DIGITAL LOCK-IN AMPLIFIER

LI 5645 / LI 5650

INSTRUCTION MANUAL
(REMOTE CONTROL)

NF Corporation
DIGITAL LOCK-IN AMPLIFIER

LI 5645 / LI 5650

INSTRUCTION MANUAL
(REMOTE CONTROL)
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Preface

This instruction manual explains procedures remotely controlling the LI5645 / LI5650.

- The LI 5645 / LI 5650 are provided with the following instruction manuals.
  - LI5645 / LI5650 Instruction Manual (Operations)
    Explains procedures for operating the LI5645 / LI5650 from the panel, maintaining it, and other basic information.
  - LI5645 / LI5650 Instruction Manual (Remote Control)
    This instruction manual explains procedures for using the LI5645 / LI5650 by remote control.

LI5645 / LI5650 Instruction Manual (Remote Control) is included on the provided CD-ROM.

A sample program for controlling the LI5645 / LI5650 is included on the provided CD-ROM. Also included are representative programming languages, and examples of combinations of the GPIB, USB, RS-232, and LAN interfaces. For details, see the instructions provided with the included CD-ROM.
This instruction manual has the following chapter organization.

1. Preparation Before Use
   Explains interface settings and precautions.

2. Switching between remote / local states
   Explains how to switch between remote operation and local operation.

3. Responses to interface messages
   Shows responses to principle IEEE-488.1 interface messages.

4. Command list and command tree
   Provides outlines of all commands.

5. Command explanation
   Explains details of individual commands.

6. Status system
   Explains the status system.

7. Trigger system
   Outlines the trigger system.

8. Data acquisition using the measurement data buffers
   Provides procedures for measurement using the measurement data buffer.

9. Error Messages
   Explains error messages related to remote control.

10. Embedded Web Site
    Explains the embedded web site.
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Preparation Before Use

The LI5645 / LI5650 can be used for remote control by USB, RS-232, GPIB, or LAