5.
F	Channel 6.
G	Channel 7.
H	Channel 8.

C Data type. One character.

C	Explanation
V	Voltage measurement data (*Data*).
I	Current measurement data (*Data*).
T	Time data (*Time*).

D

Value of *Data*, *Source_data*, Data_search, *Data_sense*, or *Time*.
Twelve or 13 digits depends on FMT setting, which may be one of the following:

- *sn*.*nnnnn*E*snn* or *sn*.*nnnnnn*E*snn*
- *snn*.*nnnn*E*snn* or *snn*.*nnnnn*E*snn*
- *snnn*.*nnn*E*snn* or *snnn*.*nnnn*E*snn*

where,

s: Sign, + or -.

n: Digit, 0 to 9.

E: Exponent symbol.

E

Status. Three digits. Ignore status for the *Time* value.

- Status for *Data*, *Data_search*, or *Data_sense*:

EEE	Explanation
1	A/D converter overflowed.
2	One or more units are oscillating.
4	Another unit reached its compliance setting.
8	This unit reached its compliance setting.
16	Target value was not found within the search range.
32	Search measurement was automatically stopped.
64	Invalid data is returned. *D* is not used.
128	EOD (End of Data).

If multiple status conditions are found, the sum of the *EEE* values is returned. For example, if an A/D converter overflow occurred, and an SMU was oscillating during the measurements, the returned *EEE* value is 3 (=1+2).

- Status for *Source_data*: Priority of appearance is W<E.

EEE	Explanation
W	Data is for the first or intermediate sweep step.
E	Data is for the last sweep step.

F Channel number of the measurement/source unit. One character.

F	Explanation
A	Channel 1.
B	Channel 2.
C	Channel 3.
D	Channel 4.
E	Channel 5.
F	Channel 6.
G	Channel 7.
H	Channel 8.
V	GNDU.
Z	Status code for extraneous data in the channel. TSQ command response or invalid data is returned.

G Data type. One character.

G	Explanation
V	Voltage measurement data (*Data*).
v	Voltage source setup data (*Setup_data*).
I	Current measurement data (*Data*).
i	Current source setup data (*Setup_data*).
T	Time data (*Time*).
Z	Invalid data is returned.
z	

Table 1-2 **Status for Data, Data_search, or Data_sense**

A	Explanation
N	No status error occurred.
T	Another channel reached its compliance setting.
C	This channel reached its compliance setting.
V	Measurement data is over the measurement range. Or the sweep measurement was aborted by the automatic stop function or power compliance. *D* will be the meaningless value 199.999E+99.
X	One or more channels are oscillating. Or source output did not settle before measurement.[a]
G	For linear or binary search measurement, the target value was not found within the search range. Returns the source output value. For quasi-pulsed spot measurement, the detection time was over the limit (3 s for Short mode, 12 s for Long mode).[b]
S	For linear or binary search measurement, the search measurement was stopped. Returns the source output value. See status of *Data_sense*. For quasi-pulsed spot measurement, output slew rate was too slow to perform the settling detection.[c] Or quasi-pulsed source channel reached the current compliance before the source output voltage changed 10 V from the start voltage.[d]

a. Make the wait time or delay time longer. Or make the current compliance larger. For pulsed measurement, make the pulse width longer, or make the pulse base value closer to the pulse peak value. For current output by limited auto ranging, make the output range lower.
b. Make the current compliance or start voltage larger. Or set the detection interval to Long. If this status occurs with the Long mode, perform the spot measurement.
c. Make the current compliance larger. Or set the detection interval to Long. If this status occurs with the Long mode, perform the spot measurement or pulsed spot measurement.
d. Perform the pulsed spot measurement or spot measurement.

Binary Data Output Format

This section describes the binary data output format, and the elements of the data.

- "Data Format"
- "Data Elements"

NOTE

Data resolution

The resolution of binary data is as shown below.

- Measurement data: Measurement range / 50000
- Output data: Output range / 20000

Note that the resolution of the measurement data is larger than the resolution of the high resolution A/D converter.

Data Format

The data output format depends on the measurement mode as shown below.

High Speed Spot

Data <terminator>

Data is the value measured by the channel you specify by using the TI or TV command.

Spot

Data1 [*Data2*] . . . . <terminator>

DataN (*N*: integer) is the value measured by a channel. The order of *Data* is defined by the MM command.

Pulsed Spot, Quasi-Pulsed Spot

Data <terminator>

Data is the value measured by the channel you specify by using the MM command.

Staircase Sweep, Multi Channel Sweep

Block1 [*Block2*] . . . . <terminator>

Block1 is the block of data measured at the first sweep step. *Block2* is the block of data measured at the second sweep step.

where *Block* consists of the following data:

Data1 [*Data2*] . . . . [*Source_data*]

DataN (*N*: integer) is the value measured by a channel. The order of *Data* is defined by the MM command.

Source_data is the sweep source output value. It is sent if the data output is enabled by the FMT command.

Pulsed Sweep, Staircase Sweep with Pulsed Bias

Block1 [*Block2*] . . . . <terminator>

Block1 is the block of data measured at the first sweep step. *Block2* is the block of data measured at the second sweep step.

where *Block* consists of the following data:

Data [*Source_data*]

Data is the value measured by the channel you specify by using the MM command.

Source_data is the sweep source output value. It is sent if the data output is enabled by the FMT command.

Linear Search, Binary Search

Data_search [*Data_sense*]<terminator>

This is the data at the measurement point closest to the search target.

Data_search is the value forced by the search output channel.

Data_sense is the value measured by the search monitor channel. It is sent if data output is enabled by the BSVM command for the binary search, or the LSVM command for the linear search.

Data Elements

The measurement data (*Data*), source output data (*Source_data*), and search data (*Data_search* and *Data_sense*) are the 4 byte data as shown below.

<table>
<tr><td colspan="8">Byte 1</td><td colspan="8">Byte 2</td><td colspan="8">Byte 3</td><td colspan="8">Byte 4</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>A</td><td>B</td><td colspan="5">C</td><td colspan="17">D</td><td colspan="3">E</td><td colspan="5">F</td></tr>
</table>

There are 6 data elements. Details of the elements are described in the following pages.

A: Measurement or source output data type. One bit.

B: Data type. One bit.

C: Measurement or output range. Five bits.

D: Data. 17 bits.

E: Status. Three bits.

F: Channel number. Five bits.

A Measurement or source output data type. One bit.

A	Explanation
0	Source output data.
1	Measurement data.

B Data type. One bit.

B	Explanation
0	Voltage data.
1	Current data.

C Measurement or output range. Five bits.

C	Explanation
01010 (10)	0.2 V range.
01011 (11)	2 V or 1 nA range.
01100 (12)	20 V or 10 nA range.
01101 (13)	40 V or 100 nA range.
01110 (14)	100 V or 1 μA range.
01111 (15)	200 V or 10 μA range.
10000 (16)	100 μA range.
10001 (17)	1 mA range.
10010 (18)	10 mA range.
10011 (19)	100 mA range.
10100 (20)	1 A range for HPSMU or 200 mA range for MPSMU.
11111 (21)	Invalid data is returned.

D

Value of *Data*, *Source_data*, *Data_search*, or *Data_sense*.
This value is expressed in 17-bit binary data. The value can be calculated by the following formula.

Measurement data = $Count \times Range$ /50000

Source data = $Count \times Range$ /20000

where, *Count* is the decimal value of *D*, and *Range* is the measurement range or output range indicated by *C*.

For the current data, the Range value can be calculated by the following formula:

Range = 10^(*C*-20)

If the top bit of the 17-bit binary data is 0, the *Count* is positive and equal to the decimal value of the 16-bit binary data that follows the top bit.

If the top bit is 1, the *Count* is negative. Calculate the *Count* by subtracting 65536 (10000000000000000 in binary) from the decimal value of the 16-bit binary data.

Example:

If the output binary data is:

11010110000100111000100000000001

then,

Data type:	Current measurement data (*A*=1, *B*=1)
***Range*:**	1 nA=1E–9 A (*C*=01011)
***Count*:**	5000 (*D*=00001001110001000)
Status:	Normal condition (*E*=000)
Channel:	SMU1 (channel number 1) (*F*=00001)

Measurement data = 5000 × 1E–9/5E+4 = 100 pA

NOTE

B=1 and *C*=10100 means that HPSMU used 1 A range or MPSMU used 200 mA range. Then use *Range*=1 to calculate the data for both HPSMU and MPSMU. *Range*=0.2 is not available even if the range value is 200 mA.

E Status. Three bits.

- Status for *Source_data*:

  Priority of appearance is 001<010.

E	Explanation
001	Data is for the first or intermediate sweep step.
010	Data is for the last sweep step.

- Status for *Data*, *Data_search*, or *Data_sense*. See Table 1-3.

  Priority of appearance is as follows:

  - For the quasi-pulsed spot measurement: 0<1<2<3<4<6 or 7
  - For other measurement: 0<6<7<1<2<3<4<5

F Channel number of the measurement/source channel. Five bits.

F	Explanation
00001 (1)	Channel 1.
00010 (2)	Channel 2.
00011 (3)	Channel 3.
00100 (4)	Channel 4.
00101 (5)	Channel 5.
00110 (6)	Channel 6.
00111 (7)	Channel 7.
01000 (8)	Channel 8.
11111 (31)	Invalid data is returned.

Table 1-3 Status for Data, Data_search, or Data_sense

E	Explanation
000 (0)	No status error occurred.
001 (1)	Another channel reached its compliance setting.
010 (2)	This channel reached its compliance setting.
011 (3)	Measurement data is over the measurement range. *D* will be the meaningless value 1111111111111111 (65535).
100 (4)	One or more channels are oscillating. Or source output did not settle before measurement.[a]
110 (6)	For linear or binary search measurement, the target value was not found within the search range. Returns the source output value. For quasi-pulsed spot measurement, the detection time was over the limit (3 s for Short mode, 12 s for Long mode).[b]
111 (7)	For linear or binary search measurement, the search measurement was stopped. Returns the source output value. See status of *Data_sense*. For quasi-pulsed spot measurement, output slew rate was too slow to perform the settling detection.[c] Or quasi-pulsed source channel reached the current compliance before the source output voltage changed 10 V from the start voltage.[d]

a. Make the wait time or delay time longer. Or make the current compliance larger. For pulsed measurement, make the pulse width longer, or make the pulse base value closer to the pulse peak value. For current output by limited auto ranging, make the output range lower.
b. Make the current compliance or start voltage larger. Or set the detection interval to Long. If this status occurs with the Long mode, perform the spot measurement.
c. Make the current compliance larger. Or set the detection interval to Long. If this status occurs with the Long mode, perform the spot measurement or pulsed spot measurement.
d. Perform the pulsed spot measurement or spot measurement.

GPIB Interface Capability

The following table lists the GPIB capabilities and functions of the Agilent E5270. These functions provide the means for an instrument to receive, process, and transmit, commands, data, and status over the GPIB bus.

Interface Function	Code	Description
Source Handshake	SH1	Complete capability
Acceptor Handshake	AH1	Complete capability
Talker	T6	Basic Talker: YES Serial Poll: YES Talk Only Mode: NO Unaddress if MLA (my listen address): YES
Listener	L4	Basic Listener: YES Unaddress if MTA (my talk address): YES Listen Only Mode: NO
Service Request	SR1	Complete capability
Remote/Local	RL1	Complete capability (with local lockout)
Parallel Poll	PP0	No capability
Device Clear	DC1	Complete capability
Device Trigger	DT1	Complete capability
Controller Function	C0	No capability
Driver Electronics	E1	Open Collector

The Agilent E5270 responds to the following HP BASIC statements:

- ABORT (IFC)
- CLEAR (DCL or SDC. same as AB command)
- LOCAL (GTL)
- LOCAL LOCKOUT (LL0)
- REMOTE
- SPOLL (Serial Poll)
- TRIGGER (GET. same as XE command)

Status Byte

Status byte bits are turned off or on (0 or 1) to represent the instrument operation status. When you execute a serial poll, an external computer (controller) reads the contents of the status byte, and responds accordingly. When an unmasked status bit is set to “1”, the instrument sends an SRQ to the controller, causing the controller to perform an interrupt service routine.

Bit	Decimal Value	Description
0	1	Data Ready Indicates whether the output buffer is empty. If an unread data or query response exists, this bit is set to “1”. It is set to “0” when all the stored data has been transferred to the controller, or when the Agilent E5270 receives a *RST, BC, FMT, or device clear command.
1	2	Wait Indicates whether the instrument is in the wait status. This bit is set to “1” when the Agilent E5270 has been set to the wait state by the PA, WS, PAX, or WSX command. It is set to “0” when the waiting condition is complete, or when the Agilent E5270 receives a *RST or device clear command.
2	4	Not used. This bit is always set to “0”.
3	8	Interlock Open If the interlock circuit is open, and a voltage output or voltage compliance setup value exceeds ±42 V, this bit is set to “1” . It is set to “0” when the Agilent E5270 receives a serial poll, *RST, or device clear command.
4	16	Set Ready If the Agilent E5270 receives a GPIB command or a trigger signal, this bit is set to “0”. It is set to “1” when its operation is completed. This bit is also set to “0” when the self-test or calibration is started by front panel operation, and set to “1” when it is completed.

Bit	Decimal Value	Description
5	32	Error Indicates whether any error has occurred. If an error occurred, this bit is set to “1”. It is set to “0” when the Agilent E5270 receives a serial poll, *RST, ERR?, CA, *TST?, *CAL?, DIAG? or device clear command.
6	64	RQS (You cannot mask this bit.) Indicates whether an SRQ (Service Request) has occurred. This bit is set to “1” whenever any other unmasked bit is set to “1”. This causes the Agilent E5270 to send an SRQ to the controller. It is set to “0” when the Agilent E5270 receives a serial poll, *RST, or device clear command.
7	128	Shutdown If the Agilent E5270 turned off by itself to avoid damage, or an instantaneous power down occurred on the site power line, this bit is set to “1”. It is set to “0” when the Agilent E5270 receives a serial poll, *RST, or device clear command.

The status byte register can be read with either a serial poll or the *STB? query command. Serial poll is a low-level GPIB command that can be executed by the `SPOLL` command in HP BASIC, for example `Status=SPOLL(@E5270)`.

In general, use serial polling (not *STB?) inside interrupt service routines. Use *STB? in other cases (not in interrupt service routine) when you want to know the value of the Status Byte.

NOTE

If Bit 3, Bit 5, or Bit 7 are masked, they are not set to “0” by a serial poll. Also, if these bits are masked, set to “1”, and then unmasked, a serial poll does not set them to “0”.

After a masked bit is set to “1”, removing the mask does not set Bit 6 to “1”. That is, the Agilent E5270 does not send an SRQ to the controller. Therefore, if you remove a mask from a bit, it is usually best to do it at the beginning of the program.

Programming Tips

This section provides the following additional information on creating measurement programs. It is useful for checking the operation status, improving the measurement speed, and so on.

- "To Confirm the Operation"
- "To Confirm the Command Completion"
- "To Disable the Auto Calibration"
- "To Optimize the Measurement Range"
- "To Optimize the Integration Time"
- "To Disable the ADC Zero Function"
- "To Optimize the Source/Measurement Wait Time"
- "To Use the Internal Program Memory"
- "To Get Time Data with the Best Resolution"
- "To Use Sweep Source as a Constant Source"
- "To Start Measurements Simultaneously"
- "To Interrupt Command Execution"
- "To Use Programs for Agilent 4142B"
- "To Use Programs for Agilent 4155/4156"

Programming Basics
Programming Tips

To Confirm the Operation

To complete the measurement program, you can insert statements to check the E5270 operation status as shown below. This example starts the measurement, checks the status caused by the statements before the ERR? command, reads and displays the measurement data without errors, or displays an error message when an error occurs.

```
OUTPUT @E5270;"XE"
OUTPUT @E5270;"ERR? 1"
ENTER @E5270;Code
IF Code=0 THEN
  ENTER @E5270 USING "#,3X,12D,X";Mdata
  PRINT "I(A)=";Mdata
ELSE
  OUTPUT @E5270;"EMG? ";Code
  ENTER @E5270;Msg$
  PRINT "ERROR: ";Msg$
END IF
```

To Confirm the Command Completion

To check the completion of the previous command execution, use the *OPC? query command. Entering the *OPC command before sending a command to other equipment serves to delay its operation until the Agilent E5270 has completed its operation. The *OPC? command is useful to control equipments sequentially.

For example, the following program segment waits until the Agilent E5270 completes the DI command execution, and sends the *DCV* command to equipment identified by *@Address*.

```
OUTPUT @E5270;"DI";1,0,1.0E-10,1
OUTPUT @E5270;"*OPC?"
ENTER @E5270; A$
OUTPUT @Address;"DCV"
```

To Disable the Auto Calibration

The auto calibration function triggers self-calibration automatically every 30 minutes after measurement. When the function is enabled, open the measurement terminals frequently because calibration requires open terminals.

If you execute automatic measurements as a batch job that might leave the device connected for over 30 minutes after the measurements, disable auto calibration. Otherwise, the calibration might not be performed properly, or unexpected output might appear at the measurement terminals, and it could even damage the device. To disable auto calibration, send the `CM 0` command.

To Optimize the Measurement Range

The most effective way to improve measurement speed is to reduce the number of range changes. The limited auto ranging mode is more effective than the auto ranging mode. The fixed range mode is the most effective.

Check the typical value of the measurement data, select the optimum range, and perform measurement using the fixed range mode.

To Optimize the Integration Time

For best reliability and repeatability of the measurement data, the integration time or the number of averaging samples of the A/D converter must be increased. This increases the measurement time.

A long integration time and numerous samples are required for low current/ voltage measurements. However, the values can be decreased for medium or high current/voltage measurements. Enter the following commands:

AAD Selects the A/D converter (high-speed ADC or high-resolution ADC).

AIT Sets the integration time of the high-resolution ADC or the number of averaging samples of the high-speed ADC.

AV Sets the number of averaging samples of the high-speed ADC. This command is compatible with the AV command of the Agilent 4142B. The function of the AV command is covered by the AIT command. The last command setting of the AV or AIT command is available for the measurement.

For more information regarding these commands, refer to Chapter 4, “Command Reference.”

To Disable the ADC Zero Function

This information is effective only when the high resolution A/D converter is used for the measurement. If measurement speed is given top priority or is more important than reliability, disable the ADC zero function by sending the `AZ 0` command. This roughly halves integration time.

NOTE The ADC zero function is the function to cancel offset of the high resolution ADC. This function is especially effective for low voltage measurements.

To Optimize the Source/Measurement Wait Time

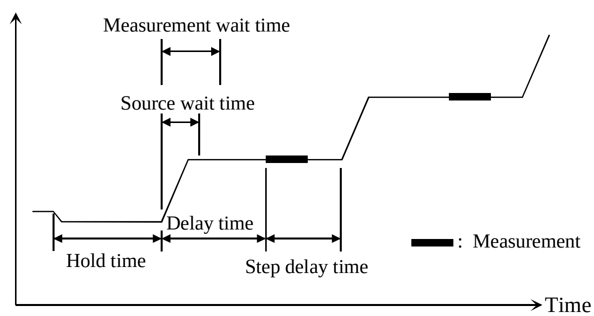
If measurement speed is given top priority or is more important than reliability, set the wait time shorter by using the WAT command. The source wait time is the time the source channel always waits before changing the source output value. The measurement wait time is the time the measurement channel always waits before starting measurement. The time is given by the following formula:

wait time = *initial wait time* × *A*+*B*

where, *initial wait time* is the time the Agilent E5270 automatically sets and you cannot change. The *initial source wait time* is not the same as the *initial measurement wait time*. *A* and *B* are the command parameters of the WAT command.

The wait time settings are effective for all modules.

Figure 1-1 **Source/Measurement Wait Time**



NOTE

The wait time can be ignored if it is shorter than the delay time.

It is not easy to determine the best wait time. If you specify it too short, the measurement may start before device characteristics stable. If too long, time will be wasted.

The initial wait time may be too short for measurements of high capacitance or slow response devices. Then set the wait time longer.

For measurements of low capacitance or fast response devices, if measurement speed has top priority or is more important than reliability and accuracy, set the wait time shorter.

To Use the Internal Program Memory

If your program repeats the setup and measurement for a number of devices, use the internal program memory. For these measurements, using the internal program memory reduces the command transfer time, and improves the program execution speed.

You can enter a maximum of 2,000 programs (total 40,000 commands) into the internal program memory. Refer to Chapter 2, “Remote Mode Functions.”

To Get Time Data with the Best Resolution

To read the time data with the best resolution (100 μs), the timer must be cleared within the following interval:

- 100 sec or less (for FMT1, 2, or 5 data output format)
- 1000 sec or less (for FMT 11, 12, 15, 21, 22, or 25 data output format)

Send the TSR command to clear the timer.

To Use Sweep Source as a Constant Source

The following setup enables sweep source to force a constant current or voltage.

- Sweep start value = Sweep stop value (for WI, WV, or WNX).

Also, setting number of sweep steps to 1 enables to perform a spot measurement.

To Start Measurements Simultaneously

Spot measurement, staircase sweep measurement, and multi channel sweep measurement enable to use multiple measurement channels. Then the measurement channels perform measurement in the order defined in the MM command. However, the measurement channels with the following setup start measurements simultaneously.

- Sets the multi channel sweep measurement mode (MM 16).
- Uses the high-speed A/D converter (for AAD).
- Sets the measurement ranging mode to fixed (for RI or RV).

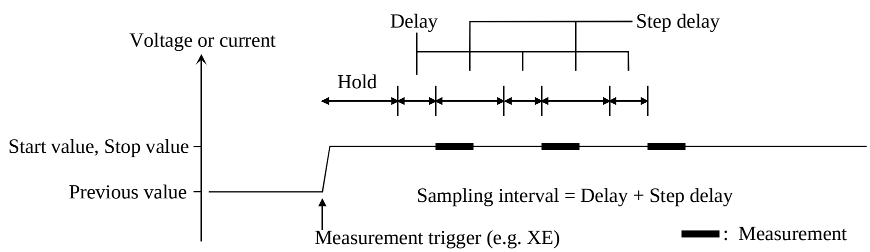
NOTE

Measurement setup is independent from source output setup. So, this simultaneous measurement cannot be broken by the source output setup. Any setting of the output ranging mode is effective for the simultaneous measurement.

To Perform Quasi-Sampling Measurement

The following setup enables to perform a quasi-sampling measurement. Then the sampling interval will be sum of delay time and step delay time.

- Sets the sweep measurement mode (MM 2 or MM 16).
- Sweep start value = Sweep stop value (for WI, WV, or WNX).
- Sets hold time, delay time, and step delay time (WT).



To Interrupt Command Execution

The Agilent E5270 executes commands in the received order. However, only the following commands can interrupt the command execution.

Table 1-4 **Interrupt Commands**

Command	Description
AV	Changes the number of averaging samples during the measurement.
AIT	Changes the integration time during the measurement.
AB	Aborts the command execution.
*RST	Resets the Agilent E5270 during the command execution.
XE	If the Agilent E5270 has been set to the wait status by the PA or PAX command, the XE command can be used to release the wait status. For details, refer to Chapter 4, “Command Reference.”

To Use Programs for Agilent 4142B

The Agilent E5270 supports most of the commands supported by the Agilent 4142B Modular DC Source/Monitor, and supports the data output format of the 4142B. To reuse the programs created for the Agilent 4142B, confirm the following and modify the programs if necessary.

- To remove all unsupported commands

  Some commands are not supported owing to differences in the modules supported by each instrument. Refer to Table 1-5 that shows the commands not supported by the Agilent E5270. Do not use these commands.

  Perform the linear search or binary search measurement as a substitute for the analog search measurement that needs the analog feedback unit (AFU).

  Use a source/monitor unit (SMU) instead of the voltage source/voltage monitor unit (VS/VMU). Note that the SMU cannot perform the differential voltage measurements.

- FL command

  The initial setting of the FL command is different. It is ON for the Agilent 4142B, and OFF for the Agilent E5270.

  Add the FL1 command to use the filter.

- AV command

  The Agilent E5270 provides two A/D converters, high speed ADC and high resolution ADC. And it supports new commands, AAD and AIT to set the A/D converters.

  The AV command is also available. But it is effective only for the high speed ADC. To use the high resolution ADC, enter the AAD and AIT commands. For the performance of ADCs, refer to *User's Guide*.

Table 1-5 Modules and Commands Unsupported

Plug-in Module	Commands
Analog Feedback Unit	ASM, AT, ASV, AIV, AVI
High Current Unit	PDM, PDI, PDV
High Voltage Unit	POL
Voltage Source/Voltage Monitor Unit	VM

Programming Basics
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To Use Programs for Agilent 4155/4156

The Agilent E5270 supports commands similar to the FLEX command of the Agilent 4155B/4156B/4155C/4156C Parameter Analyzer. However, not all command sets are fully compatible. To reuse the programs created for the Agilent 4155/4156, the following modifications are required.

- To remove all unsupported commands

  Table 1-6 shows the commands not supported by the Agilent E5270. You cannot use these commands. The SCPI commands and 4145 syntax commands are not supported either.

  The Agilent E5270 does not need the US and :PAGE commands that are necessary to change the control mode of the Agilent 4155/4156.

- To check and correct the command syntax

  Even if the command name is the same, the available parameters and values may be different. Check and correct the command parameters.

- To change the FMT command parameter

  Use the FMT 21, FMT 22, or FMT 25 command that sets the data output format compatible with the 4155/4156 ASCII format.

- To delete RMD?

  The Agilent E5270 does not need the RMD? command that is necessary to put the measurement data into the output data buffer of the Agilent 4155/4156.

- FL command

  The initial setting of the FL command is different. It is ON for the Agilent 4155/4156, and OFF for the Agilent E5270.

  Add the FL1 command to use the filter.

- AV command

  The Agilent E5270 provides two A/D converters, high speed ADC and high resolution ADC. And it supports new commands, AAD and AIT to set the A/D converters.

  The AV command is also available. But it is effective only for the high speed ADC. To use the high resolution ADC, enter the AAD and AIT commands. For the performance of ADCs, refer to *User's Guide*.

- To replace TI?/TV?/TTI?/TTV? with TI/TV/TTI/TTV respectively
- To replace WM with LSM for the linear search measurement

- To replace TSQ? with TSQ
- If you reuse the built-in IBASIC programs:
    - Change the GPIB address.
    - Remove the statements to use the built-in flexible disk drive.

Table 1-6 **FLEX Commands Unsupported**

Category	Command
Control mode	:PAGE, US, US42
Measurement mode	VM, VMD
Staircase/pulsed sweep source setup	ESC
Sampling source setup	MCC, MI, MP, MSC, MV
Quasi-static CV measurement setup	QSL, QSM, QSR, QST, QSV, QSZ, QSZ?
PGU control	POR, SPG, SPP, SRP
Stress source setup	STC, STI, STM, STP, STT, STV
Measurement setup	MT
Integration time	SIT, SLI
Measurement execution	TI?, TTI?, TTV?, TV?
Time stamp	TSQ?
Output data	RMD?
Abort/pause/wait	*WAI
Zero offset cancel	GOC, SOC
SMU/PGU selector	SSP
R-box	RBC
External trigger	STG
Network operation	CLOSE, OPEN, PRN, RD?, SDSK, SPL, SPR, WR
Status byte	*CLS, *ESE(?), *ESR?
Query	CMD?, *OPT?, :SYST:ERR?

Programming Basics
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2 Remote Mode Functions

This chapter describes the functions of the Agilent E5270 in the remote mode, and the initial settings.

- “Measurement Modes”
- “Synchronous Output”
- “Automatic Sweep Abort Function”
- “Program Memory”
- “Digital I/O Port”
- “Trigger Function”
- “Initial Settings”

NOTE

Synchronous Output

You can use synchronous output that will be synchronized to the output of the primary sweep or search source. The output is available for the following measurement modes:

- “Staircase Sweep Measurements”
- “Pulsed Sweep Measurements”
- “Staircase Sweep with Pulsed Bias Measurements”
- “Binary Search Measurements”
- “Linear Search Measurements”

The synchronous source supports the output mode (voltage or current) same as the primary source, and does not support the pulsed output.

Measurement Modes

The Agilent E5270 provides the following measurement modes.

- "Spot Measurements"
- "Pulsed Spot Measurements"
- "Staircase Sweep Measurements"
- "Multi Channel Sweep Measurements"
- "Pulsed Sweep Measurements"
- "Staircase Sweep with Pulsed Bias Measurements"
- "Quasi-Pulsed Spot Measurements"
- "Binary Search Measurements"
- "Linear Search Measurements"

NOTE

About Search Measurements

The Agilent E5270 supports search measurement to find a point on an I-V curve where a specified condition is satisfied. For example, it searches for a breakdown voltage or threshold voltage at a specified current.

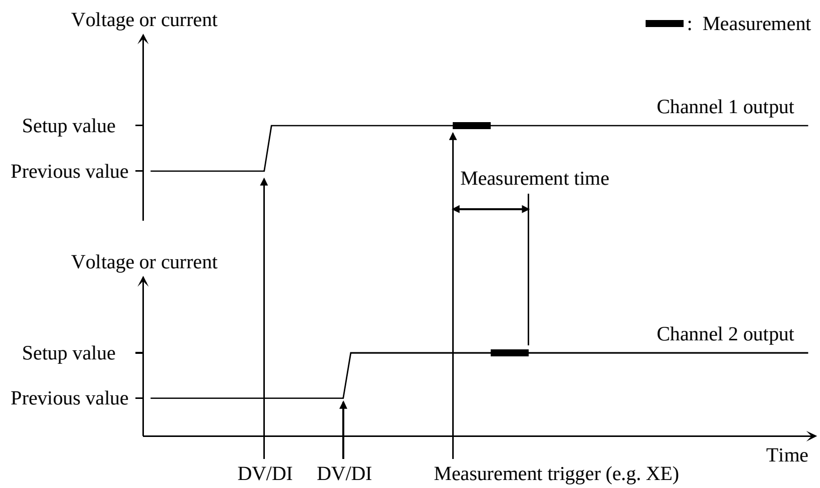
Search measurements are performed by one or two SMUs. For two SMUs, one is the search channel, and the other is a sense channel. When one SMU is used, it serves as both search and sense channel.

Basically, the search channel forces voltage or current until the search stop condition is satisfied.

Spot Measurements

Spot measurement is performed as shown below. The measurement channel performs one point measurement.

Figure 2-1 **Spot Measurements**



1. The source channel starts output by the DV or DI command.

   You can use up to eight channels for the 8-ch mainframe, two channels for the 2-ch mainframe.

2. The measurement channel starts measurement by a trigger, such as the XE command. If the trigger is received during the settling time of the source channels, measurement starts after the settling time.

   You can use up to eight channels for the 8-ch mainframe, two channels for the 2-ch mainframe. If you use multiple measurement channels, the channels perform measurement in the order defined in the MM command.

3. After measurement, the source channels continue the source output.

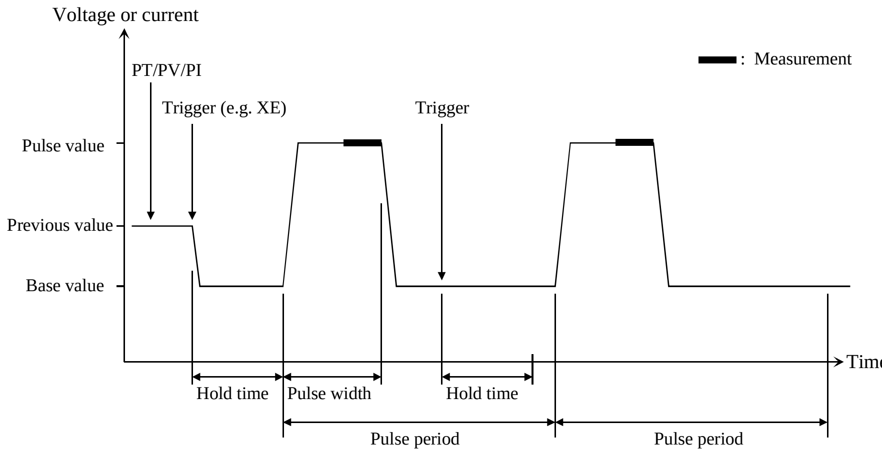
   For 0 V output, enter the DZ command that is used to memorize the present settings of the channel and change the output to 0 V.

NOTE The DV command is used to force voltage, and the DI command is used to force current.

Pulsed Spot Measurements

Pulsed spot measurement is performed as shown below. The measurement channel performs one point measurement while the source channel is forcing a pulse.

Figure 2-2 **Pulsed Spot Measurements**



1. The pulse source channel sets output by the PT command and the PV or PI command. Only one channel can be used for the pulse source.
2. The pulse source channel starts output by a trigger, such as the XE command.
3. The measurement channel starts measurement as shown in Figure 2-2.
   The channel performs measurement so that the pulse width and pulse period are kept (the integration time setting is ignored). Only one channel can be used for measurement.
4. After measurement, the pulse source channel forces the pulse base value.

   If the next trigger occurs within the pulse period, and if the rest of the pulse period is longer than the hold time as shown in Figure 2-2, the pulse source waits for the rest, then starts the pulse output immediately. If the rest of the pulse period is shorter than the hold time, the pulse source waits for the hold time since the last trigger, then starts the pulse output.

   For 0 V output, enter the DZ command that is used to memorize the present settings of the channel and change the output to 0 V.

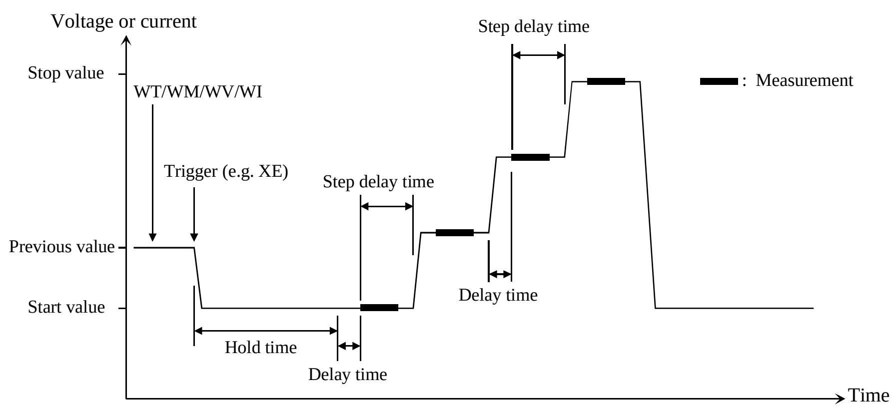
NOTE

The PT command sets the pulse timing parameters, such as pulse width and pulse period. The PV command sets voltage pulse, and the PI command sets current pulse.

Staircase Sweep Measurements

Staircase sweep measurement is performed as shown below. The source channel forces staircase sweep voltage or current, and the measurement channel performs one point measurement at each sweep step.

Figure 2-3 **Staircase Sweep Measurements**



1. The staircase sweep source sets output by the WT, WM, and WV or WI commands. Only one channel can be used for the sweep source.
2. The sweep source starts output by a trigger, such as the XE command.
3. After the hold time, the sweep source waits for the delay time.
4. After the delay time, the measurement channel starts measurement.

   You can use up to eight channels for the 8-ch mainframe, two channels for the 2-ch mainframe. If you use multiple measurement channels, the channels perform measurement in the order defined in the MM command.
5. After measurement, the sweep source waits for the rest of the step delay time if it is set, and the sweep source changes the output value.
6. The Agilent E5270 repeats 4 and 5 for all sweep steps.
7. After the sweep measurement, the sweep source forces the start or stop value, as specified by the WM command, and keeps it.

   For 0 V output, enter the DZ command that is used to memorize the present settings of the channel and change the output to 0 V.

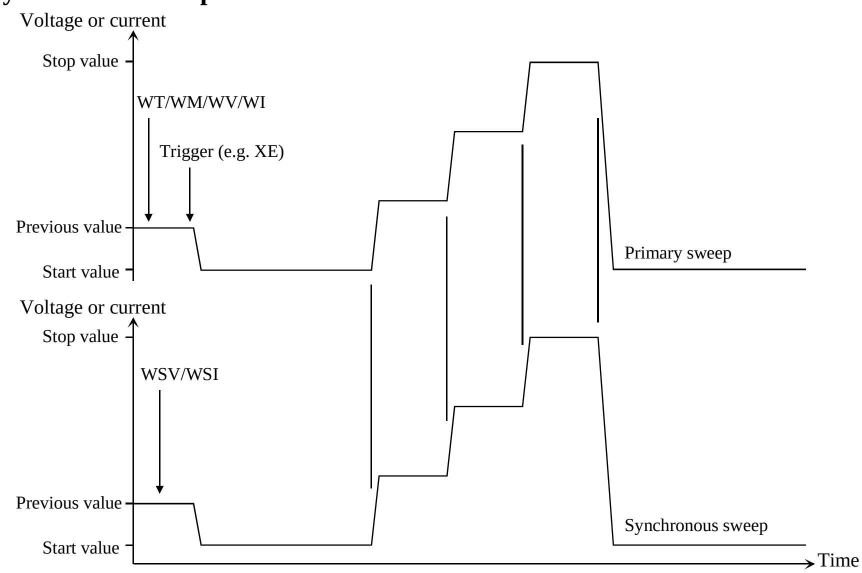
NOTE

The WT command sets the hold time, delay time, and step delay time. The WM command sets the automatic sweep abort function and the output after sweep. The WV command sets the sweep voltage, and the WI command sets the sweep current. The start and stop values must have the same polarity for log sweep.

To Use Synchronous Sweep Source

One more channel can be set up as a sweep source that has the output synchronized with the staircase sweep. Refer to "Synchronous Output" on page 2-21. After the measurement, the synchronous sweep source forces the start or stop value, as specified by the WM command, and keeps it.

Figure 2-4 **Synchronous Sweep**



NOTE

The WSV command sets the sweep voltage, and the WSI command sets the sweep current. You can use the same output mode (voltage or current) as the primary sweep. The start and stop values must have the same polarity for log sweep.

To Stop Sweep Output

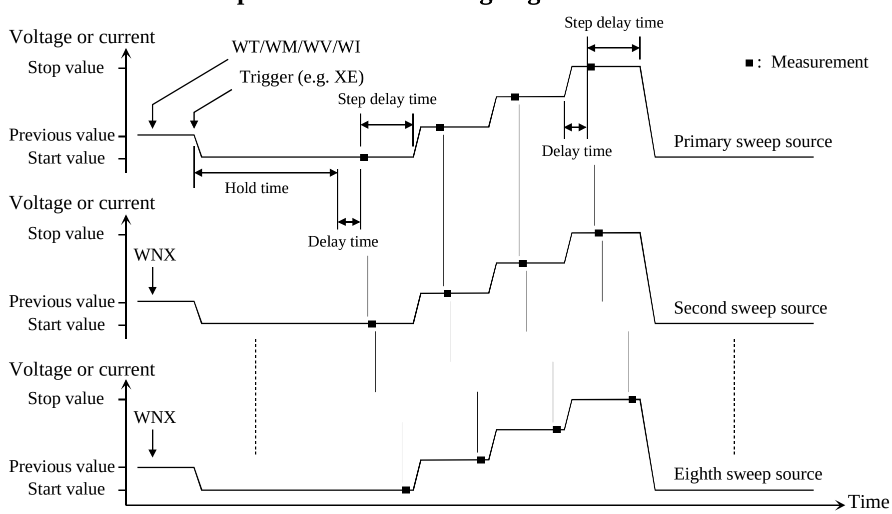
An automatic sweep abort function is available. Refer to "Automatic Sweep Abort Function" on page 2-23.

Even if the automatic sweep abort function is disabled, the Agilent E5270 automatically stops measurement if power compliance is enabled for the sweep source and the power compliance or an automatic sweep abort condition is detected.

Multi Channel Sweep Measurements

Multi channel sweep measurement is performed as shown below. The source channel forces staircase sweep voltage or current, and the measurement channel performs one point measurement at each sweep step. Up to eight channels can be used for both sweep output and measurement. Both voltage output mode and current output mode are available for the sweep sources regardless of the output mode of the primary sweep source.

Figure 2-5 **Multi Channel Sweep Measurements using High-Resolution A/D Converter**



1. The primary sweep source sets output by the WV or WI commands. And the *n*th (*n*=2 to 8) sweep source sets output by the WNX command.
2. The sweep sources simultaneously start output by a trigger, such as the XE command. However, if a sweep source sets power compliance or forces logarithmic sweep current, the sweep sources start output in the order specified by the *n* value. Then the first output is forced by the channel set by the WI or WV command.
3. After the hold time, the sweep sources wait for the delay time.
4. After the delay time, the measurement channel starts measurement. If you use multiple measurement channels, the channels that use the high-speed A/D converter with the fixed measurement ranging mode start measurement simultaneously, then other channels perform measurement in the order defined in the MM command.

5. After measurement, the sweep source waits for the rest of the step delay time if it is set, and the sweep source changes the output value.
6. The Agilent E5270 repeats 4 and 5 for all sweep steps.
7. After the sweep measurement, the sweep sources force the start or stop value, as specified by the WM command, and keep it.

   For 0 V output, enter the DZ command that is used to memorize the present settings of the channel and change the output to 0 V.

NOTE The WT command sets the hold time, delay time, and step delay time. The WM command sets the automatic sweep abort function and the output after sweep. The WV/WI command sets the output of the first sweep source, and the WNX command sets the output of the *n*th (*n*=2 to 8) sweep source. The start and stop values must have the same polarity for log sweep.

To Stop Sweep Output

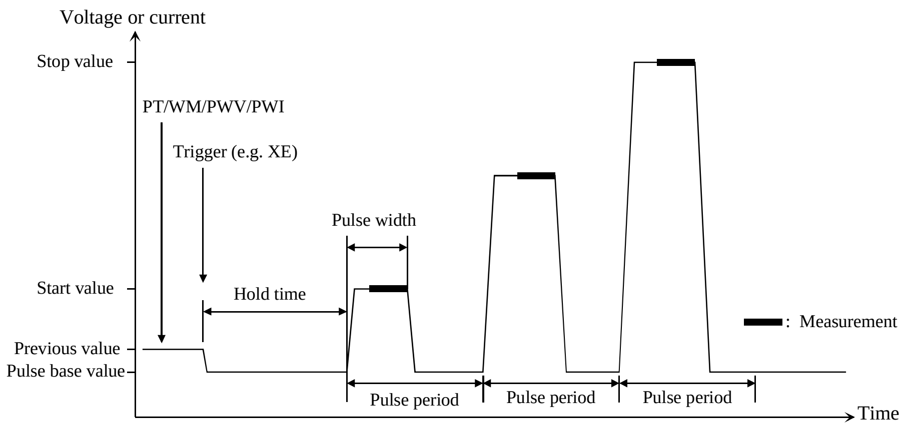
An automatic sweep abort function is available. Refer to “Automatic Sweep Abort Function” on page 2-23.

Even if the automatic sweep abort function is disabled, the Agilent E5270 automatically stops measurement if power compliance is enabled for the sweep source and the power compliance or an automatic sweep abort condition is detected.

Pulsed Sweep Measurements

Pulsed sweep measurement is performed as shown below. The source channel forces pulsed sweep voltage or current, and the measurement channel performs one point measurement at each sweep step.

Figure 2-6 **Pulsed Sweep Measurements**



1. The pulsed sweep source sets output by the PT, WM, and PWV or PWI commands. Only one channel can be used for the pulsed sweep source.
2. The pulsed sweep source starts output by a trigger, such as the XE command.
3. After the hold time, the measurement channel starts measurement as shown in Figure 2-6. The channel performs measurement so that the pulse width and pulse period are kept (the integration time setting is ignored). Only one channel can be used for measurement.
4. After measurement, the pulsed sweep source forces the pulse base value, and waits for the rest of the pulse period. Then the pulsed sweep source changes the output value.
5. The Agilent E5270 repeats 3 and 4 for all sweep steps.
6. After the pulsed sweep measurement, the pulsed sweep source forces the pulse base value, and keeps it.

   For 0 V output, enter the DZ command that is used to memorize the present settings of the channel and change the output to 0 V.

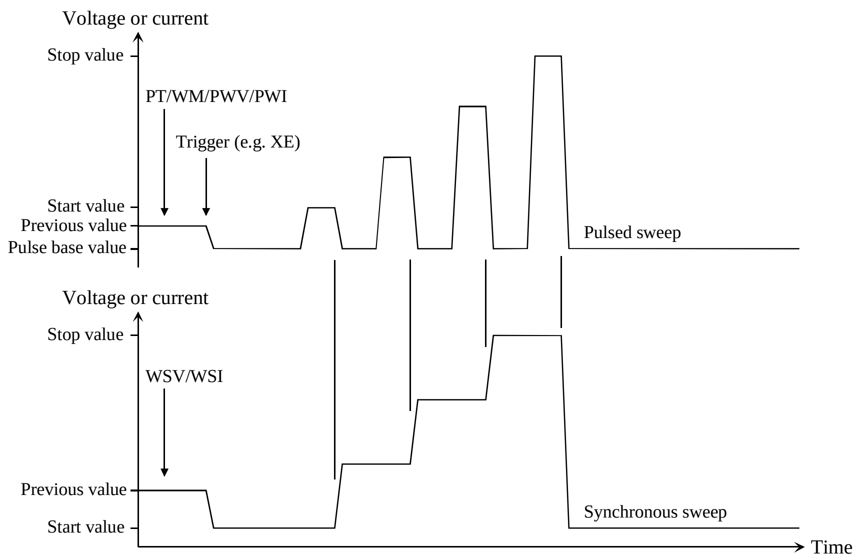
NOTE

The PT command sets the hold time, pulse width, and pulse period. The WM command sets the automatic sweep abort function and the output after sweep. The PWV sets the pulsed sweep voltage, and the PWI sets the pulsed sweep current. The start, stop, and pulse base values must have the same polarity for log sweep.

To Use Synchronous Sweep Source

One more channel can be set up as a staircase sweep source that has the output synchronized with the pulsed sweep. Refer to “Synchronous Output” on page 2-21. After the measurement, the synchronous sweep source forces the start value, and keeps it.

Figure 2-7 **Synchronous Sweep**



NOTE

The WSV command sets the sweep voltage, and the WSI command sets the sweep current. You can use the same output mode (voltage or current) as the pulsed sweep. The start and stop values must have the same polarity for log sweep.

To Stop Sweep Output

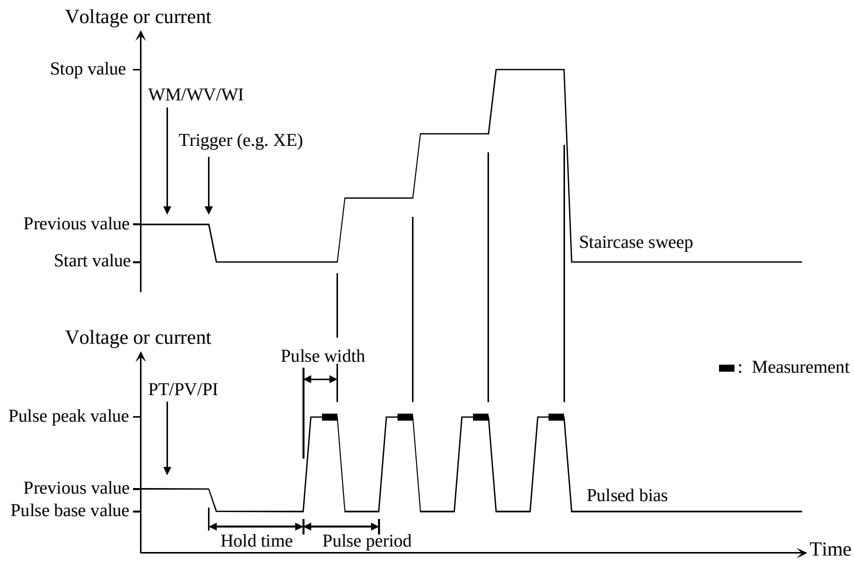
An automatic sweep abort function is available. Refer to “Automatic Sweep Abort Function” on page 2-23.

Even if the automatic sweep abort function is disabled, the Agilent E5270 automatically stops measurement if power compliance is enabled for the sweep source and the power compliance or an automatic sweep abort condition is detected.

Staircase Sweep with Pulsed Bias Measurements

Staircase sweep with pulsed bias measurement is performed as shown below. The source channel forces staircase sweep voltage or current, the pulse channel forces pulsed bias, and the measurement channel performs one point measurement at each sweep step.

Figure 2-8 **Staircase Sweep with Pulsed Bias Measurements**



1. The staircase sweep source sets output by the WM, and WV or WI commands. Only one channel can be used for the sweep source.
2. The pulsed source sets output by the PT, and PV or PI commands. Only one channel can be used for the pulsed source.
3. The source channels start output by a trigger, such as the XE command.
4. After the hold time, the measurement channel starts measurement as shown in Figure 2-8. The channel performs measurement so that the pulse width and pulse period are kept (the integration time setting is ignored). Only one channel can be used for measurement.
5. After the measurement, the sweep source changes the output value. Then the pulsed source forces the pulse base value, and waits for the rest of the pulse period until the next pulse output.
6. The Agilent E5270 repeats 4 and 5 for all sweep steps.

7. After the sweep measurement, the pulsed source forces the pulse base value, and the sweep source forces the start or stop value, as specified by the WM command, and keeps it.

   For 0 V output, enter the DZ command that is used to memorize the present settings of the channel and change the output to 0 V.

NOTE

The WM command sets the automatic sweep abort function and the output after sweep. The WV command sets the sweep voltage, and the WI command sets the sweep current. The start and stop values must have the same polarity for log sweep.

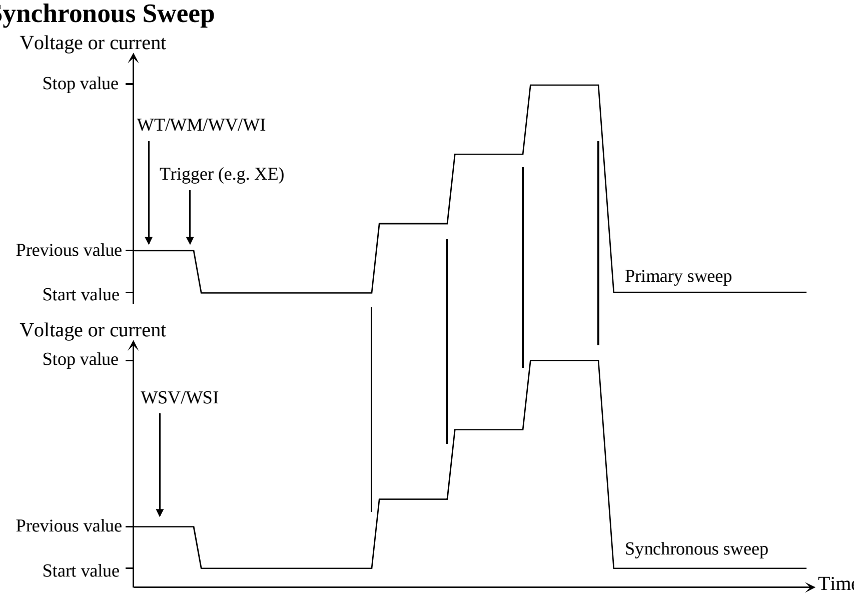
The PT command sets the pulse timing parameters, such as pulse width and pulse period. The PV command sets the voltage pulse, and the PI command sets current pulse.

To Use Synchronous Sweep Source

One more channel can be set up as a sweep source that has the output synchronized with the staircase sweep. Refer to “Synchronous Output” on page 2-21.

After the measurement, the synchronous sweep source forces the start or stop value, as specified by the WM command, and keeps it.

Figure 2-9 **Synchronous Sweep**



Remote Mode Functions
Measurement Modes

NOTE

The WSV command sets the sweep voltage, and the WSI command sets the sweep current. You can use the same output mode (voltage or current) as the primary sweep. The start and stop values must have the same polarity for log sweep.

To Stop Sweep Output

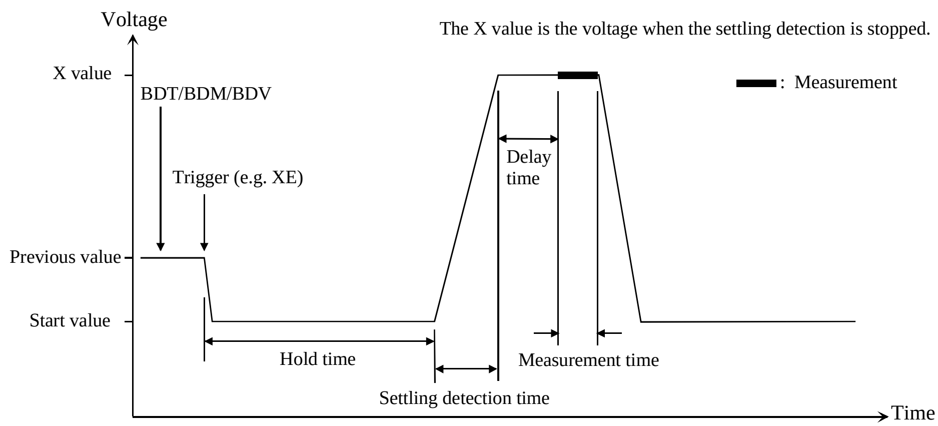
An automatic sweep abort function is available. Refer to "Automatic Sweep Abort Function" on page 2-23.

Even if the automatic sweep abort function is disabled, the Agilent E5270 automatically stops measurement if power compliance is enabled for the sweep source and the power compliance or an automatic sweep abort condition is detected.

Quasi-Pulsed Spot Measurements

Quasi-pulsed spot measurement is performed as shown below. The measurement channel performs one point measurement while the source channel forces a quasi-pulse voltage. This measurement mode can minimize the output time of the measurement voltage. So it is effective for the breakdown voltage measurement and the reliability test.

Figure 2-10 **Quasi-Pulsed Spot Measurements**



1. The quasi-pulse source channel sets output by the BDT, BDM, and BDV commands. Only one channel can be used for the quasi-pulse source.
2. The quasi-pulse source starts output by a trigger, such as the XE command.
3. After the hold time, the quasi-pulse source starts the voltage transition to the stop value (settling detection time). Also, it performs voltage measurement (settling detection) in the interval set by the BDM command. The voltage transition and settling detection continue until the output voltage slew rate becomes half of the rate when settling detection started. The slew rate depends on the cabling and the characteristics of the device. You cannot define it directly. In normal operation, the slew rate will be slower in the following conditions:
   - When the quasi-pulse source applies voltage close to the stop value.
   - When the quasi-pulse source reaches its current compliance due to the breakdown condition of the device under test.

NOTE

If the slew rate was too slow when settling detection started or if the settling detection time was too long, an error occurs and the source returns its output to the start value immediately. See "BDM" on page 4-25.

4. After the settling detection stops, the quasi-pulse source keeps the output.
5. After the delay time, the measurement channel starts measurement.
   Only one channel can be used for measurement.
6. After measurement, the quasi-pulse source immediately returns the output to the start value and keeps it.

   For 0 V output, enter the DZ command that is used to memorize the present settings of the channel and change the output to 0 V.

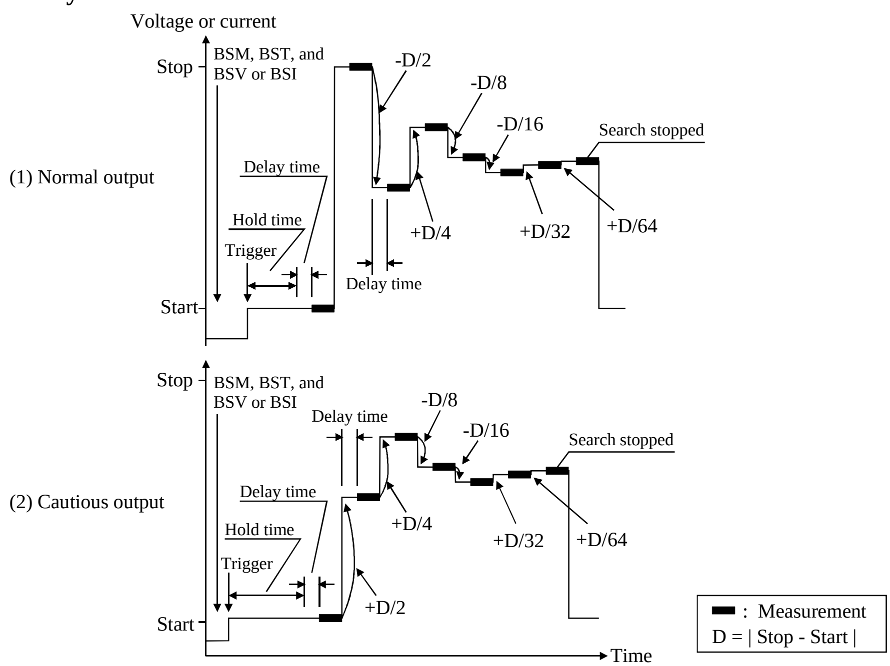
NOTE If there is noise or skew on the output voltage, settling detection might stop at an unexpected voltage.

NOTE The BDT command sets the hold time and delay time, and the BDM command sets the settling detection interval and measurement mode (voltage or current); the BDV command sets the output. Also |start - stop| must be 10 V or more.

Binary Search Measurements

Binary search measurement is performed as shown below. The source channel forces voltage or current, and the measurement channel performs one point measurement. The Agilent E5270 repeats this until the search stop condition is satisfied, and returns the source's last output value. The last measurement data is also returned if it is set by the BSVM command.

Figure 2-11 **Binary Search Measurements**



1. The search source sets output by the BSM, BST, and BSV or BSI commands. Only one channel can be used for the search source.
2. The search source starts output by a trigger, such as the XE command.
3. After the hold time, the measurement channel waits for the delay time, and starts measurement as shown in Figure 2-11. The measurement channel can be set by the BGI or BGV command. Only one channel can be used for measurement.
4. After measurement, the search source changes the output value. The output value depends on the output control mode, normal or cautious, selected by the BSM command. See Figure 2-11.

5. The Agilent E5270 repeats 3 and 4 until the search stop condition is satisfied. The search stop condition is one of the following conditions selected by the BGI or BGV command.

    - Measured value = Search target value ± limit
    - Number of measurement points > limit

6. After the search measurement, the search source forces the start value, the stop value, or the last output value, as specified by the BSM command, and keeps it.

    For 0 V output, enter the DZ command that is used to memorize the present settings of the channel and change the output to 0 V.

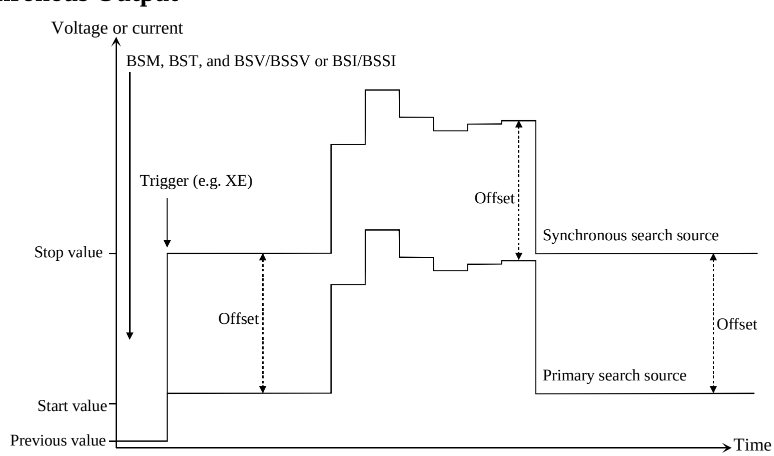
NOTE

The BSM command sets the search control mode, the automatic abort function, and the output after search. The BST command sets the hold time and delay time. The BSV/BSI command sets the search output, and the BGI/BGV command sets the measurement channel.

To Use Synchronous Output Channel

You can use the synchronous output channel that provides the output synchronized with the search source. Refer to “Synchronous Output” on page 2-21. After measurement, the synchronous channel forces the start+offset, stop+offset, or the last output value, as specified by the BSM command, and keeps it.

Figure 2-12 **Synchronous Output**



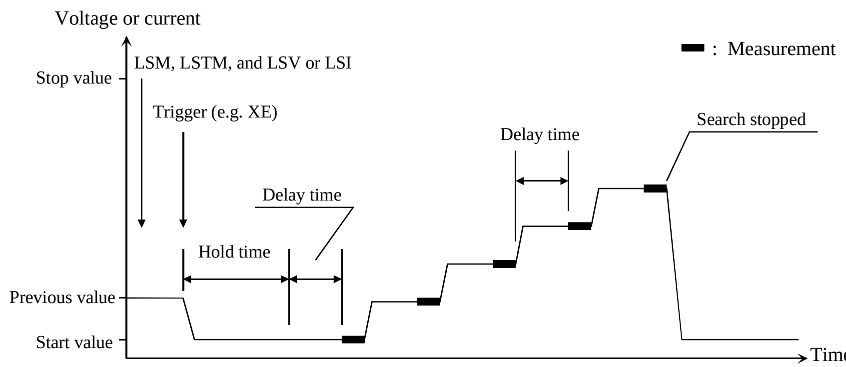
NOTE

The BSSV/BSSI command sets the synchronous output. You can use the same output mode (voltage or current) as the search source. All output values must be covered by the output range of the search source.

Linear Search Measurements

Linear search measurement is performed as shown below. The source channel sweeps voltage or current, and the measurement channel performs one point measurement at each sweep step. The Agilent E5270 stops sweep and measurement when the search stop condition is satisfied, and returns the source's last output value. The last measurement data is also returned if it is set by the LSVM command.

Figure 2-13 **Linear Search Measurements**



1. The search source sets output by the LSM, LSTM, and LSV or LSI commands. Only one channel can be used for the search source.
2. The search source starts output by a trigger, such as the XE command.
3. After the hold time, the measurement channel waits for the delay time, and starts measurement as shown in Figure 2-13. The measurement channel can be set by the LGI or LGV command. Only one channel can be used for the measurement.
4. After measurement, the search source changes the output value.
5. The Agilent E5270 repeats 3 and 4 until the search stop condition is satisfied. The search stop condition is one of the following conditions selected by the LGV or LGI command.
   - Measured value is over the search target value.
   - Measured value breaks the search target value.
6. After the search measurement, the search source forces the start value, the stop value, or the last output value, as specified by the LSM command, and keeps it.

   For 0 V output, enter the DZ command that is used to memorize the present settings of the channel and change the output to 0 V.

NOTE

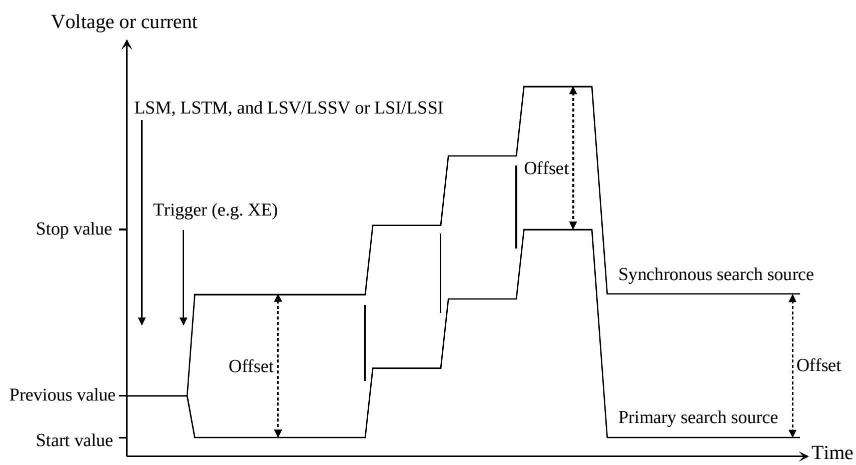
The LSM command sets the automatic abort function and the output after search. The LSTM command sets the hold time and delay time. The LSV/LSI command sets the search output, and the LGI/LGV command sets the measurement channel.

To Use Synchronous Output Channel

You can use the synchronous output channel that provides output synchronized with the search source. Refer to “Synchronous Output” on page 2-21.

After measurement, the synchronous channel forces the start+offset, stop+offset, or the last output value, as specified by the LSM command, and keeps it.

Figure 2-14 **Synchronous Output**



NOTE

The LSSV/LSSI command sets the synchronous output. You can use the same output mode (voltage or current) as the search source. All output values must be covered by the output range of the search source.

Synchronous Output

You can use synchronous output that will be synchronized to the output of the primary sweep or search source. See Figure 2-15 and Figure 2-16. Synchronous output is available for the following measurement modes and set by the following commands:

Measurement Mode	Command
"Staircase Sweep Measurements"	WSI or WSV
"Pulsed Sweep Measurements"	WSI or WSV
"Staircase Sweep with Pulsed Bias Measurements"	WSI or WSV
"Binary Search Measurements"	BSSI or BSSV
"Linear Search Measurements"	LSSI or LSSV

The synchronous source supports the same output mode (voltage or current) as the primary source, and does not support pulsed output.

Parameters

The following parameters are used to set up a synchronous output. For details of the commands, refer to Chapter 4, "Command Reference."

- For the WSI and WSV commands:

  start Synchronous sweep start value.

  stop Synchronous sweep stop value.

  The start and stop values must have the same polarity for logarithmic sweep.

- For the BSSI, BSSV, LSSI, and LSSV commands:

  offset Offset value from the search source output.

  polarity Polarity (+ or `-`) of the synchronous source output.

  Synchronous output is given by one of the following formulas:

  - *Synchronous output* = *primary source output* + *offset*
  - *Synchronous output* = `-1`× *primary source output* + *offset*

  All output values must be covered by the output range of the search source.

Figure 2-15 **Synchronous Sweep Output Example for Staircase Sweep**

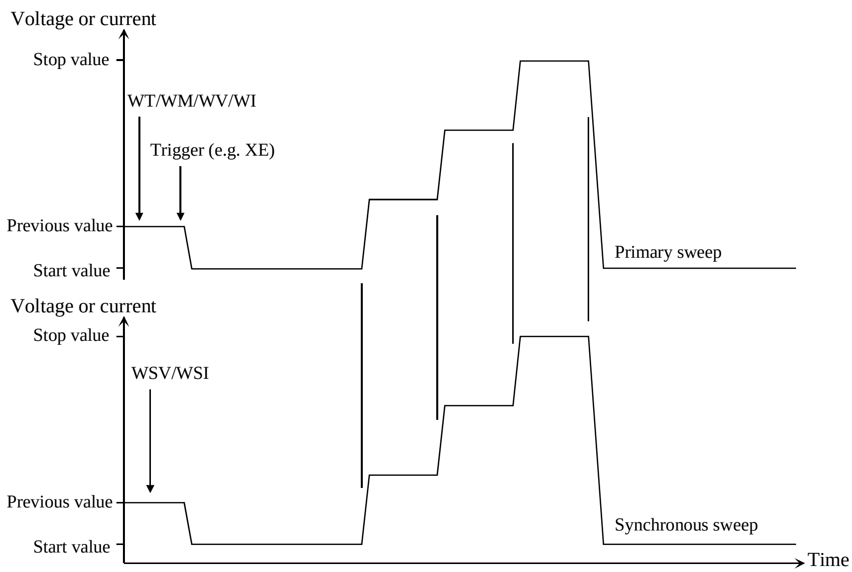
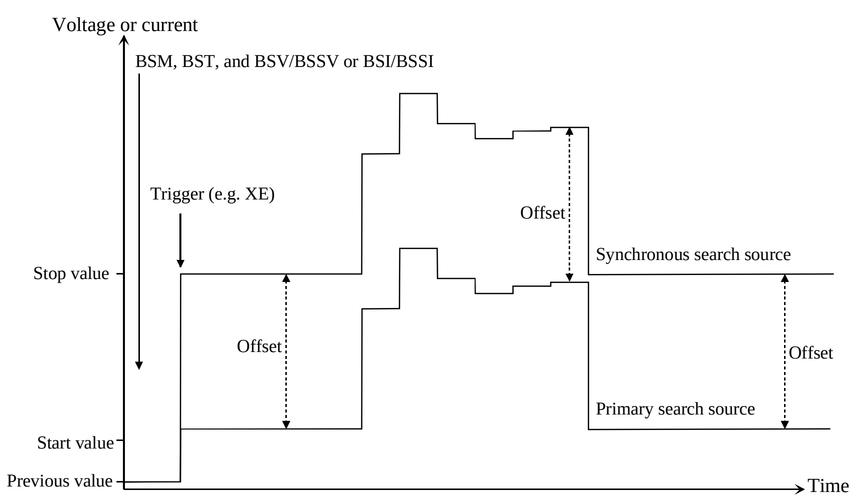


Figure 2-16 **Synchronous Output Example for Binary Search**



Automatic Sweep Abort Function

The automatic sweep abort function stops sweep (increasing or decreasing source output value) when one of the following conditions occurs. This function is useful to reduce sweep time and to prevent damage to the device during sweep measurement.

- The output reaches voltage compliance or current compliance
- A measurement value exceeds the specified measurement range
- An SMU oscillates

The automatic abort function is enabled by using the WM, LSM, or BSM command. This function is available for the following measurement modes:

- "Staircase Sweep Measurements"
- "Staircase Sweep with Pulsed Bias Measurements"
- "Multi Channel Sweep Measurements"
- "Pulsed Sweep Measurements"
- "Linear Search Measurements" and "Binary Search Measurements"

When abort occurs After sweep or search is aborted, the source forces the following value. And then the dummy data (199.999E+99) is returned for measurement points not reached.

- Start value (for staircase sweep source and search source)
- Pulse base value (for pulsed source and pulsed sweep source)

Output after sweep You can specify the post sweep condition for normal sweep end. The source output value is set by the WM, LSM, or BSM command, and it can be one of the following values:

- Start value
- Stop value
- Last output value (for search measurement)

The setting is not effective for the pulsed sweep measurement.

NOTE Even if the output after sweep value is set, the source forces the start value if output is stopped by the automatic abort function, power compliance, or AB command.

Program Memory

The program memory is a volatile memory that is used to store command strings temporarily. The Agilent E5270 has a built-in program memory that can store 2,000 programs maximum, and a total of 40,000 commands.

The program memory can eliminate several processes in the program execution, such as transferring commands, checking command syntax, and converting commands to the internal codes. Thus, using the program memory speeds up program execution. If frequently used command strings are stored in the program memory, GPIB/computer activity is minimized.

Using Program Memory

You can store, execute, read, and delete programs in the program memory as shown below. For details on each command, refer to Chapter 4, “Command Reference.”

To store programs

Send the ST and END commands to store a program. The following procedure stores a program (program number *n*) in the program memory. A multiple command string is also available.

1. `OUTPUT @E5270;"ST n"`

   where, *n* is the program number for the program now stored in the program memory. The value must be an integer, 1 to 2000.

2. `OUTPUT @E5270;"XXXX"`

   where, *XXXX* must be the command you want to store in the program memory. Repeat this until all required commands are stored.

   Table 2-1 lists the invalid commands for the program memory.

3. `OUTPUT @E5270;"END"`

NOTE

The program must be complete and free of errors.

An error occurs if the program memory overflows while a program is being stored.

If you store a new program using an existing program number, the old program is deleted and the new program is stored.

To call programs from a memory program

A memory program can invoke another memory program by storing the DO or RU command in the memory program. Up to eight levels of nesting are available. The first level is always the DO or RU command sent by the external computer.

To execute programs

Send the RU or DO command to execute the memory program.

- `OUTPUT @E5270;"RU 1,5"`

  This example executes the programs numbered 1 through 5 sequentially. These programs must be stored in the memory.

- `OUTPUT @E5270;"DO 1,2,3,4,5"`

  This example executes programs 1, 2, 3, 4, and 5 in this order. These programs must be stored in the memory. A maximum of eight numbers can be specified.

To use variables

You can use variables in the memory programs. To enter the value to the variable, send the VAR command. If the variable is referred by multiple programs or commands, set or change the value carefully so that the program works fine without errors. Format of the variable is %*tn* (*t*: integer I or real R, *n*: integer, 1 to 99).

In the following example, the first line stores a program (program 99) which uses the `%I50` variable. The second line enters 2 to `%I50`, and executes the program 99.

```
OUTPUT @E5270;"ST99;CN%I50;DV%I50,0,2;TI%I50;CL%I50;END"
OUTPUT @E5270;"VAR0,50,2;DO99"
```

To read programs

To read the program numbers of the memory programs, send the LST? command without a command parameter.

To read the contents of a memory program, send the LST? command with the program number as shown below. Up to 3000 commands can be read by one command execution.

```
OUTPUT @E5270;"LST? 100"
```

To delete programs

To delete all memory programs, send the SCR command without a parameter.

To delete a memory program, send the SCR command with the program number as shown below.

```
OUTPUT @E5270;"SCR 100"
```

NOTE

Turning off the instrument also clears the program memory. The device clear and *RST commands do not clear the program memory.

Table 2-1 **Invalid Commands for Program Memory**

Category	GPIB Command
Reset	*RST
Diagnostics	DIAG?
Self-test	*TST?
Self Calibration	CA
	*CAL?
	CM
Abort	AB
Channel Control	RCV
	WZ?
Program Memory	ST
	END
	SCR
	VAR?
	LST?
16 bit Control Port	ERS?
Query	ERR?
	EMG?
	*IDN?
	LOP?
	*LRN?
	NUB?
	*OPC?
	UNT?
	WNU?
Status Byte	*SRE?
	*STB?

Digital I/O Port

The digital I/O port is used for the trigger input/output terminals or an interface to control an external relay circuit and so on. For the trigger input/output, refer to "Trigger Function". For another usage, the following commands are available:

ERM Changes the digital I/O port assignments.

ERS? Returns the digital I/O port status.

ERC Changes the output status of the digital I/O port

Connector type of the digital I/O port is D-Sub 25-pin. The pin assignment is shown in Table 2-2. In the initial setting, the all port forces TTL high level (approx. 2.4 V. TTL low is approx. 0.8 V). The above commands are available for non trigger ports from DIO 1 to DIO 16.

Table 2-2 **Digital I/O Pin Assignment**

Description	Pin Number		Description
GND	25	13	GND
NC	24	12	NC
NC	23	11	NC
DIO 15 (bit 15)	22	10	DIO 16 (bit 16)
DIO 13 (bit 13)	21	9	DIO 14 (bit 14)
DIO 11 (bit 11)	20	8	DIO 12 (bit 12)
DIO 9 (bit 9)	19	7	DIO 10 (bit 10)
DIO 7 (bit 7)	18	6	DIO 8 (bit 8)
DIO 5 (bit 5)	17	5	DIO 6 (bit 6)
DIO 3 (bit 3)	16	4	DIO 4 (bit 4)
DIO 1 (bit 1)	15	3	DIO 2 (bit 2)
NC	14	2	NC
		1	NC

Accessories

The following accessories are available to connect the Digital I/O port.

- Agilent 16493G Digital I/O connection cable

  Used to connect the Digital I/O port to a D-Sub (f) 25-pin connector. This cable should be connected between two E5270s, or between the E5270 and the N1253A-200 BNC box. Cable length depends on the following option items:

  16493G-001: Approx. 1.5 m

  16493G-002: Approx. 3 m

- Agilent N1253A-100 Digital I/O T-cable

  Used to connect the Digital I/O port to a D-Sub (f) 25-pin connector and a D-Sub (m) 25-pin connector. This cable must be used to connect three or more E5270s. Cable length is as following:

  - D-Sub (m) to D-Sub (m): Approx. 1.5 m

    Both connectors should be connected to the Digital I/O ports.

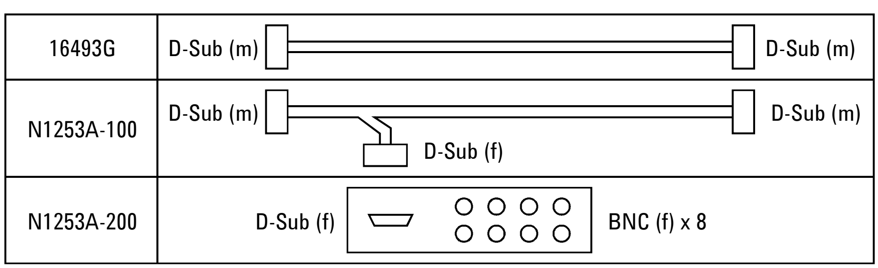
  - D-Sub (m) to D-Sub (f): Approx. 30 cm

    The D-Sub (f) connector should be connected to the additional N1253A-100 or the 16493G cable to connect the third or following E5270.

- Agilent N1253A-200 Digital I/O BNC box

  Used to convert the D-Sub connector to the BNC connectors. Only the DIO 1 to DIO 8 are connected to the BNC (f) connectors individually. To use the BNC box, connect the 16493G cable between the Digital I/O port and the BNC box.

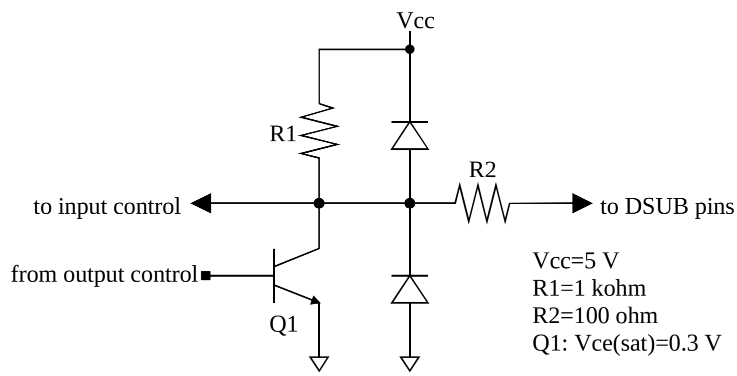
Figure 2-17 Accessories for Digital I/O Port



Digital I/O Internal Circuit

The following figure shows the input/output circuits internally connected to each port/pin of the Digital I/O connecter.

Figure 2-18 **Digital I/O Internal Circuit**



Trigger Function

The Agilent E5270 can be synchronized with other equipment, such as capacitance meters, voltmeters, ammeters, probers, handlers and so on, by using the following terminals:

- Ext Trig In

  BNC connector. Only for trigger input (to receive trigger).

- Ext Trig Out

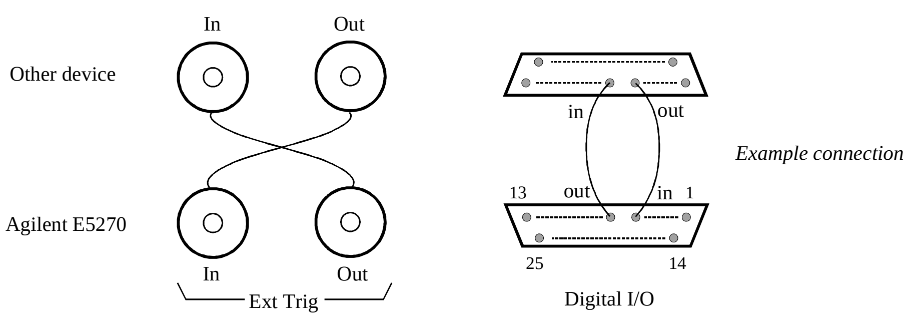
  BNC connector. Only for trigger output (to send trigger).

- Digital I/O

  D-Sub 25-pin connector. Sixteen paths are available for the trigger port. Each path can be used for either input or output. For the pin assignment and accessories, refer to "Digital I/O Port".

Figure 2-19 shows a connection example of the Agilent E5270 and another device.

Figure 2-19 **Connecting Trigger Input/Output**

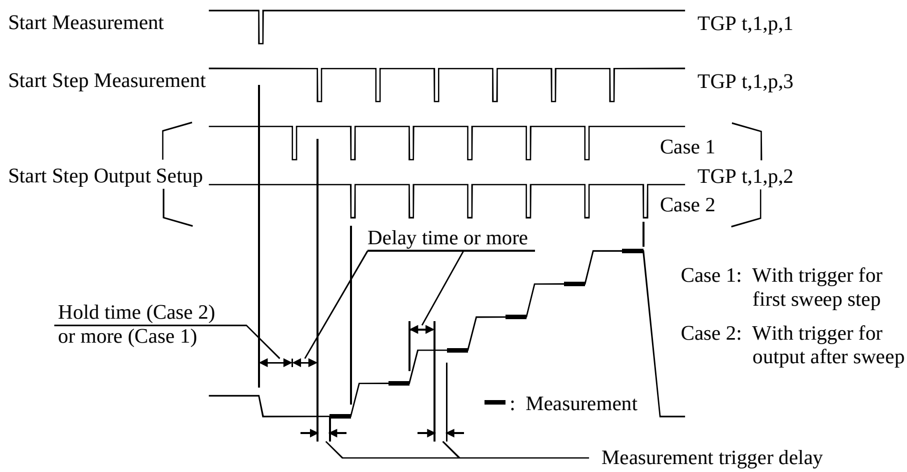


NOTE To use the digital I/O port for the trigger input/output port, send the TGP command. DIO 1 to DIO 16 can be used for the trigger input/output port. See Table 2-2.

Trigger Input

A trigger input operation example is shown in Figure 2-20. Measurement or source output can be started by the input trigger sent through the port specified by the TGP command. See Table 2-3.

Figure 2-20 **Trigger Input Example, Staircase Sweep Measurement, Negative Logic**



Initial Settings

The following functions are available in the initial settings:

- Trigger port: Ext Trig In
- Trigger type: Start Measurement (type 1)
- Commands for the trigger wait: WS, TM3, or PA with TM3

Input Trigger

The Agilent E5270 responds to the input trigger (minimum pulse width 10 µs) that changes the signal level from high (approx. 2.4 V) to low (approx. 0.8 V). This is negative logic. You can change it to positive logic by using the third parameter of the TGP command.

Measurement Trigger Delay

Delay time from a trigger input to starting a step measurement. The delay time is available for the Start Step Measurement trigger (type 3). You can set the delay time value by using the WT command.

PA/PAX/WS/WSX Commands

The commands put the Agilent E5270 in the trigger wait state. The Agilent E5270 can recover from the wait state if an external trigger is sent to a trigger input port. You can use the commands regardless of the trigger type.

If you use the PA or PAX command to put the Agilent E5270 in the trigger wait state, send the TM3 command before the PA or PAX command.

Table 2-3 Type of Trigger Input

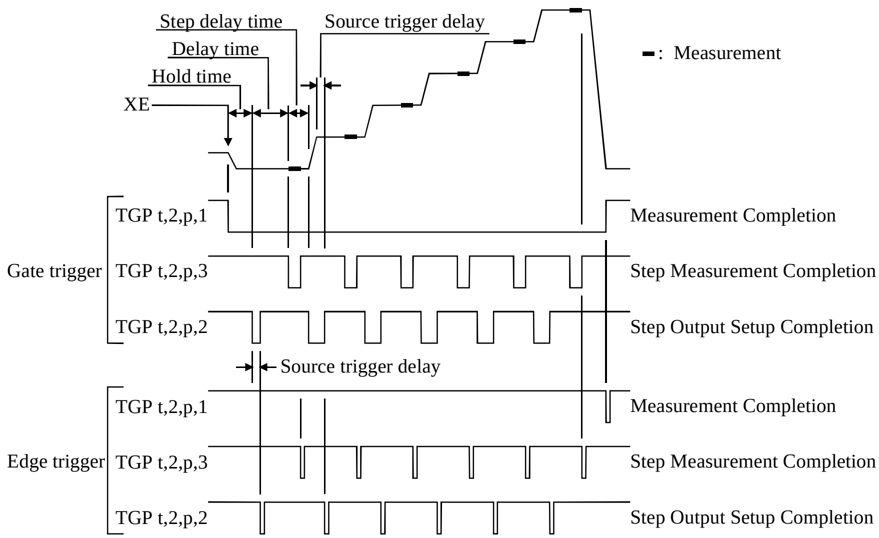
Type	Agilent E5270 Operation by Input Trigger	Command[a]
1	Starts the measurement specified by the MM command.	TGP *t*,1,*p*,1 TM3
2	The sweep source starts to set the sweep step output. The pulse source starts to set the pulsed output. This trigger type is available for the staircase sweep, pulsed spot, pulsed sweep, staircase sweep with pulsed bias, or multi channel sweep measurement.	TGP *t*,1,*p*,2 TGSI *m*
3	Waits for the measurement trigger delay, and starts the sweep step measurement. This trigger type is available for the staircase sweep and multi channel sweep measurement.	TGP *t*,1,*p*,3

a. *t* selects trigger input terminal, Ext Trig In or a digital I/O path.
p selects positive or negative logic of the trigger.
m selects Case 1 or Case 2 of the trigger type 2 (see Figure 2-20).

Trigger Output

A trigger output operation example is shown in Figure 2-21. When the measurement or source output setup is completed, the output trigger is sent through the port specified by the TGP command. See Table 2-4.

Figure 2-21 **Trigger Output Example, Staircase Sweep Measurement, Negative Logic**



Initial Settings

The following functions are available in the initial settings:

- Trigger port: Ext Trig Out
- Trigger type: Measurement Completion (type 1)
- Commands for the trigger output: OS

Output Trigger

An edge trigger or a gate trigger will be sent when an operation is completed (see Figure 2-22). Initially, the negative edge trigger is sent.

Source Trigger Delay

Delay time from when the source output setup is completed until an edge trigger is sent or a gate trigger level is returned. The delay time is available for the Step Output Setup Completion trigger (type 2). You can set the delay time value by using the WT command.

OS/OSX Commands

The command is used to send a trigger immediately from a trigger output terminal. You can use the commands regardless of the trigger type.

Using Multiple Channels

If you use the multiple measurement channels, an edge trigger will be sent or a gate trigger level will be returned when the measurement is completed by all channels.

For the multi channel sweep measurement, an edge trigger will be sent or a gate trigger level will be returned when the source output setup is completed by all channels, or when the measurement is completed by all channels.

Figure 2-22 **Output Trigger**

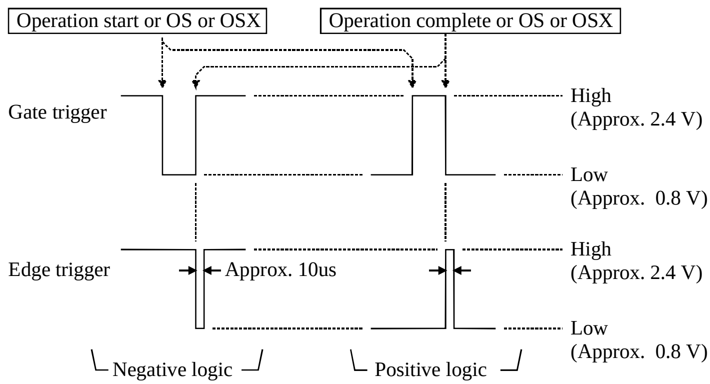


Table 2-4 **Type of Trigger Output**

Type	Timing of Trigger Output by Agilent E5270	Command[a]
1	When the measurement specified by the MM command is completed.	TGP *t*,2,*p*,1 TGXO *m* TM3
2	When the source trigger delay time is elapsed after the sweep step output setup or pulse output setup is completed. Available for the staircase sweep, pulsed spot, pulsed sweep, staircase sweep with pulsed bias, and multi channel sweep measurement.	TGP *t*,2,*p*,2 TGSO *m*
3	When the measurement is completed at each sweep step for the staircase sweep or multi channel sweep measurement.	TGP *t*,2,*p*,3 TGMO *m*

a. *t* selects the trigger output terminal, Ext Trig Out or a digital I/O. *p* selects positive or negative logic. *m* selects edge or gate trigger.

Using Trigger Function

- "To Make Wait State Using PA/PAX"
- "To Make Wait State Using WS/WSX"
- "To Send Trigger Using OS/OSX"
- "To Receive Measurement Trigger"
- "To Specify Trigger Port and Receive Trigger"
- "To Control Measurement Timing Using External Trigger"

To Make Wait State Using PA/PAX

The PA or PAX command puts the Agilent E5270 into a wait state. The Agilent E5270 can be recovered from the wait state when the specified wait time elapses, or when an event selected by the TM command occurs. Then the Agilent E5270 executes the commands following the PA/PAX command. The event only releases the wait state set by the PA/PAX command.

The wait time parameter is available for the PA/PAX command. If you specify the wait time, the wait state continues until the time has elapses or until the event occurs.

Available value: -99.9999 to 99.9999 s, in 100 μs resolution.

If you set a negative value, the wait state is kept until the event occurs.

You can select the event by using the TM command. If you want to use an external trigger as the event, enter the TM3 command. Then the PA/PAX command waits for the XE command execution, or:

- PA waits for a trigger sent to the Ext Trig In terminal.
- PAX waits for a trigger sent to the specified terminal.

In the initial setting, negative logic is available. To change it to positive, send the TGP command.

NOTE

The TM command is used to select the event effective for starting measurement, or releasing the wait time set by the PA or PAX command. Enter the TM command before the PA or PAX command.

To Make Wait State Using WS/WSX

The WS or WSX command puts the Agilent E5270 into a wait state. The Agilent E5270 can be recovered from the wait state by an external trigger. Then the Agilent E5270 executes the commands following the WS/WSX command. The external trigger only releases the wait state set by the WS/WSX command.

- WS waits for a trigger sent to the Ext Trig In terminal.
- WSX waits for a trigger sent to the specified terminal.

In the initial setting, the negative logic is available. To change it to the positive, send the TGP command.

If you want to end a wait state before receiving an external trigger, enter the AB or *RST command, or use the device clear (HP BASIC CLEAR statement) if any other commands have already been entered.

NOTE For easy programming, do not enter the TM command, or use the TM1, TM2, or TM4 event mode. The TM3 event mode will complicate programming.

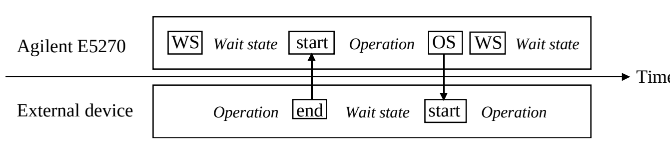
To Send Trigger Using OS/OSX

To trigger an external device from the Agilent E5270, use the OS or OSX command.

- OS sends an edge trigger to the Ext Trig Out terminal.
- OSX sends a trigger to the specified terminal.

In the initial setting, negative logic is available. To change it to positive, send the TGP command.

Enter the WS/WSX command immediately after the OS/OSX command. Then the Agilent E5270 triggers an external device to start its operation by the OS/OSX, and waits for an operation complete trigger from the external equipment. This scenario ensures that the Agilent E5270 and external equipment operations do not overlap.



To Receive Measurement Trigger

To use an external trigger just for starting measurement, instead of the XE command, perform the next step. This is not effective for the high speed spot measurement.

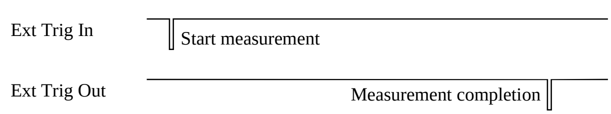
1. Connect a BNC cable between the Ext Trig In connector and a trigger output connector of an external device.
2. Create a control program. Then the TM3 command and HP BASIC ENTER statement should be entered as shown in the following example:

```
       :
OUTPUT @E5270;"MM1"     ! Sets spot measurement mode
       :                ! Sets measurement condition
       :
OUTPUT @E5270;"TM3"     ! Uses external trigger
ENTER @E5270 USING "#,3X,12D,2X";M_data
       :
```

3. Execute the control program.

   The Agilent E5270 sets the measurement conditions, and waits for an external trigger (negative trigger) sent to the Ext Trig In connector.

   When the trigger is received, the Agilent E5270 starts measurement. When measurement is completed, the Agilent E5270 sends a negative edge trigger to the Ext Trig Out connector, and puts the measurement data in the data output buffer.



NOTE

The HP BASIC ENTER statement pauses program execution until measurement data is put in the data buffer, reads the data from the buffer, and then continues program execution.

To Specify Trigger Port and Receive Trigger

To use an external trigger just for starting measurement, instead of the XE command, perform the next step. This is not effective for the high speed spot measurement.

This example specifies the trigger input/output ports and uses the gate trigger for the output trigger.

1. Connect a BNC cable between the Ext Trig In connector and a trigger output connector of an external device.

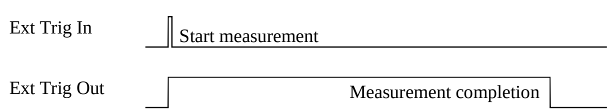
2. Create a control program. Then the TM3 and TGP commands and HP BASIC ENTER statement should be entered as shown in the following example:

```
       :
OUTPUT @E5270;"MM1"                ! Sets spot measurement mode
       :                           ! Sets measurement condition
       :
OUTPUT @E5270;"TM3"                ! Uses external trigger
OUTPUT @E5270;"TGP -1,1,1,1"       ! Sets trigger input
OUTPUT @E5270;"TGP -2,2,1,1"       ! Sets trigger output
OUTPUT @E5270;"TGXO 2"             ! Enables gate trigger
ENTER @E5270 USING "#,3X,12D,2X";M_data
       :
```

3. Execute the control program.

   The Agilent E5270 sets the measurement conditions, and waits for an external trigger (positive trigger) sent to the Ext Trig In connector.

   When the trigger is received, the Agilent E5270 starts measurement and sends a positive gate trigger to the Ext Trig Out connector. When measurement is completed, the Agilent E5270 returns the gate trigger level to logical low, and puts the measurement data in the data output buffer.



NOTE

The HP BASIC ENTER statement pauses program execution until measurement data is put in the data buffer, reads the data from the buffer, and then continues program execution.

To Control Measurement Timing Using External Trigger

Multiple trigger terminals will be used to control measurement timing. Refer to the following example that controls the staircase sweep measurement timing.

The example below uses the following triggers and terminals:

Trigger Name or Trigger Type	Terminal	TGP Command [a]
Start Measurement	Ext Trig In	`TGP -1,1,2,1`
Start Step Measurement	DIO 2	`TGP 2,1,2,3`
Start Step Output Setup	DIO 1	`TGP 1,1,2,2`
Measurement Completion	Ext Trig Out	`TGP -2,2,2,1`
Step Measurement Completion	DIO 12	`TGP 12,2,2,3`
Step Output Setup Completion	DIO 11	`TGP 11,2,2,2`

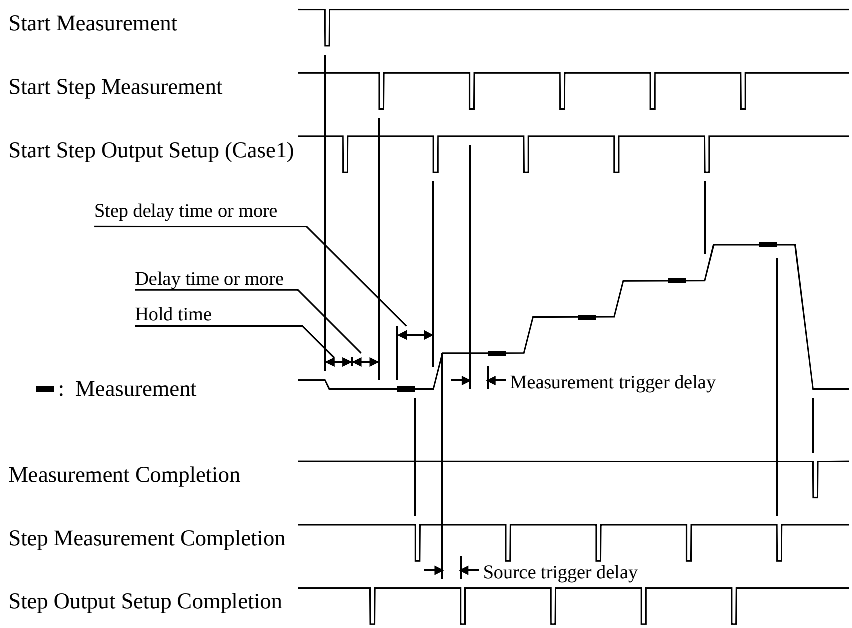
a. Parameters mean the port number, trigger input/output, positive/negative logic, and trigger type in this order from left.

Example

This example uses the negative edge trigger (set by the TGP and TGXO/TGMO/TGSO commands), and the Case 1 Start Step Output Setup trigger (set by the TGSI command). The WT command sets the hold time, delay time, step delay time, source trigger delay time, and the measurement trigger delay time.

```
       :
OUTPUT @E5270;"MM2"      ! Sets staircase sweep measurement mode
       :                 ! Sets measurement condition
       :
OUTPUT @E5270;"TM3"          !Uses external trigger
OUTPUT @E5270;"TGP -1,1,2,1" !Start Measurement trigger
OUTPUT @E5270;"TGP 2,1,2,3"  !Start Step Measurement trigger
OUTPUT @E5270;"TGP 1,1,2,2"  !Start Step Output Setup trigger
OUTPUT @E5270;"TGP -2,2,2,1" !Measurement Completion trigger
OUTPUT @E5270;"TGP 12,2,2,3" !Step Measurement Completion trigger
OUTPUT @E5270;"TGP 11,2,2,2" !Step Output Setup Completion trigger
OUTPUT @E5270;"TGXO 1"       !1:Edge trigger
OUTPUT @E5270;"TGMO 1"       !1:Edge trigger
OUTPUT @E5270;"TGSO 1"       !1:Edge trigger
OUTPUT @E5270;"TGSI 1"       !1:Case 1
OUTPUT @E5270;"WT";Hold,Delay,Sdelay,Tdelay,Mdelay
       :
FOR N=1 TO No_step
  ENTER @E5270 USING "#,3X,12D,2X";M_data
  PRINT "DATA";N;"=";M_data
NEXT N
       :
```

Figure 2-23 **Trigger Input/Output Example, Staircase Sweep, Negative Logic**



The Agilent E5270 sets the measurement conditions, sets the trigger ports, and waits for a Start Measurement trigger.

By the Start Measurement trigger, the Agilent E5270 starts the staircase sweep measurement.

By the Start Step Output Setup trigger, the Agilent E5270 waits until the source trigger delay is elapsed, and sends the Step Output Setup Completion trigger. If the trigger is received during the hold time, the Agilent E5270 performs this after the hold time.

By the Start Step Measurement trigger, the Agilent E5270 waits until the measurement trigger delay is elapsed, executes a step measurement, and sends the Step Measurement Completion trigger. If the trigger is received during the delay time, the Agilent E5270 performs this after the delay time.

By the next Start Step Output Setup trigger, the Agilent E5270 changes the source output value, and waits until the source trigger delay is elapsed, and sends the Step Output Setup Completion trigger. If the trigger is received during the step delay time, the Agilent E5270 performs this after the step delay time.

After the staircase sweep measurement, the Agilent E5270 sends the Step Measurement Completion trigger and the Measurement Completion trigger, and puts the measurement data in the data output buffer.

Trig In/Out Internal Circuit

The following figures show the trigger input/output circuits internally connected to the Trig In/Out connecters.

Figure 2-24 **Trigger Input Internal Circuit**

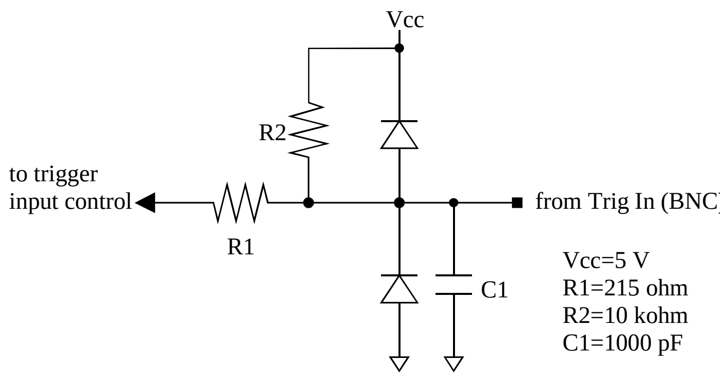
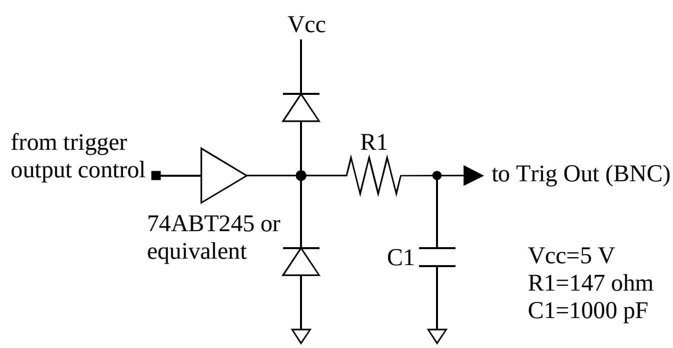


Figure 2-25 **Trigger Output Internal Circuit**



Initial Settings

Agilent E5270 is initialized by turning the E5270 on, the *RST command, or the device clear. Initial settings of the Agilent E5270 are shown in Table 2-5 and Table 2-6. Table 2-6 fits into one page, and lists all initial settings.

Table 2-5 Initial Settings

Setup Item	Initial Setting		Commands
Measurement channel	Channel assigned the lowest number.		MCH
Measurement data to be displayed	Data 1	Compliance side data	MPA
	Data 2	none	MPA
Output channel	Channel assigned the lowest number.		SCH
Output data to be displayed	Data 1	OUT	SPA
	Data 2	CPL	SPA
Data display format	ENGINEERING		DFM
Remote mode data display	off		RED
Remote mode key lock/unlock	unlock		KLC
Auto calibration	on		CM
ADC zero function	off		AZ
SMU output switch	open		CN, CL
Filter	off		FL
Series resistor	off		SSR
A/D converter	High speed ADC		AAD
Integration time	High speed ADC: auto		AIT
	High resolution ADC: auto		AIT

Setup Item	Initial Setting		Commands
AV command parameter	*number*=1, *mode*=0		AV
Current measurement range	with pulse	Compliance range	RI
	without pulse	auto	
Voltage measurement range	with pulse	Compliance range	RV
	without pulse	auto	
Sweep source parameters	cleared		WV, WSV, WI, WSI
Automatic sweep abort function	off		WM
Output after sweep measurement	Start value		WM
Pulse source parameters	cleared		PV, PI
Pulse sweep source parameters	cleared		PWV, PWI
Pulse width	0.001 s		PT
Pulse period	0.01 s		PT
Search source parameters	cleared		BSV, BSSV, BSI, BSSI, LSV, LSSV, LSI, LSSV
Search monitor parameters	cleared		BGV, BGI, LGV, LGI
Output after search measurement	Start value		BSM, LSM
Search measurement data	Source output value only		BSVM, LSVM
Quasi-pulse source parameters	cleared		BDV
Quasi-pulsed spot measurement mode	Voltage		BDM
Quasi-pulse settling detection interval	Short		BDM
Hold time	0 s		WT, PT, BDT, BST, LSTM

Setup Item	Initial Setting		Commands
Delay time	0 s		WT, PT, BDT, BST, LSTM
Step delay time	0 s		WT
Trigger delay time	0 s		WT, PT
Trigger mode	XE, TV, TI, or GET		TM
Trigger port	Ext Trig In	Start Measurement trigger input	TGP
	Ext Trig Out	Measurement Completion trigger output	TGP
	Digital I/O	cleared	TGP
Trigger condition of Start Step Output Setup trigger	with trigger for first sweep step		TGSI
Type of output trigger	Edge trigger		TGXO, TGSO, TGMO
Digital I/O port	Output for all port		ERM
Program memory	cleared [a]		SCR
Value of internal variable (%In, %Rn)	0		VAR
Data output format	ASCII with header, CR/LF^EOI		FMT
Data output buffer	cleared		BC
Status byte	Only bit 6 is enabled.		*SRE
Error code register	cleared		ERR?

a. Program memory is not cleared by the *RST command or the device clear.

Table 2-6 Initial Settings

Setup Item	Initial Setting		Commands
Measurement channel	Channel assigned the lowest number.		MCH
Measurement data to be displayed	Data 1	Compliance side data	MPA
	Data 2	none	MPA
Output channel	Channel assigned the lowest number.		SCH
Output data to be displayed	Data 1	OUT	SPA
	Data 2	CPL	SPA
Data display format	ENGINEERING		DFM
Remote mode data display	off		RED
Remote mode key lock/unlock	unlock		KLC
Auto calibration	on		CM
ADC zero function	off		AZ
SMU output switch	open		CN, CL
Filter	off		FL
Series resistor	off		SSR
A/D converter	High speed ADC		AAD
Integration time	High speed ADC: auto		AIT
	High resolution ADC: auto		AIT
AV command parameter	*number*=1, *mode*=0		AV
Current measurement range	with pulse	Compliance range	RI
	without pulse	auto	
Voltage measurement range	with pulse	Compliance range	RV
	without pulse	auto	
Sweep source parameters	cleared		WV, WSV, WI, WSI
Automatic sweep abort function	off		WM
Output after sweep measurement	Start value		WM
Pulse source parameters	cleared		PV, PI
Pulse sweep source parameters	cleared		PWV, PWI
Pulse width	0.001 s		PT
Pulse period	0.01 s		PT
Search source parameters	cleared		BSV, BSSV, BSI, BSSI, LSV, LSSV, LSI, LSSV
Search monitor parameters	cleared		BGV, BGI, LGV, LGI
Output after search measurement	Start value		BSM, LSM
Search measurement data	Source output value only		BSVM, LSVM
Quasi-pulse source parameters	cleared		BDV
Quasi-pulsed spot measurement mode	Voltage		BDM
Quasi-pulse settling detection interval	Short		BDM
Hold time	0 s		WT, PT, BDT, BST, LSTM
Delay time	0 s		WT, PT, BDT, BST, LSTM
Step delay time	0 s		WT
Trigger delay time	0 s		WT, PT
Trigger mode	XE, TV, TI, or GET		TM
Trigger port	Ext Trig In	Start Measurement trigger input	TGP
	Ext Trig Out	Measurement Completion trigger output	TGP
	Digital I/O	cleared	TGP
Trigger condition of Start Step Output Setup trigger	with trigger for first sweep step		TGSI
Type of output trigger	Edge trigger		TGXO, TGSO, TGMO
Digital I/O port	Output for all port		ERM
Program memory	cleared. Not cleared by *RST command or device clear.		SCR
Value of internal variable (%In, %Rn)	0		VAR
Data output format	ASCII with header, CR/LF^EOI		FMT
Data output buffer	cleared		BC
Status byte	Only bit 6 is enabled.		*SRE
Error code register	cleared		ERR?

3 Programming Examples

This chapter lists the GPIB commands required for each measurement mode, and provides the programming examples.

- “High-Speed Spot Measurements”
- “Spot Measurements”
- “Pulsed Spot Measurements”
- “Staircase Sweep Measurements”
- “Pulsed Sweep Measurements”
- “Staircase Sweep with Pulsed Bias Measurements”
- “Quasi Pulsed Spot Measurements”
- “Linear Search Measurements”
- “Binary Search Measurements”
- “Multi Channel Sweep Measurements”
- “Using Program Memory”
- “Using Trigger Function”
- “Reading Time Stamp Data”
- “Reading Binary Output Data”
- “Using Programs for 4142B”
- “Using Programs for 4155B/4156B/4155C/4156C”

Refer to Chapter 4, “Command Reference,” for the command syntax and descriptions of the Agilent E5270 GPIB commands.

The following command conventions are used in this chapter.

command	Required command for measurement execution.
[command]	Optional command for measurement execution.
parameter	Required command parameter. A value or variable *must* be specified.
[*parameter*]	Optional command parameter. A value may be specified.

NOTE

After the Automatic Measurement

After the automatic measurements, open the measurement terminals or disconnect the device under test from the measurement terminals. If you leave the connection with the device, the device may be damaged by unexpected operations.

Do not leave the connection over 30 minutes after measurement if the auto calibration is set to ON. Then, the Agilent E5270 performs the self-calibration automatically every 30 minutes after measurement. The calibration requires to open the measurement terminals.

To disable the auto calibration, enter the `CM 0` command.

High-Speed Spot Measurements

To perform high-speed spot measurements, use the following commands.

Function	Command	Parameters
Enables channels	CN	[*chnum* ... [,*chnum*] ...]
Disables channels	CL	[*chnum* ... [,*chnum*] ...]
Sets filter ON/OFF	[FL]	*mode*[,*chnum* ... [,*chnum*] ...]
Sets series resistor ON/OFF	[SSR]	*chnum*[,*mode*]
Sets integration time (use either AV command or AAD/AIT commands)	[AAD]	*chnum*[,*type*]
	[AIT]	*type*,*mode*[,*N*]
	[AV]	*number*[,*mode*]
Forces constant voltage	DV	*chnum*,*vrange*,*output* [,*comp*[,*polarity*[,*irange*]]]
Forces constant current	DI	*chnum*,*irange*,*output* [,*comp*[,*polarity*[,*vrange*]]]
Measures current	TI	*chnum*[,*range*]
Measures voltage	TV	*chnum*[,*range*]

You can use the DV/DI commands and TI/TV commands regardless of the measurement mode (MM command settings).

A program example of a high-speed spot measurement is shown below. This program executes current measurement, using the TI command, and prints the measured data on the screen.

```
10    ASSIGN @E5270 TO 717
20   !
30    INTEGER Fmt,Ninteg,Filter,Source,Drain,Gate,Sub
40    INTEGER Range_2v,Range_20v,Range_i,B,C
50    DIM B$[50]
60   !
70    Fmt=5             !1:ASCII with Header <,>
80    Ninteg=10         !Integ time=Ninteg x 80us
90    Filter=0          !0:off, 1:on
100   Source=1          !1:MPSMU in slot1
110   Drain=2           !2:MPSMU in slot2
120   Gate=3            !3:MPSMU in slot3
130   Sub=4             !4:MPSMU in slot4
140   Range_2v=11       !11: 2 V Limited Auto Ranging
150   Range_20v=12      !12:20 V Limited Auto Ranging
160   Range_i=15        !15:10 uA Limited Auto Ranging
170   Vs=0              ! Source Voltage
180   Vd=5              ! Drain Voltage
190   Vg=3              ! Gate Voltage
200   Vsub=0            ! Substrate Voltage
210   Icomp_g=.01       ! Current compliance for gate
220   Icomp=.1          ! Current compliance
230  !
240   OUTPUT @E5270;"FMT ";Fmt
250   OUTPUT @E5270;"CN ";Source,Drain,Gate,Sub
260   OUTPUT @E5270;"AAD ";Drain,1
270   OUTPUT @E5270;"AIT ";1,1,Ninteg
280   OUTPUT @E5270;"FL ";Filter
```

Line Number	Description
10	Assigns the I/O path to control the E5270.
70 to 220	Sets the value of the variables for source setup and so on.
240	Specifies the data output format.
250	Enables the source/measurement channels.
260	Uses the high-resolution ADC for the drain current measurement.
270	Sets the integration time for the high-resolution ADC.
280	Sets the filter off.

```
290   OUTPUT @E5270;"DV ";Source,Range_2v,Vs,Icomp
300   OUTPUT @E5270;"DV ";Sub,Range_2v,Vsub,Icomp
310   OUTPUT @E5270;"DV ";Gate,Range_20v,Vg,Icomp_g
320   OUTPUT @E5270;"DV ";Drain,Range_20v,Vd,Icomp
330  !
340   OUTPUT @E5270;"*OPC?"
350   ENTER @E5270;C
360  !
370   OUTPUT @E5270;"ERR? 1"
380   ENTER @E5270;B
390   IF B=0 THEN
400     OUTPUT @E5270;"TI ";Drain,Range_i
410     ENTER @E5270 USING "#,3X,12D,X";A
420     PRINT "Id(A)=";A
430   ELSE
440     OUTPUT @E5270;"EMG? ";B
450     ENTER @E5270;B$
460     PRINT "ERROR:";B$
470   END IF
480  !
490   OUTPUT @E5270;"CL"
500   END
```

Line Number	Description
290 to 320	Forces voltage.
340 to 350	Waits for the operation complete flag.
370 to 390	Checks for errors.
400 to 420	Executes a high-speed spot measurement and prints the results on the screen.
430 to 470	Displays an error message if an error has occurred.
490	Disables the source/measurement channels.

Spot Measurements

To perform spot measurements, use the following commands.

Function	Command	Parameters
Enables channels	CN	[*chnum* ... [,*chnum*] ...]
Disables channels	CL	[*chnum* ... [,*chnum*] ...]
Sets filter ON/OFF	[FL]	*mode*[,*chnum* ... [,*chnum*] ...]
Sets series resistor ON/OFF	[SSR]	*chnum*[,*mode*]
Sets integration time (use either AV command or AAD/AIT commands)	[AAD]	*chnum*[,*type*]
	[AIT]	*type*,*mode*[,*N*]
	[AV]	*number*[,*mode*]
Forces constant voltage	DV	*chnum*,*vrange*,*output* [,*comp*[,*polarity*[,*irange*]]]
Forces constant current	DI	*chnum*,*irange*,*output* [,*comp*[,*polarity*[,*vrange*]]]
Sets voltage measurement range	[RV]	*chnum*,*range*
Sets current measurement range	[RI]	*chnum*,*range*
	[RM]	*chnum*,*mode*[,*rate*]
Selects measurement mode	MM	1,*chnum*[,*chnum* ... [,*chnum*] ...]
Sets SMU operation mode	[CMM]	*chnum*,*mode*
Executes measurement	XE	

NOTE

If you use multiple measurement channels, the channels start measurement in the order defined in the MM command.

A program example of a spot measurement is shown below. This program executes current measurement and prints the measured data on the screen.

```
10    ASSIGN @E5270 TO 717
20   !
30    INTEGER Fmt,Average,Filter,Source,Drain,Gate,Sub
40    INTEGER Range_2v,Range_20v,Range_i,B
50    INTEGER Mmode,Smode,Mnum
60    DIM B$[50]
70   !
80    Fmt=5            !1:ASCII with Header <,>
90    Average=10       !Number of averaging samples
100   Filter=0         !0:off, 1:on
110   Source=1         !1:MPSMU in slot1
120   Drain=2          !2:MPSMU in slot2
130   Gate=3           !3:MPSMU in slot3
140   Sub=4            !4:MPSMU in slot4
150   Range_2v=11      !11: 2 V Limited Auto Ranging
160   Range_20v=12     !12:20 V Limited Auto Ranging
170   Range_i=15       !15:10 uA Limited Auto Ranging
180   Vs=0             ! Source Voltage
190   Vd=5             ! Drain Voltage
200   Vg=3             ! Gate Voltage
210   Vsub=0           ! Substrate Voltage
220   Icomp_g=.01      ! Current compliance for gate
230   Icomp=.1         ! Current compliance
240   Mmode=1          !1:Spot measurement
250   Smode=1          !1:Compliance side measurement
260  !
270   OUTPUT @E5270;"FMT ";Fmt
280   OUTPUT @E5270;"CN ";Source,Drain,Gate,Sub
290   OUTPUT @E5270;"AV ";Average,1
300   OUTPUT @E5270;"FL ";Filter
```

Line Number	Description
10	Assigns the I/O path to control the E5270.
80 to 260	Sets the value of the variables for source setup and so on.
270	Specifies the data output format.
280	Enables the source/measurement channels.
290	Sets the number of averaging samples for the high-speed ADC.
300	Sets the filter off.

```
310   OUTPUT @E5270;"DV ";Source,Range_2v,Vs,Icomp
320   OUTPUT @E5270;"DV ";Sub,Range_2v,Vsub,Icomp
330   OUTPUT @E5270;"DV ";Gate,Range_20v,Vg,Icomp_g
340   OUTPUT @E5270;"DV ";Drain,Range_20v,Vd,Icomp
350   OUTPUT @E5270;"MM ";Mmode,Drain
360   OUTPUT @E5270;"CMM ";Drain,Smode
370  !
380   OUTPUT @E5270;"ERR? 1"
390   ENTER @E5270;B
400   IF B=0 THEN
410     OUTPUT @E5270;"XE"
420     ENTER @E5270 USING "#,3X,12D,X";A
430     PRINT "Id(A)=";A
440   ELSE
450     OUTPUT @E5270;"EMG? ";B
460     ENTER @E5270;B$
470     PRINT "ERROR:";B$
480   END IF
490  !
500   OUTPUT @E5270;"CL"
510   END
```

Line Number	Description
310 to 340	Forces voltage.
350	Sets the measurement mode and the measurement channel.
360	Sets the SMU operation mode.
380 to 400	Checks for errors.
410	Executes a spot measurement.
420 to 430	Reads the measurement data and prints the results on the screen.
440 to 480	Displays an error message if an error has occurred.
500	Disables the source/measurement channels.

Pulsed Spot Measurements

To perform pulsed spot measurements, use the following commands.

Function	Command	Parameters
Enables channels	CN	[*chnum* ... [,*chnum*] ...]
Disables channels	CL	[*chnum* ... [,*chnum*] ...]
Sets filter ON/OFF	[FL]	*mode*[,*chnum* ... [,*chnum*] ...]
Sets series resistor ON/OFF	[SSR]	*chnum*[,*mode*]
Forces constant voltage	DV	*chnum*,*vrange*,*output* [,*comp*[,*polarity*[,*irange*]]]
Forces constant current	DI	*chnum*,*irange*,*output* [,*comp*[,*polarity*[,*vrange*]]]
Sets pulse timing parameters	PT	*hold*,*width*[,*period* [,*tdelay*]]
Forces pulse voltage	PV	*chnum*,*range*,*base*,*pulse*[,*comp*]
Forces pulse current	PI	*chnum*,*range*,*base*,*pulse* [,*comp*]
Sets voltage measurement range	[RV]	*chnum*,*range*
Sets current measurement range	[RI]	*chnum*,*range*
	[RM]	*chnum*,*mode*[,*rate*]
Selects measurement mode	MM	3,*chnum*
Sets SMU operation mode	[CMM]	*chnum*,*mode*
Executes measurement	XE	

NOTE

Measurement channel always uses the high-speed A/D converter, and performs measurement so that the pulse width and pulse period are kept. The integration time is automatically set by the Agilent E5270, and you cannot change. The AAD/AIT/AV/WT command settings are ignored.

A program example of a pulsed spot measurement is shown below. This program executes current measurement and prints the measured data on the screen.

```
10     ASSIGN @E5270 TO 717
20    !
30     INTEGER Emitter,Base,Collector,Mmode,Fmt,Filter
40     INTEGER Range,B
50     DIM B$[50]
60    !
70     Emitter=1       ! 1: MPSMU in slot1
80     Base=2          ! 2: MPSMU in slot2
90     Collector=3     ! 3: MPSMU in slot3
100    Fmt=5           ! 1:ASCII with Header <,>
110    Filter=0        ! Filter mode. 0: OFF, 1: ON
120    Range=0         ! Auto ranging
130    Vcomp=2         ! V compliance (V) for base/collector
140    Icomp=.1        ! I compliance (A) for emitter
150    Ve=0            ! Emitter voltage (V)
160    Ibbase=0        ! Base current base value (A)
170    Ibpulse=.005    ! Base current pulse value (A)
180    Ic=.05          ! Collector current (A)
190    Hold=0          ! Hold time (sec) of Ib
200    Width=.001      ! Pulse width (sec) of Ib
210    Mmode=3         ! 3: Pulsed spot measurement
220   !
230    OUTPUT @E5270;"FMT ";Fmt
240    OUTPUT @E5270;"CN ";Emitter,Base,Collector
250    OUTPUT @E5270;"FL ";Filter
260    OUTPUT @E5270;"PT ";Hold,Width
270    OUTPUT @E5270;"PI ";Base,Range,Ibbase,Ibpulse,Vcomp
```

Line Number	Description
10	Assigns the I/O path to control the E5270.
70 to 210	Sets the value of the variables for source setup and so on.
230	Specifies the data output format.
240	Enables the source/measurement channels.
250	Sets the filter off.
260	Sets the hold time and the pulse width.
270	Sets the pulse current source (base current).

```
280    OUTPUT @E5270;"DV ";Emitter,Range,Ve,Icomp
290    OUTPUT @E5270;"DI ";Collector,Range,Ic,Vcomp
300    OUTPUT @E5270;"MM ";Mmode,Collector
310   !
320    OUTPUT @E5270;"ERR? 1"
330    ENTER @E5270;B
340    IF B=0 THEN
350      OUTPUT @E5270;"XE"
360      ENTER @E5270 USING "#,3X,12D,X";Mdata
370      PRINT "Vce(V)= ";Mdata
380    ELSE
390      OUTPUT @E5270;"EMG? ";B
400      ENTER @E5270;B$
410      PRINT "ERROR:";B$
420    END IF
430   !
440    OUTPUT @E5270;"CL"
450    END
```

Line Number	Description
280	Forces voltage (Ve).
290	Forces current (Ic).
300	Sets the measurement mode and the measurement channel.
320 to 340	Checks for errors.
350	Executes a pulsed spot measurement.
360 to 370	Reads the measurement data and prints the results on the screen.
380 to 420	Displays an error message if an error has occurred.
440	Disables the source/measurement channels.

Staircase Sweep Measurements

To perform staircase sweep measurements, use the following commands.

Function	Command	Parameters
Enables channels	CN	[*chnum* ... [,*chnum*] ...]
Disables channels	CL	[*chnum* ... [,*chnum*] ...]
Sets filter ON/OFF	[FL]	*mode*[,*chnum* ... [,*chnum*] ...]
Sets series resistor ON/OFF	[SSR]	*chnum*[,*mode*]
Sets integration time (use either AV command or AAD/AIT commands)	[AAD]	*chnum*[,*type*]
	[AIT]	*type*,*mode*[,*N*]
	[AV]	*number*[,*mode*]
Sets sweep source timing parameter	[WT]	*hold*,*delay* [,*sdelay*[,*tdelay*[,*mdelay*]]]
Sets sweep abort function	[WM]	*abort*[,*post*]
Sets voltage sweep source	WV	*chnum*,*mode*,*range*,*start*,*stop*,*step* [,*comp*[,*Pcomp*]]
Sets current sweep source	WI	
Sets synchronous sweep source [a]	[WSV]	*chnum*,*range*,*start*,*stop* [,*comp*[,*Pcomp*]]
	[WSI]	
Forces constant voltage	DV	*chnum*,*range*,*output* [,*comp*[,*polarity*[,*crange*]]]
Forces constant current	DI	
Sets voltage measurement range	[RV]	*chnum*,*range*
Sets current measurement range	[RI]	*chnum*,*range*
	[RM]	*chnum*,*mode*[,*rate*]
Selects measurement mode	MM	2,*chnum*[,*chnum* ... [,*chnum*] ...]
Sets SMU operation mode	[CMM]	*chnum*,*mode*
Executes measurement	XE	

a. The WSV/WSI command must be entered after the WV/WI command.

NOTE

If you use multiple measurement channels, the channels start measurement in the order defined in the MM command.

A program example of a staircase sweep measurement is shown below. This program executes the bipolar transistor Ib-Vb and Ic-Vb characteristics measurement and prints the measured data list on the screen.

```
10      ASSIGN @E5270 TO 717
20      OPTION BASE 1
30      INTEGER Emitter,Base,Collector,Linlog,Mrange,Range,Var1
40      DIM St$[1],Ch$[1],Md$[1],A$[100],Channel$(3)[1]
50     !
60      Channel$(1)="A" !A: SMU in slot1
70      Channel$(2)="B" !B: SMU in slot2
80      Channel$(3)="C" !C: SMU in slot3
90     !
100     Emitter=1       ! 1: MPSMU in slot1
110     Base=2          ! 2: MPSMU in slot2
120     Collector=3     ! 3: MPSMU in slot3
130     Hold=1          ! Hold time
140     Delay=.1        ! Delay time
150     Linlog=1        ! 1: Linear single sweep mode
160     V1=0            ! Base start voltage (V)
170     V2=1            ! Base stop voltage (V)
180     Comp=.002       ! Current compliance (A) of base
190     Ve=0            ! Emitter voltage (V)
200     Vc=1            ! Collector voltage (V)
210    Icomp=.1        ! Current compliance (A) of emitter/collector
220     Mrange=11       ! 11: 1 nA limited auto ranging
230     Range=0         ! 0: Auto ranging
240     Var1=11         ! Number of Var1 step
250    !
260     OUTPUT @E5270;"FMT 5,1"      !Data w/Header<,>Source_data
270     OUTPUT @E5270;"CN ";Emitter,Base,Collector
280     OUTPUT @E5270;"FL 0"         !Filter off
290     OUTPUT @E5270;"MM ";2,Base,Collector !Staircase sweep
```

Line Number	Description
10	Assigns the I/O path to control the E5270.
100 to 240	Sets the value of the variables for source setup and so on.
260	Specifies the data output format.
270	Enables the source/measurement channels.
280	Sets the filter off.
290	Sets the measurement mode and the measurement channels.

```
300    OUTPUT @E5270;"WT ";Hold,Delay
310    OUTPUT @E5270;"WM 2,1"         !Stops any abnormal
320    OUTPUT @E5270;"WV ";Base,Linlog,Range,V1,V2,Var1,Comp
330    OUTPUT @E5270;"DV ";Emitter,Range,Ve,Icomp
340    OUTPUT @E5270;"DV ";Collector,Range,Vc,Icomp
350    OUTPUT @E5270;"RI ";Base,Mrange
360    OUTPUT @E5270;"RI ";Collector,Mrange
370   !
380    OUTPUT @E5270;"XE"
390    OUTPUT @E5270;"*OPC?"
400    ENTER @E5270;A
410    OUTPUT @E5270;"CL"
420   !
430    OUTPUT @E5270;"ERR? 1"
440    ENTER @E5270;A
450    IF A<>0 THEN
460      OUTPUT @E5270;"EMG? ";A
470      ENTER @E5270;A$
480      PRINT "ERROR:";A$
490      BEEP
500      DISP "Press Continue to read data. Or press Stop."
510      PAUSE
520      DISP ""
530    END IF
540   !
```

Line Number	Description
300	Sets the hold time and delay time.
310	Sets the sweep stop function.
320	Sets the staircase sweep source.
330 to 340	Forces voltage.
350 to 360	Sets the measurement range.
380 to 400	Executes a staircase sweep measurement.
410	Disables the source/measurement channels.
430 to 530	Checks to see if an error has occurred. If an error is detected, the error message is displayed on the screen.

```
550   ! Reading data
560   !
570    OUTPUT @E5270;"NUB?"
580    ENTER @E5270;C
590    IF C<>0 THEN
600      FOR I=1 TO C
610        ENTER @E5270 USING "#,A,A,A,12D,X";St$,Ch$,Md$,Mdata
620        IF Md$="V" THEN
630          PRINT " Vb=";Mdata*1000;"(mV), Status=";St$
640        ELSE
650          IF Md$="I" THEN
660            IF Ch$=Channel$(Base) THEN
670              PRINT "INDEX=";INT((I+2)/3)
680              PRINT " Ib=";Mdata*1000;"(mA), Status=";St$
690            ELSE
700              IF Ch$=Channel$(Collector) THEN
710                PRINT " Ic=";Mdata*1000;"(mA), Status=";St$
720              ELSE
730                PRINT " XX=INVALID DATA, Status=";St$
740              END IF
750            END IF
760          ELSE
770            PRINT " XX=INVALID DATA, Status=";St$
780          END IF
790        END IF
800      NEXT I
810    ELSE
820      PRINT "STATUS: No data returned."
830    END IF
840    END
```

Line Number	Description
570 to 590	Confirms the number of data stored in the output buffer.
600 to 800	Reads the measurement data, and displays the measurement data.
730 and 770	Displays “XX=INVALID DATA” if the data is not current measurement data or voltage output data.
820	Displays “No data returned” if the number of data is zero.

The following program example executes the synchronous sweep measurement using two sweep sources. This program executes the MOS FET Id-Vg characteristics measurement and prints the measured data list on the screen.

```
10     ASSIGN @E5270 TO 717
20     INTEGER Source,Drain,Gate,Sub,Range_v,Range_i
30     DIM A$[100]
40    !
50     Drain=1         !1:MPSMU in slot1
60     Gate=2          !2:MPSMU in slot2
70     Sub=3           !3:MPSMU in slot3
80     Source=4        !4:MPSMU in slot4
90     Range_v=0       !0: Auto Ranging
100    Range_i=15      !15:10 uA Limited Auto Ranging
110    Vs=0            ! Source Voltage
120    Vd=3            ! Drain Voltage
130    Vg=3            ! Gate Voltage
140    Vsub=0          ! Substrate Voltage
150    Icomp_g=.01     ! Current compliance for gate
160    Icomp=.1        ! Current compliance
170    Var1=11         ! Number of Var1 step
180   !
190    OUTPUT @E5270;"FMT 5,0"     !Data w/Header<,>
200    OUTPUT @E5270;"CN ";Source,Drain,Gate,Sub
210    OUTPUT @E5270;"MM ";2,Drain !Sweep measurement
220    OUTPUT @E5270;"WT 1,.1"     !Hold, Delay
230    OUTPUT @E5270;"WM 2,1"      !Stops any abnormal
240    OUTPUT @E5270;"DV ";Source,Range_v,Vs,Icomp
250    OUTPUT @E5270;"DV ";Sub,Range_v,Vsub,Icomp
260    OUTPUT @E5270;"WV ";Drain,1,Range_v,0,Vd,Var1,Icomp
270    OUTPUT @E5270;"WSV ";Gate,Range_v,0,Vg,Icomp_g
280    OUTPUT @E5270;"RI ";Drain,Range_i
290    !
```

Line Number	Description
10	Assigns the I/O path to control the E5270.
50 to 170	Sets the value of the variables for source setup and so on.
190	Specifies the data output format.
200	Enables the source/measurement channels.
210	Sets the measurement mode and the measurement channel.
220	Sets the hold time (=1s) and delay time (=0.1s).
230	Enables measurement abort function for abnormal conditions.
240 to 270	Forces voltage, and sets voltage sweep sources.
280	Sets current measurment range.

```
300    OUTPUT @E5270;"XE"
310    OUTPUT @E5270;"*OPC?"
320    ENTER @E5270;A
330    OUTPUT @E5270;"ERR? 1"
340    ENTER @E5270;A
350    IF A<>0 THEN
360      OUTPUT @E5270;"EMG? ";A
370      ENTER @E5270;A$
380      PRINT "ERROR:";A$
390      BEEP
400      DISP "Press Continue to read data. Or press Stop."
410      PAUSE
420      DISP ""
430    END IF
440   !
450   ! Reading data
460    OUTPUT @E5270;"NUB?"
470    ENTER @E5270;A
480    IF A<>0 THEN
490      FOR I=1 TO A
500        ENTER @E5270 USING "#,A,X,A,12D,X";A$,B$,Mdata
510        IF B$="I" THEN
520          PRINT "Id=";Mdata*1000;"(mA), Status=";A$
530        ELSE
540          PRINT "XX=INVALID DATA, Status=";A$
550        END IF
560      NEXT I
570    ELSE
580      PRINT "STATUS: No data returned."
590    END IF
600    OUTPUT @E5270;"CL"
610    END
```

Line Number	Description
300 to 320	Executes a staircase sweep measurement.
330 to 430	Checks to see if an error has occurred. If an error is detected, the error message is displayed on the screen.
460 to 470	Confirms the number of data stored in the output buffer.
480 to 570	Reads the measurement data, and displays the measurement data.
540	Displays “XX=INVALID DATA” if the data is not current measurement data.
580	Displays “No data returned” if the number of data is zero.
600	Disables the source/measurement channels.

Pulsed Sweep Measurements

To perform pulsed sweep measurements, use the following commands.

Function	Command	Parameters
Enables channels	CN	[*chnum* ... [,*chnum*] ...]
Disables channels	CL	[*chnum* ... [,*chnum*] ...]
Sets filter ON/OFF	[FL]	*mode*[,*chnum* ... [,*chnum*] ...]
Sets series resistor ON/OFF	[SSR]	*chnum*[,*mode*]
Sets pulse timing parameters	PT	*hold*,*width*,*period* [,*tdelay*]
Sets sweep abort function	[WM]	*abort*[,*post*]
Sets pulsed sweep source	PWV	*chnum*,*mode*,*range*,*base*,*start*, *stop*, *step*[,*comp*]
	PWI	
Sets synchronous sweep source [a]	[WSV]	*chnum*,*range*,*start*,*stop* [,*comp*[,*Pcomp*]]
	[WSI]	
Forces constant voltage	DV	*chnum*,*range*,*output* [,*comp*[,*polarity*[,*crange*]]]
Forces constant current	DI	
Sets voltage measurement range	[RV]	*chnum*,*range*
Sets current measurement range	[RI]	*chnum*,*range*
	[RM]	*chnum*,*mode*[,*rate*]
Selects measurement mode	MM	4,*chnum*
Sets SMU operation mode	[CMM]	*chnum*,*mode*
Executes measurement	XE	

a. The WSV/WSI command must be entered after the PWV/PWI command.

NOTE

Measurement channel always uses the high-speed A/D converter, and performs measurement so that the pulse width and pulse period are kept. The integration time is automatically set by the Agilent E5270, and you cannot change. The AAD/AIT/AV/WT command settings are ignored.

A program example of a pulsed sweep measurement is shown below. This program executes the bipolar transistor Ic-Vc characteristics measurement and prints the measured data list on the screen.

```
10      ASSIGN @E5270 TO 717
20      OPTION BASE 1
30      INTEGER Te,Tb,Tc,Irange,Range,Var1,Var2
40      DIM St$[1],Ch$[1],Md$[1],C$[100]
50     !
60      Te=1            ! 1: MPSMU in slot1
70      Tb=2            ! 2: MPSMU in slot2
80      Tc=3            ! 3: MPSMU in slot3
90      Var1=11         ! Collector voltage number of steps
100     Var2=3          ! Number of Ib steps
110     Irange=14       ! 14: 1 uA limited auto ranging
120     Range=0         ! 0: Auto ranging
130     Vc0=0           ! Collector voltage pulse base value (V)
140     Vc1=0           ! Collector voltage pulse start value (V)
150     Vc2=1           ! Collector voltage pulse stop value (V)
160     Ic_comp=.01     ! Current compliance (A) for collector
170     Ve=0            ! Emitter voltage (V)
180     Ib1=1.E-5       ! Ib start value (A)
190     Ib2=3.E-5       ! Ib stop value (A)
200     Ie_comp=.1      ! Current compliance (A) for emitter
210     Vb_comp=2       ! Voltage compliance (V) for base
220     Hold=1          ! Hold time
230     Width=.001      ! Pulse width
240     Period=.01      ! Pulse period
250     OUTPUT @E5270;"FMT 5,1"      !Data w/Header<,>Source data
260     OUTPUT @E5270;"CN ";Te,Tb,Tc
270     OUTPUT @E5270;"FL 0"         !Filter off
280     OUTPUT @E5270;"MM ";4,Tc     !Pulsed sweep measurement
```

Line Number	Description
10	Assigns the I/O path to control the E5270.
60 to 240	Sets the value of the variables for source setup and so on.
250	Specifies the data output format.
260	Enables the source/measurement channels.
270	Sets the filter off.
280	Sets the measurement mode and the measurement channel.

```
290    OUTPUT @E5270;"PT ";Hold,Width,Period
300    OUTPUT @E5270;"WM 2,1"
310    OUTPUT @E5270;"PWV ";Tc,1,Range,Vc0,Vc1,Vc2,Var1,Ic_comp
320    OUTPUT @E5270;"RI ";Tc,Irange
330    OUTPUT @E5270;"DV ";Te,Range,Ve,Ie_comp
340   !
350    FOR I=1 TO Var2
360      Ib=Ib1+(I-1)*(Ib2-Ib1)/(Var2-1)
370      OUTPUT @E5270;"DI ";Tb,Range,Ib,Vb_comp
380      OUTPUT @E5270;"XE"
390      OUTPUT @E5270;"*OPC?"
400      ENTER @E5270;C
410      OUTPUT @E5270;"ERR? 1"
420      ENTER @E5270;C
430      IF C<>0 THEN
440        OUTPUT @E5270;"EMG? ";C
450        ENTER @E5270;C$
460        PRINT "ERROR:";C$
470        BEEP
480        DISP "Press Continue to read data. Or press Stop."
490        PAUSE
500        DISP ""
510      END IF
```

Line Number	Description
290	Sets the hold time, pulse width, and pulse period.
300	Enables measurement abort function for abnormal conditions.
310	Sets the pulsed sweep source (Vc).
320	Sets the measurement range (Ic).
330	Forces voltage (Ve).
360	Calculates the base current value.
370	Forces current (Ib).
380 to 400	Executes a pulsed sweep measurement.
410 to 510	Checks to see if an error has occurred. If an error is detected, the error message is displayed on the screen.

```
520    ! Reading data
530    !
540       OUTPUT @E5270;"NUB?"
550       ENTER @E5270;C
560       IF C<>0 THEN
570         PRINT "Ib=";Ib*1.E+6;"(uA)"
580         FOR N=1 TO C
590           ENTER @E5270 USING "#,A,A,A,12D,X";St$,Ch$,Md$,Mdata
600           IF Md$="I" THEN
610             PRINT " Ic=";Mdata*1000;"(mA), Status=";St$
620           ELSE
630             IF Md$="V" THEN
640               PRINT " Vc=";Mdata*1000;"(mV), Status=";St$
650             ELSE
660               PRINT " XX=INVALID DATA, Status=";St$
670             END IF
680           END IF
690         NEXT N
700       ELSE
710         PRINT "STATUS: No data returned."
720       END IF
730     NEXT I
740     OUTPUT @E5270;"CL"
750     END
```

Line Number	Description
540 to 560	Confirms the number of data stored in the output buffer.
560 to 720	Reads the measurement data, and displays the measurement data, Ic and Vc.
660	Displays “XX=INVALID DATA” if the data is not current measurement data or voltage output data.
710	Displays “No data returned” if the number of data is zero.
740	Disables the source/measurement channels.

Staircase Sweep with Pulsed Bias Measurements

To perform staircase sweep with pulsed bias measurements, use the following commands.

Function	Command	Parameters
Enables channels	CN	[*chnum* ... [,*chnum*] ...]
Disables channels	CL	[*chnum* ... [,*chnum*] ...]
Sets filter ON/OFF	[FL]	*mode*[,*chnum* ... [,*chnum*] ...]
Sets series resistor ON/OFF	[SSR]	*chnum*[,*mode*]
Sets sweep abort function	[WM]	*abort*[,*post*]
Sets voltage sweep source	WV	*chnum*,*mode*,*range*,*start*,*stop*, *step*[,*comp*[,*Pcomp*]]
Sets current sweep source	WI	
Sets synchronous sweep source [a]	[WSV]	*chnum*,*range*,*start*,*stop* [,*comp*[,*Pcomp*]]
	[WSI]	
Sets pulse timing parameters	PT	*hold*,*width*,*period* [,*tdelay*]
Forces pulse voltage	PV	*chnum*,*range*,*base*,*pulse*[,*comp*]
Forces pulse current	PI	*chnum*,*range*,*base*,*pulse* [,*comp*]
Forces constant voltage	DV	*chnum*,*range*,*output* [,*comp*[,*polarity*[,*crange*]]]
Forces constant current	DI	
Sets voltage measurement range	[RV]	*chnum*,*range*
Sets current measurement range	[RI]	*chnum*,*range*
	[RM]	*chnum*,*mode*[,*rate*]
Selects measurement mode	MM	5,*chnum*
Sets SMU operation mode	[CMM]	*chnum*,*mode*
Executes measurement	XE	

a. The WSV/WSI command must be entered after the WV/WI command.

NOTE

Measurement channel always uses the high-speed A/D converter, and performs measurement so that the pulse width and pulse period are kept. The integration time is automatically set by the Agilent E5270, and you cannot change. The AAD/AIT/AV/WT command settings are ignored.

A program example of a staircase sweep with pulsed bias measurement is shown below. This program executes the bipolar transistor Ic-Vc characteristics measurement and prints the measured data list on the screen.

```
10      ASSIGN @E5270 TO 717
20      OPTION BASE 1
30      INTEGER Emitter,Base,Col,Linlog,Mrange,Range
40      DIM C$[100]
50     !
60      Te=1             ! 1: MPSMU in slot1
70      Tb=2             ! 2: MPSMU in slot2
80      Tc=3             ! 3: MPSMU in slot3
90      Linlog=1         ! 1: Linear single sweep mode
100     Mrange=14        ! 14: 1 uA limited auto ranging
110     Range=0          ! 0: Auto ranging
120     Var1=11          ! Number of Var1 step
130     Var2=3           ! Number of Var2 step
140     Vc1=0            ! Collector voltage start value (V)
150     Vc2=1            ! Collector voltage stop value (V)
160     Comp=.1          ! Current compliance (A) for collector
170     Ve=0             ! Emitter voltage (V)
180     Ib_base=0        ! Ib pulse base value (A)
190     Ib1=1.E-5        ! Ib start value (A)
200     Ib2=1.E-5        ! Ib step value (A)
210     Ie_comp=.01      ! Current compliance (A) for emitter
220     Vb_comp=2        ! Voltage compliance (V) for base
230     Hold=1           ! Hold time
240     Width=.001       ! Pulse width
250     Period=.01       ! Pulse period
260    !
270     OUTPUT @E5270;"FMT 5,1"      !Data w/Header<,>Source_data
280     OUTPUT @E5270;"CN ";Te,Tb,Tc
290     OUTPUT @E5270;"FL 0"         !Filter off
300     OUTPUT @E5270;"MM ";5,Tc     !Sweep with pulsed bias
```

Line Number	Description
10	Assigns the I/O path to control the E5270.
60 to 250	Sets the value of the variables for source setup and so on.
270	Specifies the data output format.
280	Enables the source/measurement channels.
290	Sets the filter off.
300	Sets the measurement mode and the measurement channel.

```
310    OUTPUT @E5270;"WM 2,1"
320    OUTPUT @E5270;"WV ";Tc,Linlog,Range,Vc1,Vc2,Var1,Comp
330    OUTPUT @E5270;"RI ";Tc,Mrange
340    OUTPUT @E5270;"DV ";Te,Range,Ve,Ie_comp
350    OUTPUT @E5270;"PT ";Hold,Width,Period
360   !
370    FOR I=1 TO Var2
380      Ib=Ib1+(I-1)*Ib2
390      OUTPUT @E5270;"PI ";Tb,Range,Ib_base,Ib,Vb_comp
400      OUTPUT @E5270;"XE"
410      OUTPUT @E5270;"*OPC?"
420      ENTER @E5270;C
430     !
440      OUTPUT @E5270;"ERR? 1"
450      ENTER @E5270;C
460      IF C<>0 THEN
470        OUTPUT @E5270;"EMG? ";C
480        ENTER @E5270;C$
490        PRINT "ERROR:";C,C$
500        BEEP
510        DISP "Press Continue to read data. Or press Stop."
520        PAUSE
530        DISP ""
540      END IF
550   !
```

Line Number	Description
310	Enables measurement abort function for abnormal conditions.
320	Sets the staircase sweep source (Vc).
330	Sets the measurement range (Ic).
340	Forces voltage (Ve).
350	Sets the hold time, pulse width, and pulse period of the pulsed source (base current).
380	Calculates the base current peak value.
390	Sets the pulsed bias (Ib).
400 to 420	Executes a staircase sweep with pulsed bias measurement.
440 to 540	Checks to see if an error has occurred. If an error is detected, the error code and error message are displayed on the screen.

```
560   ! Reading data
570   !
580      OUTPUT @E5270;"NUB?"
590      ENTER @E5270;C
600      IF C<>0 THEN
610        PRINT "Ib=";Ib*1.E+6;"(uA)"
620        FOR N=1 TO C
630          ENTER @E5270 USING "#,A,A,A,12D,X";St$,Ch$,Md$,Mdata
640          IF Md$="I" THEN
650            PRINT " Ic=";Mdata*1000;"(mA), Status=";St$
660          ELSE
670            IF Md$="V" THEN
680              PRINT " Vc=";Mdata;"(V), Status=";St$
690            ELSE
700              PRINT " XX=INVALID DATA, Status=";St$
710            END IF
720          END IF
730        NEXT N
740      ELSE
750        PRINT "STATUS: No data returned."
760      END IF
770    NEXT I
780    OUTPUT @E5270;"CL"
790    END
```

Line Number	Description
580 to 600	Confirms the number of data stored in the output buffer.
620 to 730	Reads the measurement data, and displays the measurement data.
700	Displays “XX=INVALID DATA” if the data is not current measurement data or voltage output data.
750	Displays “No data returned” if the number of data is zero.
780	Disables the source/measurement channels.

Quasi Pulsed Spot Measurements

To perform quasi-pulsed spot measurements, use the following commands.

Function	Command	Parameters
Enables channels	CN	[*chnum* ... [,*chnum*] ...]
Disables channels	CL	[*chnum* ... [,*chnum*] ...]
Sets filter ON/OFF	[FL]	*mode*[,*chnum* ... [,*chnum*] ...]
Sets series resistor ON/OFF	[SSR]	*chnum*[,*mode*]
Sets integration time (use either AV command or AAD/AIT commands)	[AAD]	*chnum*[,*type*]
	[AIT]	*type*,*mode*[,*N*]
	[AV]	*number*[,*mode*]
Sets detection interval	[BDM]	*interval*[,*mode*]
Sets timing parameters	[BDT]	*hold*,*delay*
Sets quasi-pulsed source	BDV	*chnum*,*range*,*start*,*stop*[,*comp*]
Forces constant voltage	DV	*chnum*,*vrange*,*output* [,*comp*[,*polarity*[,*irange*]]]
Forces constant current	DI	*chnum*,*irange*,*output* [,*comp*[,*polarity*[,*vrange*]]]
Sets voltage measurement range	[RV]	*chnum*,*range*
Sets current measurement range	[RI]	*chnum*,*range*
	[RM]	*chnum*,*mode*[,*rate*]
Selects measurement mode	MM	9[,*chnum*]
Sets SMU operation mode	[CMM]	*chnum*,*mode*
Executes measurement	XE	

A program example of a spot measurement is shown below. This program executes current measurement and prints the measured data on the screen.

```
10      ASSIGN @E5270 TO 717
20      OPTION BASE 1
30      INTEGER Te,Tb,Tc,Range,Interval,Mmode
40      DIM Status$[3],B$[100]
50    !
60      Te=3        ! Emitter   : MPSMU (slot3)
70      Tb=4        ! Base      : MPSMU (slot4)
80      Tc=2        ! Collector : HPSMU (slot1,2)
90      Range=0
100     Ib=0        ! Base current
110     Ve=0        ! Emitter current
120     Ie_c=.1     ! Compliance for Emitter
130     Vb_c=2      ! Compliance for Base
140     Ic_c=.0001  ! Compliance for Collector
150     Vc1=0       ! Collector Start V
160     Vc2=200     ! Collector Stop V
170     Hold=1      ! Hold time
180     Delay=.1    ! Delay time
190     Interval=0  ! 0: Short, 1: Long
200     Mmode=0     ! 0: Voltage, 1: Current
210   !
220     OUTPUT @E5270;"FMT5" !Data w/Header <,>
230     OUTPUT @E5270;"MM";9,Tc
240     OUTPUT @E5270;"CN";Te,Tb,Tc
250     OUTPUT @E5270;"BDT";Hold,Delay
260     OUTPUT @E5270;"BDM";Interaval,Mmode
270     OUTPUT @E5270;"BDV";Tc,Range,Vc1,Vc2,Ic_c
```

Line Number	Description
10	Assigns the I/O path to control the E5270.
60 to 200	Sets the value of the variables for source setup and so on.
220	Specifies the data output format.
230	Sets the measurement mode and the measurement channel.
240	Enables the source/measurement channels.
250	Sets the hold time and delay time.
260	Sets the detection interval and the measurement item.
270	Sets the quasi-pulsed voltage source.

```
280    OUTPUT @E5270;"DV";Te,Range,Ve,Ie_c
290    OUTPUT @E5270;"DI";Tb,Range,Ib,Vb_c
300   !
310    OUTPUT @E5270;"XE"
320    OUTPUT @E5270;"*OPC?"
330    ENTER @E5270;C
340  !
350    OUTPUT @E5270;"ERR?1"
360    ENTER @E5270;B
370    IF B<>0 THEN
380     OUTPUT @E5270;"EMG?";B
390     ENTER @E5270;B$
400     PRINT B,B$
410    ELSE
420     ENTER @E5270 USING "#,3A,12D,X";Status$,Bvceo
430     PRINT "BVceo= ";Bvceo;"[V]";TAB(23);"(Status:";Status$;")"
440    END IF
450  !
460    OUTPUT @E5270;"CL"
470    END
```

Line Number	Description
280	Forces voltage.
290	Forces current.
310 to 330	Executes a quasi-pulsed spot measurement.
350 to 410	Checks to see if an error has occurred. If an error is detected, the error code and error message are displayed on the screen.
420 to 430	Reads the measurement data and prints the results on the screen.
460	Disables the source/measurement channels.

Linear Search Measurements

To perform linear search measurements, use the following commands.

Function	Command	Parameters
Enables channels	CN	[*chnum* ... [,*chnum*] ...]
Disables channels	CL	[*chnum* ... [,*chnum*] ...]
Sets filter ON/OFF	[FL]	*mode*[,*chnum* ... [,*chnum*] ...]
Sets series resistor ON/OFF	[SSR]	*chnum*[,*mode*]
Sets integration time (use either AV command or AAD/AIT commands)	[AAD]	*chnum*[,*type*]
	[AIT]	*type*,*mode*[,*N*]
	[AV]	*number*[,*mode*]
Sets measurement mode	MM	14
Selects output data	[LSVM]	*output_data*
Sets timing parameters	[LSTM]	*hold*,*delay*
Sets abort function	[LSM]	*abort*[,*post*]
Sets current search or voltage search condition	LGI or LGV	*chnum*,*mode*,*range*,*target*
Sets voltage source or current source	LSV or LSI	*chnum*,*range*,*start*,*stop*,*step* [,*comp*]
Sets synchronous voltage source or current source	[LSSV] or [LSSI]	*chnum*,*polarity*,*offset*[,*comp*]
Forces constant voltage	DV	*chnum*,*range*,*output* [,*comp*[,*polarity*[,*crange*]]]
Forces constant current	DI	
Executes measurement	XE	

The LSV and LSI commands clear the previous source settings.

Send the LSI command before sending the LSSI command.

Send the LSV command before sending the LSSV command.

The LSI/LSSV commands or LSV/LSSI commands cannot be used together.

A program example of a linear search measurement is shown below. This program executes MOSFET threshold voltage measurement, and displays the result data on the screen.

```
10      ASSIGN @E5270 TO 717
20      OPTION BASE 1
30      INTEGER Gate,Drain,Source,Sub,Rm,Ro,Judge,Posneg
40      DIM A$[100]
50      Drain=1          ! 1: MPSMU in slot1
60      Gate=2           ! 2: MPSMU in slot2
70      Sub=3            ! 3: MPSMU in slot3
80      Source=4         ! 4: MPSMU in slot4
90      V_b=.5           ! Search start voltage (V)
100     V_e=1            ! Search stop voltage (V)
110     V_s=.01          ! Search step voltage (V)
120     D_comp=.01       ! Drain compliance (A)
130     G_comp=.01       ! Gate compliance (A)
140     Rm=14            ! 14: 1 uA limited auto ranging
150     Ro=11            ! 11: 2 V limited auto ranging
160     Hold=0           ! Hold time (s)
170     Delay=0          ! Delay time (s)
180     Judge=1          ! 1: Meas >= Target
190     Target=1.E-6     ! Target value
200     Posneg=1         ! 1: Positive, 0: Negative
210     Offset=0         ! Offset voltage (V)
220    !
230     OUTPUT @E5270;"FMT 5"    ! Data w/Header <,>
240     OUTPUT @E5270;"MM 14"    ! Linear search
250     OUTPUT @E5270;"LSM 2,3" ! Stops any abnormal
260     OUTPUT @E5270;"LSVM 1"   ! Returns Data_search,Data_sense
270     OUTPUT @E5270;"LSTM ";Hold,Delay
```

Line Number	Description
10	Assigns the I/O path for controlling the E5270.
50 to 210	Sets the value of the variables for source setup and so on.
230	Specifies the data output format.
240	Sets the linear search measurement mode.
250	Enables abort function, and specifies source output after stop.
260	Specifies the data output mode.
270	Sets the hold time and delay time.

```
280    OUTPUT @E5270;"LGI ";Drain,Judge,Rm,Target
290    OUTPUT @E5270;"LSV ";Drain,Ro,V_b,V_e,V_s,D_comp
300    OUTPUT @E5270;"LSSV ";Gate,Posneg,Offset,G_comp
310   !
320    OUTPUT @E5270;"CN ";Source,Drain,Gate,Sub
330    OUTPUT @E5270;"DV ";Source,Ro,0,.01
340    OUTPUT @E5270;"DV ";Sub,Ro,0,.01
350    OUTPUT @E5270;"XE"
360    OUTPUT @E5270;"*OPC?"
370    ENTER @E5270;A
380    OUTPUT @E5270;"ERR? 1"
390    ENTER @E5270;A
400    IF A=0 THEN
410      ENTER @E5270 USING "#,3X,12D,X";Data_search
420      ENTER @E5270 USING "#,3X,12D,X";Data_sense
430      PRINT "Vth=";Data_search;"V at Id=";Data_sense*1.E+6;"uA"
440    ELSE
450      OUTPUT @E5270;"EMG? ";A
460      ENTER @E5270;A$
470      PRINT "ERROR:";A$
480    END IF
490    OUTPUT @E5270;"CL"
500    END
```

Line Number	Description
280	Sets current search condition.
290	Sets the linear search source for the drain terminal.
300	Sets the synchronous source for the gate terminal.
320	Enables the source/measurement channels.
330 to 340	Forces voltage to the source and substrate terminals.
350 to 370	Executes a linear search measurement.
380 to 480	Checks to see if an error has occurred. If an error is detected, the error code and error message are displayed on the screen.
410 to 430	Reads the measurement data, and prints the data on the screen.
490	Disables the source/measurement channels.

Binary Search Measurements

To perform binary search measurements, use the following commands.

Function	Command	Parameters
Enables channels	CN	[*chnum* ... [,*chnum*] ...]
Disables channels	CL	[*chnum* ... [,*chnum*] ...]
Sets filter ON/OFF	[FL]	*mode*[,*chnum* ... [,*chnum*] ...]
Sets series resistor ON/OFF	[SSR]	*chnum*[,*mode*]
Sets integration time (use either AV command or AAD/AIT commands)	[AAD]	*chnum*[,*type*]
	[AIT]	*type*,*mode*[,*N*]
	[AV]	*number*[,*mode*]
Sets measurement mode	MM	15
Selects output data	[BSVM]	*output_data*
Sets timing parameters	[BST]	*hold*,*delay*
Sets source control mode	BSM	*mode*,*abort*[,*post*]
Sets current search or voltage search condition	BGI or BGV	*chnum*,*mode*,*condition*,*range*, *target*
Sets voltage source or current source	BSV or BSI	*chnum*,*range*,*start*,*stop*[,*comp*]
Sets synchronous voltage source or current source	[BSSV] or [BSSI]	*chnum*,*polarity*,*offset*[,*comp*]
Forces constant voltage	DV	*chnum*,*range*,*output* [,*comp*[,*polarity*[,*crange*]]]
Forces constant current	DI	
Executes measurement	XE	

The BSV and BSI commands clear the previous source settings.

Send the BSI command before sending the BSSI command.

Send the BSV command before sending the BSSV command.

The BSI/BSSV commands or BSV/BSSI commands cannot be used together.

A program example of a binary search measurement is shown below. This program executes MOSFET threshold voltage measurement, and prints result data on the screen.

```
10      ASSIGN @E5270 TO 717
20      OPTION BASE 1
30      INTEGER Gate,Drain,Source,Sub,Nub,I
40      INTEGER V_n,Rm,Ro,Posneg,Offset
50      DIM A$[50]
60      Source=1        ! 1: MPSMU in slot1
70      Drain=2         ! 2: MPSMU in slot2
80      Gate=3          ! 3: MPSMU in slot3
90      Sub=4           ! 4: MPSMU in slot4
100     V_b=.5          ! Search start voltage (V)
110     V_e=1           ! Search stop voltage (V)
120     D_comp=.01      ! Drain compliance (A)
130     G_comp=.01      ! Gate compliance (A)
140     Rm=14           ! 14: 1 uA limited auto ranging
150     Ro=11           ! 11: 2 V limited auto ranging
160     Hold=0          ! Hold time (s)
170     Delay=0         ! Delay time (s)
180     Mode=0          ! 0: Limit, 1: Repeat
190     Judge=1.E-8     ! Limit in A. for Limit mode.
200    !Judge=10        ! No of repeats. for Repeat mode.
210     Target=1.E-6    ! Target value
220     Posneg=1        ! 1: Positive, 0: Negative
230     Offset=0        ! Offset voltage (V)
240    !
250     OUTPUT @E5270;"FMT 5"    ! ASCII w/header <,>
260     OUTPUT @E5270;"MM 15"    ! Binary search
270     OUTPUT @E5270;"BSM 1,1"  ! Cautious mode, Abort OFF
280     OUTPUT @E5270;"BSVM 1"   ! Returns Data_search,Data_sense
```

Line Number	Description
10	Assigns the I/O path for controlling the E5270.
60 to 230	Sets the value of the variables for source setup and so on.
250	Specifies the data output format.
260	Sets the binary search measurement mode.
270	Selects the cautious control mode, disables auto abort function.
280	Specifies the data output mode.

```
290    OUTPUT @E5270;"BST ";Hold,Delay
300    OUTPUT @E5270;"BGI ";Drain,Mode,Judge,Rm,Target
310    OUTPUT @E5270;"BSV ";Drain,Ro,V_b,V_e,D_comp
320    OUTPUT @E5270;"BSSV ";Gate,Posneg,Offset,G_comp
330   !
340    OUTPUT @E5270;"CN ";Source,Drain,Gate,Sub
350    OUTPUT @E5270;"DV ";Source,Ro,0,.01
360    OUTPUT @E5270;"DV ";Sub,Ro,0,.01
370    OUTPUT @E5270;"XE"
380    OUTPUT @E5270;"*OPC?"
390    ENTER @E5270;B
400    OUTPUT @E5270;"ERR? 1"
410    ENTER @E5270;A
420    IF A=0 THEN
430      ENTER @E5270 USING "#,3X,12D,X";Data_search
440      ENTER @E5270 USING "#,3X,12D,X";Data_sense
450      PRINT "Vth=";Data_search;"V at Id=";Data_sense*1.E+6;"uA"
460    ELSE
470      OUTPUT @E5270;"EMG? ";A
480      ENTER @E5270;A$
490      PRINT "ERROR:";A$
500    END IF
510    OUTPUT @E5270;"CL"
520    END
```

Line Number	Description
290	Sets the hold time and delay time.
300	Sets current search condition.
310	Sets the binary search source for the drain terminal.
320	Sets the synchronous source for the gate terminal.
340	Enables the source/measurement channels.
350 to 360	Forces voltage to the source and substrate terminals.
370 to 390	Executes a binary search measurement.
400 to 500	Checks to see if an error has occurred. If an error is detected, the error code and error message are displayed on the screen.
430 to 450	Reads the measurement data, and prints the data on the screen.
510	Disables the source/measurement channels.

Multi Channel Sweep Measurements

To perform multi channel sweep measurements, use the following commands.

Function	Command	Parameters
Enables channels	CN	[*chnum* ... [,*chnum*] ...]
Disables channels	CL	[*chnum* ... [,*chnum*] ...]
Sets filter ON/OFF	[FL]	*mode*[,*chnum* ... [,*chnum*] ...]
Sets series resistor ON/OFF	[SSR]	*chnum*[,*mode*]
Sets integration time (use either AV command or AAD/AIT commands)	[AAD]	*chnum*[,*type*]
	[AIT]	*type*,*mode*[,*N*]
	[AV]	*number*[,*mode*]
Sets sweep source timing parameter	[WT]	*hold*,*delay* [,*sdelay*[,*tdelay*[,*mdelay*]]]
Sets sweep abort function	[WM]	*abort*[,*post*]
Sets voltage sweep source	WV	*chnum*,*mode*,*range*,*start*,*stop*,*step* [,*comp*[,*Pcomp*]]
Sets current sweep source	WI	
Sets synchronous sweep source [a]	WNX	*N*,*chnum*,*mode*,*range*,*start*,*stop* [,*comp*[,*Pcomp*]]
Forces constant voltage	DV	*chnum*,*range*,*output* [,*comp*[,*polarity*[,*crange*]]]
Forces constant current	DI	
Sets voltage measurement range	[RV]	*chnum*,*range*
Sets current measurement range	[RI]	*chnum*,*range*
	[RM]	*chnum*,*mode*[,*rate*]
Selects measurement mode	MM	2,*chnum*[,*chnum* ... [,*chnum*] ...]
Sets SMU operation mode	[CMM]	*chnum*,*mode*
Executes measurement	XE	

a. The WNX command must be entered after the WV/WI command.

NOTE

Sweep sources simultaneously start output by a trigger such as the XE command. However, if a sweep source sets power compliance or forces logarithmic sweep current, the sweep sources start output in the order specified by the WNX's *N* value. Then the first output is forced by the channel set by the WI or WV command.

If you use multiple measurement channels, the channels that use the high-speed A/D converter with the fixed ranging mode start measurement simultaneously, then other channels start measurement in the order defined in the MM command.

A program example of a multi channel sweep measurement is shown below. This program executes MOSFET Id-Vg and Ig-Vg characteristics measurement and prints the measured data list on the screen.

```
10      ASSIGN @E5270 TO 717
20      OPTION BASE 1
30      INTEGER Gate,Drain,Source,Sub,Linlog,Mrange,Range,Var1,V_i
40      DIM St$[1],Ch$[1],Md$[1],A$[100],Channel$(4)[1]
50 !
60      Channel$(1)="A"!A: SMU in slot1
70      Channel$(2)="B"!B: SMU in slot2
80      Channel$(3)="C"!C: SMU in slot3
90      Channel$(4)="D"!D: SMU in slot4
100 !
110     Sub=4          ! 4: MPSMU in slot4
120     Source=3       ! 3: MPSMU in slot3
130     Gate=2         ! 2: MPSMU in slot2
140     Drain=1        ! 1: MPSMU in slot1
150     Hold=1         ! Hold time
160     Delay=.1       ! Delay time
170     Linlog=1       ! 1: Linear single sweep mode
180     V1=0           ! Gate/Drain start voltage (V)
190     V2=1           ! Gate/Drain stop voltage (V)
200     Comp=.001      ! Current compliance (A) for Gate
210     Vs=0           ! Source/Sub voltage (V)
220     Icomp=.1       ! Current compliance (A) for D/S/Sub
230     Mrange=-17     ! 1 mA fixed range
240     Range=0        ! Auto ranging
250     Var1=5         ! Number of Var1 step
260     V_i=1          ! 1: Voltage output
270 !
```

Line Number	Description
10	Assigns the I/O path to control the E5270.
110 to 260	Sets the value of the variables for source setup and so on.

```
280    OUTPUT @E5270;"FMT5,1"      !Data w/Header<,>Source_data
290    OUTPUT @E5270;"TSC1"        !Time stamp ON
300    OUTPUT @E5270;"CN";Gate,Drain,Source,Sub
310    OUTPUT @E5270;"FL0"         !Filter off
320    OUTPUT @E5270;"AV -1"       !H-SPEED ADC
330    OUTPUT @E5270;"MM";16,Gate,Drain
340    OUTPUT @E5270;"WT";Hold,Delay
350    OUTPUT @E5270;"WM 2,1"      !Stops any abnormal
360    OUTPUT @E5270;"WV";Gate,Linlog,Range,V1,V2,Var1,Comp
370    OUTPUT @E5270;"DV";Source,Range,Vs,Icomp
380    OUTPUT @E5270;"DV";Sub,Range,Vs,Icomp
390    OUTPUT @E5270;"WNX 2,";Drain,V_i,Range,V1,V2,Icomp
400    OUTPUT @E5270;"RI";Gate,Mrange
410    OUTPUT @E5270;"RI";Drain,Mrange
420 !
430    OUTPUT @E5270;"TSR"
440    OUTPUT @E5270;"XE"
450    OUTPUT @E5270;"*OPC?"
460    ENTER @E5270;A
```

Line Number	Description
280	Specifies the data output format.
290	Enables the time stamp data output.
300	Enables the source/measurement channels.
310	Sets the filter off.
320	Selects the high-speed ADC, and sets the averaging mode.
330	Sets the measurement mode and the measurement channels.
340	Sets the hold time and delay time.
350	Sets the sweep stop function.
360	Sets the staircase sweep source.
370 to 380	Forces voltage.
390	Sets the synchronous sweep source.
400 to 410	Sets the measurement range.
430	Resets the time stamp.
440 to 460	Executes multi channel sweep measurement.

```
470    OUTPUT @E5270;"CL"
480 !
490    OUTPUT @E5270;"ERR? 1"
500    ENTER @E5270;A
510    IF A<>0 THEN
520      OUTPUT @E5270;"EMG?";A
530      ENTER @E5270;A$
540      PRINT "ERROR:";A$
550      BEEP
560      DISP "Press Continue to read data. Or press Stop."
570      PAUSE
580      DISP ""
590    END IF
600 !
610 ! Reading data
620 !
630    OUTPUT @E5270;"NUB?"
640    ENTER @E5270;C
650    IF C<>0 THEN
660      FOR I=1 TO C
670        ENTER @E5270 USING "#,A,A,A,12D,X";St$,Ch$,Md$,Mdata
680        IF Md$="T" THEN
690          IF Ch$=Channel$(Gate) THEN
700            PRINT " Tg= ";Mdata;"Status=";St$
710          ELSE
720            IF Ch$=Channel$(Drain) THEN
730              PRINT " Td= ";Mdata;"Status=";St$
740            ELSE
750              PRINT " XX=INVALID DATA, Status=";St$
760            END IF
770          END IF
780        ELSE
```

Line Number	Description
470	Disables the source/measurement channels.
490 to 590	Checks to see if an error has occurred. If an error is detected, the error message is displayed on the screen.
630 to 640	Confirms the number of data stored in the output buffer.
650 to 1010	Reads the measurement data, and displays the measurement data.
750	Displays “XX=INVALID DATA” if the data is not time data when starting gate current or drain current measurement.

```
790          IF Md$="V" THEN
800            PRINT " Vg=";Mdata*1000;"(mV), Status=";St$
810            PRINT "-------------------------DATA=";INT((I+4)/5)
820          ELSE
830            IF Md$="I" THEN
840              IF Ch$=Channel$(Gate) THEN
850                PRINT " Ig=";Mdata*1000;"(mA), Status=";St$
860              ELSE
870                IF Ch$=Channel$(Drain) THEN
880                  PRINT " Id=";Mdata*1000;"(mA), Status=";St$
890                ELSE
900                  PRINT " XX=INVALID DATA, Status=";St$
910                END IF
920              END IF
930            ELSE
940              PRINT " XX=INVALID DATA, Status=";St$
950            END IF
960          END IF
970        END IF
980      NEXT I
990    ELSE
1000     PRINT "STATUS: No data returned."
1010   END IF
1020   END
```

Line Number	Description
900	Displays “XX=INVALID DATA” if the data is not gate current or drain current.
940	Displays “XX=INVALID DATA” if the data is not time data, voltage output data, or current measurement data.
1000	Displays “No data returned” if the number of data is zero.

Using Program Memory

The program memory can store approximately 2,000 programs or 40,000 commands. Storing programs and executing them will improve the program execution speed. The following commands are available to use program memory.

Command	Function and Syntax

ST and END	Stores the program in the memory.
	`ST` *pnum*`;`*command*`[ ... [;`*command*`] ..];END`
	or
	`ST` *pnum*
	`[`*command*`]`
	`:`
	`[`*command*`]`
	`END`

[SCR]	Scratches the program. `SCR [`*pnum*`]`
[LST?]	Gets a catalog of program numbers or a specific program listing (up to 3000 commands). `LST? [`*pnum*`[,`*index*`[,`*size*`]]]`
DO	Executes specified programs. `DO` *pnum*`[,`*pnum* ... `[,`*pnum*`] ...]`
RU	Executes programs sequentially. `RU` *start*`,`*stop*
[PA]	Pauses command execution or internal memory program execution. `PA [`*wait*`]`
[VAR]	Defines an internal memory variable, and sets the value. `VAR` *Type*`,`*N*`,`*Value*
[VAR?]	Reads the value of the internal memory variable. `VAR?` *Type*`,`*N*

A program example using the internal program memory is shown below. This program does the following:

- enters a high-speed spot measurement program in program memory 1.
- enters a pulsed spot measurement program in program memory 2.
- prints the internal memory program listing on the screen.
- executes the internal memory program 1 and 2.
- prints the measurement results on the screen.

```
10      ASSIGN @E5270 TO 717
20      OPTION BASE 1
30      INTEGER Fmt,Source,Gate,Drain,Sub,Mem
40      INTEGER Vrange,Arange,Irange
50      Fmt=5                !ASCII with header <,>
60      Source=1             !MPSMU in slot1
70      Drain=2              !MPSMU in slot2
80      Gate=3               !MPSMU in slot3
90      Sub=4                !MPSMU in slot4
100     Vrange=12            !12:20 V Limited auto ranging
110     Arange=0             ! 0:Auto ranging
120     Irange=14            !14:1 uA Limited auto ranging
130     Vg=3                 !Gate voltage (V)
140     Vd=5                 !Drain voltage (V)
150     Vsub=0               !Substrate voltage (V)
160     Vs=0                 !Source voltage (V)
170     Icomp=.1             !Current compliance (A)
180     Icomp_g=.01          !Current compliance for Gate (A)
190     Vg_b=0               !Gate pulse base voltage (V)
200     Hold=.1              !Hold time of Gate pulse (sec)
210     Width=.01            !Pulse width of Gate pulse (sec)
220     Period=.1            !Pulse period of Gate pulse (sec)
230    !
240     OUTPUT @E5270;"FMT ";Fmt
250    !
```

Line No.	Description
10	Assigns the I/O path to control the E5270.
50 to 220	Sets the value of the variables for source setup and so on.
240	Specifies the data output format.

```
260    Mem=1              ! High-speed spot measurement
270    OUTPUT @E5270;"ST ";Mem
280    OUTPUT @E5270;"CN ";Gate,Drain,Source,Sub
290    OUTPUT @E5270;"DV ";Source,Arange,Vs,Icomp
300    OUTPUT @E5270;"DV ";Sub,Arange,Vsub,Icomp
310    OUTPUT @E5270;"DV ";Drain,Vrange,Vd,Icomp
320    OUTPUT @E5270;"DV ";Gate,Vrange,Vg,Icomp_g
330    OUTPUT @E5270;"TI ";Drain,Irange
340    OUTPUT @E5270;"CL"
350    OUTPUT @E5270;"END"
360    CALL Check_memory(Mem)
370   !
380    Mem=2              ! Pulsed spot measurement
390    OUTPUT @E5270;"ST ";Mem
400    OUTPUT @E5270;"CN ";Gate,Drain,Source,Sub
410    OUTPUT @E5270;"FL 0"
420    OUTPUT @E5270;"PT ";Hold,Width,Period
430    OUTPUT @E5270;"DV ";Source,Arange,Vs,Icomp
440    OUTPUT @E5270;"DV ";Sub,Arange,Vsub,Icomp
450    OUTPUT @E5270;"DV ";Drain,Vrange,Vd,Icomp
460    OUTPUT @E5270;"PV ";Gate,Vrange,Vg_b,Vg,Icomp
470    OUTPUT @E5270;"MM ";3,Drain
480    OUTPUT @E5270;"XE"
490    OUTPUT @E5270;"CL"
500    OUTPUT @E5270;"END"
510    CALL Check_memory(Mem)
520   !
```

Line No.	Description
260 to 350	Stores the high-speed spot measurement program in the memory 1.
360	Calls the Check_memory subprogram.
380 to 500	Stores the pulsed spot measurement program in the memory 2.
510	Calls the Check_memory subprogram.

```
530    FOR I=1 TO 2
540      OUTPUT @E5270;"DO ";I
550      OUTPUT @E5270;"*OPC?"
560      ENTER @E5270;C
570      OUTPUT @E5270;"ERR? 1"
580      ENTER @E5270;B
590      IF B<>0 THEN
600        OUTPUT @E5270;"EMG?";B
610        ENTER @E5270;B$
620        PRINT "ERROR:";B$
630      ELSE
640        ENTER @E5270 USING "#,3X,12D,X";Mdata
650        PRINT "MEM";I,TAB(4);"Id(A)=";Mdata
660      END IF!
670      PRINT
680    NEXT I
690   !
700    END
710   !
720    SUB Check_memory(INTEGER Mem)
730      DIM Mem$[100]
740      ASSIGN @E5270 TO 717
750      OUTPUT @E5270;"LST? ";Mem
760      LOOP
770        ENTER @E5270;Mem$
780        PRINT Mem$
790      EXIT IF Mem$="END"
800      PRINT
810      END LOOP
820    SUBEND
```

Line No.	Description
540 to 560	Executes the internal program memory.
570 to 630	Checks to see if an error has occurred. If an error is detected, the error code and error message are displayed on the screen.
640 to 650	Reads the measurement data, and prints it on the screen.
720 to 820	Reads the memory program and prints the program list on the screen.

The following program example stores a high speed spot measurement program in the program memory, executes it, and displays the measurement result data. The program uses the internal memory variables for the command parameters.

```
10      ASSIGN @E5270 TO 717
20      OPTION BASE 1
30      INTEGER Fmt,Source,Gate,Drain,Sub
40      INTEGER Vrange,Arange,Irange,Mmem
50     !
60      Fmt=5               !ASCII with header <,>
70      Source=1            !MPSMU in slot1
80      Drain=2             !MPSMU in slot2
90      Gate=3              !MPSMU in slot3
100     Sub=4               !MPSMU in slot4
110     Arange=0            ! 0:Auto ranging
120     Vrange=12           !12:20 V Limited auto ranging
130     Irange=14           !14:1 uA Limited auto ranging
140     Vs=0                !Source voltage (V)
150     Vd=5                !Drain voltage (V)
160     Vg=3                !Gate voltage (V)
170     Vsub=0              !Substrate voltage (V)
180     Icomp=.1            !Current compliance (A)
190     Icomp_g=.01         !Current compliance for Gate (A)
200    !
210     OUTPUT @E5270;"FMT ";Fmt
220    !
230     Mem=1               ! High-speed spot measurement
240     OUTPUT @E5270;"ST";Mem
250     OUTPUT @E5270;"CN %I0,%I1,%I2,%I3"
260     OUTPUT @E5270;"DV %I0,%I4,%R0,%R4"
270     OUTPUT @E5270;"DV %I3,%I4,%R3,%R4"
280     OUTPUT @E5270;"DV %I1,%I5,%R1,%R4"
290     OUTPUT @E5270;"DV %I2,%I5,%R2,%R5"
300     OUTPUT @E5270;"TI %I1,%I6"
310     OUTPUT @E5270;"CL"
320     OUTPUT @E5270;"END"
330    !
```

Line No.	Description
10	Assigns the I/O path to control the E5270.
60 to 190	Sets the value of the variables for source setup and so on.
210	Specifies the data output format.
230 to 320	Stores the high-speed spot measurement program in the memory 1.

```
340    OUTPUT @E5270;"VAR";0,0,Source      ! =%I0
350    OUTPUT @E5270;"VAR";0,1,Drain       ! =%I1
360    OUTPUT @E5270;"VAR";0,2,Gate        ! =%I2
370    OUTPUT @E5270;"VAR";0,3,Sub         ! =%I3
380    OUTPUT @E5270;"VAR";0,4,Arange      ! =%I4
390    OUTPUT @E5270;"VAR";0,5,Vrange      ! =%I5
400    OUTPUT @E5270;"VAR";0,6,Irange      ! =%I6
410    OUTPUT @E5270;"VAR";1,0,Vs          ! =%R0
420    OUTPUT @E5270;"VAR";1,1,Vd          ! =%R1
430    OUTPUT @E5270;"VAR";1,2,Vg          ! =%R2
440    OUTPUT @E5270;"VAR";1,3,Vsub        ! =%R3
450    OUTPUT @E5270;"VAR";1,4,Icomp       ! =%R4
460    OUTPUT @E5270;"VAR";1,5,Icomp_g     ! =%R5
470   !
480    OUTPUT @E5270;"DO";Mem
490    OUTPUT @E5270;"*OPC?"
500    ENTER @E5270;C
510   !
520    ENTER @E5270 USING "#,3X,12D,X";Mdata
530    PRINT "MEM";Mem,TAB(4);"Id(A)=";Mdata
540   !
550    END
```

Line No.	Description
340 to 460	Defines the internal memory variables, and sets the values.
480 to 500	Executes the internal program memory.
520 to 530	Reads the measurement data, and prints it on the screen.

NOTE

Tips to use program memory

1. Completes program:

   Before storing the program in the program memory, verify that the program is complete and free of errors. Command parameter check will be performed when the program is executed.

   If the program being stored makes changes to the present measurement setup, verify that these changes are correct and compatible with the present setup.

2. For the invalid commands in the internal memory program, refer to Table 2-1 on page 2-26.

Using Trigger Function

The Agilent E5270 can be equipped with eight trigger ports that will be used for different purpose individually. The Agilent E5270 can synchronize the operation with other device by using the trigger function. For details about the trigger input/output operation, see "Trigger Function" on page 2-30. The commands below are available to use the trigger function.

Command	Function and Syntax
TGP	Sets the trigger port for the specified terminal. `TGP` *port*`,`*terminal*`,`*polarity*`[,`*type*`]`
TGPC	Clears the trigger setting of the specified ports. `TGPC [`*port* `... [,`*port*`] ... ]`
TGSI	Selects the sweep step first or last that ignores the Start Step Output Setup trigger input set by the `TGP` *port*`,1,`*polarity*`,2` command. `TGSI` *mode*
TGSO	Selects the trigger type, edge or gate, for the Step Output Setup Completion trigger output set by the `TGP` *port*`,2,`*polarity*`,2` command. `TGSO` *mode*
TGXO	Selects the trigger type, edge or gate, for the Measurement Completion trigger output set by the `TGP` *port*`,2,`*polarity*`,1` command. `TGXO` *mode*
TGMO	Selects the trigger type, edge or gate, for the Step Measurement Completion trigger output set by the `TGP` *port*`,2,`*polarity*`,3` command. `TGMO` *mode*
TM3	Enables the trigger set by the `TGP` *port*`,`*terminal*`,`*polarity*`,1` command.

The following commands are also available to send a trigger or wait for an external trigger input. Refer to “Using Trigger Function” on page 2-35.

Command	Function and Syntax
OS	Causes the Agilent E5270 to send a trigger signal from the Ext Trig Out terminal. `OS`
OSX [a]	Causes the Agilent E5270 to send a trigger signal from the specified port. `OSX` *port*`[,`*level*`]`
WS	Enters a wait state until the Agilent E5270 receives an external trigger via the Ext Trig In terminal. `WS [`*mode*`]`
WSX [a]	Enters a wait state until the Agilent E5270 receives an external trigger via the specified port. `WSX` *port*`[,`*mode*`]`
PA	Pauses command execution or internal memory program execution until the specified wait time has elapsed, or until a trigger is received from the Ext Trig In terminal if the TM3 command has been entered. `PA [`*wait*`]`
PAX [a]	Pauses command execution or internal memory program execution until the specified wait time has elapsed, or until a trigger is received from the specified port if the TM3 command has been entered. `PAX` *port*`[,`*wait*`]`
TGP	Sets trigger port to the specified terminal. `TGP` *port*`,`*terminal*`,`*polarity*`[,`*type*`]`
TM3	Uses an external trigger to release the PA/PAX command state or to start measurement when the E52570 is not in the PA/PAX/ WS/WSX command state.

a. Enter the TGP command to set the trigger port.

The following program shows the example to use the WS and OS commands, the TM and OS commands, and the TM, PA, and OS commands.

This program uses two E5270 units. A unit applies voltage to a MOSFET source and substrate terminals and the other unit applies voltage to the MOSFET gate and drain terminals and measures the drain current.

Before running the program, connect a BNC cable between the Ext Trig In terminal of the E5270 with address 722 (Unit1) and the Ext Trig Out terminal of the E5270 with address 725 (Unit2).

```
10      ASSIGN @Unit1 TO 722
20      ASSIGN @Unit2 TO 725
30      OPTION BASE 1
40      INTEGER Gate,Source,Drain,Sub,A
50     !
60      Gate=1
70      Drain=2
80      Source=1
90      Sub=2
100     Vg=5
110     Igcomp=.01
120     Vd=2.5
130     I_comp=.1
140     Vs=0
150    !
160     OUTPUT @Unit2;"CN";Source,Sub
170     OUTPUT @Unit2;"DV";Sub,0,Vs,I_comp
180     OUTPUT @Unit2;"DV";Source,0,Vs,I_comp
190     OUTPUT @Unit1;"FMT 5"        ! ASCII w/header<,>
200     OUTPUT @Unit1;"TM 1"
210     OUTPUT @Unit1;"AV -1"        ! Averaging=1PLC
220     OUTPUT @Unit1;"CN";Drain,Gate
230     OUTPUT @Unit1;"MM";1,Drain
240     OUTPUT @Unit1;"DV";Drain,0,Vd,I_comp
250     OUTPUT @Unit1;"DV";Gate,0,Vg,Ig_comp
```

Line No.	Description
10 to 20	Assigns the I/O path to control the E5270.
60 to 140	Sets the value of the variables for source setup and so on.
160 to 180	Unit2 applies voltage.
190 to 250	Unit1 sets the measurement conditions and applies voltage.

```
260   !
270    OUTPUT @Unit1;"WS 2"
280    OUTPUT @Unit1;"XE"
290    OUTPUT @Unit2;"OS"
300   !
310   ! OUTPUT @Unit1;"TM 3"
320   ! OUTPUT @Unit1;"*OPC?"
330   ! ENTER @Unit1;A
340   ! OUTPUT @Unit2;"OS"
350   !
360   ! OUTPUT @Unit1;"PA"
370   ! OUTPUT @Unit2;"OS"
380   ! OUTPUT @Unit1;"XE"
390   !
400    OUTPUT @Unit1;"*OPC?"
410    ENTER @Unit1;A
420   !
430    ENTER @Unit1 USING "#,3X,12D,X";Id
440    PRINT "Id=";Id*1000;" [mA]"
450    OUTPUT @Unit1;"CL"
460    OUTPUT @Unit2;"CL"
470   !
480    END
```

Line No.	Description
270 to 280	Unit1 waits for a trigger sent to the Ext Trig In terminal, and starts measurement when the trigger is received.
290	Unit2 sends a trigger to the Ext Trig Out terminal.
310 to 340	The lines can be replaced with 270 to 290. Delete 270 to 290, and delete ! at the top of the lines 310 to 340, then run the program. Unit1 starts measurement when a trigger is received via the Ext Trig In terminal.
360 to 380	The lines can be replaced with 270 to 290. Delete 270 to 290 and 340, and delete ! at the top of the lines 310 to 330 and 360 to 380, then run the program. Unit1 starts measurement when a trigger is received via the Ext Trig In terminal.
400 to 460	After measurement, the data is read and displayed. Also the source output is disabled.

The following program also uses two E5270 units. Each unit performs I-V measurement of a two-terminal device simultaneously.

Before running the program, connect a BNC cable between the Ext Trig In terminal of Unit1 and the Ext Trig Out terminal of Unit2, and connect a BNC cable between the Ext Trig Out terminal of Unit1 and the Ext Trig In terminal of Unit2.

```
10      ASSIGN @Unit1 TO 722
20      ASSIGN @Unit2 TO 725
30      OPTION BASE 1
40      INTEGER High,Low,Nop
50     !
60      High=2
70      Low=1
80      V1=0
90      V2=5
100     Nop=5
110     Icomp=.1
120     Vs=0
130    !
140     OUTPUT @Unit1;"FMT 5"        ! ASCII w/header<,>
150     OUTPUT @Unit1;"AV -1"        ! Averaging=1PLC
160     OUTPUT @Unit1;"WT 0,.01"     ! Hold Time, Delay Time
170     OUTPUT @Unit1;"CN";Low,High
180     OUTPUT @Unit1;"TM3"
190     OUTPUT @Unit1;"TGP -1,1,2,1" ! MeasStartTrg Input
200     OUTPUT @Unit1;"TGP -2,2,2,3" ! StepMeasEndTrg Output
210     OUTPUT @Unit1;"TGMO 1"       ! Edge Trigger
220     OUTPUT @Unit1;"DV";Low,0,Vs,Icomp
230     OUTPUT @Unit1;"WV";High,1,0,V1,V2,Nop,Icomp
240     OUTPUT @Unit1;"MM";2,High
250    !
```

Line No.	Description
10 to 20	Assigns the I/O path to control the E5270.
60 to 120	Sets the value of the variables for source setup and so on.
140 to 240	Unit1 sets the measurement conditions and applies voltage.
180 to 190	Sets the Start Measurement trigger input for the Ext Trig In terminal.
200 to 210	Sets the Step Measurement Completion trigger output for the Ext Trig Out terminal.

```
260    OUTPUT @Unit2;"FMT 5"        ! ASCII w/header<,>
270    OUTPUT @Unit2;"AV -1"        ! Averaging=1PLC
280    OUTPUT @Unit2;"WT 0,.01"     ! Hold Time, Delay Time
290    OUTPUT @Unit2;"CN";Low,High
300    OUTPUT @Unit2;"TM3"
310    OUTPUT @Unit2;"TGP -2,2,2,1" ! MeasEndTrg Output
320    OUTPUT @Unit2;"TGXO 2"       ! Gate Trigger
330    OUTPUT @Unit2;"TGP -1,1,2,2" ! StepSetupStartTrg Input
340    OUTPUT @Unit2;"TGSI 2"       ! Ignore TRG for 1st step
350    OUTPUT @Unit2;"DV";Low,0,Vs,Icomp
360    OUTPUT @Unit2;"WV";High,1,0,V1,V2,Nop,Icomp
370    OUTPUT @Unit2;"MM";2,High
380    OUTPUT @Unit2;"XE"
390   !
400    OUTPUT @Unit1;"*OPC?"
410    ENTER @Unit1;A
420   !
430    FOR I=1 TO Nop
440      ENTER @Unit1 USING "#,3X,12D,X";I1
450      PRINT "I1= ";I1*1000;" [mA]"
460      ENTER @Unit2 USING "#,3X,12D,X";I2
470      PRINT "I2= ";I2*1000;" [mA]"
480    NEXT I
490   !
500    OUTPUT @Unit1;"CL"
510    OUTPUT @Unit2;"CL"
520    END
```

Line No.	Description
260 to 370	Unit2 sets the measurement conditions and applies voltage.
300 to 320	Sets the Measurement Completion trigger output for the Ext Trig Out terminal, and specifies the gate trigger. Unit1 will start measurement when this trigger is sent to its Ext Trig In terminal.
330 to 340	Sets the Start Step Output Setup trigger input for the Ext Trig In terminal. Unit2 will start step output setup when the Step Measurement Completion trigger is sent by the unit1.
380	Unit2 starts measurement, and sends a trigger to the Ext Trig Out terminal. Then the unit1 starts measurement.
400 to 510	After measurement, the data is read and displayed. Also the source output is disabled.

Part of the program used to synchronize the Agilent E5270 operation with the operation of other device is shown below. This program performs the following:

1. Sets the Agilent E5270 for the bipolar transistor Ib-Ic measurement
2. Triggers a sweep measurement
3. Performs a step measurement and sends the Step Measurement Completion output gate trigger
4. Waits for the Start Step Output Setup input trigger
5. Displays a measurement data (Ic)
6. Repeats 3 to 5 the number of times specified by Ib_num
7. Disables the Agilent E5270 channel output

This program does not include the program lines to control other device and its trigger function. Please add the program lines to control other device before running the program. For the timing of the trigger, refer to the comments in the following program listing.

```
10      ASSIGN @E5270 TO 717
20      OPTION BASE 1
30      INTEGER Collector,Base,Ib_num,Vc_num
40     !
50      Collector=2
60      Base=1
70      Ib_start=.0001
80      Ib_stop=.001
90      Ib_num=10
100     Ib_step=(Ib_stop-Ib_start)/(Ib_num-1)
110     Vb_comp=1
120     Vc=2.5
130     Ic_comp=.1
140    !
150    !Other device should be initialized and set up.
160    !
```

Line No.	Description
10	Assigns the I/O path to control the E5270.
50 to 130	Sets the value of the variables for source setup and so on.
140 to 160	Add program lines to perform initialization and measurement setup of other device.

```
170     OUTPUT @E5270;"FMT 5"        ! ASCII w/header<,>
180     OUTPUT @E5270;"AV -1"        ! Averaging=1PLC
190     OUTPUT @E5270;"WT 0,.01"     ! Hold Time, Delay Time
200     OUTPUT @E5270;"CN";Collector,Base
210     OUTPUT @E5270;"TGP -2,2,2,3" ! StepMeasEndTrg Output
220     OUTPUT @E5270;"TGMO 2"       ! Gate Trigger
230     OUTPUT @E5270;"TGP -1,1,2,2" ! StartStepSetupTrg Input
240     OUTPUT @E5270;"TGSI 2" ! Ignore TRG for 1st step setup
250     OUTPUT @E5270;"DV";Collector,0,Vc,Ic_comp
260     OUTPUT @E5270;"WI";Base,1,0,Ib_start,Ib_stop,Ib_num,Vb_comp
270     OUTPUT @E5270;"MM";2,Collector
280    !
290    !Other device must be set to the measurement ready and
300    !trigger wait condition.
310    !
```

Line No.	Description
170	Specifies the data output format.
180	Sets the number of averaging samples for the high-speed ADC.
190	Sets the hold time and delay time.
200	Enables the source/measurement channels.
210 to 220	Sets the Step Measurement Completion trigger output for the Ext Trig Out terminal, and specifies the gate trigger.
230 to 240	Sets the Start Step Output Setup trigger input for the Ext Trig In terminal, also disables the input trigger for the first sweep step.
250	Forces voltage.
260	Sets the staircase sweep source.
270	Sets the measurement mode and the measurement channel.
280 to 310	To synchronize the Agilent E5270 operation with the operation of other device, add program lines to set it to the measurement ready and trigger wait condition.

```
320    OUTPUT @E5270;"XE"
330   !
340   !E5270 starts measurement. Then it sends negative gate
350   !trigger to the device.
360   !Then the device should start measurement.
370   !
380    FOR I=1 TO Ib_num
390      ENTER @E5270 USING "#,3X,12D,X";Ic
400      PRINT "Ic= ";Ic*1000;" [mA]"
410   !
420   !Measurement data of the other device should be read.
430   !And the data should be displayed.
440   !
450   !The device must be set to the measurement ready and
460   !trigger wait condition.
470   !
480   !The device must send trigger to E5270.
490   !The E5270 will start a step source output by the trigger,
500   !and perform a step measurement.
510   !
520    NEXT I
530   !
540    OUTPUT @E5270;"CL"
550    END
```

Line No.	Description
320	Starts sweep measurement, and performs a step measurement. When the Agilent E5270 starts a step measurement, it sends a negative gate trigger. Then the other device should start measurement.
390 to 400	Reads the measurement data, and displays the measurement data.
410 to 510	To synchronize the Agilent E5270 operation with the operation of other device, add program lines to do following: • To read and display the data measured by the device • To set it to the measurement ready and trigger wait condition • To send a trigger from the device When the Agilent E5270 receives the trigger, it starts a step measurement and sends negative gate trigger.
520	Repeats 390 to 510 the number of times specified by Ib_num.
540	Disables the source/measurement channels.

Reading Time Stamp Data

Time stamp function outputs a time data with a measurement result data.

NOTE

This function is not available for binary data output format (FMT 3 and 4).

This function is not available for the quasi-pulsed spot measurement (MM 9) and the search measurement (MM 14 and 15).

To read the time data with the best resolution (100 μs), reset the time stamp every 100 sec or less for the FMT 1, 2, or 5 data output format, or every 1000 sec or less for the FMT 11, 12, 15, 21, 22, or 25 data output format.

Enter the MM command to define the measurement mode and enter the TSC command to set the time stamp function ON. You can get the time data with the measurement data. The time data is the time from when the time stamp is cleared until the measurement is started.

Function	Command	Parameters
Sets the time stamp function	TSC	*onoff*

The following commands returns the time data regardless of the TSC command setting. The time data is the time from when the time stamp is cleared until the following command is entered.

Function	Command	Parameters
Forces voltage	TDV	*chnum*,*range*,*output*[,*Icomp*]
Forces current	TDI	*chnum*,*range*,*output*[,*Vcomp*]
Performs high speed spot current measurement	TTI	*chnum*,*range*
Performs high speed spot voltage measurement	TTV	*chnum*,*range*
Just returns the time data	TSQ	

To clear the time stamp, enter the TSR command.

The following example program executes a high-speed spot measurement using the TTI command, and displays the measurement result and time stamp on the screen.

```
10      ASSIGN @E5270 TO 717
20      INTEGER Source,Drain,Gate,Sub,Range
30    !
40      Source=1       !1:MPSMU in slot1
50      Drain=2        !2:MPSMU in slot2
60      Gate=3         !3:MPSMU in slot3
70      Sub=4          !4:MPSMU in slot4
80      Range=0        ! Auto ranging
90      Vs=0           ! Source Voltage
100     Vd=5           ! Drain Voltage
110     Vg=3           ! Gate Voltage
120     Vsub=0         ! Substrate Voltage
130     Icomp_g=.01    ! Current compliance for gate
140     Icomp=.1       ! Current compliance
150   !
160     OUTPUT @E5270;"FMT 25"       !ASCII w/header <,>
170     OUTPUT @E5270;"CN ";Source,Drain,Gate,Sub
180     OUTPUT @E5270;"TSR"
190     OUTPUT @E5270;"DV ";Source,Range,Vs,Icomp
200     OUTPUT @E5270;"DV ";Sub,Range,Vsub,Icomp
210     OUTPUT @E5270;"DV ";Gate,Range,Vg,Icomp_g
220     OUTPUT @E5270;"DV ";Drain,Range,Vd,Icomp
230   !
```

Line Number	Description
10	Assigns the I/O path for controlling the E5270.
40 to 140	Sets the value of the variables for source setup and so on.
160	Specifies the data output format.
170	Enables the source/measurement channels.
180	Resets the time stamp (sets the time stamp to 0 sec).
190 to 220	Forces voltage.

```
240    OUTPUT @E5270;"TTI ";Drain,Range
250    OUTPUT @E5270;"TSQ"
260    ENTER @E5270 USING "#,5X,13D,6X,13D,X";Time1,Mdata1
270    ENTER @E5270 USING "#,5X,13D,X";Time2
280  !
290    PRINT "Id=";Mdata1*1000;"mA"
300    PRINT "Measurement time=";Time2-Time1;"s"
310  !
320    OUTPUT @E5270;"CL"
330    OUTPUT @E5270;"TSQ"
340    ENTER @E5270 USING "#,5X,13D,X";Time3
350    PRINT "Source output time=";Time3;"s"
360  !
370    END
```

Line Number	Description
240	Executes a high-speed spot measurement, and puts the time data and measurement data in the data output buffer. The time data is the time when measurement was started.
250	Puts the time data in the data output buffer. This data is the time when measurement was completed.
260	Reads the measurement data and the time data when measurement was started.
270	Reads the time data when measurement was stopped.
290 to 300	Prints the measurement data and the measurement time on the screen.
320	Disables the source/measurement channels.
330 to 340	Reads the time data when the source output was stopped.
350	Prints the source output time on the screen.

The following example program executes a staircase sweep measurement, and displays the measurement result and time data on the screen.

```
10     ASSIGN @E5270 TO 717
20     INTEGER Source,Drain,Gate,Sub,Range_v,Range_i
30     DIM A$[100],B$[1]
40   !
50     Drain=1         !1:MPSMU in slot1
60     Gate=2          !2:MPSMU in slot2
70     Sub=3           !3:MPSMU in slot3
80     Source=4        !4:MPSMU in slot4
90     Range_v=0       !0: Auto Ranging
100    Range_i=15      !15:10 uA Limited Auto Ranging
110    Vs=0            ! Source Voltage
120    Vd=3            ! Drain Voltage
130    Vg=3            ! Gate Voltage
140    Vsub=0          ! Substrate Voltage
150    Icomp_g=.01     ! Current compliance for gate
160    Icomp=.1        ! Current compliance
170    Var1=11         ! Number of Var1 step
180  !
190    OUTPUT @E5270;"FMT 25"     !ASCII w/Header <,>
200    OUTPUT @E5270;"CN ";Source,Drain,Gate,Sub
210    OUTPUT @E5270;"MM ";2,Drain !Sweep measurement
220    OUTPUT @E5270;"WT 1,.1"     !Hold, Delay
230    OUTPUT @E5270;"WM 2,1"      !Stops any abnormal
240    OUTPUT @E5270;"DV ";Source,Range_v,Vs,Icomp
250    OUTPUT @E5270;"DV ";Sub,Range_v,Vsub,Icomp
260    OUTPUT @E5270;"WV ";Drain,1,Range_v,0,Vd,Var1,Icomp
270    OUTPUT @E5270;"WSV ";Gate,Range_v,0,Vg,Icomp_g
280    OUTPUT @E5270;"TSC1"
```

Line Number	Description
10	Assigns the I/O path to control the E5270.
50 to 170	Sets the value of the variables for source setup and so on.
190	Specifies the data output format.
200	Enables the source/measurement channels.
210	Sets the measurement mode and the measurement channel.
220	Sets the hold time (=1s) and delay time (=0.1s).
230	Enables measurement abort function for abnormal conditions.
240 to 270	Forces voltage, and sets voltage sweep sources.
280	Enables the time stamp data output.

```
290    OUTPUT @E5270;"RI ";Drain,Range_i
300    OUTPUT @E5270;"TSR"
310    OUTPUT @E5270;"XE"
320    OUTPUT @E5270;"*OPC?"
330    ENTER @E5270;A
340    OUTPUT @E5270;"ERR? 1"
350    ENTER @E5270;A
360    IF A=0 THEN
370      OUTPUT @E5270;"NUB?"
380      ENTER @E5270;A
390      IF A<>0 THEN
400        FOR I=1 TO A
410          ENTER @E5270 USING "#,3A,X,A,13D,X";A$,B$,Mdata
420          IF B$="I" THEN
430            PRINT "Id=";Mdata*1000;"(mA), Status=";A$
440          ELSE
450            IF B$="T" THEN
460              PRINT "Time=";Mdata;"(s), Status=";A$
470            ELSE
480              PRINT "XX=INVALID DATA, Status=";A$
490            END IF
500          END IF
510        NEXT I
520      ELSE
530        PRINT "STATUS: No data returned."
540      END IF
550    ELSE
560      OUTPUT @E5270;"EMG? ";A
570      ENTER @E5270;A$
580      PRINT "ERROR:";A$
590    END IF
600    OUTPUT @E5270;"CL"
610    END
```

Line Number	Description
290	Sets current measurment range.
300 to 330	Resets the timer, and executes a staircase sweep measurement.
340 to 590	Checks to see if an error has occurred. If an error is detected, the error message is displayed on the screen.
370 to 380	Confirms the number of data stored in the output buffer.
400 to 510	Reads the measurement data and time data, and displays the data.
480	Displays “XX=INVALID DATA” if the data is not current measurement data or time data.
530	Displays “No data returned” if the number of data is zero.
600	Disables the source/measurement channels.

Reading Binary Output Data

This section provides the example to read binary data. The following program example:

1. executes high-speed spot measurements
2. reads the measurement data in binary data format
3. rearranges the data and calculates the measured data
4. prints the measured data on the screen

```
10     ASSIGN @E5270 TO 717
20     INTEGER Fmt,Source,Drain,Gate,Sub
30     INTEGER Vrange,Irange
40     DIM Mdata$[4]
50     DIM Status$[10]
60   !
70     Source=1       !1:SMU1
80     Drain=2        !2:SMU2
90     Gate=3         !3:SMU3
100    Sub=4          !4:SMU4
110    Vrange=0       !0: Auto Ranging
120    Irange=15      !15:10 uA Limited Auto Ranging
130    Vs=0           ! Source Voltage
140    Vd=.5          ! Drain Voltage
150    Vg=3           ! Gate Voltage
160    Vsub=0         ! Substrate Voltage
170    Icomp_g=.1     ! Current compliance for gate
180    Icomp=.1       ! Current compliance
190  !
200    OUTPUT @E5270;"FMT4"  !BINARY <^EOI>
210    OUTPUT @E5270;"CN";Source,Drain,Gate,Sub
220    OUTPUT @E5270;"DV";Source,Vrange,Vs,Icomp
230    OUTPUT @E5270;"DV";Sub,Vrange,Vsub,Icomp
240    OUTPUT @E5270;"DV";Gate,Vrange,Vg,Icomp_g
250    OUTPUT @E5270;"DV";Drain,Vrange,Vd,Icomp
260  !
```

Line No.	Description
10	Assigns the I/O path to control the E5270.
70 to 180	Sets the value of the variables for source setup and so on.
200	Sets binary data output format with terminator <^EOI>.
210 to 250	Enables source/measurement channels and forces voltage.

```
270    OUTPUT @E5270;"TI";Drain,Irange
280    ENTER @E5270 USING "#,4A";Mdata$
290    CALL Cal_bin(Mdata$,Value,Status$)
300    IF Status$="0" THEN
310      PRINT "Id(A)=";Value*1000;"(mA)"
320    ELSE
330      PRINT "Error: ";Value
340    END IF
350    OUTPUT @E5270;"CL"
360    END
370   !
380    SUB Cal_bin(Mdata$,Value,Status$)
390      REAL D1,D2,D3,D4
400      D1=NUM(Mdata$[1;1])!Byte1
410      D2=NUM(Mdata$[2;1])!Byte2
420      D3=NUM(Mdata$[3;1])!Byte3
430      D4=NUM(Mdata$[4;1])!Byte4
440   !
450      Status=SHIFT(D4,5)
460      IF Status<>0 THEN
470        Status$="E"
480        Value=Status
```

Line No.	Description
270	Executes a high speed spot current measurement.
280	Reads the measurement result data (4 bytes of binary data).
290	Calls sub-routine used to arrange binary data.
300 to 340	Displays the measurement data if no status error has occurred. If an error is detected, the status number is displayed on the screen.
350	Disables the source/measurement channels.
380	Starting of the sub-routine “Cal_bin”.
390 to 430	Separates the binary data (Mdata$) to a byte (D1 to D4).
450	Reads the Status value.
460 to 480	If any status error has occurred, sets the Status$=”E”, enters the status number to the variable Value, and returns to the program.

```
490      ELSE
500        Status$="0"
510   !
520        Type=BIT(D1,7) !0:Source, 1:Measurement
530        Mode=BIT(D1,6) !0:Voltage, 1:Current
540        Range=SHIFT(BINAND(D1,62),1) !62=00111110
550   !
560        Count=D2*256+D3
570        Sign=BIT(D1,0)
580        IF Sign=1 THEN !0:Positive, 1:Negative
590          Count=Count-65536
600        END IF
610   !
620        SELECT Mode
630        CASE 0            !Voltage range
640          SELECT Range
650          CASE 11
660            Rng=2
670          CASE 12
680            Rng=20
690          CASE 13
700            Rng=40
710          CASE 14
720            Rng=100
730          CASE 15
740            Rng=200
750          END SELECT
760        CASE 1            !Current range
770          Rng=10^(Range-20)
780        END SELECT
790   !
800        SELECT Type
810        CASE 0            !Source data
820          Value=Count*Rng/20000
830        CASE 1            !Measurement data
840          Value=Count*Rng/50000
850        END SELECT
860      END IF
870    SUBEND
```

Line No.	Description
490 to 870	If no status error has occurred, reads the data, calculates the source/ measurement data, and returns to the program.
520 to 600	Reads the data and parameters included in the binary data.
620 to 780	Specifies the source/measurement range.
800 to 850	Calculates the source/measurement data.

NOTE

Data resolution

The resolution of binary data is as shown below.

- Measurement data: Measurement range / 50000
- Output data: Output range / 20000

Note that the resolution of the measurement data is larger than the resolution of the high resolution A/D converter.

Using Programs for 4142B

This section describes the program modification example to use a program created for the Agilent 4142B Modular DC Source/Monitor. To use the program:

1. change the GPIB address, if necessary.
2. enter the ACH command to translate the channel numbers, if necessary.
3. remove the unsupported command, or replace it with the command supported by the E5270.

For more information, refer to “To Use Programs for Agilent 4142B” on page 1-43.

The following program examples show a modified measurement program, which performs a high-speed spot measurement.

The original 4142B program:

```
10     ASSIGN @Hp4142 TO 717
20     INTEGER G_ch,D_ch,S_ch
30   !
40   !          !Source:    GNDU
50     G_ch=2   !Gate:      HPSMU (SLOT2)
60     D_ch=3   !Drain:     MPSMU (SLOT3)
70     S_ch=4   !Substrate: MPSMU (SLOT4)
80   !
90     OUTPUT @Hp4142;"FMT5"
100    OUTPUT @Hp4142;"CN";D_ch,G_ch,S_ch
110    OUTPUT @Hp4142;"DV";S_ch;",0,0,.1"
120    OUTPUT @Hp4142;"DV";G_ch;",0,3,.01"
130    OUTPUT @Hp4142;"DV";D_ch;",0,5,.1"
140    OUTPUT @Hp4142;"TI";D_ch;",0"
150    ENTER @Hp4142 USING "#,3X,12D,X";Mdata
160    PRINT "Id(A)=";Mdata
170    OUTPUT @Hp4142;"CL"
180    END
```

Line No.	Description
10	Assigns the I/O path to control the 4142B.
90	Specifies the data output format.
100 to 130	Enables the source/measurement channels, and forces voltage.
140 to 180	Executes the measurement, reads and displays the measurement data, and disables channels.

The program modified to control the E5270:

```
10     ASSIGN @Hp4142 TO 717               !<<<<
20     INTEGER G_ch,D_ch,S_ch
21     INTEGER Sub                         !<<<<
30    !
40    !        !Source:    GNDU
50     G_ch=2  !Gate:      HPSMU (SLOT2)
60     D_ch=3  !Drain:     MPSMU (SLOT3)
70     S_ch=4  !Substrate: MPSMU (SLOT4)
80    !
81     Sub=5                               !<<<<
82     OUTPUT @Hp4142;"ACH";Sub,S_ch       !<<<<
83     OUTPUT @Hp4142;"*OPC?"              !<<<<
84     ENTER @Hp4142;A                     !<<<<
85    !
90     OUTPUT @Hp4142;"FMT5"
100    OUTPUT @Hp4142;"CN";D_ch,G_ch,S_ch
110    OUTPUT @Hp4142;"DV";S_ch;",0,0,.1"
120    OUTPUT @Hp4142;"DV";G_ch;",0,3,.01"
130    OUTPUT @Hp4142;"DV";D_ch;",0,5,.1"
140    OUTPUT @Hp4142;"TI";D_ch;",0"
150    ENTER @Hp4142 USING "#,3X,12D,X";Mdata
160    PRINT "Id(A)=";Mdata
170    OUTPUT @Hp4142;"CL"
180    END
```

Line No.	Note
10	Change GPIB address, if necessary.
21, 81	Add program lines if the module configuration is different from the 4142B. This example adds the variable Sub, and uses the SMU in slot 5 instead of slot 4 for substrate.
82 to 84	Add program line to set the channel map. This example transfers the Sub value to the variable S_ch used in the original program.

Using Programs for 4155B/4156B/4155C/4156C

This section describes the program modification example to use a FLEX command program created for the Agilent 4155B/4156B/4155C/4156C Parameter Analyzer. To use the program:

1. change the GPIB address, if necessary.
2. enter the ACH command to translate the channel numbers, if necessary.
3. change the FMT command parameter value to use the data output format compatible with the 4155/4156 output data, or change the program lines to read the measurement data.
4. remove the US command.
5. remove the RMD? command.
6. remove the unsupported command, or replace the command with the corresponding command supported by the E5270.

For more information, refer to “To Use Programs for Agilent 4155/4156” on page 1-44.

The following program examples show a modified measurement program, which performs a high-speed spot measurement.

The original 4156C program:

```
10      ASSIGN @Hp415x TO 717
20      INTEGER G_ch,D_ch,S_ch,B_ch
30    !
40      S_ch    !Source:    SMU1
50      G_ch=2  !Gate:      SMU2
60      D_ch=3  !Drain:     SMU3
70      B_ch=4  !Substrate: SMU4
80    !
90      OUTPUT @Hp415x;"US"
100     OUTPUT @Hp415x;"FMT 5"
110     OUTPUT @Hp415x;"CN ";D_ch,G_ch,S_ch,B_ch
120     OUTPUT @Hp415x;"DV ";S_ch;",0,0,.1"
130     OUTPUT @Hp415x;"DV ";B_ch;",0,0,.1"
140     OUTPUT @Hp415x;"DV ";G_ch;",0,3,.01"
150     OUTPUT @Hp415x;"DV ";D_ch;",0,5,.1"
160     OUTPUT @Hp415x;"TI ";D_ch;",0"
170     OUTPUT @Hp415x;"RMD? 1"
180     ENTER @Hp415x USING "#,5X,13D,X";Mdata
190     PRINT "Id(A)=";Mdata
200     OUTPUT @Hp415x;"CL"
210     END
```

Line No.	Description
10	Assigns the I/O path to control the 4155/4156.
90	Enters the FLEX command mode.
100	Specifies the data output format.
110 to 150	Enables the source/measurement channels, and forces voltage.
160 to 210	Executes the measurement, reads and displays the measurement data, and disables channels.

The program modified to control the E5270:

```
10     ASSIGN @Hp415x TO 717                        !<<<<
20     INTEGER G_ch,D_ch,S_ch,B_ch
21     INTEGER Sub                                  !<<<<
30   !
40   ! S_ch=1  !Source:    SMU1 <<<< replaced with GNDU
50     G_ch=2  !Gate:      SMU2
60     D_ch=3  !Drain:     SMU3
70     B_ch=4  !Substrate: SMU4
80   !
81     Sub=5                                        !<<<<
82     OUTPUT @Hp415x;"ACH ";Sub,B_ch               !<<<<
83   !
90   ! OUTPUT @Hp415x;"US"                           <<<<
100    OUTPUT @Hp415x;"FMT 25"                      !<<<<
110    OUTPUT @Hp415x;"CN ";D_ch,G_ch,B_ch          !<<<<
120  ! OUTPUT @Hp415x;"DV ";S_ch;",0,0,.1"           <<<<
130    OUTPUT @Hp415x;"DV ";B_ch;",0,0,.1"
140    OUTPUT @Hp415x;"DV ";G_ch;",0,3,.01"
150    OUTPUT @Hp415x;"DV ";D_ch;",0,5,.1"
160    OUTPUT @Hp415x;"TI ";D_ch;",0"
170  ! OUTPUT @Hp415x;"RMD? 1"                       <<<<
180    ENTER @Hp415x USING "#,5X,13D,X";Mdata
190    PRINT "Id(A)=";Mdata
200    OUTPUT @Hp415x;"CL"
210    END
```

Line No.	Note
10	Change GPIB address, if necessary.
21, 81	Add program lines if the module configuration is different from the 415x. This example adds the Sub variable, and uses the SMU in slot 5 instead of slot 4 for substrate.
82	Add program line to set the channel map. This example transfers the Sub value to the variable B_ch used in the original program.
90	Remove the US command. This command is not required.
100	Change the FMT command parameter value.
40, 110, 120	This example uses the GNDU instead of the SMU1. So remove the program lines that include the variable S_ch (SMU1).
170	Remove the RMD? command. This command is not required.

4 Command Reference

This chapter is the complete reference of the GPIB commands of the Agilent E5270:

- “Command Summary”
- “Command Parameters”
- “Command Reference”

Command Summary

The following table summarizes the GPIB commands.

Category	Command	Summary
Reset	*RST	Resets the E5270 to the initial settings.
Diagnostics	DIAG?	Performs diagnostics, and returns the result.
Self-test	*TST?	Performs the self-test, and returns the result.
Self Calibration	CA	Performs self calibration.
	*CAL?	Performs self calibration, and returns the result.
	CM	Sets auto-calibration ON or OFF.
Abort	AB	Aborts the present operation and subsequent command execution.
Pause/ Continue	PA/PAX	Pauses command execution or internal memory program execution, until the specified wait time has elapsed or until an event specified by the TM command is received.
	TM	Sets the event to start measurement or to release the E5270 from the paused status set by the PA or PAX command.
Channel Control	ACH	Translates a channel number to another channel number.
	CN	Enables the specified channels by setting the output switches to ON.
	CL	Disables the specified channels by setting the output switches to OFF.
	IN	Sets the specified channels to 0 V.
	DZ	Stores the setup of the channels, and sets the output to 0 V.
	RZ	Returns the channel to the settings that are stored by the DZ command and clears the stored channel settings.
	RCV	Enables the channels that fail self-test.
Series Resistor	SSR	Sets the SMU series resistor of the specified channel to ON or OFF.
Filter	FL	Sets the filter of the specified channels to ON or OFF.

Category	Command	Summary
Integration Time and Averaging	AZ	Enables or disables the ADC zero function.
	AV	Selects the number of samples for averaging the high-speed ADC, not the high-resolution ADC.
	AAD	Selects the type of A/D converter, high-speed or high-resolution ADC.
	AIT	Selects the number of samples for averaging or the integration time of the ADC.
	WAT	Sets the source wait time and the measurement wait time.
Output Data	FMT	Specifies the measurement data output format and the data terminator.
	BC	Clears the E5270 output data buffer that stores measurement data and/or query command response data.
Source Setup	DI	Forces current from the specified channel.
	DV	Forces voltage from the specified channel.
High speed spot measurement	TI	Executes the current measurement, and returns the measured data.
	TV	Executes the voltage measurement, and returns the measured data.
Time Stamp	TDI TDV	Forces current (TDI) or voltage (TDV), and returns the time data from when the timer is cleared until source output is started.
	TSC	Enables the time stamp function for the MM 1, 2, 3, 4, 5, or 16 mode.
	TSQ	Returns the time data from when TSR is given until TSQ is given.
	TSR	Clears the timer count.
	TTI TTV	Measures current (TTI) or voltage (TTV), and returns the measurement data and the time data for the time from when the timer is cleared until the measurement is started.
Measurement Mode	MM	Sets the measurement mode and measurement channels.
Measurement Execution	XE	Performs measurements, and returns the measurement data; or recovers from the paused state if the PA/PAX command has been sent. Not available for the high speed spot measurement.

Category	Command	Summary
Staircase Sweep Source Setup	WT	Sets the hold time, delay time, step delay time, and trigger delay time.
	WI	Sets the staircase current sweep source.
	WV	Sets the staircase voltage sweep source.
	WM	Sets the automatic sweep abort function, and also sets the post sweep condition.
Synchronous Sweep Source Setup	WSI	Sets the synchronous current sweep source used with the WI or PWI command.
	WSV	Sets the synchronous voltage sweep source used with the WV or PWV command.
Multi channel Sweep Source Setup	WNX	Sets the synchronous current sweep source or synchronous voltage sweep source used with the WI or WV command.
Pulsed Source Setup	PT	Sets the hold time, pulse width, pulse period, and trigger delay time.
	PI	Sets the pulsed current source.
	PV	Sets the pulsed voltage source.
Pulsed Sweep Source Setup	PT	Sets the hold time, pulse width, pulse period, and trigger delay time.
	PWI	Sets the pulsed current sweep source.
	PWV	Sets the pulsed voltage sweep source.
	WM	Sets the automatic sweep abort function, also sets the post sweep condition.
Quasi-pulsed Voltage Source Setup	BDM	Specifies the detection interval, and either voltage or current measurement.
	BDT	Specifies the hold time and delay time.
	BDV	Sets the quasi-pulsed voltage source.

Category	Command	Summary
Binary Search Measurement Setup	BSM	Sets the source output control mode, the automatic abort function, and the post search condition.
	BST	Specifies the hold time and delay time.
	BSVM	Selects the data output mode.
	BSI	Sets the current source channel.
	BSSI	Sets the synchronous current source channel.
	BGV	Sets the voltage monitor channel.
	BSV	Sets the voltage source channel.
	BSSV	Sets the synchronous voltage source channel.
	BGI	Sets the current monitor channel.
Linear Search Measurement Setup	LSTM	Specifies the hold time and delay time.
	LSVM	Selects the data output mode.
	LSI	Sets the current source channel.
	LSSI	Sets the synchronous current source channel.
	LGV	Sets the voltage monitor channel.
	LSV	Sets the voltage source channel.
	LSSV	Sets the synchronous voltage source channel.
	LGI	Sets the current monitor channel.
	LSM	Sets the automatic abort function and the post search condition.
Measurement Setup	CMM	Sets the SMU measurement operation mode.
	RI	Specifies the current measurement ranging mode for measurement other than the high speed spot measurement that uses TI/TTI command.
	RV	Specifies the voltage measurement ranging mode for measurement other than the high speed spot measurement that uses TV/TTV command.
	RM	Sets the range selection rule for the auto ranging current measurement.

Category	Command	Summary
Program Memory	ST	Used with END command to store a program in the internal program memory. The ST command indicates the beginning of the program.
	END	Used with the ST command to store a program in the internal program memory. The END command indicates the end of the program.
	SCR	Scratches the specified program from the internal program memory.
	VAR	Sets the value to the variable used in an internal memory program.
	VAR?	Returns the value set to the internal memory program variable.
	LST?	Returns a catalog of internal memory programs or a specific program listing (3000 commands maximum).
	DO	Executes internal memory programs in the order specified.
	RU	Executes internal memory programs sequentially.
Query	ERR?	Returns error codes.
	EMG?	Returns error message for the specified error code.
	*IDN?	Returns the instrument model number and the ROM version number.
	LOP?	Returns the operation status of all modules.
	*LRN?	Returns channel settings or the E5270 command parameter settings.
	NUB?	Returns the number of measurement data items in the output data buffer.
	*OPC?	Starts to monitor pending operations, or asks the OPC bit setting.
	UNT?	Returns the model and revision numbers of all modules.
	WNU?	Returns the number of sweep steps specified by the sweep command.
	WZ?	Returns 0 if all channel output is ±2 V or less, or 1 if any channel applies more than ±2 V.
Status Byte	*SRE	Enables the specified bits of the status byte register.
	*SRE?	Returns which bits of the status byte register are enabled.
	*STB?	Returns the status byte setting.

Category	Command	Summary
External Trigger	TGP	Enables the trigger function for a terminal.
	TGPC	Clears the trigger setting of the specified ports.
	TGSI	Selects the sweep step first or last that ignores the Start Step Output Setup trigger input set by the `TGP` *port*`,1,`*polarity*`,2` command.
	TGSO	Selects the trigger type, edge or gate, for the Step Output Setup Completion trigger output set by the `TGP` *port*`,2,`*polarity*`,2` command.
	TGXO	Selects the trigger type, edge or gate, for the Measurement Completion trigger output set by the `TGP` *port*`,2,`*polarity*`,1` command.
	TGMO	Selects the trigger type, edge or gate, for the Step Measurement Completion trigger output set by the `TGP` *port*`,2,`*polarity*`,3` command.
	OS/OSX	Causes the E5270 to send a trigger signal from a trigger output terminal.
	WS/WSX	Enters a wait state until the E5270 receives an external trigger via a trigger input terminal.
	TM3	Enables use of an external trigger to release the PA/PAX state, or to start measurement if the E5270 has not been set to the PA/PAX/WS/WSX state. Or enables trigger set by the TGP *port*,*terminal*,*polarity*,1.
Digital I/O port	ERM	Changes the digital I/O port assignments.
	ERS?	Returns the digital I/O port status.
	ERC	Changes the output status of the digital I/O port.
Display and keyboard	RED	Enables or disables the measurement data display and the setup data display in the remote mode.
	DFM	Selects the data display format, scientific or engineering.
	SPA	Selects the parameter displayed in the Source Data display area.
	MPA	Selects the parameter displayed in the Measurement Data display area.
	SCH	Selects the source channel for the data is displayed on the LCD.
	MCH	Selects the measurement channel for the data is displayed on the LCD.
	KLC	Locks or unlocks the front panel keys.

Command Parameters

The parameters used by several commands are explained in this section.

- “Channel Number”
- “Voltage Measurement Ranging Type”
- “Current Measurement Ranging Type”
- “Voltage Output Ranging Type”
- “Current Output Ranging Type”
- “Voltage Source Setup Parameters (DV/WV/WSV/WNX/PV/PWV)”
- “Current Source Setup Parameters (DI/WI/WSI/WNX/PI/PWI)”

In the following tables, the command parameters are put in italics such as *chnum*.

Table 4-1 **Channel Number**

Mainframe	*chnum*	Description
E5270A	1 to 8	MPSMU in the slot specified by *chnum*.
	2 to 4, 6 to 8[a]	HPSMU in the slot specified by *chnum*.
E5272A	1	MPSMU in slot 1.
	2	MPSMU in slot 2.
E5273A	1	MPSMU in slot 1.
	2	HPSMU.

a. HPSMU uses two slots. Then *chnum* must be the greater slot number. For example, if it is installed in slot 3 and 4, *chnum* must be 4.

Table 4-2 Voltage Measurement Ranging Type

range [a]	Ranging type	
	for measurement mode without pulse	**for measurement mode that uses pulse**
0	Auto ranging	Measurement channel uses the minimum range that covers the compliance value.
11	2 V limited auto ranging	
12	20 V limited auto ranging	
13	40 V limited auto ranging	
14	100 V limited auto ranging	
15	200 V limited auto ranging (for HPSMU)	
-11	2 V range fixed	
-12	20 V range fixed	
-13	40 V range fixed	
-14	100 V range fixed	
-15	200 V range fixed (for HPSMU)	

a. If the measurement channel forces voltage, the channel uses the voltage output range regardless of the *range* value.

Table 4-3 Current Measurement Ranging Type

range [a]	Ranging type	
	for measurement mode without pulse	**for measurement mode that uses pulse**
0	Auto ranging	Measurement channel uses the minimum range that covers the compliance value.
11	1 nA limited auto ranging	
12	10 nA limited auto ranging	
13	100 nA limited auto ranging	
14	1 μA limited auto ranging	
15	10 μA limited auto ranging	
16	100 μA limited auto ranging	
17	1 mA limited auto ranging	
18	10 mA limited auto ranging	
19	100 mA limited auto ranging	
20	200 mA limited auto ranging (for MPSMU)	
	1 A limited auto ranging (for HPSMU)	
–11	1 nA range fixed	
–12	10 nA range fixed	
–13	100 nA range fixed	
–14	1 μA range fixed	
–15	10 μA range fixed	
–16	100 μA range fixed	
–17	1 mA range fixed	
–18	10 mA range fixed	
–19	100 mA range fixed	
–20	200 mA range fixed (for MPSMU)	
	1 A range fixed (for HPSMU)	

a. If the measurement channel forces current, the channel uses the current output range regardless of the *range* value.

Table 4-4 **Voltage Output Ranging Type**

range or *vrange*	Ranging type
0	Auto ranging
11	2 V limited auto ranging
12	20 V limited auto ranging
13	40 V limited auto ranging
14	100 V limited auto ranging
15	200 V limited auto ranging (for HPSMU)

Table 4-5 **Current Output Ranging Type**

range or *irange*	Ranging type
0	Auto ranging
11	1 nA limited auto ranging (not available for pulsed output)
12	10 nA limited auto ranging
13	100 nA limited auto ranging
14	1 μA limited auto ranging
15	10 μA limited auto ranging
16	100 μA limited auto ranging
17	1 mA limited auto ranging
18	10 mA limited auto ranging
19	100 mA limited auto ranging
20	200 mA limited auto ranging (for MPSMU)
	1 A limited auto ranging (for HPSMU)

Table 4-6 **Voltage Source Setup Parameters (DV/WV/WSV/WNX/PV/PWV)**

Output Range	Resolution in V	*voltage*, *start*, *stop*, *base*, or *pulse* in V	Maximum *Icomp* in A	Remarks
2 V	100E–6	0 to ±2	±200E–3	For MPSMU.
			±1	For HPSMU.
20 V	1E–3	0 to ±20	±200E–3	For MPSMU.
			±1	For HPSMU.
40 V	2E–3	0 to ±20	±200E–3	For MPSMU.
		to ±40	±50E–3	
		0 to ±40	±500E–3	For HPSMU.
100 V	5E–3	0 to ±20	±200E–3	For MPSMU.
		to ±40	±50E–3	
		to ±100	±20E–3	
		0 to ±100	±125E–3	For HPSMU.
200 V	10E–3	0 to ±200	±50E–3	For HPSMU.

Table 4-7 Current Source Setup Parameters (DI/WI/WSI/WNX/PI/PWI)

Output Range	Resolution in A	*current*, *start*, *stop*, *base*, or *pulse* in A	Maximum *Vcomp* in V	Remarks
1 nA	50E–15	0 to ±1.15 E–9	±100	For MPSMU.
			±200	For HPSMU.
10 nA	500E–15	0 to ±11.5E–9	±100	For MPSMU.
			±200	For HPSMU.
100 nA	5E–12	0 to ±115E–9	±100	For MPSMU.
			±200	For HPSMU.
1 μA	50E–12	0 to ±1.15E–6	±100	For MPSMU.
			±200	For HPSMU.
10 μA	500E–12	0 to ±11.5E–6	±100	For MPSMU.
			±200	For HPSMU.
100 μA	5E–9	0 to ±115E–6	±100	For MPSMU.
			±200	For HPSMU.
1 mA	50E–9	0 to ±1.15E–3	±100	For MPSMU.
			±200	For HPSMU.
10 mA	500E–9	0 to ±11.5E–3	±100	For MPSMU.
			±200	For HPSMU.
100 mA	5E–6	0 to ±20E–3	±100	For MPSMU.
		to ±50E–3	±40	
		to ±115E–3	±20	
		0 to ±50E–3	±200	For HPSMU.
		to ±115E–3	±100	
200 mA	10E–6	0 to ±20E–3	±100	For MPSMU.
		to ±50E–3	±40	
		to ±200E–3	±20	
1 A	50E–6	0 to ±50E–3	±200	For HPSMU.
		to ±125E–3	±100	
		to ±500E–3	±40	
		to ±1	±20	

Command Reference

This section contains detailed descriptions of all GPIB commands. The commands are listed in alphabetical order. Each entry:

1. Defines one GPIB command
2. Describes the execution conditions, if any exist
3. Describes the syntax
4. Lists the parameters
5. Shows the query response after command execution, if there is a query command
6. Explains any additional information
7. Provides examples

The following conventions are used in this section.

parameter	Required command parameters, for which you must substitute a value or variable.
[*parameter*]	Optional command parameters, for which you may substitute a value or omit it.

AAD

This command selects the A/D converter (ADC), high-speed or high-resolution for each measurement channel.

This command setting is ignored by the pulsed spot, pulsed sweep, and staircase sweep with pulsed bias measurements.

Execution Conditions

Enter the AIT or AV command to set up the ADC.

Syntax

AAD *chnum*[,*type*]

Parameters

***chnum* :** Measurement channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***type* :** Type of the A/D converter. Integer expression. 0 or 1.

- 0: High-speed ADC (default setting). For high speed measurement.
- 1: High-resolution ADC. For high accurate measurement.

Example Statements

```
OUTPUT @E5270;"AAD 1,0"
OUTPUT @E5270;"AAD 1,1"
```

AB

The AB command aborts the present operation and subsequent command execution.

This command stops the operation now in progress, such as the measurement execution, source setup changing, and so on. But this command does not change the present condition. For example, if the E5270 just keeps to force the DC bias, the AB command does not stop the DC bias output.

Syntax

AB

Conditions after Execution

The AB command sets the E5270 as listed in the following table.

Operation before AB	Setting after AB
Staircase sweep measurement	Sets specified start value.
Pulsed spot measurement	Sets specified base value.
Pulsed sweep measurement	Sets specified base value.
Staircase sweep with pulsed bias measurement	Sets specified start value and base value.
Quasi-pulsed spot measurement	Sets specified start value.
Linear search measurement	Sets specified start value.
Binary search measurement	Sets specified start value.
Multi channel sweep measurement	Sets specified start value.
Self-test	Same as set by CL command.
Self-calibration	Same as set by CL command.
Wait state (PA/PAX/WS/WSX command)	Settings do not change.
Program execution (RU or DO command)	Settings do not change.

Example Statements

```
OUTPUT @E5270;"AB"
```

Remarks

If you start an operation that you may want to abort, do not send any command after the command or command string that starts the operation. If you do, the AB command cannot enter the command input buffer until the intervening command execution starts, so the operation cannot be aborted. In this case, use the device clear (HP BASIC CLEAR command) to end the operation.

If the AB command is entered in a command string, the other commands in the string are not executed. For example, the CN command in the following command string is not executed.

OUTPUT @E5270;"AB;CN"

During sweep measurement, if the E5270 receives the AB command, it returns only the measurement data obtained before abort. Then the dummy data is not returned.

For the quasi-pulsed spot measurement, the E5270 cannot receive any command during the settling detection. So the AB command cannot abort the operation, and it will be performed after the settling detection.

ACH

The ACH command translates the specified *program* channel number to the specified *actual* channel number at the program execution. This command is useful when you use a control program created for an instrument, such as the Agilent 4142B, 4155B/4155C/4156B/4156C, and E5270, that has a module configuration different from the E5270 actually you use. After the ACH command, enter the *OPC? command to confirm that the command execution is completed.

Syntax

`ACH [actual[,program]]`

Parameter

***actual* :** Channel number actually used for measurement instead of *program*. The value must be slot number where the module has been installed in the E5270. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***program* :** Channel number used in a program and will be replaced with *actual*. Integer expression.

If you do not set *program*, this command is the same as ACH *n*,*n*.

If you do not set *actual* and *program*, the all channel number mapping is cleared.

For parameter settings, you cannot use the variables set by the VAR command.

Remarks

The ACH commands must be put at the beginning of the program or before the command line that includes a *program* channel number. In the program lines that follow the ACH command, you must leave the *program* channel numbers. The measurement data is returned as the data of the channel *program*, not *actual*.

Example Statements

If you want to use channels 1 to 3 instead of channels 5 to 7 respectively, enter the following statements. The measurement data is returned as the data of channel 5, not channel 1.

```
OUTPUT @E5270;"ACH 1,5"    !uses ch1 instead of ch5
OUTPUT @E5270;"ACH 2,6"    !     ch2            ch6
OUTPUT @E5270;"ACH 3,7"    !     ch3            ch7
OUTPUT @E5270;"*OPC?"
ENTER @E5270;A
!
OUTPUT @E5270;"CN 5,6,7"            !leave prog ch No.
!                                           |
OUTPUT @E5270;"DV 5,0,3"            !       |
OUTPUT @E5270;"DV 6,0,0"            !       |
OUTPUT @E5270;"DV 7,0,0"            !       |
!                                           |
OUTPUT @E5270;"TI 5,0"              !       |
ENTER @E5270 USING "#,3X,12D,X";Data!       |
PRINT "I=";Data                     !       |
!                                           |
OUTPUT @E5270;"CL 5,6,7"            !       V
```

AIT

The AIT command sets the integration time or the number of samples required to obtain the measurement data. You can set it for each A/D converter type, high speed ADC or high resolution ADC.

This command setting is ignored by the pulsed spot, pulsed sweep, and staircase sweep with pulsed bias measurements.

Execution Conditions

Enter the AAD command to select the ADC type for the measurement channel.

Syntax

`AIT type,mode[,N]`

Parameters

type **:** A/D converter type. Integer expression.

0: High-speed A/D converter.

1: High-resolution A/D converter.

mode **:** ADC operation mode. Integer expression. Initial value is 0.

0: Auto mode.

1: Manual mode.

2: Power line cycle (PLC) mode.

N **:** Coefficient used to define the integration time or the number of averaging samples. Integer expression. See Table 4-8.

Example Statements

```
OUTPUT @E5270;"AIT 0,2,1"
OUTPUT @E5270;"AIT 1,1,10"
```

Table 4-8 **Available Parameter Values**

type	*mode*	*N*
0	0	Value that defines the number of averaging samples given by the following formula. 1 to 1023. Default value is 1. *Number of averaging samples* = $N \times$ *initial averaging* where *initial averaging* is the number of averaging samples automatically set by Agilent E5270 and you cannot change.
	1	Number of averaging samples. 1 to 1023. Default value is 1.
	2	Value that defines the number of averaging samples given by the following formula. 1 to 100. Default value is 1. *Number of averaging samples* = $N \times 128$ The Agilent E5270 gets 128 samples in a power line cycle, repeats this for the times you specify, and performs averaging to get the measurement data.
1	0	Value that defines the integration time given by the following formula. 1 to 127. Default value is 6. *Integration time* = $N \times$ *initial integration time* where *initial integration time* is the integration time automatically set by Agilent E5270 and you cannot change.
	1	Value that defines the integration time given by the following formula. 1 to 127. Default value is 3. *Integration time* = $N \times 80$ μsec
	2	Value that defines the integration time given by the following formula. 1 to 100. Default value is 1. *Integration time* = N / *power line frequency*

AV

The AV command sets the number of samples for averaging of the high-speed A/D converter (ADC), not the high-resolution ADC.

This command setting is ignored by the pulsed spot, pulsed sweep, and staircase sweep with pulsed bias measurements.

Execution Conditions

Enter the AAD command to select the ADC type for the measurement channel.

Syntax

AV *number*[,*mode*]

Parameters

***number* :** 1 to 1023, or –1 to –100. Initial value is 1.

For *positive* number input, this value specifies the number of samples depended on the *mode* value. See below.

For *negative* number input, this parameter specifies the number of power line cycles (PLC) for one point measurement. The E5270 gets 128 samples in 1 PLC. Ignore the *mode* parameter.

***mode* :** Averaging mode. Integer expression. This parameter is meaningless for negative *number*.

0: Auto mode (default setting).

Number of samples = *number* × *initial number*

1: Manual mode.

Number of samples = *number*

where *initial number* means the number of samples the E5270 automatically sets and you cannot change. For voltage measurement, *initial number*=1. For current measurement, see Table 4-9.

If you select the manual mode, *number* must be *initial number* or more to satisfy the specifications.

Table 4-9 Initial Number for Current Measurement

Current Measurement Range	Voltage Output Range [a]		
	2, 20, 40 V	100 V	200 V
1 nA to 10 μA	4	10	25
100 μA to 1 A	1	1	1

a. For measurement channels that force current, this is the minimum range that covers the voltage compliance value.

Example Statements

```
OUTPUT @E5270;"AV 10"
OUTPUT @E5270;"AV -50"
OUTPUT @E5270;"AV 100,1"
```

AZ

The AZ command enables or disables the ADC zero function that is the function to cancel offset of the high-resolution A/D converter. This function is especially effective for low voltage measurements. Power on, *RST command, and device clear disable the function.

This command is effective for the high-resolution A/D converter, not effective for the high-speed A/D converter.

Syntax `AZ` *`mode`*

Parameters

***mode* :** Mode ON or OFF.

0: OFF. Disables the function. Initial setting.

1: ON. Enables the function.

Remarks Set the function to OFF in cases that the measurement speed is more important than the measurement accuracy. This roughly halves the integration time.

Example Statements

```
OUTPUT @E5270;"AZ 0"
```

BC

The BC command clears the output data buffer that stores measurement data and query command response data. This command does not change the measurement settings.

NOTE Multi command statement is not allowed for this command.

Syntax `BC`

Example Statements

```
OUTPUT @E5270;"BC"
```

BDM

The BDM command specifies the settling detection interval and the measurement mode; voltage or current, for the quasi-pulsed measurements.

Syntax

`BDM interval[,mode]`

Parameters

interval **:** Settling detection interval. Numeric expression.

0: Short. Initial setting.
1: Long. For measurements of the devices that have the stray capacitance, or the measurements with the compliance less than 1 μA

mode **:** Measurement mode. Numeric expression.

0: Voltage measurement mode. Default setting.
1: Current measurement mode.

Remarks

The following conditions must be true to perform the measurement successfully:

When *interval*=0: A > 1 V/ms and B ≤ 3 s

When *interval*=1: A > 0.1 V/ms and B ≤ 12 s

where A means the slew rate when source output sweep was started, and B means the settling detection time. See "Quasi-Pulsed Spot Measurements" on page 2-15. These values depend on the conditions of cabling and device characteristics. And you cannot specify the values directly.

Example Statements

```
OUTPUT @E5270;"BDM 0,1"
```

BDT

The BDT command specifies the hold time and delay time for the quasi-pulsed measurements.

Syntax

`BDT hold,delay`

Parameters

hold **:** Hold time (in sec). Numeric expression.
0 to 655.35 s, 0.01 s resolution. Initial setting is 0.

delay **:** Delay time (in sec). Numeric expression.
0 to 6.5535 s, 0.0001 s resolution. Initial setting is 0.

Example Statements

```
OUTPUT @E5270;"BDT 0.1,1E-3"
```

BDV

The BDV command specifies the quasi-pulsed voltage source and its parameters.

Syntax

`BDV` *`chnum`*`,`*`range`*`,`*`start`*`,`*`stop`*`[,`*`Icomp`*`]`

Parameters

chnum **:** Source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

range **:** Ranging type for quasi-pulsed source. Integer expression. 0 for auto ranging, or 11 to 15 for limited auto ranging. 15 is only for HPSMU. The E5270 uses the minimum range that covers both *start* and *stop* values.

The minimum range of each ranging type is as follows:

0, 11	12	13	14	15
2 V	20 V	40 V	100 V	200 V

start, stop **:** Start or stop voltage (in V). Numeric expression. See Table 4-6 on page 4-13.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

|*start* - *stop*| must be 10 V or more.

Icomp **:** Current compliance (in A). Numeric expression. See Table 4-6.

If you do not set *Icomp*, the previous value is used.

The compliance polarity is automatically set to the same polarity as the *stop* value, regardless of the specified *Icomp* value. If *stop*=0, the polarity is positive.

Remarks

The time forcing the *stop* value will be approximately 1.5 ms to 1.8 ms with the following settings:

- BDM, BDT command parameters: *interval*=0, *mode*=0, *delay*=0
- AV or AAD/AIT command parameters: initial setting

Example Statements

```
OUTPUT @E5270;"BDV 1,0,0,100,0.01"
```

BGI

The BGI command specifies the current monitor channel and its search parameters for the binary search measurement. This command ignores the RI command setting. This command setting is cleared by the BGV command.

Syntax `BGI` *`chnum`*`,`*`mode`*`,`*`condition`*`,`*`range`*`,`*`target`*

Parameters

***chnum* :** Search monitor channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***mode*, *condition* :** Search mode (0: limit mode or 1: repeat mode) and search stop condition. The meaning of *condition* depends on the *mode* setting:

mode	***condition***
0	Limit value for the search target (*target*). The search stops when the monitor data reaches *target* ± *condition*. Numeric expression. Positive value. in A. Setting resolution: *range*/20000. where *range* means the measurement range actually used for the measurement.
1	Repeat count. The search stops when the repeat count of the operation that changes the source output value is over the specified value. Numeric expression. 1 to 16.

***range* :** Measurement ranging type. Integer expression. 11 to 20. 20 is for 200 mA range (MPSMU) or 1 A range (HPSMU). The E5270 uses the minimum range that covers the *target* value.

The minimum range of each ranging type is as follows:

11	**12**	**13**	**14**	**15**
1 nA	10 nA	100 nA	1 μA	10 μA
16	**17**	**18**	**19**	**20**
100 μA	1 mA	10 mA	100 mA	0.2 or 1 A

target **:** Search target current (in A). Numeric expression.

0 to ±200 mA (for MPSMU)

0 to ±1 A (for HPSMU)

Remarks

In the limit search mode, if search cannot find the search target and the following two conditions are satisfied, the E5270 repeats the binary search between the last source value and the source *start* value.

- *target* is between the data at source *start* value and the last measurement data.
- *target* is between the data at source *stop* value and the data at:
  source value = | *stop* – *start* | / 2.

If the search cannot find the search target and the following two conditions are satisfied, the E5270 repeats the binary search between the last source value and the source *stop* value.

- *target* is between the data at source *stop* value and the last measurement data.
- *target* is between the data at source *start* value and the data at:
  source value = | *stop* – *start* | / 2.

Example Statements

```
OUTPUT @E5270;"BGI 1,0,1E-8,14,1E-6"
```

See Also

"BSM"

BGV

The BGV command specifies the voltage monitor channel and its search parameters for the binary search measurement. This command ignores the RV command setting. This command setting is cleared by the BGI command.

Syntax `BGV` *`chnum,mode,condition,range,target`*

Parameters

chnum **:** Search monitor channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

mode,
condition **:** Search mode (0: limit mode or 1: repeat mode) and search stop condition. The meaning of *condition* depends on the *mode* setting:

mode	***condition***
0	Limit value for the search target (*target*). The search stops when the monitor data reaches *target* ± *condition*. Numeric expression. Positive value. in V. Setting resolution: *range*/20000. where *range* means the measurement range actually used for the measurement.
1	Repeat count. The search stops when the repeat count of the operation that changes the source output value is over the specified value. Numeric expression. 1 to 16.

range **:** Measurement ranging type. Integer expression. 11 to 15 for limited auto ranging. 15 is only for HPSMU. The E5270 uses the minimum range that covers the *target* value.

The minimum range of each ranging type is as follows:

11	**12**	**13**	**14**	**15**
2 V	20 V	40 V	100 V	200 V

target **:** Search target voltage (in V). Numeric expression.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

Remarks

In the limit search mode, if search cannot find the search target and the following two conditions are satisfied, the E5270 repeats the binary search between the last source value and the source *start* value.

- *target* is between the data at source *start* value and the last measurement data.
- *target* is between the data at source *stop* value and the data at:
  source value = | *stop* – *start* | / 2.

If the search cannot find the search target and the following two conditions are satisfied, the E5270 repeats the binary search between the last source value and the source *stop* value.

- *target* is between the data at source *stop* value and the last measurement data.
- *target* is between the data at source *start* value and the data at:
  source value = | *stop* – *start* | / 2.

Example Statements

```
OUTPUT @E5270;"BGV 1,0,0.1,12,5"
```

See Also

“BSM”

BSI

The BSI command specifies and sets the current search source for the binary search measurement. This command setting is cleared by the BSV command. After search stops, the search channel forces the value specified by the BSM command.

Syntax

BSI *chnum*,*range*,*start*,*stop*[,*Vcomp*]

Parameters

chnum **:** Search source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

range **:** Output ranging type. Integer expression. 0 for auto ranging, 11 to 20 for limited auto ranging. 20 is for 200 mA range (MPSMU) or 1 A range (HPSMU). The E5270 uses the minimum range that covers both *start* and *stop* values.

The minimum range of each ranging type is as follows:

0, 11	**12**	**13**	**14**	**15**
1 nA	10 nA	100 nA	1 μA	10 μA
16	**17**	**18**	**19**	**20**
100 μA	1 mA	10 mA	100 mA	0.2 or 1 A

start, stop **:** Search start or stop current (in A). Numeric expression. See Table 4-7 on page 4-14. The *start* and *stop* must have different values.

0 to ±200E–3 (for MPSMU)

0 to ±1 (for HPSMU)

Vcomp **:** Voltage compliance value (in V). Numeric expression. See Table 4-7 on page 4-14. If you do not specify *Vcomp*, the previous value is set.

Example Statements

```
OUTPUT @E5270;"BSI 1,0,1E-12,1E-6,10"
```

BSM

The BSM command specifies the search source control mode in the binary search measurement, and enables or disables the automatic abort function. The automatic abort function stops the output when one of the following conditions occurs:

- Compliance on the measurement channel
- Compliance on the non-measurement channel
- Overflow on the AD converter
- Oscillation on any channel

This command also sets the post search condition for the binary search sources. After the search measurement is normally completed, the binary search sources force the value specified by the *post* parameter.

If the search operation is stopped by the automatic abort function, the binary search sources force the start value after search.

Syntax

`BSM` *`mode`*`,`*`abort`*`[,`*`post`*`]`

Parameters

mode **:** Source output control mode, 0 (normal mode) or 1 (cautious mode). If you do not enter this command, the normal mode is set. See Figure 4-1.

abort **:** Automatic abort function. Integer expression.

1: Disables the function. Initial setting.

2: Enables the function.

post **:** Source output value after search. Integer expression.

1: forces the start value. Default setting.

2: forces the stop value.

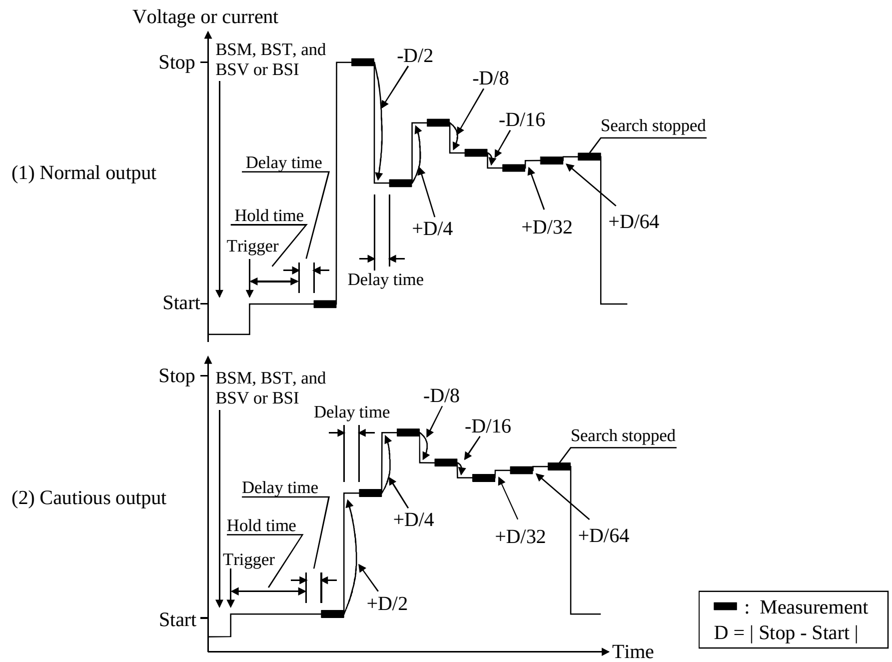
3: keeps the source output when the search target value is get.

If you do not specify *post*, the search source forces the start value.

Example Statements

```
OUTPUT @E5270;"BSM 1,2,3"
```

Figure 4-1 **Binary Search Source Output Control Mode**



Normal mode

The operation of the normal mode is explained below:

1. The source channel forces the Start value, and the monitor channel executes a measurement.
2. The source channel forces the Stop value, and the monitor channel executes a measurement.

   If the search target value is out of the range between the measured value at the Start value and the measured value at the Stop value, the search stops.
3. The source channel forces the Stop - D/2 value (or Stop+D/2 if Start>Stop), and the monitor channel executes a measurement.

   If the search stop condition is not satisfied, the measured data is used to decide the direction (+ or –) of the next output change. The value of the change is always half of the previous change.
4. Repeats the output change and measurement until the search stop condition is satisfied.

   For information on the search stop condition, see “BGI” or “BGV”. If the output change value is less than the setting resolution, the search stops.

Cautious mode

The operation of the cautious mode is explained below:

1. The source channel forces the Start value, and the monitor channel executes a measurement.
2. The source channel forces the Start+D/2 value (or Start-D/2 if Start>Stop), and the monitor channel executes a measurement.

   If the search stop condition is not satisfied, the measured data is used to decide the direction (+ or –) of the next output change. The value of the change is always half of the previous change.
3. Repeats the output change and measurement until the search stop condition is satisfied.

   For information on the search stop condition, see “BGI” or “BGV”. If the output change value is less than the setting resolution, the search stops.

BSSI

The BSSI command specifies and sets the synchronous current source for the binary search measurement. The synchronous source output will be:

Synchronous source output = *polarity* × BSI source output + *offset*

where BSI source output means the output set by the BSI command.

This command setting is cleared by the BSV/BSI command.

Execution Conditions

The BSI command must be sent *before* sending this command.

Syntax

`BSSI chnum,polarity,offset[,Vcomp]`

Parameters

***chnum* :** Synchronous source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***polarity* :** Polarity of the BSSI output for the BSI output.

0: Negative. BSSI output = –BSI output +*offset*

1: Positive. BSSI output = BSI output + *offset*

***offset* :** Offset current (in A). Numeric expression.

0 to ±200E-3 (for MPSMU)

0 to ±1 (for HPSMU)

The synchronous output level must *not* be greater than the output range specified by the BSI command.

***Vcomp* :** Voltage compliance value (in V). Numeric expression. If you do not specify *Vcomp*, the previous value is set.

Example Statements

```
OUTPUT @E5270;"BSSI 1,0,1E-6,10"
```

See Also

Refer to Table 4-7 on page 4-14 for the source output value, output range, and the available compliance values.

BSSV

The BSSV command specifies the synchronous voltage source for the binary search measurement. The synchronous source output will be:

Synchronous source output = *polarity* × BSV source output + *offset*

where BSV source output means the output set by the BSV command.

This command setting is cleared by the BSI/BSV command.

Execution Conditions

The BSV command must be sent *before* sending this command.

Syntax

`BSSV chnum,polarity,offset[,Icomp]`

Parameters

***chnum* :** Synchronous source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***polarity* :** Polarity of the BSSV output for the BSV output.

0: Negative. BSSV output = –BSV output +*offset*

1: Positive. BSSV output = BSV output + *offset*

***offset* :** Offset voltage (in V). Numeric expression.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

Synchronous output must *not* be over the output range specified by the BSV command.

***Icomp* :** Current compliance value (in A). Numeric expression. If you do not specify *Icomp*, the previous value is set. Zero amps (0 A) is not a valid value for the *Icomp* parameter.

Example Statements

```
OUTPUT @E5270;"BSSV 1,0,5,1E-6"
```

See Also

Refer to Table 4-6 on page 4-13 for the source output value, output range, and the available compliance values.

BST

The BST command sets the hold time and delay time for the binary search measurement.

If you do not enter this command, all parameters are set to 0.

Syntax

`BST` *`hold,delay`*

Parameters

***hold* :** Hold time (in seconds) that is the wait time after starting the search measurement and before starting the delay time for the first search point. Numeric expression.

0 to 655.35 sec. 0.01 sec resolution.

***delay* :** Delay time (in seconds) that is the wait time after starting to force a step output value and before starting a step measurement. Numeric expression.

0 to 65.535 sec. 0.0001 sec resolution.

Example Statements

```
OUTPUT @E5270;"BST 5,0.1"
```

BSV

The BSV command specifies and sets the voltage search source for the binary search measurement. This command setting is cleared by the BSI command. After search stops, the search channel forces the value specified by the BSM command.

Syntax

```
BSV chnum,range,start,stop[,Icomp]
```

Parameters

***chnum* :** Search source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***range* :** Output ranging type. Integer expression. 0 for auto ranging, 11 to 15 for limited auto ranging. 15 is only for HPSMU. The E5270 uses the minimum range that covers both *start* and *stop* values.

The minimum range of each ranging type is as follows:

0, 11	**12**	**13**	**14**	**15**
2 V	20 V	40 V	100 V	200 V

***start, stop* :** Search start or stop voltage (in V). Numeric expression. See Table 4-6 on page 4-13. The *start* and *stop* parameters must have different values.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

***Icomp* :** Current compliance value (in A). Numeric expression. See Table 4-6 on page 4-13. If you do not specify *Icomp*, the previous value is set. Zero amps (0 A) is not allowed for *Icomp*.

Example Statements

```
OUTPUT @E5270;"BSV 1,0,0,20,1E-6"
```

BSVM

The BSVM command selects the data output mode for the binary search measurement.

Syntax

`BSVM` *`mode`*

Parameters

mode **:** Data output mode. Integer expression.

0 : Returns *Data_search* only (initial setting).

1 : Returns *Data_search* and *Data_sense*.

where

Data_search is the value forced by the search output channel set by the BSV or BSI command.

Data_sense is the value measured by the search monitor channel set by the BGI or BGV command.

For data output format, refer to “Data Output Format” on page 1-19.

Example Statements

```
OUTPUT @E5270;"BSVM 1"
```

CA

The CA command performs the self-calibration.

Modules that fail the self-calibration are disabled, and can only be enabled by the RCV command.

After the CA command, enter the *OPC? command to confirm that the command execution is completed.

Execution Conditions

No channel may be in the HIGH VOLTAGE state (forcing more than ±42 V, or voltage compliance set to more than ±42 V).

To perform the self-calibration correctly, the measurement terminals should be opened.

Syntax

`CA [slotnum]`

Parameters

***slotnum* :** Slot number that specifies the module to perform the self-calibration. Integer expression. 1 to 8.

For HPSMU that uses two slots, set the greater slot number. For example, if it is installed in slot 3 and 4, *slotnum* must be 4.

If you do not specify *slotnum*, this command performs the self-calibration for the mainframe and all modules.

If *slotnum* specifies the slot that installs no module, this command causes an error.

Example Statements

```
OUTPUT @E5270;"CA"
OUTPUT @E5270;"*OPC?"
ENTER @E5270;A
```

*CAL?

The CAL? query command performs the self-calibration, and returns the results in ASCII format. Modules that fail the self-calibration are disabled, and can only be enabled by the RCV command.

After the *CAL? command, read the results soon.

Execution Conditions

No module may be in the HIGH VOLTAGE state (forcing more than ±42 V, or voltage compliance set to more than ±42 V).

To perform the self-calibration correctly, the measurement terminals should be opened.

Syntax

```
*CAL? [slotnum]
```

Parameters

***slotnum* :** Specifies the module to perform the self-calibration. Integer expression. 0 to 9.

0: Mainframe and all modules. Default setting.

1 to 8: Module installed in the slot specified by *slotnum*.

9: Mainframe.

For HPSMU that uses two slots, set the greater slot number. For example, if it is installed in slot 3 and 4, *slotnum* must be 4.

If *slotnum* specifies the slot that installs no module, this command causes an error.

Query Response

results<CR/LF^EOI>

results returns the sum of the following values corresponding to the failures.

results	Description	*results*	Description
0	Passed. No failure detected.	16	Slot 5 module failed.
1	Slot 1 module failed.	32	Slot 6 module failed.
2	Slot 2 module failed.	64	Slot 7 module failed.
4	Slot 3 module failed.	128	Slot 8 module failed.
8	Slot 4 module failed.	256	Mainframe failed.

Example Statements

```
OUTPUT @E5270;"*CAL?"
ENTER @E5270;A
```

CL

The CL command disables the specified channels by setting the output switches to OFF. Then the channel output is opened, and the power consumption is 0 W.

Execution Conditions

No channel may be in the HIGH VOLTAGE state (forcing more than ±42 V, or voltage compliance set to more than ±42 V). However, if you do not specify *chnum* for CL command, there are no restrictions on the execution conditions.

Syntax

`CL [`*`chnum`*`[,`*`chnum`*`...[,`*`chnum`*`]...]]`

A maximum of eight channels can be set.

Parameters

chnum **:** Channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

If you do not specify *chnum*, this command sets all channels to 0 V in order from higher voltage range (output or measurement range) to lower voltage range.

If you specify multiple *chnum*s, the E5270 sets the channels to 0 V in the specified order.

Remarks

The CL command sets the specified channels to the following conditions:

Item	Setting	Item	Setting
Output Switch	OFF	I Compliance	100 μA
Source Mode	Voltage	I Range	100 μA
Output Voltage	0 V	Filter	OFF
V Range	20 V	Series Resistor	Not changed

Example Statements

```
OUTPUT @E5270;"CL"
OUTPUT @E5270;"CL 1,2,3,5"
```

CM

The CM command sets the auto-calibration function to ON or OFF. If the following two conditions are satisfied, the E5270 automatically calibrates all channels every 30 minutes.

- Auto-calibration is ON
- Output switches of all channels have been OFF for 30 minutes

Syntax

`CM` *`mode`*

Parameters

***mode* :** Auto-calibration ON or OFF. Integer expression.

0: OFF

1: ON (initial setting)

Remarks

To perform the calibration correctly, the measurement terminals should be opened before starting the calibration.

If the auto-calibration is enabled, do not forget to open the measurement terminals after measurements.

Example Statements

```
OUTPUT @E5270;"CM 0"
OUTPUT @E5270;"CM 1"
```

CMM

The CMM command sets the SMU measurement operation mode. This command is not available for the high speed spot measurement.

Syntax

`CMM chnum,mode`

Parameters

***chnum* :** Channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***mode* :** SMU measurement operation mode. Integer expression.

- 0: Compliance side measurement (initial setting).
- 1: SMU always performs current measurement.
- 2: SMU always performs voltage measurement.
- 3: Force side measurement.

If *mode*=0, SMU measures current when it forces voltage, or measures voltage when it forces current.

If *mode*=3, SMU measures current when it forces current, or measures voltage when it forces voltage.

The *mode* setting is kept until the *mode* is changed by this command. If you want to return it to the initial setting, enter the CMM command with *mode*=0.

Example Statements

```
OUTPUT @E5270;"CMM 1,1"
```

CN

This command enables the specified channels by setting the output switches to ON. Then the power consumption is 0 W.

WARNING

SETTING THE OUTPUT SWITCH TO "ON" ENABLES THE CHANNEL TO FORCE DANGEROUS VOLTAGES.

WHEN THE CHANNEL IS NOT IN USE, SET THE OUTPUT SWITCH TO "OFF" WHENEVER POSSIBLE.

Execution Conditions

No channel may be in the HIGH VOLTAGE state (forcing more than ±42 V, or voltage compliance set to more than ±42 V).

Syntax

`CN [`*`chnum`*`[,`*`chnum`*`...[,`*`chnum`*`]...]]`

A maximum of eight channels can be set.

Parameters

***chnum* :** Channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

If you do not specify *chnum*, the E5270 sets all output switches to ON, in the order from lower to higher slot number.

If you specify multiple *chnum*s, the E5270 sets the output switches to ON, in the specified order.

Remarks

The CN command sets the specified channels to the following conditions:

Item	Setting	Item	Setting
Output Switch	ON	I Compliance	100 µA
Source Mode	Voltage	I Range	100 µA
Output Voltage	0 V	Filter	Not changed
V Range	20 V	Series Resistor	Not changed

If the output switch of the specified channel is already set to ON, no action is performed by the CN command.

Example Statements

```
OUTPUT @E5270;"CN"
OUTPUT @E5270;"CN 1,2,3,5"
```

DFM

The DFM command selects the data display format on the front panel LCD.

The *RST command or the device clear selects scientific.

Syntax `DFM format`

Parameters ***format* :** Data display format. Integer expression.

format	Description
0	Engineering. +/- sign, 6 digits numeric value with arithmetic point, and unit. Example: `+123.456mA`
1	Scientific. +/- sign, 4 digits numeric value with arithmetic point, exponential part (E, +/- sign, and 1 or 2 digits numeric value), and unit. Example: `+1.234E-1A`

Example Statements

```
OUTPUT @E5270;"DFM 0"
```

DI

The DI command forces current from the specified channel.

Execution Conditions

The CN command has been executed for the specified channel.

If the voltage compliance is greater than ±42 V, the interlock circuit must be shorted.

Syntax

`DI chnum,irange,current[,Vcomp[,comp_polarity[,vrange]]]`

Parameters

***chnum* :** Source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***irange* :** Ranging type for current output. Integer expression. 0 for auto ranging, or 11 to 20 for limited auto ranging that uses the specified range and above. 20 is for 200 mA (MPSMU) or 1 A (HPSMU). See Table 4-5 on page 4-12.

The E5270 uses the minimum range that covers *current* value.

***current* :** Output current value (in A). Numeric expression. See Table 4-7 on page 4-14.

0 to ±200E–3 (for MPSMU)

0 to ±1 (for HPSMU)

***Vcomp* :** Voltage compliance value (in V). Numeric expression. See Table 4-7 on page 4-14. If you do not specify this parameter, *Vcomp* is set to the previous setting.

***comp_polarity* :** Polarity of voltage compliance. Integer expression.

- **0:** Auto mode (default setting). The compliance polarity is automatically set to the same polarity as *current*, regardless of the specified *Vcomp*. If *current*=0 A, the polarity is set to positive.
- **1:** Manual mode. Uses the polarity of *Vcomp* you specified.

***vrange* :** Voltage compliance ranging type. Integer expression. 0 for auto ranging, or 11 to 15 for limited auto ranging. See Table 4-4 on page 4-12. The E5270 uses the minimum range that covers *Vcomp* value.

Example Statements

```
OUTPUT @E5270;"DI 1,0,1E-6"
OUTPUT @E5270;"DI 3,14,5E-7,20,0,0"
```

DIAG?

The DIAG? command starts the diagnostics, and returns the results in ASCII format.

Before starting the diagnostics, refer to Remarks below.

After the DIAG? command, read the results soon.

Syntax

`DIAG? *item*[,*pause*]`

Parameters

***item* :** Diagnostics item. Integer expression. 1 to 5.

item	Description	*pause*
1	Trigger In/Out diagnostics.	effective
2	Front panel key diagnostics.	n.a
3	High voltage LED diagnostics.	n.a
4	Digital I/O diagnostics.	effective
5	Beeper diagnostics.	n.a

***pause* :** Pauses before starting diagnostics or not. Integer expression. 0 or 1. This parameter is effective for *item*=1 and 4.

0: Agilent E5270 starts diagnostics immediately.

1: Agilent E5270 starts diagnostics when the **Enter** key is pressed.

If you do not specify *pause*, 1 is set.

For *pause*=1, you can abort execution of the diagnostics by pressing the **Exit** key while a message is being displayed on the LCD.

Query Response

result <CR/LF^EOI>

0: Passed.

1: Failed.

2: Aborted.

Example Statements

```
OUTPUT @E5270;"DIAG? 1,1"
ENTER @E5270;A
```

Remarks

- Before starting the trigger in/out diagnostics, connect a BNC cable between the Ext Trig In and Out connectors.
- After starting the front panel key diagnostics, press any key and confirm that the key name is displayed. Repeat this for all keys.

  If all response was good, press the **Enter** key twice to stop. *result* returns 0.

  If any response was bad, press the **Exit** key twice to stop. *result* returns 1.
- After starting the high voltage LED diagnostics:

  If the LED blinks, press the **Enter** key to stop. *result* returns 0.

  If the LED does not blink, press the **Exit** key to stop. *result* returns 1.
- Before starting the digital I/O diagnostics, disconnect any cable from the digital I/O port.
- After starting the beeper diagnostics:

  If you listen 2 types of beep sounds every 1 second, press the **Enter** key to stop. *result* returns 0.

  If you do not listen it, press the **Exit** key to stop. *result* returns 1.

DO

The DO command executes the E5270 internal memory programs (up to 8 programs) in the order specified.

Execution Conditions

The specified programs have been stored by using the ST and END commands.

Syntax

`DO pnum[,pnum[,pnum[,pnum[,pnum[,pnum[,pnum[,pnum]]]]]]]`

Parameters

***pnum* :** Internal memory program number. Numeric expression. 1 to 2000.

Example Statements

```
OUTPUT @E5270;"DO 1,2,3,4,5,6,7,8"
OUTPUT @E5270;"DO 98,99"
```

DV

The DV command forces output voltage from the specified channel.

Execution Conditions

The CN command has been executed for the specified channel.

If the output voltage is greater than ±42 V, the interlock circuit must be shorted.

Syntax

DV *chnum*,*vrange*,*voltage*[,*Icomp*[,*comp_polarity*[,*irange*]]]

Parameters

chnum **:** Source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

vrange **:** Ranging type for voltage output. Integer expression. 0 for auto ranging, or 11 to 15 for limited auto ranging that uses the specified range and above. 15 is only for HPSMU. See Table 4-4 on page 4-12.

The E5270 uses the minimum range that covers *voltage* value.

voltage **:** Output voltage value (in V). Numeric expression. See Table 4-6 on page 4-13.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

Icomp **:** Current compliance value (in A). Numeric expression. See Table 4-6 on page 4-13. If you do not set *Icomp*, the previous value is used. 0 A is not allowed for *Icomp*.

comp_polarity **:** Polarity of current compliance. Integer expression.

- **0:** Auto mode (default setting). The compliance polarity is automatically set to the same polarity as *voltage*, regardless of the specified *Icomp*. If *voltage*=0 V, the polarity is set to positive.
- **1:** Manual mode. Uses the polarity of *Icomp* you specified.

irange **:** Current compliance ranging type. Integer expression. 0 for auto ranging, or 11 to 20 for limited auto ranging. See Table 4-5 on page 4-12. The E5270 uses the minimum range that covers *Icomp* value.

Example Statements

```
OUTPUT @E5270;"DV 1,0,20,1E-6,0,15"
OUTPUT @E5270;"DV 2,12,10"
```

DZ

The DZ command stores the settings (V/I output values, V/I output ranges, V/I compliance values, and series resistor setting) of the specified channels, and sets the channels to 0 V. The settings can be recovered by using the RZ command. The stored settings are cleared by using a device clear (HP BASIC CLEAR) command, *RST, RZ, CL, CA, or *TST?.

Execution Conditions

The CN command has been executed for the specified channels.

Syntax

`DZ [chnum[,chnum...[,chnum]...]]`

A maximum of eight channels can be set.

Parameters

chnum **:** Channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

If you do not specify *chnum*, the DZ command applies 0 V to all channels where the output switch is set to ON, in order from higher (output or measurement range) to lower voltage range.

If you specify multiple *chnum*s, the E5270 sets the channels to 0 V in the specified order.

Remarks

The DZ command sets the specified channels to the following conditions:

Item	Setting	Item	Setting
Output Switch	ON	I Range	See next table
Source Mode	Voltage	Compliance	See next table
Output Voltage	0 V	Filter	Not changed
V Range	Not changed	Series Resistor	Not changed

Previous range [a]	I Range	I Compliance
1 nA to 100 μA	same as previous range	range value
over 100 μA	100 μA	100 μA

a. Range value that was set before the DZ command.

Example Statements

```
OUTPUT @E5270;"DZ 1,2,3"
```

EMG?

The EMG? query command returns error message corresponding to the specified error code.

Syntax

`EMG? errcode`

Parameters

***errcode* :** Error code returned by the ERR? command. Numeric expression.

Query Response

`Error message <CR/LF^EOI>`

For the error codes and error messages, refer to Chapter 5, “Error Messages.”

Example Statements

```
OUTPUT @E5270;"EMG? 100"
ENTER @E5270;A$
```

END

The END command is used with the ST command to store a program in the internal program memory. See “ST” on page 4-105.

Syntax

`END`

Example Statements

```
OUTPUT @E5270;"ST1;CN1;DV1,0,5,1E-4;TI1,0;CL1"
OUTPUT @E5270;"END"
```

ERC

The ERC command changes the output status of the digital I/O port. This command does not change the status of the trigger ports and the input ports set by the ERM command.

The *RST command or the device clear sets the digital I/O port (total 16 paths) to the output port, and sets the port output level to TTL high.

Syntax

`ERC mode,value[,rule]`

Parameters

mode **:** Control mode. Integer expression. Set *mode* to 2.

2: Controls the digital I/O port.

If you set 1 that is effective for the Agilent 4142B, an error occurs.

value **:** Decimal value of the output status bit pattern. Integer expression. 0 to 65535. The bit pattern must comply with the following rule:

Bit value 0: TTL high level (approx. 2.4 V)

Bit value 1: TTL low level (approx. 0.8 V)

rule **:** Place holder to keep the same syntax as the ERC command of the Agilent 4142B. Input value is ignored.

Example Statements

If you want to set TTL low level for the output ports of the digital I/O port bit 0 to 7, enter the following command.

```
OUTPUT @E5270;"ERC 2,255"
```

where the decimal value 255 means binary bit pattern `0000000011111111`. This command does not change the status of the trigger ports and the input ports.

See Also

“ERM” and “ERS?”

ERM

The ERM command changes the input/output assignments of the digital I/O port (total 16 paths). This command does not change the trigger port assignments and settings.

The *RST command or the device clear sets the digital I/O port to the output port, and sets the port output level to TTL high.

Syntax

`ERM` *`iport`*

Parameters

***iport* :** Decimal value of the port setting. Integer expression. 0 to 65535.

The setting of each port must be designated by 0 or 1 that has the following meaning:

0: Output port

1: Input port

Example Statements

If you want to use the non-trigger ports of the digital I/O ports 0 to 7 as the input port, enter the following statement.

```
OUTPUT @E5270;"ERM 255"
```

where the decimal value 255 means binary bit pattern `0000000011111111`.

Remarks

The ERM command sets the port level to TTL high for all ports where the port assignment is changed from output to input or from input to output.

The ERM command does not change the port assignment of the trigger ports.

See Also

“ERS?”

ERR?

The ERR? query command returns error codes from the E5270 error register to the output data buffer (query buffer).

This command clears the error register.

Syntax

`ERR? [`*`mode`*`]`

Parameters

***mode* :** Error code output mode. Integer expression. 0 (default setting) or 1.

0: Returns up to four error codes in order from their occurrence.

1: Returns one error code.

If you do not specify *mode*, the ERR? command returns four error codes (same as *mode*=0).

Query Response

`Error Code``,`*`Error Code`*`,`*`Error Code`*`,`*`Error Code`* `<CR/LF^EOI>`

or

`Error Code` `<CR/LF^EOI>`

For the error codes, refer to Chapter 5, “Error Messages.” If no error occurred, *Error Code* is 0.

Example Statements

```
OUTPUT @E5270;"ERR?"
ENTER @E5270;A$

OUTPUT @E5270;"ERR? 1"
ENTER @E5270;A
```

ERS?

The ERS? command returns the status of the digital I/O port (16 paths).

Syntax

```
ERS?
```

Query Response

pattern <CR/LF^EOI>

pattern returns the decimal value of the port status.

The status of each port is designated by 0 or 1 that has the following meaning:

0: TTL high level (approx. 2.4 V)

1: TTL low level (approx. 0.8 V)

Example Statements

```
OUTPUT @E5270;"ERS?"
ENTER @E5270;A
PRINT "Port Status=";A
```

For example, 255 (0000000011111111) is returned when the port 0 to 7 have been set to the TTL low level and the port 8 to 15 have been set to the TTL high level.

See Also

"ERM"

FL

This command sets the connection mode of a filter for each channel.

A filter is mounted on each module. It assures clean source output with no spikes or overshooting.

Syntax

`FL mode[,chnum[,chnum...[,chnum]...]]`

A maximum of eight channels can be set.

Parameters

***mode* :** Status of the filter. Integer expression.

0: Disconnect (initial setting).

1: Connect.

***chnum* :** Channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

If you do not specify *chnum*, the FL command sets the same *mode* for all channels.

Example Statements

```
OUTPUT @E5270;"FL"
OUTPUT @E5270;"FL 0,1,3,5"
```

FMT

The FMT command clears the E5270 output data buffer, and specifies the data output format and the data terminator. For details about data output format, see “Data Output Format” on page 1-19.

Query command output data is always stored in the query buffer in ASCII format, regardless of this command.

If you do not enter this command, the data output format is same as the data format by the FMT1,0 command.

NOTE Multi command statement is not allowed for this command.

Syntax

```
FMT format[,mode]
```

Parameters

***format* :** Data output format. Integer expression. 1 to 5, 11, 12, 15, 21, 22, or 25. See Table 4-11.

***mode* :** Source data output mode. Integer expression. 0 to 8. See Table 4-10. You can select the source data returned with the measurement data. If you do not specify this parameter, no source data is returned.

Example Statements

```
OUTPUT @E5270;"FMT 1"
OUTPUT @E5270;"FMT 2,1"
```

Table 4-10 FMT mode parameter

mode	Source data returned with measurement data
0	None (default setting). Only the measurement data is returned.
1	Data of the primary sweep source set by the WI/WV/PWI/PWV command.
2	Data of the synchronous sweep source set by the WSI/WSV command.
2 to 8	For the multi channel sweep measurement: Data of the synchronous sweep source set by the WNX command. The *mode* value must be the sweep source number (2 to 8) you want to get data. For the sweep source number, refer to “WNX” on page 4-131.

Table 4-11 **FMT format parameter**

format	**Data format**	**Terminator**
1 [a]	ASCII (12 digits data with header)	<CR/LF^EOI>
2 [a]	ASCII (12 digits data without header)	<CR/LF^EOI>
3 [a]	binary	<CR/LF^EOI>
4 [a]	binary	<^EOI>
5 [a]	ASCII (12 digits data with header)	,
11	ASCII (13 digits data with header)	<CR/LF^EOI>
12	ASCII (13 digits data without header) [b]	<CR/LF^EOI>
15	ASCII (13 digits data with header)	,
21	ASCII (13 digits data with header) [b]	<CR/LF^EOI>
22	ASCII (13 digits data without header) [b]	<CR/LF^EOI>
25	ASCII (13 digits data with header) [b]	,

a. Compatible with the Agilent 4142B data output format.
b. Compatible with the Agilent 4155/4156 FLEX mode ASCII data.

12 digits data will be `sn.nnnnnEsnn`, `snn.nnnnEsnn`, or `snnn.nnnEsnn`.

13 digits data will be `sn.nnnnnnEsnn`, `snn.nnnnnEsnn`, or `snnn.nnnnEsnn`.

where, `s` is `+` or `-`, `E` is exponent symbol, and `n` means one digit number.

NOTE

For binary data output format, the time stamp function is not available. Refer to “Data Output Format” on page 1-19.

*IDN?

The *IDN? query command returns the instrument model number and the ROM version number, then stores the results in the output data buffer (query buffer).

Syntax

`*IDN?`

Query Response

`AGILENT,`*`model`*`,0,`*`ROM rev`* <CR/LF^EOI>

Response	Explanation
model	`E5270A`, `E5272A`, or `E5273A`
ROM rev	ROM version number

Example Statements

```
OUTPUT @E5270;"*IDN?"
ENTER @E5270;A$
```

Example Response

```
AGILENT,E5270,0,01.00
```

IN

The IN command sets the specified channel to 0 V with an output range change.

Execution Conditions

The CN command has been executed for the specified channel.

Syntax

`IN [`*`chnum`*`[,`*`chnum`*`...[,`*`chnum`*`]...]]`

A maximum of eight channels can be set.

Parameters

***chnum* :** Channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

If you do not specify *chnum*, this command sets all channels to 0 V in order from higher voltage range (output or measurement range) to lower voltage range.

If you specify multiple *chnum*s, the E5270 sets the channels to 0 V in the specified order.

Remarks

The IN command sets the specified channels to the following conditions, which are the same as the conditions after executing the CN command.

Item	SMU	GNDU
Output Switch	ON	ON
Source Mode	V	
Output Voltage	0 V	0 V
V Range	20 V	
I Compliance	100 μA	
I Range	100 μA	
Filter	Not changed	
Power Consumption	0 W	

Example Statements

```
OUTPUT @E5270;"IN"
OUTPUT @E5270;"IN 1,2,3,5,6"
```

KLC

The KLC command locks or unlocks the front panel keys.

The *RST command or the device clear unlocks the front panel keys.

Syntax

`KLC mode`

Parameters

mode **:** Front panel key lock or unlock. Integer expression.

0: Unlock.

1: Lock.

Example Statements

```
OUTPUT @E5270;"KLC 1"
```

LGI

The LGI command specifies the current monitor channel and its search parameters for the linear search measurement.

This command ignores the RI command setting.

This command setting is cleared by the LGV command.

Syntax

`LGI chnum,mode,range,target`

Parameters

***chnum* :** Search monitor channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***mode* :** Search mode. Integer expression.

0 : If the measured value ≤ *target*, it is the search result data.

1 : If the measured value ≥ *target*, it is the search result data.

***range* :** Measurement ranging type. Integer expression. 11 to 20 for limited auto ranging. 20 is for 200 mA range (MPSMU) or 1 A range (HPSMU). The E5270 uses the minimum range that covers the *target* value.

The minimum range of each ranging type is as follows:

11	**12**	**13**	**14**	**15**
1 nA	10 nA	100 nA	1 μA	10 μA
16	**17**	**18**	**19**	**20**
100 μA	1 mA	10 mA	100 mA	0.2 or 1 A

***target*:** Search target current (in A). Numeric expression.

0 to ±200E-3 (for MPSMU)

0 to ±1 (for HPSMU)

Example Statements

```
OUTPUT @E5270;"LGI 0,1,14,1E-6"
```

LGV

The LGV command specifies the voltage monitor channel and its search parameters for the linear search measurement.

This command ignores the RV command setting.

This command setting is cleared by the LGI command.

Syntax

`LGV` *`chnum`*`,`*`mode`*`,`*`range`*`,`*`target`*

Parameters

chnum **:** Search monitor channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

mode **:** Search mode. Integer expression.

0 : If the measured value ≤ *target*, it is the search result data.

1 : If the measured value ≥ *target*, it is the search result data.

range **:** Measurement ranging type. Integer expression. 11 to 15 for limited auto ranging. 15 is only for HPSMU. The E5270 uses the minimum range that covers the *target* value.

The minimum range of each ranging type is as follows:

11	12	13	14	15
2 V	20 V	40 V	100 V	200 V

target **:** Search target voltage (in V). Numeric expression.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

Example Statements

```
OUTPUT @E5270;"LGV 1,2,12,3"
```

LOP?

The LOP? query command returns the operation status of all modules and stores the results in the output data buffer (query buffer).

Syntax `LOP?`

Query Response `LOP` *`slot1 status`*`,`*`slot2 status`*`..,`*`slot8 status`* `<CR/LF^EOI>`

where *slotN status* (N: 1 to 8) means the following:

Response	Description
slot1 status	Status number indicates the operation status of slot 1 module.
slot2 status	Status number indicates the operation status of slot 2 module.
slot3 status	Status number indicates the operation status of slot 3 module.
slot4 status	Status number indicates the operation status of slot 4 module.
slot5 status	Status number indicates the operation status of slot 5 module.
slot6 status	Status number indicates the operation status of slot 6 module.
slot7 status	Status number indicates the operation status of slot 7 module.
slot8 status	Status number indicates the operation status of slot 8 module.

Status numbers are two-digit decimal numbers. Available numbers and meanings are as follows:

Status Number	Description
00	No module is installed, or the output switch is OFF.
01	SMU forces voltage, and does not reach current compliance.
02	SMU forces positive current, and does not reach voltage compliance.
03	SMU forces negative current, and does not reach voltage compliance.
10	Not applicable.
11	SMU reaches voltage compliance.

Status Number	Description
12	SMU reaches positive current compliance.
13	SMU reaches negative current compliance.
20	SMU is oscillating.
30	Not applicable.

The HPSMU occupies two slots. The status number is returned for the greater slot number, and 00 is returned for the lower slot number.

Example Statements

```
OUTPUT @E5270;"LOP?"
ENTER @E5270;A$
```

*LRN?

The *LRN? (learn) query command returns information about the channel settings or the E5270 command parameter settings, and stores the results in the E5270 output data buffer (query buffer).

Syntax

```
*LRN? type
```

Example Statements

```
DIM A$[200]
OUTPUT @E5270;"*LRN? 1"
ENTER @E5270;A$
```

Parameters and Query Response

***type* :** This parameter selects the type of query response. Available values are 0 to 60, but some numbers are not used. See below. Integer expression.

A description and the query response of each *type* is described below.

0 : Returns the output switch ON/OFF status:

CN[*chnum*[,*chnum* . . . [,*chnum*] . . .]]<CR/LF^EOI>

where *chnum* is the channel number for the channel whose output switch is set to ON.

If no output switches are ON, the query response is:

CL<CR/LF^EOI>

1 to 8 : Returns the SMU source status.

The *type* parameter corresponds to slot number where the module is installed.

If the output switch is ON, the query response is:

DV *chnum*,*range*,*voltage*[,*Icomp*[,*comp polarity*[,*irange*]]] <CR/LF^EOI>

or

DI *chnum*,*range*,*current*[,*Vcomp*[,*comp polarity*[,*vrange*]]] <CR/LF^EOI>

where *range* is the present setting of the output range.

If the output switch is OFF, the query response is:

CL *chnum* <CR/LF^EOI>

9 to 29 : Not used.

30 : Returns the filter ON/OFF status:

FL0 [*off ch*[,*off ch* . . . [,*off ch*] . . .];
FL1 [*on ch*[,*on ch* . . . [,*on ch*] . .] <CR/LF^EOI>

If all modules are Filter OFF, the query response is:

FL0<CR/LF^EOI>

If all modules are Filter ON, the query response is:

FL1<CR/LF^EOI>

31 : Returns the parameter values of the TM, AV, CM, FMT, and MM commands:

TM *trigger mode*;AV *number*[,*mode*];CM *auto calibration mode*;
FMT *output data format*,*output data mode*
[;MM *measurement mode*[,*chnum*[,*chnum*...[,*chnum*]...]]]
<CR/LF^EOI>

32 : Returns the measurement ranging status:

RI *chnum*,*Irange*;RV *chnum*,*Vrange*
[;RI *chnum*,*Irange*;RV *chnum*,*Vrange*]
:
[;RI *chnum*,*Irange*;RV *chnum*,*Vrange*]<CR/LF^EOI>

33 : Returns the staircase sweep measurement settings:

WM *automatic sweep abort function*,*output after sweep*;
WT *hold time*,*delay time*[,*step delay time*[,*S trig delay*[,*M trig delay*]]]
[;WV *chnum*,*mode*,*range*,*start*,*stop*,*nop*[,*Icomp* [,*pcomp*]]] or
[;WI *chnum*,*mode*,*range*,*start*,*stop*,*nop*[,*Vcomp*[,*pcomp*]]]
[;WSV *chnum*,*range*,*start*,*stop*[,*Icomp*[,*pcomp*]]] or
[;WSI *chnum*,*range*,*start*,*stop*[,*Vcomp*[,*pcomp*]]]<CR/LF^EOI>

34 : Returns the pulsed source settings:

PT *hold time*,*pulse width*[,*pulse period*[,*trig delay*]]
[;PV *chnum*,*output range*,*base voltage*,*pulse voltage* [,*Icomp*]] or
[;PI *chnum*,*output range*,*base current*,*pulse current* [,*Vcomp*]]
[;PWV *chnum*,*mode*,*range*,*base*,*start*,*stop*,*nop*[,*Icomp*]] or
[;PWI *chnum*,*mode*,*range*,*base*,*start*,*stop*,*nop*[,*Vcomp*]]<CR/LF^EOI>

35 to 36 : Not used.

37 : Returns the quasi-pulsed source settings:

BDM *detection interval*[,*mode*];
BDT *hold time*,*delay time*
[;BDV *chnum*,*range*,*start*,*stop*[,*Icomp*]]<CR/LF^EOI>

38 : Returns the digital I/O port information:

ERM *input pin*;ERC2,*value* <CR/LF^EOI>

39 : Not used.

40 : Returns channel mapping information:

If multiple channel numbers are translated to another numbers.

ACH *actual*,*program*
[;ACH *actual*,*program*]
:
[;ACH *actual*,*program*]<CR/LF^EOI>

If no channel number is defined by the ACH command.

ACH<CR/LF^EOI>

41 to 45 : Not used.

46 : Returns SMU measurement operation mode settings:

CMM *chnum*,*mode*
[;CMM *chnum*,*mode*]
:
[;CMM *chnum*,*mode*]<CR/LF^EOI>

47 to 49 : Not used.

50 : Returns the linear search measurement settings:

LSM *abort*,*post*;LSTM *hold*,*delay*;LSVM *mode*;
[;LGI *chnum*,*mode*,*Irange*,*Itarget*] or
[;LGV *chnum*,*mode*,*Vrange*,*Vtarget*]
[;LSV *chnum*,*range*,*start*,*stop*,*step*[,*Icomp*]] or
[;LSI *chnum*,*range*,*start*,*stop*,*step*[,*Vcomp*]]
[;LSSV *chnum*,*polarity*,*offset*[,*Icomp*]] or
[;LSSI *chnum*,*polarity*,*offset*[,*Vcomp*]]
<CR/LF^EOI>

51 : Returns the binary search measurement settings:

BSM *mode*,*past*;BST *hold*,*delay*;BSVM *mode*
[;BGI *chnum*,*mode*,*condition*,*Irange*,*Itarget*] or
[;BGV *chnum*,*mode*,*condition*,*Vrange*,*Vtarget*]
[;BSV *chnum*,*range*,*start*,*stop*[,*Icomp*]] or
[;BSI *chnum*,*range*,*start*,*stop*[,*Vcomp*]]
[;BSSV *chnum*,*polarity*,*offset*[,*Icomp*]] or
[;BSSI *chnum*,*polarity*,*offset*[,*Vcomp*]]
<CR/LF^EOI>

52 : Not used.

53 : Returns the SMU series resistor ON/OFF status:

SSR *chnum*,*mode*
[;SSR *chnum*,*mode*]
:
[;SSR *chnum*,*mode*]<CR/LF^EOI>

54 : Returns the auto ranging mode status:

RM *chnum*,*mode*[,*rate*]
[;RM *chnum*,*mode*[,*rate*]]
:
[;RM *chnum*,*mode*[,*rate*]]<CR/LF^EOI>

55 : Returns the A/D converter settings:

AAD *chnum*,*type*
[;AAD *chnum*,*type*]
:
[;AAD *chnum*,*type*]<CR/LF^EOI>

56 : Returns the ADC averaging/integration time settings:

AIT0,*mode*,*time*;AIT1,*mode*,*time*;
AZ *mode*<CR/LF^EOI>

57 : Returns the source/measurement wait time settings:

WAT0,*set_set*;WAT1,*set_meas*<CR/LF^EOI>

58 : Returns the trigger settings:

[TGP *port*,*terminal*,*polarity*,*type*]
[;TGP *port*,*terminal*,*polarity*,*type*]
:
[;TGP *port*,*terminal*,*polarity*,*type*]
TGSI *mode*;TGXO *mode*;TGSO *mode*;TGMO *mode*<CR/LF^EOI>

59 : Returns the multi channel sweep source settings:

WNX *n*,*chnum*,*mode*,*range*,*start*,*stop*[,*comp*[,*pcomp*]]
[;WNX *n*,*chnum*,*mode*,*range*,*start*,*stop*[,*comp*[,*pcomp*]]]
:
[;WNX *n*,*chnum*,*mode*,*range*,*start*,*stop*[,*comp*[,*pcomp*]]]
<CR/LF^EOI>

If no multi channel sweep source is set, the query response is:

WNX<CR/LF^EOI>

60 : Returns the time stamp setting:

TSC *enable*<CR/LF^EOI>

61 : Returns the display settings:

RED *enable*;
KLC *lock*;
DFM *format*;
SPA1,*param*;
SPA2,*param*;
MPA *param*;
SCH *chnum*;
MCH *chnum*<CR/LF^EOI>

LSI

The LSI command specifies and sets the current search source for the linear search measurement. This command setting is cleared by the LSV command. After search stops, the search channel forces the value specified by the LSM command.

Syntax

`LSI` *`chnum,range,start,stop,step`*`[,`*`Vcomp`*`]`

Parameters

chnum **:** Search source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

range **:** Output ranging type. Integer expression. 0 for auto ranging, 11 to 20 for limited auto ranging. 20 is for 200 mA range (MPSMU) or 1 A range (HPSMU). The E5270 uses the minimum range that covers both *start* and *stop* values.

The minimum range of each ranging type is as follows:

0, 11	**12**	**13**	**14**	**15**
1 nA	10 nA	100 nA	1 µA	10 µA
16	**17**	**18**	**19**	**20**
100 µA	1 mA	10 mA	100 mA	0.2 or 1 A

start, stop **:** Search start or stop current (in A). Numeric expression. See Table 4-7 on page 4-14. The *start* and *stop* must have different values.

0 to ±200E–3 (for MPSMU)

0 to ±1 (for HPSMU)

step**:** Step current (in A). Numeric expression.

If *start* < *stop*, *step* must be positive, and if *start* > *stop*, *step* must be negative. Maximum number of search steps is 1001.

Vcomp**:** Voltage compliance value (in V). Numeric expression. See Table 4-7 on page 4-14. If you do not specify *Vcomp*, the previous value is set.

Example Statements

```
OUTPUT @E5270;"LSI 1,0,0,1E-6,1E-8,10"
```

LSM

The LSM command enables or disables the automatic abort function for the linear search source. The automatic abort function stops the output when one of the following conditions occurs:

- Compliance on the measurement channel
- Compliance on the non-measurement channel
- Overflow on the AD converter
- Oscillation on any channel

This command also sets the post search condition for the linear search sources. After the search measurement is normally completed, the linear search sources force the value specified by the *post* parameter.

If the search operation is stopped by the automatic abort function, the linear search sources force the start value after search.

Syntax

`LSM` *`abort`*`[,`*`post`*`]`

Parameters

***abort* :** Automatic abort function. Integer expression.

1: Disables the function. Initial setting.

2: Enables the function.

***post* :** Post search condition. Integer expression.

1: forces the start value. Default setting.

2: forces the stop value.

3: keeps the source output when the search target value is obtained.

If this parameter is not specified, the search source forces the start value.

Example Statements

```
OUTPUT @E5270;"LSM 2"
OUTPUT @E5270;"LSM 2,3"
```

LSSI

The LSSI command specifies and sets the synchronous current source for the linear search measurement. The synchronous source output will be:

Synchronous source output = *polarity* × LSI source output + *offset*

where the LSI source output is the output set by the LSI command.

This command setting is cleared by the LSV/LSI command.

Execution Conditions

The LSI command must be entered before this command.

Syntax

`LSSI` *`chnum`*`,`*`polarity`*`,`*`offset`*`[,`*`Vcomp`*`]`

Parameters

chnum **:** Synchronous source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***polarity*:** Polarity of the LSSI output for the LSI output.

0 (negative): LSSI output = –LSI output +*offset*

1 (positive): LSSI output = LSI output + *offset*

***offset*:** Offset current (in A). Numeric expression.

0 to ±200E-3 (for MPSMU)

0 to ±1 (for HPSMU)

The synchronous output level must *not* be greater than the output range specified by the LSI command.

***Vcomp*:** Voltage compliance value (in V). Numeric expression. If you do not specify *Vcomp*, the previous value is set.

Example Statements

```
OUTPUT @E5270;"LSSI 1,1,1E-6,5"
```

See Also

Refer to Table 4-7 on page 4-14 for the source output value, output range, and the available compliance values.

LSSV

The LSSV command specifies and sets the synchronous voltage source for the linear search measurement. The synchronous source output will be:

Synchronous source output = *polarity* × LSV source output + *offset*

where the LSV source output is the value set by the LSV command.

This command setting is cleared by the LSI/LSV command.

Execution Conditions

The LSV command must be entered before this command.

Syntax

`LSSV chnum,polarity,offset[,Icomp]`

Parameters

chnum **:** Synchronous source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***polarity*:** Polarity of the LSSV output for the LSV output.

0 (negative): LSSV output = –LSV output +*offset*

1 (positive): LSSV output = LSV output + *offset*

***offset*:** Offset voltage (in V). Numeric expression.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

Synchronous output must *not* be over the output range specified by the LSV command.

***Icomp*:** Current compliance value (in A). Numeric expression. If you do not specify *Icomp*, the previous value is set. Zero amps (0 A) is not a valid value for the *Icomp* parameter.

Example Statements

```
OUTPUT @E5270;"LSSV 1,0,5,1E-6"
```

See Also

Refer to Table 4-6 on page 4-13 for the source output value, output range, and the available compliance values.

LST?

The LST? query command stores a catalog of internal memory programs or a specific program listing in the output data buffer (query buffer) of the E5270.

Syntax

`LST? [pnum[,index[,size]]]`

Parameters

***pnum* :** Memory program number. Numeric expression. 0 to 2000. If you do not specify the value, 0 is set.

LST? 0 returns the catalog of the memory programs. This is same as the LST? command results. Then *index* and *size* are not required.

***index* :** Command index that is the number of top command to read. Numeric expression. If you do not specify the value, 1 is set.

index=1 specifies the first command stored in the memory program. This command is always the ST command. And the last command is always the END command. If the *index* value is greater than the number of commands, the LST? returns the END only.

If you set *index*=0, the LST? returns the number of commands stored in the memory program. For empty memory programs, the LST? returns 2 (ST and END).

***size* :** Number of commands to read. Numeric expression. 1 to 3000. If you do not specify the value, 3000 is set.

If you set the value greater than the number of commands from the command specified by *index* to the last command (END), the LST? command stops operation after reading the END command.

Query Response

Response by LST? or LST? 0:

Number of programs[,*pnum*[,*pnum* ... [,*pnum*]...]]<CR/LF^EOI>

Response by LST? *pnum*[, *index*[, *size*]]:

```
ST pnum<CR/LF^EOI>
[saved command <CR/LF^EOI>]
[saved command <CR/LF^EOI>]
          :
[saved command <CR/LF^EOI>]
END<CR/LF^EOI>
```

The LST? command reads the command specified by the *index*, reads the command stored next, and repeats this operation until the *size* each of commands are read. If you do not specify the *index* and *size* values, the LST? command reads the first stored command (ST *pnum*) to the 3000th stored command. If the number of commands are less than 3000, the LST? command reads the commands from ST to END. See Example Statements that show an HP BASIC programming example.

Example Statements

Example of LST? :

```
DIM A$[100]
OUTPUT @E5270;"LST?"
ENTER @E5270;A$
PRINT A$
```

Example of LST? *pnum*[, *index*[, *size*]] :

```
DIM A$[100]
P_num=1
!
OUTPUT @E5270;"LST?";P_num,0
ENTER @E5270;Num_c
Num_l=Num_c/3000
!
IF Num_c>3000 THEN
 C_index=1
 FOR I=1 TO INT(Num_l)
   OUTPUT @E5270;"LST?";P_num,C_index
   FOR N=1 TO 3000
     ENTER @E5270;A$
     PRINT A$
     C_index=C_index+1
   NEXT N
 NEXT I
 OUTPUT @E5270;"LST?";P_num,C_index
 LOOP
   ENTER @E5270;A$
   PRINT A$
 EXIT IF A$="END"
 END LOOP
ELSE
 OUTPUT @E5270;"LST?";P_num
 LOOP
   ENTER @E5270;A$
   PRINT A$
 EXIT IF A$="END"
 END LOOP
END IF
```

LSTM

The LSTM command sets the timing parameters for the linear search measurement.

If you do not enter this command, all parameters are set to 0.

Syntax

`LSTM hold,delay`

Parameters

hold **:** Hold time (in seconds) that is the wait time after starting the search measurement and before starting the delay time for the first search point. Numeric expression.

0 to 655.35 sec. 0.01 sec resolution.

delay **:** Delay time (in seconds) that is the wait time after starting to force a step output value and before starting a step measurement. Numeric expression.

0 to 65.535 sec. 0.0001 sec resolution.

Example Statements

```
OUTPUT @E5270;"LSTM 5,0.1"
```

LSV

The LSV command specifies and sets the voltage search source for the linear search measurement. This command setting is cleared by the LSI command. After search stops, the search channel forces the value specified by the LSM command.

Syntax

`LSV` *`chnum`*`,`*`range`*`,`*`start`*`,`*`stop`*`,`*`step`*`[,`*`Icomp`*`]`

Parameters

chnum **:** Search source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

range **:** Output ranging type. Integer expression. 0 for auto ranging, 11 to 15 for limited auto ranging. 15 is only for HPSMU. The E5270 uses the minimum range that covers both *start* and *stop* values. Range changing may cause 0 V output in a moment.

The minimum range of each ranging type is as follows:

0, 11	12	13	14	15
2 V	20 V	40 V	100 V	200 V

start, stop **:** Search start or stop voltage (in V). Numeric expression. See Table 4-6 on page 4-13. The *start* and *stop* parameters must have different values.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

step **:** Step voltage (in V). Numeric expression.

If *start* < *stop*, *step* must be positive, and if *start* > *stop*, *step* must be negative. Maximum number of search steps is 1001.

Icomp**:** Current compliance value (in A). Numeric expression. See Table 4-6 on page 4-13. If you do not specify *Icomp*, the previous value is set. Zero amps (0 A) is not allowed for *Icomp*.

Example Statements

```
OUTPUT @E5270;"LSV 1,0,0,20,.5,1E-6"
```

LSVM

The LSVM command selects the data output mode for the linear search measurement.

Syntax

`LSVM mode`

Parameters

mode **:** Data output mode. Integer expression. 0 (initial setting) or 1.

0 : Returns *Data_search* only.

1 : Returns *Data_search* and *Data_sense*.

where

Data_search is the value forced by the search output channel set by the LSV or LSI command.

Data_sense is the value measured by the search monitor channel set by the LGI or LGV command.

For data output format, refer to “Data Output Format” on page 1-19.

Example Statements

```
OUTPUT @E5270;"LSVM 1"
```

MCH

The MCH command selects the measurement channel for the data is displayed on the front panel LCD.

Syntax

`MCH chnum`

Parameters

chnum **:** Measurement channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

Example Statements

```
OUTPUT @E5270;"MCH 1"
```

MM

The MM command specifies the measurement mode and the channels used for measurements. This command must be entered to specify the measurement mode. For the high speed spot measurements, do not enter the MM command.

Syntax

- For spot, staircase sweep, and multi channel sweep:

  `MM mode,chnum[,chnum[,chnum...[,chnum]...]]`

  A maximum of eight channels can be set.

- For pulsed spot, pulsed sweep, and staircase sweep with pulsed bias:

  `MM mode,chnum`

- For binary search and linear search:

  `MM mode`

- For quasi pulsed spot:

  `MM mode[,chnum]`

Parameters

mode **:** Measurement mode. Integer expression. 1 to 5, 9, and 14 to 16.

mode	**Measurement mode**	**Related source setup command**
1	Spot	DI, DV
2	Staircase sweep	WI, WV, WT, WM, WSI, WSV
3	Pulsed spot	PI, PV, PT
4	Pulsed sweep	PWI, PWV, PT, WM, WSI, WSV
5	Staircase sweep with pulsed bias	WI, WV, WM, WSI, WSV, PI, PV, PT
9	Quasi-pulsed spot	BDV, BDT, BDM
14	Linear search	LSV, LSI, LGV, LGI, LSM, LSTM, LSSV, LSSI, LSVM
15	Binary search	BSV, BSI, BGV, BGI, BSM, BST, BSSV, BSSI, BSVM
16	Multi channel sweep	WI, WV, WT, WM, WNX

chnum**:** Measurement channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

Remarks

The SMU operation mode is defined by the CMM command.

The measurement range is defined by the RI or RV command for the measurements except for the search measurement.

To execute the measurement, enter the XE command.

For the spot and staircase sweep measurements, if you use multiple measurement channels, the channels start measurement in the order defined in the MM command.

For the multi channel sweep measurement, if you use multiple measurement channels, the channels that use the high-speed A/D converter with the fixed ranging mode start measurement simultaneously, then other channels start measurement in the order defined in the MM command.

For the quasi-pulsed spot measurement, if you do not specify *chnum*, the E5270 uses the channel specified by the BDV command to execute measurement.

For the quasi-pulsed spot measurement and the linear/binary search measurements, the time stamp function is not available. See “Data Output Format” on page 1-19.

Example Statements

```
OUTPUT @E5270;"MM 1,1"
OUTPUT @E5270;"MM 2,1,3"
```

MPA

The MPA command selects the data displayed in the measurement data display area on the front panel LCD.

The *RST command or the device clear sets the compliance side data only.

Syntax

`MPA item`

Parameters

***item* :** Measurement data displayed. Integer expression.

1: Compliance side data. Initial setting.

2: Compliance side data and force side data.

3: Resistance data. Displays “`------`” in the remote mode.

4: Power data. Displays “`------`” in the remote mode.

Example Statements

```
OUTPUT @E5270;"MPA 2"
```

NUB?

The NUB? query command checks the number of measurement data in the output data buffer, and stores the results in the output data buffer (query buffer).

Syntax NUB?

Query Response *Number of measurement data*<CR/LF^EOI>

Example Statements

```
OUTPUT @E5270;"NUB?"
ENTER @E5270;A
```

*OPC?

The *OPC? command monitors the pending operations, and places ASCII character 1 into the output queue when all pending operations are completed. Also this command sets/clears the operation complete (OPC) bit in the standard event status register as follows:

- If there are no pending operations, sets the OPC bit to 1.
- If there are any pending operations, sets the OPC bit to 0.
  The bit will be set to 1 when all pending operations are completed.

Syntax *OPC?

Query Response 1<CR/LF^EOI>

No response will be returned until all pending operations are completed.

Example Statements

```
OUTPUT @E5270;"*OPC?"
ENTER @E5270;A
```

OS

The OS command causes the E5270 to send a edge trigger from the Ext Trig Out terminal. To set the trigger logic (initial value: negative), send the TGP command for the Ext Trig Out terminal.

Syntax

`OS`

Example Statements

```
OUTPUT @E5270;"OS"
```

OSX

The OSX command causes the E5270 to send a trigger from a trigger output terminal specified by the *port* parameter. To set the trigger logic (initial value: negative), send the TGP command for the specified port.

Syntax

`OSX port[,level]`

Parameters

***port* :** External trigger output port number. Integer expression. -2, or 1 to 16.

-2: Ext Trig Out terminal.

1 to 16: Port 1 to 16 of the digital I/O terminal.

To use a digital I/O port, send the TGP command. The *port* value must be same as the *port* value set to the TGP command.

***level* :** Trigger output level. Integer expression. 0, 1, or 2.

0: Logical low.

1: Logical high.

2: Edge trigger (default setting).

If *level* is not specified, the E5270 sends the edge trigger. For the gate trigger output, send OSX *port*,1 when starting trigger output, and send OSX *port*,0 when stopping trigger output.

Example Statements

```
OUTPUT @E5270;"OSX 1,1"
OUTPUT @E5270;"TI";1
ENTER @E5270 USING "#,3X,12D,X";Idata
OUTPUT @E5270;"OSX 1,0"
```

See Also

"TGP" and "TGPC"

PA

The PA command pauses the command execution or internal memory program execution, until the specified wait time has elapsed or until an event specified by the TM command is received. The event set by the TM command only releases the paused status. It does not start the measurement.

Syntax

PA [*wait time*]

Parameters

***wait time* :** -99.9999 to 99.9999 seconds, with 100 µsec resolution. Numeric expression.

If *wait time* is not specified or negative *wait time* is set, the paused status is kept until receiving an event specified by the TM command.

Remarks

The TM3 command enables an external trigger from the Ext Trig In terminal as an event used to break the pause state set by the PA command.

The E5270 counts the *wait time* independent of the source wait time and the measurement wait time set by the WAT command. So the *wait time* can cover them as shown in the following program example:

```
OUTPUT @E5270;"CN";1
OUTPUT @E5270;"WAT";1,0,1E-3  !Source Wait Time =1ms
OUTPUT @E5270;"WAT";2,0,1E-3  !Meas Wait Time =1ms
OUTPUT @E5270;"DV";1,0,5,1E-2
OUTPUT @E5270;"PA";1E-3       !Wait Time =1ms
OUTPUT @E5270;"TI";1
ENTER @E5270 USING "#,3X,12D,X";Idata
```

Example Statements

```
OUTPUT @E5270;"PA 10"
```

See Also

“TM”

PAX

The PAX command pauses the command execution or internal memory program execution, until the specified wait time has elapsed or until an event specified by the TM command is received. The event set by the TM command only releases the paused status. It does not start the measurement.

Execution Conditions

The *port* parameter is meaningful only for the event (trigger input) set by the TM3 command. Set 1 (dummy) for the event set by the TM1, TM2, or TM4 command.

Syntax

`PAX port[,wait time]`

Parameters

port **:** External trigger input port number. Integer expression. -1, or 1 to 16.

-1: Ext Trig In terminal.

1 to 16: Port 1 to 16 of the digital I/O terminal.

To use a digital I/O port, send the TGP command. The *port* value must be same as the *port* value set to the TGP command.

wait time **:** -99.9999 to 99.9999 seconds, with 100 μsec resolution. Numeric expression.

If *wait time* is not specified or negative *wait time* is set, the paused status is kept until receiving an event specified by the TM command.

Remarks

The TM3 command enables an external trigger from a trigger input terminal specified by the *port* parameter as an event used to break the pause state set by the PA command.

The E5270 counts the *wait time* independent of the source wait time and the measurement wait time set by the WAT command. So the *wait time* can cover them as shown in the following program example:

```
OUTPUT @E5270;"CN";1
OUTPUT @E5270;"WAT";1,0,1E-3  !Source Wait Time =1ms
OUTPUT @E5270;"WAT";2,0,1E-3  !Meas Wait Time =1ms
OUTPUT @E5270;"DV";1,0,5,1E-2
OUTPUT @E5270;"PAX";-1,1E-3   !Wait Time =1ms
OUTPUT @E5270;"TI";1
ENTER @E5270 USING "#,3X,12D,X";Idata
```

Example Statements

```
OUTPUT @E5270;"PAX 1,10"
```

See Also

“TM”, “TGP”, and “TGPC”

PI

The PI command specifies the pulse current source and its parameters. This command also clears, and is cleared by, the PV command setting.

In the staircase sweep with pulsed bias measurement mode (set by the MM 5 command), the output forced by the PI command synchronized with the staircase sweep outputs forced by the WI or WV command.

Measurement channel always uses the high-speed A/D converter, and performs measurement so that the pulse width and pulse period are kept. The integration time is automatically set by the Agilent E5270, and you cannot change. The AAD/AIT/AV/WT command settings are ignored.

Syntax

PI *chnum*,*irange*,*base*,*pulse*[,*Vcomp*]

Parameters

chnum **:** Pulsed source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

irange**:** Ranging type for pulse current output. Integer expression. 0 for auto ranging, or 12 to 20 for limited auto ranging that uses the specified range and above. 20 is for 200 mA (MPSMU) or 1 A (HPSMU). See Table 4-5 on page 4-12.

The E5270 uses the minimum range that covers both *base* and *pulse* values.

base**,**
pulse **:** Pulse base current or pulse peak current (in A). Numeric expression. See Table 4-7 on page 4-14.

0 to ±200E–3 (for MPSMU)

0 to ±1 (for HPSMU)

base and *pulse* must have the same polarity.

Vcomp**:** Voltage compliance value (in V). Numeric expression. See Table 4-7 on page 4-14. If *Vcomp* is not specified, the previous value is set.

Compliance polarity is automatically set to the same polarity as the output value, regardless of the specified *Vcomp*. If the output value is 0, the polarity is set to positive.

Example Statements

```
OUTPUT @E5270;"PI 1,16,0,5E-5,5"
OUTPUT @E5270;"PI 3,0,0,5E-6"
```

PT

The PT command sets the hold time, pulse width, and pulse period for a pulse source set by the PI, PV, PWI or PWV command. This command also sets the trigger delay time. Measurement channel always uses the high-speed A/D converter, and performs measurement so that the pulse width and pulse period are kept. The integration time is automatically set by the Agilent E5270, and you cannot change. The AAD/AIT/AV/WT command settings are ignored.

Syntax

For pulsed spot measurements:

```
PT hold,width[,period[,Tdelay]]
```

For pulsed sweep or staircase sweep with pulsed bias measurements:

```
PT hold,width,period[,Tdelay]
```

Parameters

***hold* :** Hold time (in seconds). Numeric expression.

0 to 655.35 sec. 0.01 sec resolution. Initial setting = 0.

***width* :** Pulse width (in seconds). Numeric expression.

0.5E–3 to 2.0 sec. 1E–4 sec resolution. Initial setting = 1E–3 sec.

***period* :** Pulse period (in seconds). Numeric expression. 0, or 5E–3 to 5.0 sec. 1E–4 sec resolution. Initial or default setting = 10E–3 sec.

Restrictions:

- *period* ≥ *width* +2 msec (for *width* ≤ 100 ms)
- *period* ≥ *width* +10 msec (for *width* > 100 ms)

If you set *period*=0, the E5270 automatically sets the pulse period to 5 msec (for *width* ≤ 3 ms), *width* +2 msec (for 3 ms < *width* ≤ 100 ms), or *width* +10 msec (for *width* > 100 ms).

If you do not specify *period*, 0 sec is set.

***Tdelay* :** Trigger output delay time (in seconds). Numeric expression.

0 to *width* sec. 1E–4 sec resolution. Default setting = 0.

This parameter is the time from pulse leading edge to timing of trigger output from a trigger output terminal. If you do not specify *Tdelay*, 0 sec is set.

Example Statements

```
OUTPUT @E5270;"PT 1,0.01"
```

PV

The PV command specifies the pulsed voltage source and its parameters. This command also clears, and is cleared by, the PI command setting.

In the staircase sweep with pulsed bias measurement mode (MM 5 command), the output forced by the PV command synchronized with the staircase sweep outputs forced by the WI or WV command.

Measurement channel always uses the high-speed A/D converter, and performs measurement so that the pulse width and pulse period are kept. The integration time is automatically set by the Agilent E5270, and you cannot change. The AAD/AIT/AV/WT command settings are ignored.

Syntax

`PV chnum,vrange,base,pulse[,Icomp]`

Parameters

***chnum* :** Pulsed source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***vrange*:** Ranging type for the pulsed voltage output. Integer expression. 0 for auto ranging, or 11 to 15 for limited auto ranging that uses the specified range and above. 15 is only for HPSMU. See Table 4-4 on page 4-12.

The E5270 uses the minimum range that covers both *base* and *pulse* values.

***base*, *pulse* :** Pulse base voltage or pulse peak voltage (in V). Numeric expression. See Table 4-6 on page 4-13.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

***Icomp*:** Current compliance value (in A). Numeric expression. See Table 4-6 on page 4-13. If you do not set *Icomp*, the previous value is used.

Compliance polarity is automatically set to the same polarity as the output value, regardless of the specified *Icomp*. If the output value is 0, the polarity is set to positive.

Example Statements

```
OUTPUT @E5270;"PV 1,12,0,5,1E-3"
OUTPUT @E5270;"PV 2,0,0,3"
```

PWI

The PWI command specifies the pulsed sweep current source and its parameters. This command clears the settings of the PWV, WSV and WSI commands.

The settings specified by this command are cleared by the PWV command.

Measurement channel always uses the high-speed A/D converter, and performs measurement so that the pulse width and pulse period are kept. The integration time is automatically set by the Agilent E5270, and you cannot change. The AAD/AIT/AV/WT command settings are ignored.

Syntax

`PWI` *`chnum`*`,`*`mode`*`,`*`range`*`,`*`base`*`,`*`start`*`,`*`stop`*`,`*`step`*`[,`*`Vcomp`*`]`

Parameters

chnum **:** Pulsed sweep source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

mode **:** Sweep mode. Integer expression. 1 or 3.

1: Linear sweep (single stair, start to stop.)

3: Linear sweep (double stair, start to stop to start.)

range **:** Ranging type for pulsed current sweep. Integer expression. 0 for auto ranging, or 12 to 20 for limited auto ranging. 20 is for 200 mA (MPSMU) or 1 A (HPSMU). See Table 4-5 on page 4-12.

The E5270 uses the minimum range that covers *base*, *start*, and *stop* values.

The minimum range of each ranging type is as follows:

0, 12	**13**	**14**	**15**	**16**
10 nA	100 nA	1 µA	10 µA	100 µA
17	**18**	**19**	**20**	
1 mA	10 mA	100 mA	0.2 or 1 A	

***base*, *start*, *stop* :** Pulse base, start, or stop current (in A). Numeric expression. See Table 4-7 on page 4-14.

0 to ±200E−3 (for MPSMU)

0 to ±1 (for HPSMU)

base, *start* and *stop* must have the same polarity.

***step* :** Number of steps for pulsed sweep. Numeric expression. 1 to 1001.

The E5270 can store approximately 16000 measurement data in ASCII format with header without source data, or approximately 64000 measurement data in binary format.

***Vcomp* :** Voltage compliance (in V). Numeric expression. See Table 4-7 on page 4-14. If you do not specify *Vcomp*, the previous value is set.

Compliance polarity is automatically set to the same polarity as the output value, regardless of the specified *Vcomp*. If the output value is 0, the polarity is set to positive.

Example Statements

```
OUTPUT @E5270;"PWI 1,1,0,0,0,0.1,101"
OUTPUT @E5270;"PWI 2,3,13,0,1E-7,1E-2,100,10"
```

PWV

The PWV command specifies the pulsed sweep voltage source and its parameters. This command also clears the settings of the PWI, WSV and WSI commands.

The settings specified by this command are cleared by the PWI command.

Measurement channel always uses the high-speed A/D converter, and performs measurement so that the pulse width and pulse period are kept. The integration time is automatically set by the Agilent E5270, and you cannot change. The AAD/AIT/AV/WT command settings are ignored.

Syntax

`PWV chnum,mode,range,base,start,stop,step[,Icomp]`

Parameters

***chnum* :** Pulsed sweep source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***mode* :** Sweep mode. Integer expression. 1 or 3.

1: Linear sweep (single stair, start to stop.)

3: Linear sweep (double stair, start to stop to start.)

***range*:** Ranging type for pulsed voltage sweep. Integer expression. 0 for auto ranging, or 11 to 15 for limited auto ranging. 15 is only for HPSMU. See Table 4-4 on page 4-12.

The E5270 uses the minimum range that covers *base*, *start*, and *stop* values.

The minimum range of each ranging type is as follows:

0, 11	**12**	**13**	**14**	**15**
2 V	20 V	40 V	100 V	200 V

***base*, *start*, *stop* :** Pulse base, start, or stop voltage (in V). Numeric expression. See Table 4-6 on page 4-13.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

***step* :** Number of steps for pulsed sweep. Numeric expression. 1 to 1001.

The E5270 can store approximately 16000 measurement data in ASCII format with header without source data, or approximately 64000 measurement data in binary format.

***Icomp* :** Current compliance (in A). Numeric expression. See Table 4-6 on page 4-13. If you do not specify *Icomp*, the previous value is set.

Compliance polarity is automatically set to the same polarity as the output value, regardless of the specified *Icomp*. If the output value is 0, the polarity is set to positive.

Example Statements

```
OUTPUT @E5270;"PWV 1,1,0,0,0,10,101"
OUTPUT @E5270;"PWV 2,3,14,0,1,10,100,0.1"
```

RCV

The RCV command enables the modules that fail the self-test or self-calibration so that it can receive commands again.

After the RCV command, enter the *OPC? command to confirm that the command execution is completed.

This command should only be used for servicing the E5270.

Syntax

`RCV [`*`slotnum`*`]`

Parameters

slotnum **:** Specifies the module to enable. Integer expression. 0 to 9.

0: All failed modules. Default setting.

1 to 8: Module installed in the slot specified by *slotnum*.

9: ADC module installed in the mainframe.

For HPSMU that uses two slots, set the greater slot number. For example, if it is installed in slot 3 and 4, *slotnum* must be 4.

If *slotnum* specifies the slot that installs no module, this command causes an error.

Example Statements

```
OUTPUT @E5270;"RCV 1"
OUTPUT @E5270;"*OPC?"
ENTER @E5270;A
```

RED

The RED command enables or disables the measurement data display and the setup data display in the remote mode.

The *RST command or the device clear disables the display.

Syntax

`RED `*`mode`*

Parameters

mode **:** Data display mode. Integer expression.

0: Disable.

1: Enable.

Example Statements

```
OUTPUT @E5270;"RED 1"
```

RI

The RI command specifies the current measurement range or ranging type. In the initial setting, the auto ranging is set. The range changing occurs immediately after the trigger (that is, during the measurements). Current measurement channel can be decided by the CMM command setting and the channel output mode (voltage or current).

For the high speed spot measurement, use the TI/TTI command.

The range setting is cleared by the CL, CA, IN, *TST?, *RST or a device clear (HP BASIC CLEAR) command.

Syntax

`RI` *`chnum,range`*

Parameters

chnum **:** Current measurement channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

range **:** Measurement range or ranging type. Integer expression. 0 (auto), 11 to 20 (limited), or -11 to -20 (fixed). 20 and -20 are for 200 mA (MPSMU) or 1 A (HPSMU). See Table 4-3 on page 4-11. Auto and limited auto use the minimum range that covers the measured value.

range value and minimum range for the auto and limited auto ranging:

0, 11	**12**	**13**	**14**	**15**
1 nA	10 nA	100 nA	1 μA	10 μA
16	**17**	**18**	**19**	**20**
100 μA	1 mA	10 mA	100 mA	0.2 or 1 A

If a pulsed source is used, the measurement channel uses the minimum range that covers the compliance value or current output range.

range value and measurement range for the fixed range:

-11	**-12**	**-13**	**-14**	**-15**
1 nA	10 nA	100 nA	1 μA	10 μA
-16	**-17**	**-18**	**-19**	**-20**
100 μA	1 mA	10 mA	100 mA	0.2 or 1 A

Example Statements

```
OUTPUT @E5270;"RI 1,0"
OUTPUT @E5270;"RI 2,-20"
```

RM

This command specifies the auto range operation for the current measurement.

Syntax

`RM chnum,mode[,rate]`

where the *rate* parameter is available for *mode*=2 or 3.

Parameters

***chnum* :** Current measurement channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***mode* :** Range changing operation mode. Integer expression. 1, 2 or 3.

mode	Description
1	Initial setting. If you set *mode*=1, do not set *rate*.
2	If measured data ≥ *current1*, the range changes up after measurement.
3	If measured data ≤ *current2*, the range changes down immediately, and if measured data ≥ *current1*, the range changes up after measurement.

where *current1* and *current2* are given by the following formula:

$current1 = measurement\ range \times rate\ /100$
$current2 = measurement\ range \times rate\ /1000$

For 200 mA range, they must be:

$current1$=200 mA × $rate$ /100
$current2$ =100 mA × $rate$ /100

For example, if *measurement range*=10 mA and *rate*=90, these values are as follows:

$current1$ = 9 mA
$current2$ = 0.9 mA

***rate*:** Parameter used to calculate the *current* value. Numeric expression. 11 to 100. Default value is 50.

Example Statements

```
OUTPUT @E5270;"RM 1,2"
OUTPUT @E5270;"RM 2,3,60"
```

*RST

The *RST command resets the E5270 to the initial settings. This command does not clear the program memory and the self calibration data.

Syntax

```
*RST
```

Remarks

If you want to reset channels while a sweep measurement is being performed, you must first send the AB command, then the *RST command.

Example Statement

```
OUTPUT @E5270;"*RST"
```

RU

The RU command sequentially executes the internal memory programs.

Execution Conditions

The specified programs have been stored by using the ST and END commands, from the start program number through the stop program number.

Syntax

RU *start*,*stop*

Parameters

start **:** Start program number. Numeric expression. 1 to 2000.

stop **:** Stop program number. Numeric expression. 1 to 2000.

where *stop* value must be greater than or equal to the *start* value.

Example Statements

```
OUTPUT @E5270;"RU 1,10"
OUTPUT @E5270;"RU 3,6"
```

RV

The RV command specifies the voltage measurement range or ranging type. In the initial setting, the auto ranging is set. The range changing occurs immediately after the trigger (that is, during the measurements). Voltage measurement channel can be decided by the CMM command setting and the channel output mode (voltage or current).

For the high speed spot measurement, use the TV/TTV command.

The range setting is cleared by the CL, CA, IN, *TST?, *RST or a device clear (HP BASIC CLEAR) command.

Syntax

`RV chnum,range`

Parameters

***chnum* :** Voltage measurement channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***range* :** Measurement range or ranging type. Integer expression. 0 (auto), 11 to 15 (limited), or -11 to -15 (fixed). 15 and -15 are only for HPSMU. See Table 4-2 on page 4-10. Auto and limited auto ranging use the minimum range that covers the measured value.

range value and minimum range for the auto and limited auto ranging:

0, 11	**12**	**13**	**14**	**15**
2 V	20 V	40 V	100 V	200 V

If a pulsed source is used, the measurement channel uses the minimum range that covers the compliance value or voltage output range.

range value and measurement range for the fixed range:

-11	**-12**	**-13**	**-14**	**-15**
2 V	20 V	40 V	100 V	200 V

Example Statements

```
OUTPUT @E5270;"RV 2,-15"
OUTPUT @E5270;"RV 1,12"
```

RZ

The RZ command returns the channel to the settings that are stored by the DZ command and clears the stored settings.

The DZ command stores the channel settings (V/I output values, V/I output ranges, V/I compliance values, and series resistor setting), then sets the channel to 0 V.

Execution Conditions

The DZ command has been executed for the specified channel. And the CL, CA, *TST?, *RST or a device clear (HP BASIC CLEAR) command has not been executed for the specified channel.

Syntax

RZ [*chnum*[,*chnum*...[,*chnum*]...]]

A maximum of eight channels can be set.

Parameters

chnum **:** Channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

If you do not specify this parameter, this command returns the settings for all channels that satisfy the conditions described in “Execution Conditions” above, in the order that the DZ command stored them.

You can specify up to eight channels at once using the RZ command. The E5270 returns the stored settings in the order specified.

Example Statements

```
OUTPUT @E5270;"RZ"
OUTPUT @E5270;"RZ 1,2,3"
```

SCH

The SCH command selects the source channel for the data is displayed on the front panel LCD.

Syntax

`SCH` *`chnum`*

Parameters

chnum **:** Source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

Example Statements

```
OUTPUT @E5270;"SCH 1"
```

SCR

The SCR command scratches the specified program from the internal program memory.

Syntax

`SCR [`*`pnum`*`]`

Parameters

pnum **:** Program number. Numeric expression. 1 to 2000.
If you do not specify this parameter, this command scratches all programs stored in the internal program memory.

Example Statements

```
OUTPUT @E5270;"SCR"
OUTPUT @E5270;"SCR 5"
```

SPA

The SPA command selects the parameter displayed in the source data display area on the front panel LCD.

The *RST command or the device clear sets the source force value in the first line and the source compliance value in the second line.

Syntax

```
SPA line,item
```

Parameters

***line* :** Line or position the parameter value is displayed. Integer expression.

1: First line.

2: Second line.

***item* :** Parameter displayed on the line specified by *line*. Integer expression.

item	Description
1	Source force value.
2	Source compliance value.
3	Voltage measurement range value.
4	Current measurement range value.
5	Latest error code or error number.

Example Statements

```
OUTPUT @E5270;"SPA 1,1"
OUTPUT @E5270;"SPA 2,5"
```

*SRE

The *SRE command enables the specified bits of the status byte register for SRQ (service requests), and masks (disables) the bits that are not specified.

Syntax

`*SRE bit`

Parameters

***bit* :** Sum of the decimal values corresponding to the bits to be enabled. Integer expression. 0 to 255. See the following table.

For example, to enable Bit 0, 4, and 7 for the SRQ, the *bit* value must be 145 (1 + 16 + 128).

If *bit*=0, all bits, except for Bit 6, will be masked (disabled for the SRQ). You cannot mask bit 6.

Decimal Value	Bit Number	Description
1	Bit 0	Data Ready
2	Bit 1	Wait
4	Bit 2	not used
8	Bit 3	Interlock Open
16	Bit 4	Set Ready
32	Bit 5	Error
64	Bit 6	RQS
128	Bit 7	Shut Down

Example Statements

```
OUTPUT @E5270;"*SRE 6"
OUTPUT @E5270;"*SRE 128"
```

*SRE?

The *SRE? query command returns information about which bits of the status byte register are enabled for the SRQ (service requests), and stores the results in the output data buffer (query buffer).

Syntax

```
*SRE?
```

Query Response

enabled_bits<CR/LF^EOI>

enabled_bits are represented by the corresponding decimal values shown below.

Decimal Value	Bit Number	Description
1	Bit 0	Data Ready
2	Bit 1	Wait
4	Bit 2	not used
8	Bit 3	Interlock Open
16	Bit 4	Set Ready
32	Bit 5	Error
64	Bit 6	RQS
128	Bit 7	Shut Down

For example, if Bit 0, 3, and 4 are enabled for the SRQ, 25 (1 + 8 + 16) will be returned. If all bits, except for Bit 6, are masked, *enabled_bits* will be 0.

Example Statements

```
OUTPUT @E5270;"*SRE?"
ENTER @E5270;A
```

SSR

This command sets the connection mode of a series resistor (approx. 1 MΩ) for each channel.

If the output switch is opened, the SSR command just sets the mode, and the CN command connects or disconnects the series resistor.

If the output switch is already closed, the SSR command connects the series resistor to the SMU output. Then the output forces 0 V one moment.

A series resistor is mounted on each module. If you use a series resistor, the voltage you set is applied to the near side of the series resistor. Thus, the voltage will be divided by the series resistor and the device under test.

Execution Conditions

The channel must not be in the HIGH VOLTAGE state (forcing more than ±42 V, or voltage compliance set to more than ±42 V).

For HPSMU, the series resistor cannot be used for the measurements that use 1 A range.

Syntax

`SSR` *`chnum`*`,`*`mode`*

Parameters

chnum **:** Channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

mode **:** Status of the series resistor. Integer expression.

0: Disconnect (initial setting).

1: Connect.

Example Statements

```
OUTPUT @E5270;"SSR 1,1"
OUTPUT @E5270;"SSR 2,1"
```

ST

The ST command is used with the END command to store a program in the internal program memory that can store 2,000 programs maximum, and a total of 40,000 commands.

The ST command indicates the start of the program, and assigns the program number. If the assigned program number already exists, the E5270 deletes the old program, and stores the new one.

The END command indicates the end of the program. If the END command is not included, the E5270 stores the commands until the program memory is full.

Use the DO or RU command to execute stored programs.

Syntax

```
STpnum[;command[;command...[;command]...];END
```

or

```
ST pnum
[command]
[command]
    :
    :
[command]
END
```

Parameters

pnum **:** Program number. Integer expression. 1 to 2000.

command **:** Command stored in the internal program memory. Specify commands according to normal syntax – no special syntax is necessary.

For the commands that cannot stored in the program memory, refer to Table 2-1 on page 2-26.

Example Statements

Example 1:

```
OUTPUT @E5270;"ST1;CN1;DV1,0,5,1E-4;TI1,0;CL1"
OUTPUT @E5270;"END"
```

Example 2:

```
OUTPUT @E5270;"ST 1"
OUTPUT @E5270;"CN 1"
OUTPUT @E5270;"DV 1,0,5,1E-4"
OUTPUT @E5270;"TI 1,0"
OUTPUT @E5270;"CL 1"
OUTPUT @E5270;"END"
```

*STB?

The *STB? query command stores the decimal representation of the status byte in the output data buffer (query buffer).

The *STB? command is functionally identical to the SPOLL command of BASIC, however this command does not clear the status byte (the SPOLL command clears the status byte).

Syntax

```
*STB?
```

Query Response

status_byte<CR/LF^EOI>

status_byte value is a decimal number that indicates which bits of the status byte are ON (“1”).

For example, if *status_byte* is 40 (8 + 32), then Bit 3 and 5 are set to 1.

Decimal Value	Bit Number	Description
1	Bit 0	Data Ready
2	Bit 1	Wait
4	Bit 2	not used
8	Bit 3	Interlock Open
16	Bit 4	Set Ready
32	Bit 5	Error
64	Bit 6	RQS
128	Bit 7	Shut Down

Example Statements

```
OUTPUT @E5270;"*STB?"
ENTER @E5270;A
```

TDI

Forces current and returns the time data from when the timer is cleared until output is started. This command is effective for ASCII data. Refer to “FMT” on page 4-58.

Execution Conditions

The CN command has been executed for the specified channel.

If the voltage compliance is greater than ±42 V, the interlock circuit must be shorted.

Syntax

`TDI chnum,irange,current[,Vcomp[,comp_polarity[,vrange]]]`

Parameters

chnum **:** Source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***irange*:** Ranging type for current output. Integer expression. 0 for auto ranging, or 11 to 20 for limited auto ranging that uses the specified range and above. 20 is for 200 mA (MPSMU) or 1 A (HPSMU). See Table 4-5 on page 4-12.

The E5270 uses the minimum range that covers *current* value.

***current*:** Output current value (in A). Numeric expression. See Table 4-7 on page 4-14.

0 to ±200E–3 (for MPSMU)

0 to ±1 (for HPSMU)

***Vcomp*:** Voltage compliance value (in V). Numeric expression. See Table 4-7 on page 4-14. If you do not specify this parameter, *Vcomp* is set to the previous setting.

***comp_ polarity*:** Polarity of voltage compliance. Numeric expression.

0: Auto mode (default setting). The compliance polarity is automatically set to the same polarity as *current*, regardless of the specified *Vcomp*. If *current*=0 A, the polarity is set to positive.

1: Manual mode. Uses the polarity of *Vcomp* you specified.

***vrange*:** Voltage compliance ranging type. Integer expression. 0 for auto ranging, or 11 to 15 for limited auto ranging. See Table 4-4 on page 4-12.

Example Statements

```
OUTPUT @E5270;"TDI 1,0,1E-6"
ENTER @E5270 USING "#,5X,13D,X";Time
```

TDV

Forces voltage and returns the time data from when the timer is cleared until output is started. This command is effective for ASCII data output format. Refer to "FMT" on page 4-58.

Execution Conditions

The CN command has been executed for the specified channel.

If the output voltage is greater than ±42 V, the interlock circuit must be shorted.

Syntax

`TDV` *`chnum`*`,`*`vrange`*`,`*`voltage`*`[,`*`Icomp`*`[,`*`comp_polarity`*`[,`*`irange`*`]]]`

Parameters

chnum **:** Source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***vrange*:** Ranging type for voltage output. Integer expression. 0 for auto ranging, or 11 to 15 for limited auto ranging that uses the specified range and above. 15 is only for HPSMU. See Table 4-4 on page 4-12.

The E5270 uses the minimum range that covers *voltage* value.

***voltage*:** Output voltage value (in V). Numeric expression. See Table 4-6 on page 4-13.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

***Icomp*:** Current compliance value (in A). Numeric expression. See Table 4-6 on page 4-13. If you do not set *Icomp*, the previous value is used. 0 A is not allowed for *Icomp*.

***comp_polarity*:** Polarity of current compliance. Integer expression.

0: Auto mode (default setting). The compliance polarity is automatically set to the same polarity as *voltage*, regardless of the specified *Icomp*. If *voltage*=0 V, the polarity is set to positive.

1: Manual mode. Uses the polarity of *Icomp* you specified.

***irange*:** Current compliance ranging type. Integer expression. 0 for auto ranging, or 11 to 20 for limited auto ranging. See Table 4-5 on page 4-12.

Example Statements

```
OUTPUT @E5270;"TDV 1,0,20,1E-6,0,15"
ENTER @E5270 USING "#,5X,13D,X";Time
```

TGMO

The TGMO command selects the edge trigger or the gate trigger for the Step Measurement Completion trigger output set by the `TGP` *port*`,2,`*polarity*`,3` command. See Figure 4-2.

This command is available for the staircase sweep and multi channel sweep measurements.

Syntax

`TGMO` *`mode`*

Parameters

***mode* :** Edge trigger or gate trigger. Integer expression.

1: Edge trigger (initial setting).

2: Gate trigger.

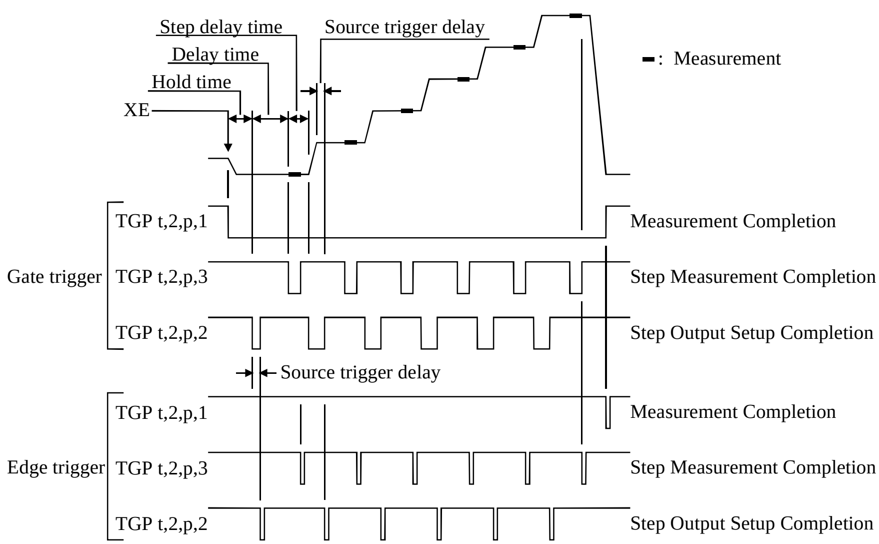
Example Statements

```
OUTPUT @E5270;"TGMO 2"
```

See Also

"TGP" and "TGPC"

Figure 4-2 **Trigger Output Example, Staircase Sweep Measurement, Negative Logic**



TGP

The TGP command enables the trigger function for the terminal specified by the *port* parameter. For the trigger function, refer to "Trigger Function" on page 2-30.

Syntax

`TGP port,terminal,polarity[,type]`

Parameters

port **:** Trigger port number. Integer expression. `-1`, `-2`, or 1 to 16.

`-1`: Ext Trig In terminal.

`-2`: Ext Trig Out terminal.

1 to 16: Port 1 to 16 of the digital I/O terminal.

terminal **:** Terminal type. Integer expression. 1 or 2.

1: Trigger input. Not available for *port*=`-2`.

2: Trigger output. Not available for *port*=`-1`.

polarity **:** Trigger logic. Integer expression. 1 or 2.

1: Positive logic.

2: Negative logic.

type **:** Trigger type. Integer expression. 0, 1, 2, or 3. Selects the function of the trigger port. See Table 4-12.

If this parameter is not specified, *type* is set to 0.

Remarks

The function of type=0 is effective for all trigger ports regardless of the *type* value. Then the PA and WS commands are used for the Ext Trig In terminal, and the OS command is used for the Ext Trig Out terminal. Also the PAX and WSX commands are used for the trigger input ports set by the TGP command, and the OSX command is used for the trigger output ports set by the TGP command.

type=1 to 3 is available for a port only. If you send the command with the same *type* more than once, only the last command is effective. *type*=0 is set for another ports.

If you send the TGP command with *terminal*=1 and *port*=1 to 16, the signal level of the trigger input terminal is set to physical high.

If you send the TGP command with *terminal*=2, the signal level of the trigger output terminal is set to logical low.

Table 4-12 Trigger Type

type	*terminal*	Description
0	1	When a trigger is received, the E5270 recovers from the wait state set by the PA, PAX, WS, or WSX command.
	2	The E5270 sends a trigger by the OS or OSX command.
1 [a]	1	Start measurement trigger When a trigger is received, the E5270 starts the measurement.
	2	Measurement completion trigger The E5270 sends a trigger after measurement.
2	1	Start step output setup trigger When a trigger is received, the E5270 starts the output setup at each sweep step or the pulsed output setup. This function is available for the staircase sweep, pulsed sweep, staircase sweep with pulsed bias, multi channel sweep, or pulsed spot measurement.
	2	Step output setup completion trigger The E5270 sends a trigger when the output setup is completed at each sweep step or the pulsed output setup is completed. This function is available for the staircase sweep, pulsed sweep, staircase sweep with pulsed bias, multi channel sweep, or pulsed spot measurement.
3	1	Start step measurement trigger When a trigger is received, the E5270 starts the measurement at each sweep step. This function is available for the staircase sweep or multi channel sweep measurement.
	2	Step measurement completion trigger The E5270 sends a trigger after measurement at each sweep step. This function is available for the staircase sweep or multi channel sweep measurement.

a. TM3 command must be entered to use this trigger type.

Example Statements

```
OUTPUT @E5270;"TGP 1,1,1,2"
```

See Also

See Figure 4-2 on page 4-109 for a trigger output example and Figure 4-3 on page 4-113 for a trigger input example.

TGPC

The TGPC command clears the trigger setting of the specified ports.

Syntax

`TGPC [port[,port...[,port]...]]`

A maximum of 18 ports can be set. If no port is specified, the TGPC command clears the setting of the all ports; Ext Trig In, Ext Trig Out, and digital I/O ports 1 to 16.

Parameters

port **:** Trigger port number. Integer expression. `-1`, `-2`, or 1 to 16.

`-1`: Ext Trig In terminal.

`-2`: Ext Trig Out terminal.

1 to 16: Port 1 to 16 of the digital I/O terminal.

Remarks

The TGPC command sets the trigger ports as shown below.

Ext Trig In	Same as after TGP -1,1,2,0 command execution.
Ext Trig Out	Same as after TGP -2,2,2,0 command execution.
Digital I/O Ports	No trigger function is available. The ERS? and ERC commands are available for the port control.

This is not same as the condition set by the *RST command that sets the ports as shown below.

Ext Trig In	Same as after TGP -1,1,2,1 command execution.
Ext Trig Out	Same as after TGP -2,2,2,1 command execution.
Digital I/O Ports	No trigger function is available. The ERS? and ERC commands are available for the port control.

Example Statements

```
OUTPUT @E5270;"TGPC -1,-2,1,2"
```

See Also

"TGP"

TGSI

The TGSI command selects Case 1 or Case 2 effective for the Start Step Output Setup trigger input set by the `TGP` *port*`,1,`*polarity*`,2` command.

This command is available for the staircase sweep, pulsed spot, pulsed sweep, staircase sweep with pulsed bias, and multi channel sweep measurements.

Syntax

`TGSI` *`mode`*

Parameters

***mode* :** Case 1 or Case 2. Integer expression. See Figure 4-3.

1: Case 1 (initial setting).

2: Case 2.

Case 1 waits for a trigger for the first sweep step, and does not wait for a trigger for the source output after sweep.

Case 2 does not wait for a trigger for the first sweep step, and waits for a trigger for the source output after sweep.

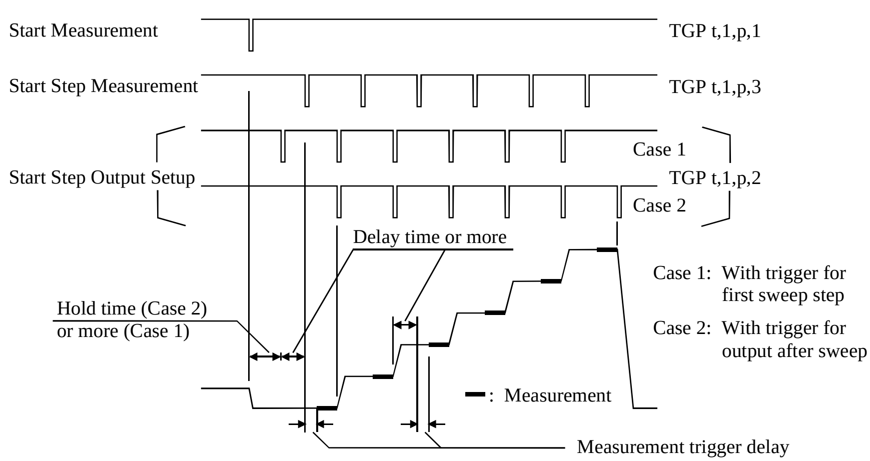
Example Statements

```
OUTPUT @E5270;"TGSI 2"
```

See Also

"TGP" and "TGPC"

Figure 4-3 **Trigger Input Example, Staircase Sweep Measurement, Negative Logic**



TGSO

The TGSO command selects the edge trigger or the gate trigger for the Step Output Setup Completion trigger output set by the `TGP` *port*`,2,`*polarity*`,2` command. See Figure 4-2 on page 4-109

This command is available for the staircase sweep, pulsed spot, pulsed sweep, staircase sweep with pulsed bias, and multi channel sweep measurements.

Syntax

`TGSO` *`mode`*

Parameters

mode **:** Edge trigger or gate trigger. Integer expression.

1: Edge trigger (initial setting).

2: Gate trigger.

Example Statements

```
OUTPUT @E5270;"TGSO 2"
```

See Also

"TGP" and "TGPC"

TGXO

The TGXO command selects the edge trigger or the gate trigger for the Measurement Completion trigger output set by the `TGP` *port*`,2,`*polarity*`,1` command. See Figure 4-2 on page 4-109

Syntax

`TGXO` *`mode`*

Parameters

mode **:** Edge trigger or gate trigger. Integer expression.

1: Edge trigger (initial setting).

2: Gate trigger.

Example Statements

```
OUTPUT @E5270;"TGXO 2"
```

See Also

"TGP" and "TGPC"

TI

The TI command performs the high speed spot measurement, and returns the measurement data. The command performs a current measurement regardless of the SMU operation mode, trigger mode (TM command), and measurement mode (MM command).

Execution Conditions

CN command has been executed for the specified channel.

Syntax

`TI chnum[,range]`

Parameters

chnum **:** Measurement channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

range **:** Ranging type for current measurement. Integer expression. 0 for auto ranging, 11 to 20 for limited auto ranging that uses the specified range and above, or –11 to –20 for fixed range. 20 and -20 are for 200 mA (MPSMU) or 1 A (HPSMU). See Table 4-3 on page 4-11.

The E5270 uses the minimum range that covers the measured value.

If you do not specify the *range* parameter for voltage output channels, the channel uses the minimum range that covers the compliance value.

The *range* parameter is meaningless for current output channels. The measurement ranging type is always same as the output ranging type.

Example Statements

```
OUTPUT @E5270;"TI 1"
ENTER @E5270 USING "#,3X,12D,X";Idata
```

TM

The TM command specifies how events are effective for the following actions:

- Releasing the E5270 from the paused status set by the PA or PAX command
- Starting the measurement except for high speed spot measurement (when the E5270 is not in the paused status set by the PA, PAX, WS, or WSX command)

Syntax

`TM mode`

Parameters

***mode* :** Event mode. Integer expression. See below.

mode	Events
1	XE command and GPIB GET (Group Execute Trigger, TRIGGER command in HP BASIC). Initial setting.
2	XE command
3	XE command and external trigger
4	XE command and MM command (automatic trigger after the MM command execution)

To enable the trigger function set by the TGP *port*,*terminal*,*polarity*,1 command, the *mode* value must be 3.

Remarks

In the TM3 event mode, if the E5270 is not in the wait status set by the PA, PAX, WS, or WSX command, the E5270 can start the measurement by an external trigger input. After measurement, the E5270 sends a trigger to a trigger output terminal. In the initial setting, you can use the Ext Trig In and Out terminals. To use the digital I/O port, enter the TGP command to set the trigger input or output terminal.

To set the trigger logic (initial value: negative), send the TGP command for the trigger input terminal.

Example Statements

```
OUTPUT @E5270;"TM 1"
OUTPUT @E5270;"TM 3"
```

See Also

“PA”, “PAX”, “TGP”, “TGPC”, “WS”, and “WSX”

TSC

The TSC command enables or disables the time stamp function.

This command is effective for ASCII data output format. Refer to "FMT" on page 4-58.

Execution Conditions

Time stamp function is not available for the following measurement modes:

- Quasi-pulsed spot measurement (MM 9)
- Linear search measurement (MM 14)
- Binary search measurement (MM 15)

Syntax

`TSC mode`

Parameters

***mode* :** Time stamp function mode. Integer expression.

mode	Description
0	Disables the time stamp function. Initial setting.
1	Enables the time stamp function.

When the function is enabled, the E5270 returns the time data with the measurement data. The time data is the time from when the timer is cleared until the measurement is started. Refer to "Data Output Format" on page 1-19.

Remarks

To read the time data with the best resolution (100 μs), the timer must be cleared every 100 sec or less for the FMT1, 2, or 5 data output format, or every 1000 sec or less for the FMT 11, 12, 15, 21, 22, or 25 data output format.

Example Statements

```
OUTPUT @E5270;"TSC 1"
```

TSQ

The TSQ command returns the time data from when the TSR command is sent until this command is sent. The time data will be put in the data output buffer as same as the measurement data.

This command is effective for all measurement modes, regardless of the TSC setting.

This command is effective for ASCII data output format. Refer to "FMT" on page 4-58.

Syntax

```
TSQ
```

Example Statements

```
OUTPUT @E5270;"TSQ"
ENTER @E5270 USING "#,5X,13D,X";Time
PRINT "Time=";Time;"s"
```

TSR

The TSR command clears the timer count.

This command is effective for all measurement modes, regardless of the TSC setting.

This command is effective for ASCII data output format. Refer to "FMT" on page 4-58.

Syntax

```
TSR
```

Remarks

To read the time data with the best resolution (100 μs), the timer must be cleared every 100 sec or less for the FMT1, 2, or 5 data output format, or every 1000 sec or less for the FMT 11, 12, 15, 21, 22, or 25 data output format.

Example Statements

```
OUTPUT @E5270;"TSR"
```

*TST?

The *TST? query command performs the self-test and self-calibration, and returns the results in ASCII format. Modules that fail the self-test are disabled, and can only be enabled by the RCV command.

After the *TST? command, read the results soon.

Execution Conditions

No module may be in the HIGH VOLTAGE state (forcing more than ±42 V, or voltage compliance set to more than ±42 V).

To perform the self-test correctly, the measurement terminals should be opened.

Syntax

`*TST? [slotnum]`

Parameters

***slotnum* :** Specifies the module to test. Integer expression. 0 to 9.

0: Mainframe and all modules. Default setting.

1 to 8: Module installed in the slot specified by *slotnum*.

9: Mainframe.

For HPSMU that uses two slots, set the greater slot number. For example, if it is installed in slot 3 and 4, *slotnum* must be 4.

If *slotnum* specifies the slot that installs no module, this command causes an error.

Query Response

`results<CR/LF^EOI>`

results returns the sum of the following values corresponding to the failures.

results	Description	*results*	Description
0	Passed. No failure detected.	16	Slot 5 module failed.
1	Slot 1 module failed.	32	Slot 6 module failed.
2	Slot 2 module failed.	64	Slot 7 module failed.
4	Slot 3 module failed.	128	Slot 8 module failed.
8	Slot 4 module failed.	256	Mainframe failed.

Example Statements

```
OUTPUT @E5270;"*TST?"
ENTER @E5270;A
```

TTI

The TTI command performs the high speed spot measurement, and returns the measurement data and the time data for the time from when the timer is cleared until the measurement is started. The command performs a current measurement regardless of the SMU operation mode, trigger mode (TM command), and measurement mode (MM command).

This command is effective for ASCII data output format. Refer to "FMT" on page 4-58.

Execution Conditions

CN command has been executed for the specified channel.

Syntax

`TTI` *`chnum`*`[,`*`range`*`]`

Parameters

***chnum* :** Measurement channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***range* :** Ranging type for current measurement. Integer expression. 0 for auto ranging, 11 to 20 for limited auto ranging that uses the specified range and above, or –11 to –20 for fixed range. 20 and -20 are for 200 mA (MPSMU) or 1 A (HPSMU). See Table 4-3 on page 4-11.

The E5270 uses the minimum range that covers the measured value.

If you do not specify the *range* parameter for voltage output channels, the channel uses the minimum range that covers the compliance value.

The *range* parameter is meaningless for current output channels. The measurement ranging type is always same as the output ranging type.

Remarks

To read the time data with the best resolution (100 μs), the timer must be cleared every 100 sec or less for the FMT1, 2, or 5 data output format, or
every 1000 sec or less for the FMT 11, 12, 15, 21, 22, or 25 data output format.

Example Statements

```
OUTPUT @E5270;"TTI 1"
ENTER @E5270 USING "#,5X,13D,X";Time
ENTER @E5270 USING "#,5X,13D,X";Idata
PRINT "Data=";Idata*1000;"mA, at";Time;"s"
```

TTV

The TTV command performs the high speed spot measurement, and returns the measurement data and the time data for the time from when the timer is cleared until the measurement is started. The command performs a voltage measurement regardless of the SMU operation mode, trigger mode (TM command), and measurement mode (MM command).

This command is effective for ASCII data output format. Refer to “FMT” on page 4-58.

Execution Conditions

CN command has been executed for the specified channel.

Syntax

`TTV chnum[,range]`

Parameters

chnum **:** Measurement channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

range **:** Ranging type for voltage measurement. Integer expression. 0 for auto ranging, 11 to 15 for limited auto ranging that uses the specified range and above, or –11 to –15 for fixed range. 15 and -15 are only for HPSMU. See Table 4-2 on page 4-10.

The E5270 uses the minimum range that covers the measured value.

If you do not specify the *range* parameter for current output channels, the channel uses the minimum range that covers the compliance value.

The *range* parameter is meaningless for voltage output channels. The measurement ranging type is always same as the output ranging type.

Remarks

To read the time data with the best resolution (100 μs), the timer must be cleared every 100 sec or less for the FMT1, 2, or 5 data output format, or every 1000 sec or less for the FMT 11, 12, 15, 21, 22, or 25 data output format.

Example Statements

```
OUTPUT @E5270;"TTV 1"
ENTER @E5270 USING "#,5X,13D,X";Time
ENTER @E5270 USING "#,5X,13D,X";Vdata
PRINT "Data=";Vdata*1000;"mV, at";Time;"s"
```

TV

The TV command performs the high speed spot measurement, and returns the measurement data. The command performs a voltage measurement regardless of the SMU operation mode, trigger mode (TM command), and measurement mode (MM command).

Execution Conditions

CN command has been executed for the specified channel.

Syntax

TV *chnum*[,*range*]

Parameters

***chnum* :** Measurement channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***range* :** Ranging type for voltage measurement. Integer expression. 0 for auto ranging, 11 to 15 for limited auto ranging that uses the specified range and above, or –11 to –15 for fixed range. 15 and -15 are only for HPSMU. See Table 4-2 on page 4-10.

The E5270 uses the minimum range that covers the measured value.

If you do not specify the *range* parameter for current output channels, the channel uses the minimum range that covers the compliance value.

The *range* parameter is meaningless for voltage output channels. The measurement ranging type is always same as the output ranging type.

Example Statements

```
OUTPUT @E5270;"TV 1"
ENTER @E5270 USING "#,3X,12D,X";Vdata
```

UNT?

This query command returns the model and revision numbers of all modules in the E5270, and stores the results in the E5270 output data buffer (query buffer).

Syntax

`UNT? [mode]`

Parameters

***mode* :** Response type. Integer expression.

0: Returns information for all modules.

1: Returns information for all modules with control unit.

If you do not specify this parameter, the *mode* is set to 0.

Query Response

```
part number of control unit,revision number of control unit;
model number at slot 1,revision number at slot 1;
         ......                ......
model number at slot 8,revision number at slot 8<CR/LF^EOI>
```

For *mode*=0, ignore the first line shown above. The E5270 does not return the information of the control unit.

Example Statements

```
DIM A$[50]
OUTPUT @E5270;"UNT?"
ENTER @E5270;A$
```

VAR

This command defines the Agilent E5270 internal variable, and sets the value. The variable name is automatically assigned by using the parameters you specify.

Syntax

`VAR type,n,value`

Parameters

type **:** Variable type. Integer expression. 0 or 1.

0: Integer variable. Variable name will be %I*n*.

1: Real variable. Variable name will be %R*n*.

n **:** Number *n* added to the variable name. Integer expression. 0 to 99.

value **:** Value entered in the variable. Numeric value. The value must be 6 digits or less. Available values are as follows:

For integer variables: -999999 to 999999

For real variables: -9999.9 to 9999.9

Example Statements

```
OUTPUT @E5270;"ST1;CN1;DV1,0,%R99,1E-4;TI1,0"
OUTPUT @E5270;"END"
OUTPUT @E5270;"VAR 1,99,2.5"
```

This example sets 2.5 to the real variable %R99.

VAR?

Returns the value of the variable set by the VAR command.

Syntax

`VAR? type,n`

Parameters

type **:** Variable type. Integer expression. 0 or 1.

0: Integer variable. For the variable %I*n*.

1: Real variable. For the variable %R*n*.

n **:** Number *n* added to the variable name. Integer expression. 0 to 99.

Query Response

`value<CR/LF^EOI>`

Example Statements

```
OUTPUT @E5270;"VAR? 1,99"
ENTER @E5270;A$
```

This example reads the %R99 real variable value.

WAT

This command sets the source wait time and the measurement wait time as shown in Figure 4-4. The wait time is given by the following formula:

wait time = *N* × *initial wait time* + *offset*

where *initial wait time* is the time the Agilent E5270 initially sets and you cannot change. The *initial source wait time* is not same as the *initial measurement wait time*. The wait time settings are effective for all modules.

Syntax

`WAT type,N[,offset]`

Parameters

type Type of the wait time. Integer expression. 1 or 2.

1: Source wait time (before changing the output value).

2: Measurement wait time (before starting the measurement).

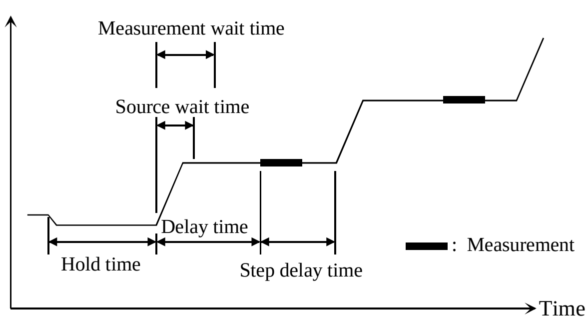
N Coefficient for *initial wait time*. Numeric expression.
0 to 10, resolution 0.1. Initial value is 1.

offset Offset for the wait time. Numeric expression.
0 to 1 sec, resolution 0.0001. Default value is 0.

Example Statements

```
OUTPUT @E5270;"WAT 1,.7"
OUTPUT @E5270;"WAT 2,0,.01"
```

Figure 4-4 **Source/Measurement Wait Time**



NOTE The wait time can be ignored if it is shorter than the delay time.

NOTE

It is not easy to determine the best wait time. If you specify it too short, the measurement may start before device characteristics stable. If too long, time will be wasted.

The initial wait time may be too short for measurements of high capacitance or slow response devices. Then set the wait time longer.

For measurements of low capacitance or fast response devices, if measurement speed has top priority or is more important than reliability and accuracy, set the wait time shorter.

WI

The WI command specifies the staircase sweep current source and its parameters. This command also clears the WV, WSV, WSI, and WNX command settings.

This command setting is cleared by the WV command.

Syntax

- For Staircase Sweep Measurement:

  `WI chnum,mode,range,start,stop,step[,Vcomp[,Pcomp]]`

- For Staircase Sweep with Pulsed Bias Measurement:

  `WI chnum,mode,range,start,stop,step[,Vcomp]`

Parameters

***chnum* :** Sweep source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

***mode* :** Sweep mode. Integer expression. Only linear sweep (*mode*=1 or 3) is available for the staircase sweep with pulsed bias.

1: Linear sweep (single stair, start to stop.)

2: Log sweep (single stair, start to stop.)

3: Linear sweep (double stair, start to stop to start.)

4: Log sweep (double stair, start to stop to start.)

***range* :** Ranging type for staircase sweep current output. Integer expression. 0 for auto ranging, or 11 to 20 for limited auto ranging. 20 is for 200 mA (MPSMU) or 1 A (HPSMU).

For the linear sweep, the E5270 uses the minimum range that covers both *start* and *stop* values to force the staircase sweep current.

For the log sweep, the E5270 uses the minimum range that covers the output value, and changes the output range dynamically.

The minimum range of each ranging type is as follows:

0, 11	**12**	**13**	**14**	**15**
1 nA	10 nA	100 nA	1 μA	10 μA
16	**17**	**18**	**19**	**20**
100 μA	1 mA	10 mA	100 mA	0.2 or 1 A

start, stop **:** Start or stop current (in A). Numeric expression. See Table 4-7.

0 to ±200E–3 (for MPSMU)

0 to ±1 (for HPSMU)

start and *stop* must have the same polarity for *log* sweep.

step **:** Number of steps for staircase sweep. Numeric expression. 1 to 1001.

The E5270 can store approximately 16000 measurement data in ASCII format with header without source data, or approximately 64000 measurement data in binary format.

Vcomp **:** Voltage compliance (in V). Numeric expression. See Table 4-7.

If you do not set *Vcomp*, the previous value is used.

Compliance polarity is automatically set to the same polarity as the output value, regardless of the specified *Vcomp*. If the output value is 0, the polarity is set to positive.

If you set *Pcomp*, the maximum *Vcomp* value for the module is allowed, regardless of the output range setting.

For the log sweep and without *Pcomp*, set the value available for the minimum range that covers *start* and *stop* values.

Pcomp **:** Power compliance (in W). Numeric expression.

1E–3 to 4, 1E-3 resolution (for MPSMU)

1E–3 to 20, 1E-3 resolution (for HPSMU)

If the *Pcomp* value is not entered, the power compliance is not set.

Example Statements

```
OUTPUT @E5270;"WI 1,1,11,0,0.1,100,10,1"
OUTPUT @E5270;"WI 2,2,15,1E–6,0.1,100"
```

WM

The WM command enables or disables the automatic abort function for the staircase sweep sources and the pulsed sweep source. The automatic abort function stops the sweep when one of the following conditions occurs:

- Compliance on the measurement channel
- Compliance on the non-measurement channel
- Overflow on the AD converter
- Oscillation on any channel

This command also sets the post sweep condition for the sweep sources. After the sweep measurement is normally completed, the staircase sweep sources force the value specified by the *post* parameter, and the pulsed sweep source forces the pulse base value.

If the sweep is stopped by the automatic abort function, the staircase sweep sources force the start value, and the pulsed sweep source forces the pulse base value after sweep.

Syntax

`WM` *`abort`*`[,`*`post`*`]`

Parameters

***abort* :** Automatic sweep abort function. Integer expression.

1: Disables the function. Initial setting.

2: Enables the function.

***post* :** Post sweep condition. Integer expression.

1: Staircase sweep sources force the start value. Default setting.

2: Staircase sweep sources force the stop value.

If this parameter is not specified, the staircase sweep sources force the start value.

Output Data

The E5270 returns the data measured before the an abort condition is detected. Dummy data 199.999E+99 will be returned for the data after abort.

Example Statements

```
OUTPUT @E5270;"WM 2"
OUTPUT @E5270;"WM 2,2"
```

WNU?

The WNU? query command returns the number of sweep steps specified by the sweep command (WI, WV, PWI or PWV), and stores the results in the output data buffer (query buffer).

Execution Conditions

If you want to know the number of steps for a pulsed sweep, you must execute an “MM 4” command before using this command, otherwise the number of steps for the staircase sweep is reported.

Syntax

`WNU?`

Query Response

number of sweep steps<CR/LF^EOI>

Example Statement

```
OUTPUT @E5270;"WNU?"
ENTER @E5270;A
```

WNX

The WNX command specifies the staircase sweep source (synchronous sweep source) that will be synchronized with the staircase sweep source (primary sweep source) set by the WI or WV command.

You can use the maximum of eight sweep sources. There is no restrictions for the output mode (voltage or current) of the sweep sources.

Execution Conditions

Available only for the multi channel sweep measurement (MM 16).

This command must be entered after the WI or WV command that clears the WNX command setting.

Syntax

`WNX N,chnum,mode,range,start,stop[,comp[,Pcomp]]`

Parameters

N **:** Sweep source number. Integer expression. 2 to 8. Sweep sources start output simultaneously or in number order. See Remarks below.

chnum **:** Sweep source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

mode **:** Sweep source type. Integer expression. 1 or 2.

1: Voltage sweep source.

2: Current sweep source.

Sweep mode, linear or log, is set by the WI or WV command.

range **:** Ranging type for synchronous sweep output. Integer expression.

- For voltage source (*mode*=1):

  0 for auto ranging, or 11 to 15 for limited auto ranging. 15 is only for HPSMU.

  The E5270 usually uses the minimum range that covers both *start* and *stop* values to force the staircase sweep voltage. However, if you set *Pcomp* and if the following formulas are true, the E5270 changes the output range dynamically (20 V range or above). Range changing may cause 0 V output in a moment.

  - *comp* > maximum current for the output range
  - *Pcomp*/output value > maximum current for the output range

The minimum range of each ranging type is as follows:

0, 11	12	13	14	15
2 V	20 V	40 V	100 V	200 V

- For current source (*mode*=2):

  0 for auto ranging, or 11 to 20 for limited auto ranging. 20 is for 200 mA (MPSMU) or 1 A (HPSMU).

  For the linear sweep, the E5270 uses the minimum range that covers both *start* and *stop* values to force the staircase sweep current.

  For the log sweep, the E5270 changes the output range dynamically.

  The minimum range of each ranging type is as follows:

0, 11	12	13	14	15
1 nA	10 nA	100 nA	1 μA	10 μA
16	**17**	**18**	**19**	**20**
100 μA	1 mA	10 mA	100 mA	0.2 or 1 A

start, stop **:** Start or stop value (in V or A). Numeric expression.

- For voltage source (*mode*=1):

  0 to ±100 (for MPSMU)

  0 to ±200 (for HPSMU)

  See Table 4-6 on page 4-13.

- For current source (*mode*=2):

  0 to ±200E–3 (for MPSMU)

  0 to ±1 (for HPSMU)

  See Table 4-7 on page 4-14.

start and *stop* must have the same polarity for *log* sweep.

Sweep mode, linear or log, and the number of sweep steps are set by the WI or WV command.

comp **:** Compliance (in A or V). Numeric expression.

If you do not set *comp*, the previous value is used.

If you set *Pcomp*, the maximum *comp* value for the module is allowed, regardless of the output range setting.

Compliance polarity is automatically set to the same polarity as the output value, regardless of the specified *comp*. If the output value is 0, the polarity is set to positive.

- For voltage source (*mode*=1):

  See *Icomp* in Table 4-6 on page 4-13.

- For current source (*mode*=2):

  See *Vcomp* in Table 4-7 on page 4-14.

  For the log sweep and without *Pcomp*, set the value available for the minimum range that covers *start* and *stop* values.

Pcomp **:** Power compliance (in W). Numeric expression.

1E–3 to 4, 1E-3 resolution (for MPSMU)

1E–3 to 20, 1E-3 resolution (for HPSMU)

If the *Pcomp* value is not entered, the power compliance is not set.

Remarks

To set multiple sweep sources, enter the WI or WV command at first, and enter the WNX command once or more. Then the *N* value and the *chnum* value must be unique for each WNX command. If you set the value used to the previous command, the previous command setting is cleared, and the last command setting is effective.

Sweep sources simultaneously start output by a trigger such as the XE command. However, if a sweep source sets power compliance or forces logarithmic sweep current, the sweep sources start output in the order specified by the *N* value. Then the first output is forced by the channel set by the WI or WV command.

If you use multiple measurement channels, the channels that use the high-speed A/D converter with the fixed ranging mode start measurement simultaneously, then other channels start measurement in the order defined in the MM command.

Example Statements

```
OUTPUT @E5270;"WNX 2,3,1,12,0,3,1E-3,2E-3"
OUTPUT @E5270;"WNX 3,4,2,0,1E-3,1E-2,3"
```

WS

The WS command causes the E5270 to enter a wait state until the E5270 receives an external trigger from the Ext Trig In terminal. To set the trigger logic (initial value: negative), send the TGP command for the Ext Trig In terminal.

To end a wait state before the trigger, execute the AB or *RST command.

Syntax

`WS [mode]`

Parameters

***mode* :** Waiting mode. Integer expression. 1 or 2.

If this parameter is not specified, *mode* is set to 1.

mode	**Description**
1	Continues the operation if an external trigger was already received. Otherwise, the E5270 immediately goes into a wait state for an external trigger.
2	In any condition, the E5270 immediately goes into a wait state for an external trigger.

Remarks

The E5270 checks its trigger flag to confirm the present trigger status, received or none. To clear the trigger flag:

- Enter the *RST or device clear command (HP BASIC CLEAR statement).
- Enter the TM3 command.
- Enter the TM1, TM2, or TM4 command to change the mode from TM3.
- Enter the OS command.
- Trigger the E5270 to start measurement via the Ext Trig In terminal.
- Trigger the E5270 to recover from wait state set by the WS command via the Ext Trig In terminal.

Example Statements

```
OUTPUT @E5270;"WS 2"
```

WSI

The WSI command specifies the staircase sweep current source (synchronous sweep source) that will be synchronized with the staircase sweep current source (primary sweep source) set by the WI command, or the pulsed sweep current source (primary sweep source) set by the PWI command.

Execution Conditions

Available for the staircase sweep (MM 2), pulsed sweep (MM 4), or staircase sweep with pulsed bias (MM5) measurement.

This command must be entered after the WI or PWI command that clears the WSI command setting. The WV and PWV command also clears the WSI setting.

Syntax

`WSI` *`chnum`*`,`*`range`*`,`*`start`*`,`*`stop`*`[,`*`Vcomp`*`[,`*`Pcomp`*`]]`

Parameters

chnum **:** Synchronous sweep source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

range **:** Ranging type for synchronous sweep current output. Integer expression. 0 for auto ranging, or 11 to 20 for limited auto ranging. 20 is for 200 mA (MPSMU) or 1 A (HPSMU).

For the linear sweep, the E5270 uses the minimum range that covers both *start* and *stop* values to force the staircase sweep current.

For the log sweep, the E5270 uses the minimum range that covers the output value, and changes the output range dynamically.

Sweep mode, linear or log, is set by the WI or PWI command.

The minimum range of each ranging type is as follows:

0, 11	**12**	**13**	**14**	**15**
1 nA	10 nA	100 nA	1 μA	10 μA
16	**17**	**18**	**19**	**20**
100 μA	1 mA	10 mA	100 mA	0.2 or 1 A

***start, stop* :** Start or stop current (in A). Numeric expression. See Table 4-7 on page 4-14.

0 to ±200E–3 (for MPSMU)

0 to ±1 (for HPSMU)

start and *stop* must have the same polarity for *log* sweep.

Sweep mode, linear or log, and the number of sweep steps are set by the WI or PWI command.

***Vcomp* :** Voltage compliance (in V). Numeric expression. See Table 4-7 on page 4-14.

If you do not set *Vcomp*, the previous value is used.

Compliance polarity is automatically set to the same polarity as the output value, regardless of the specified *Vcomp*. If the output value is 0, the compliance polarity is positive.

If you set *Pcomp*, the maximum *Vcomp* value for the module is allowed, regardless of the output range setting.

For the log sweep and without *Pcomp*, set the value available for the minimum range that covers *start* and *stop* values.

***Pcomp* :** Power compliance (in W). Numeric expression.

1E–3 to 4, 1E-3 resolution (for MPSMU)

1E–3 to 20, 1E-3 resolution (for HPSMU)

If the *Pcomp* value is not entered, the power compliance is not set.

Example Statements

```
OUTPUT @E5270;"WSI 1,16,0,4E-5"
OUTPUT @E5270;"WSI 2,0,1E-3,1E-2,5,5E-2"
```

WSV

The WSV command specifies the staircase sweep voltage source (synchronous sweep source) that will be synchronized with the staircase sweep voltage source (primary sweep source) set by the WV command, or the pulsed sweep voltage source (primary sweep source) set by the PWV command.

Execution Conditions

Available for the staircase sweep (MM 2), pulsed sweep (MM 4), or staircase sweep with pulsed bias (MM5) measurement.

This command must be entered after the WV or PWV command that clears the WSV command setting. The WI and PWI command also clears the WSV setting.

Syntax

`WSV chnum,range,start,stop[,Icomp[,Pcomp]]`

Parameters

chnum **:** Synchronous sweep source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

range **:** Ranging type for synchronous sweep voltage output. Integer expression. 0 for auto ranging, or 11 to 15 for limited auto ranging. 15 is only for HPSMU.

The E5270 usually uses the minimum range that covers both *start* and *stop* values to force the staircase sweep voltage. However, if you set *Pcomp* and if the following formulas are true, the E5270 changes the output range dynamically (20 V range or above). Range changing may cause 0 V output in a moment.

- *Icomp* > maximum current for the output range
- *Pcomp*/output voltage > maximum current for the output range

The minimum range of each ranging type is as follows:

0, 11	**12**	**13**	**14**	**15**
2 V	20 V	40 V	100 V	200 V

start, stop **:** Start or stop voltage (in V). Numeric expression. See Table 4-6 on page 4-13.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

start and *stop* must have the same polarity for *log* sweep.

Sweep mode, linear or log, and the number of sweep steps are set by the WV or PWV command.

Icomp **:** Current compliance (in A). Numeric expression. See Table 4-6 on page 4-13.

If you do not set *Icomp*, the previous value is used.

Compliance polarity is automatically set to the same polarity as the output value, regardless of the specified *Icomp*. If the output value is 0, the compliance polarity is positive.

If you set *Pcomp*, the maximum *Icomp* value for the module is allowed, regardless of the output range setting.

Pcomp **:** Power compliance (in W). Numeric expression.

1E–3 to 4, 1E-3 resolution (for MPSMU)

1E–3 to 20, 1E-3 resolution (for HPSMU)

If the *Pcomp* value is not entered, the power compliance is not set.

Example Statements

```
OUTPUT @E5270;"WSV 1,0,1,100,0.01,1"
OUTPUT @E5270;"WSV 2,12,0,10"
```

WSX

The WSX command causes the E5270 to enter a wait state until the E5270 receives an external trigger from a trigger input terminal specified by the *port* parameter. To set the trigger logic (initial value: negative), send the TGP command for the specified terminal. To end a wait state before the trigger, execute the AB or *RST command.

Syntax

`WSX port[,mode]`

Parameters

***port* :** External trigger input port number. Integer expression. -1, or 1 to 16.

-1: Ext Trig In terminal.

1 to 16: Port 1 to 16 of the digital I/O terminal.

To use a digital I/O port, send the TGP command. The *port* value must be same as the *port* value set to the TGP command.

***mode* :** Waiting mode. Integer expression. 1 or 2.
If this parameter is not specified, *mode* is set to 1.

mode	**Description**
1	Continues the operation if an external trigger was already received. Otherwise, the E5270 immediately goes into a wait state for an external trigger.
2	In any condition, the E5270 immediately goes into a wait state for an external trigger.

Remarks

The E5270 checks its trigger flag to confirm the present trigger status, received or none. To clear the trigger flag:

- Enter the *RST or device clear command (HP BASIC CLEAR statement).
- Enter the TM3 command.
- Enter the TM1, TM2, or TM4 command to change the mode from TM3.
- Enter the OS command.
- Trigger the E5270 to start measurement via the trigger input terminal.
- Trigger the E5270 to recover from wait state set by the WS command via the trigger input terminal.

Example Statements

```
OUTPUT @E5270;"WSX 2"
```

WT

The WT command sets the hold time, delay time, and step delay time for the staircase sweep or multi channel sweep measurement. This command is also used to set the step source trigger delay time effective for the step output setup completion trigger and the step measurement trigger delay time effective for the start step measurement trigger. For the trigger function, refer to “Trigger Function” on page 2-30.

If you do not enter this command, all parameters are set to 0.

This command setting is ignored by the following measurement mode.

- Pulsed spot measurements
- Pulsed sweep measurements
- Staircase sweep with pulsed bias measurements

Syntax

`WT hold,delay[,Sdelay[,Tdelay[,Mdelay]]]`

Parameters

hold **:** Hold time (in seconds) that is the wait time after starting the sweep measurement and before starting the delay time for the first step value. Numeric expression.

0 to 655.35, with 0.01 sec resolution.

delay **:** Delay time (in seconds) that is the wait time after starting to force a step output value and before starting a step measurement. Numeric expression.

0 to 65.535, with 0.0001 sec resolution.

Sdelay **:** Step delay time (in seconds) that is the wait time after starting a step measurement and before starting to force the next step output value. Numeric expression.

0 to 1, with 0.0001 sec resolution.

If this parameter is not specified, *Sdelay* is set to 0.

If the specified *Sdelay* is shorter than the measurement time, the E5270 waits until the measurement completes, then forces the next step output value.

Tdelay **:** Step source trigger delay time (in seconds) that is the wait time after completing a step output setup and before sending a step output setup completion trigger. Numeric expression.

0 to *delay*, with 0.0001 sec resolution.

If this parameter is not specified, *Tdelay* is set to 0.

Mdelay **:** Step measurement trigger delay time (in seconds) that is the wait time after receiving a start step measurement trigger and before starting a step measurement. Numeric expression.

0 to 65.535, with 0.0001 sec resolution.

If this parameter is not specified, *Mdelay* is set to 0.

Example Statements

```
OUTPUT @E5270;"WT 5,0.1,0.1,0.1,0.1"
OUTPUT @E5270;"WT 5,0.2"
```

WV

The WV command specifies the staircase sweep voltage source and its parameters. This command also clears the WI, WSI, WSV, and WNX command settings.

This command setting is cleared by the WI command.

Syntax

- For Staircase Sweep Measurement:

  `WV chnum,mode,range,start,stop,step[,Icomp[,Pcomp]]`

- For Staircase Sweep with Pulsed Bias Measurement:

  `WV chnum,mode,range,start,stop,step[,Icomp]`

Parameters

chnum **:** Sweep source channel number. The value must be slot number where the module has been installed. Integer expression. 1 to 8 (1 and 5 are not available for HPSMU). See Table 4-1 on page 4-9.

mode **:** Sweep mode. Integer expression. Only linear sweep (*mode*=1 or 3) is available for the staircase sweep with pulsed bias.

1: Linear sweep (single stair, start to stop.)

2: Log sweep (single stair, start to stop.)

3: Linear sweep (double stair, start to stop to start.)

4: Log sweep (double stair, start to stop to start.)

range **:** Ranging type for staircase sweep voltage output. Integer expression. 0 for auto ranging, or 11 to 15 for limited auto ranging. 15 is only for HPSMU. The E5270 usually uses the minimum range that covers both *start* and *stop* values to force the staircase sweep voltage. However, if you set *Pcomp* and if the following formulas are true, the E5270 uses the minimum range that covers the output value, and changes the output range dynamically (20 V range or above). Range changing may cause 0 V output in a moment.

- *Icomp* > maximum current for the output range
- *Pcomp*/output voltage > maximum current for the output range

The minimum range of each ranging type is as follows:

0, 11	**12**	**13**	**14**	**15**
2 V	20 V	40 V	100 V	200 V

***start, stop* :** Start or stop voltage (in V). Numeric expression. See Table 4-6 on page 4-13.

0 to ±100 (for MPSMU)

0 to ±200 (for HPSMU)

start and *stop* must have the same polarity for *log* sweep.

***step* :** Number of steps for staircase sweep. Numeric expression. 1 to 1001.

The E5270 can store approximately 16000 measurement data in ASCII format with header without source data, or approximately 64000 measurement data in binary format.

***Icomp* :** Current compliance (in A). Numeric expression. See Table 4-6 on page 4-13.

If you do not set *Icomp*, the previous value is used.

Compliance polarity is automatically set to the same polarity as the output value, regardless of the specified *Icomp*. If the output value is 0, the compliance polarity is positive.

If you set *Pcomp*, the maximum *Icomp* value for the module is allowed, regardless of the output range setting.

***Pcomp* :** Power compliance (in W). Numeric expression.

1E–3 to 4, 1E-3 resolution (for MPSMU)

1E–3 to 20, 1E-3 resolution (for HPSMU)

If the *Pcomp* value is not entered, the power compliance is not set.

Example Statements

```
OUTPUT @E5270;"WV 1,2,12,1E-6,10,100,0.1,1"
OUTPUT @E5270;"WV 2,1,0,0,20,101"
```

WZ?

This query command immediately confirms the all channel output, and returns the status 0 if it is within ±2 V or 1 if it is more than ±2 V.

Syntax

`WZ? [`*`timeout`*`]`

Parameters

timeout **:** Timeout. Numeric expression.

0 to 655.35 sec, with 0.01 sec resolution.

With *timeout* parameter, this command waits until the all channel output becomes within ±2 V or until the specified *timeout* elapses, and returns 0 or 1.

The `WZ? 0` command has the same effect as the `WZ?` command.

Query Response

`state``<CR/LF^EOI>`

0: All channel output is within ±2 V.

1: Any output channel applies more than ±2 V.

Example Statement

```
OUTPUT @E5270;"WZ? 5.0"
ENTER @E5270;A
```

XE

The XE command triggers the E5270 to start measurement, or causes the E5270 to recover from the wait state set by the PA command.

This command is not available for the high-speed spot measurement.

NOTE

After measurement, the measurement data will be entered to the output data buffer. For data output format, refer to “Data Output Format” on page 1-19.

Execution Conditions

The following execution conditions are for you who use the XE command to start measurement. There is no execution condition when you use the XE command to recover from the wait state.

- If any channel is set to the HIGH VOLTAGE state (forcing more than ±42 V, or voltage compliance set to more than ±42 V) after the trigger (XE), the interlock terminal must be shorted.
- The following commands must be entered before the XE command.

Measurement Mode	Commands
Spot	CN, MM, DV or DI
Staircase sweep	CN, MM, WV or WI
Pulsed spot	CN, MM, PV or PI, FL0
Pulsed sweep	CN, MM, PWV or PWI, FL0
Staircase sweep with pulsed bias	CN, MM, WV or WI, PV or PI, FL0
Quasi-pulsed spot	CN, MM, BDV
Liner search	CN, MM, LSV or LSI, LGV or LGI
Binary search	CN, MM, BSV or BSI, BGV or BGI
Multi channel sweep	CN, MM, WI or WV, WNX

The FL0 command must be executed for the channel that forces pulsed output.

Syntax

```
XE
```

Example Statement

```
OUTPUT @E5270;"XE"
```

5 Error Messages

This chapter explains the channel status code and the error code of the Agilent E5270.

- “Channel Status Code”
- “Error Codes”

If error occurs, find solutions in the following sections and solve problems. However, if problems still remain, perform self-test.

If the E5270 fails self-test, contact your nearest Agilent Technologies Service Center.

Channel Status Code

The channel status code indicates the following statuses of the measurement channel, and is displayed in the channel status area on the LCD. No status code is displayed if the Agilent E5270 is in the normal condition.

X	One or more channels are oscillating.
V	Measurement data exceeds the measurement range.
C	This channel reached its compliance setting.
T	Another channel reached its compliance setting.

The status priority is:

X > V > C > T

Error Codes

If errors occur, error codes are stored in the error buffer. To read the error code, execute the “ERR?” command. To read the error message, execute the “EMG?” command.

The output of the error codes is in the order that they occurred, and the first four error codes are stored in the buffer. If no errors occurred, ”0, 0, 0, 0” is returned.

Operation Error

100 Undefined GPIB command.

Send the correct command.

102 Incorrect numeric data syntax.

Correct the data syntax.

103 Incorrect terminator position.

Correct the command syntax. The number of parameters will be incorrect.

120 Incorrect parameter value.

Correct the parameter value.

121 Channel number must be 1 to 2, or 1 to 8.

Correct the channel number. The channel number must be 1 to 2 for the Agilent E5272A/E5273A, or 1 to 8 for the Agilent E5270A.

122 Number of channels must be corrected.

Check the MM, FL, CN, CL, IN, DZ, or RZ command, and correct the number of channels.

123 Compliance must be set correctly.

Incorrect compliance value was set. Set the compliance value correctly.

124 Incorrect range value for this channel.

Check the range value available for the channel, and correct the range value.

126 Pulse base and peak must be same polarity.

The polarity of the base and peak values must be the same in the PI command. Also the polarity of the base, start, and stop values must be the same in the PWI command.

130 Start and stop must be same polarity.

For a log sweep, the polarity of the start and stop values must be the same in the WV, WI, WSV, WSI, or WNX command. Also, 0 is not allowed for the start and stop values.

150 Command input buffer is full.

The Agilent E5270 can receive 256 characters maximum including the terminator at one time.

152 Cannot use failed module.

The channel number specifying the module failed the self-test or calibration. Specify another module that passed the self-test or calibration. For the service purpose, execute the RCV command to enable the module.

153 No module for the specified channel.

Module is not installed in the slot specified by the channel number.

160 Incorrect ST execution.

The internal memory programming can be started by the ST command and completed by the END command. Do not enter the ST command between the ST command and the END command.

161 Incorrect END execution.

The internal memory programming can be started by the ST command and completed by the END command. Do not send the END command before starting the programming.

162 Incorrect command for program memory.

Specified command cannot be stored in the program memory. For the incorrect commands, refer to Table 2-1 on page 2-26.

170 Incorrect usage of internal variable.

The internal variable must be %I*n* for integer data, or %R*n* for real data. where *n* is an integer, 0 to 99. Use %I*n* for the integer type command parameters; and use %R*n* for the real type command parameters. For the internal variables, refer to “VAR” on page 4-124.

171 Internal variable is not allowed.

The internal variables %I*n* and %R*n* are not available for the ACH, VAR, and VAR? commands. Do not use the internal variables for the commands.

200 Channel output switch must be ON.

To enter the specified command, set the channel output switch to ON.

201 Compliance must be set.

To change the source output mode (voltage or current), set the compliance value.

202 Interlock circuit must be closed.

To set the output voltage or the voltage compliance to more than ±42 V (high voltage state), close the interlock circuit. If the interlock circuit is opened in the high voltage state, outputs of all units will be set to 0 V.

203 Cannot enable channel.

The channel output switch cannot be set to ON in the high voltage state. Set the output voltage or the voltage compliance to ±42 V or less to set the switch to ON.

204 Cannot disable channel.

The channel output switch cannot be set to OFF in the high voltage state. Set the output voltage or the voltage compliance to ±42 V or less to set the switch to OFF. Or send the CL command with no parameter to set switches of all channels to OFF immediately.

205 DZ must be sent before RZ.

The RZ command is effective for the channels set to 0 V output by the DZ command.

206 Do not specify the channel recovered by RZ.

Specify the channels that have not been recovered yet by the RZ command after the DZ command. The RZ command cannot be executed if the specified channels include a channel that has already been recovered by the RZ command.

210 Ext trigger could not start measurement.

External trigger cannot start measurement because of busy condition.

211 TM1 must be sent to use GET.

Send the TM1 command to use the GPIB GET command (TRIGGER statement in HP BASIC).

212 Compliance must be set correctly.

Compliance was not set or an incorrect compliance value was set in the DV, DI, PV, PI, PWV, PWI, TDV, TDI, LSV, LSI, LSSV, LSSI, BSV, BSI, BSSV, or BSSI command. Set the compliance value correctly.

213 Cannot perform self-test or calibration.

Self-test and calibration cannot be performed in the high voltage state. Set the output voltage or the voltage compliance to ±42 V or less to perform the self-test or calibration.

214 Send MM before measurement trigger.

Before sending the measurement trigger, the MM command must be sent to set the measurement mode.

220 Send WV or WI to set primary sweep source.

Before triggering the staircase sweep measurement, triggering the staircase sweep with pulsed bias measurement, or sending the WSV, WSI, or WNX command to set the synchronous sweep source, send the WV or WI command to set the primary sweep source.

221 Send PWV or PWI to set pulse sweep source.

Before triggering the pulsed sweep measurement, or sending the WSV or WSI command to set the synchronous sweep source, send the PWV or PWI command to set the pulse sweep source.

222 Send PV or PI to set pulse source.

Before triggering the staircase sweep with pulsed bias measurement, send the PV or PI command to set the pulse source.

223 Compliance must be set correctly.

Compliance was not set or an incorrect compliance value was set in the WV, WI, WSV, WSI, WNX, or BDV command. Set the compliance value correctly.

224 Sweep and sync output modes must be the same.

The primary sweep channel and the synchronous sweep channel must be different, and they must be set to the same output mode (voltage or current).

225 Send WSV, WSI, or WNX to get sync sweep data.

If you enable data output of the synchronous sweep source, do not forget to set the synchronous sweep source by the WSV, WSI, or WNX command. For data output, refer to “FMT” on page 4-58.

226 Set linear sweep for MM4 or MM5.

Only the linear sweep is available for the PWV or PWI command for the pulsed sweep measurement (MM4) or the WV or WI command for the staircase sweep with pulsed bias measurement (MM5).

227 Sweep measurement was aborted.

Sweep measurement was aborted by the automatic sweep abort function or the power compliance.

230 Pulse source must be set.

To perform the pulsed spot measurement (MM3), send the PV or PI command to set the pulse source.

231 Compliance must be set correctly.

Compliance was not set or an incorrect compliance value was set in the PV, PI, PWV, or PWI command. Set the correct compliance value effective for the pulse output.

238 Too large pulse width (max. 2 s).

The maximum value of the pulse width is 2 s. And the available value depends on the pulse period value. Refer to “PT” on page 4-88.

239 Pulse width must be 0.5 ms or more.

Set the pulse width to 0.5 ms or more. Refer to “PT” on page 4-88.

253 Program memory is full.

Maximum of 2000 programs or 40000 commands can be stored in the program memory. Refer to “ST” on page 4-105.

254 Invalid input for a memory program.

The GPIB GET command (TRIGGER statement in HP BASIC) and an external trigger input are not allowed in a memory program (between the ST and END commands).

255 Maximum nesting level is eight.

Nesting (one program calling another) of a memory program must be eight levels or less.

260 Data output buffer is full.

Maximum 34034 measurement data items can be stored in the data output buffer.

270 Search source channel must be set.

Before triggering the search measurement or sending the LSSV, LSSI, BSSV, or BSSI command to set the synchronous search source, send the LSV, LSI, BSV, or BSI command to set the primary search source.

271 Search monitor channel must be set.

Before triggering the search measurement, send the LGV, LGI, BGV, or BGI command to set the search monitor channel.

273 Search and sync output modes must be the same.

The primary search source channel and the synchronous source channel must be different, and they must be set to the same output mode (voltage or current).

275 Search target must be compliance value or less.

The search target value must be less than or equal to the compliance value of the search monitor channel. Correct the search target value or the compliance value.

276 Start and stop must be different.

Set different values for the search start and stop values.

277 Step must be output resolution or more.

Set the search step value to the output resolution or more.

278 Search and sync channels must be different.

Set the search source and the synchronous source to different channels.

279 Search monitor mode must be compliance side.

Send the LGI/BGI command to set the voltage source search monitor channel, or send the LGV/BGV command to set the current source search monitor channel.

303 Excess voltage in MPSMU.

Voltage that exceeds maximum voltage at the present current range was detected by a MPSMU. All output switches were set to OFF.

305 Excess current in HPSMU.

Current that exceeds maximum current at the present voltage range was detected by a HPSMU. All output switches were set to OFF.

307 Unsupported module.

This module is not supported by this firmware version. Until you update the firmware, use the Agilent E5270 with this module removed.

310 Interlock open operation error. Initialized.

Initiallization was automatically performed because the E5270 failed to set its output to 0 V when the interlock circuit was opened in the high voltage condition. Any module may be defective. Perform self-test.

603 Sweep and pulse channels must be different.

Set the sweep source and the pulse source to different channels for the staircase sweep with pulsed bias measurement (MM5).

610 Quasi-pulse source channel must be set.

Before triggering the quasi-pulsed spot measurement, send the BDV command to set the quasi-pulse source.

620 TGP specified incorrect I/O port.

Specify trigger input for the Ext Trig In port, or trigger output for the Ext Trig Out port by the TGP command. Refer to “TGP” on page 4-110.

621 Specify trigger input port for PAX/WSX.

No trigger input port was specified for the PAX or WSX command. Specify the trigger input port, or set the port as the trigger input port. Refer to “TGP” on page 4-110 to set trigger port.

622 Specify trigger output port for OSX.

No trigger output port was specified for the OSX command. Specify the trigger output port, or set the port as the trigger output port. Refer to “TGP” on page 4-110 to set trigger port.

630 Incorrect polarity of search step value.

For the linear search measurement. The step value must be positive if start<stop, or negative if start>stop.

631 Number of search steps must be 1001 or less.

For the linear search measurement. The number of search steps between start and stop must be 1001 or less. This means the |step| value must be |stop-start|/1001 or more.

632 Search measurement was aborted.

Search measurement was aborted by the automatic abort function.

640 Search limits must be range/20000 or more.

For the binary search measurement. The limit value for the search target must be *range*/20000 or more. where *range* means the measurement range actually used for the measurement.

650 Data format must be ASCII to get time data.

The time stamp function is not available for the binary data output format. To use the time stamp function, set the data output format to ASCII.

655 Cannot connect/disconnect series resistor.

The series resistor status cannot be changed in the high voltage state. Set the output voltage or the voltage compliance to ±42 V or less to connect or disconnect the series resistor.

656 Series resistor must be OFF for 1 A range.

The series resistor cannot be set to ON for the measurement channels or the output channels that use 1 A range.

Self-test/Calibration Error

When the Agilent E5270 fails the self-test or self-calibration, the Agilent E5270 returns the following error code and error message.

In the error code, N indicates the slot number. If the module is installed in slot 1, and it fails the function test, the error code will be 1760.

700	CPU failed NVRAM read/write test.
701	CPU failed FPGA read/write test.
702	CPU failed H-RESOLN ADC end signal test.
703	CPU failed H-RESOLN ADC start signal test.
704	CPU failed emergency status signal test.
705	CPU failed SRQ status signal test.
706	CPU failed high voltage status signal test.
707	CPU failed low voltage status signal test.
708	CPU failed DAC settling status signal test.
709	CPU failed measure ready status signal test.
710	CPU failed set ready status signal test.
711	CPU failed measure end status signal test.
712	CPU failed measure trigger signal test.
713	CPU failed pulse trigger signal test.
714	CPU failed abort trigger signal test.
715	CPU failed DAC set trigger signal test.
716	CPU failed LCD read/write test.
720	H-RESOLN ADC is not installed.
721	H-RESOLN ADC failed ROM/RAM test.
722	H-RESOLN ADC failed B-COM offset DAC test.
723	H-RESOLN ADC failed sampling ADC test.
724	H-RESOLN ADC failed integrating ADC test.
725	H-RESOLN ADC failed bus function test.
740	GNDU failed calibration.

N760	SMU failed function test.
N761	SMU failed VF/VM function test.
N762	SMU failed IF/IM function test.
N763	SMU failed loop status test.
N764	SMU failed temperature sensor test.
N765	SMU failed CMR amplifier calibration.
N766	SMU failed CMR amplifier adjustment.
N767	SMU failed CMR 100 V range full output test.
N768	SMU failed VF/VM calibration.
N769	SMU failed VM offset calibration.
N770	SMU failed VM gain calibration.
N771	SMU failed VF offset calibration.
N772	SMU failed VF gain calibration.
N773	SMU failed VF gain calibration at 20 V range.
N774	SMU failed VF filter offset calibration.
N775	SMU failed H-SPEED ADC self-calibration.
N776	SMU failed H-SPEED ADC VM offset calibration.
N777	SMU failed H-SPEED ADC VM gain calibration.
N778	SMU failed IF/IM calibration.
N779	SMU failed calibration bus test.
N780	SMU failed IM offset calibration.
N781	SMU failed IM gain calibration.
N782	SMU failed IF offset calibration.
N783	SMU failed IF gain calibration.
N784	SMU failed IDAC filter offset calibration.
N785	SMU failed oscillation detector test.
N786	SMU failed I bias test.
N787	SMU failed common mode rejection test.

N789 SMU failed high voltage detector test.

N790 SMU failed zero voltage detector test.

N791 SMU failed V hold test.

N792 SMU failed V switch test.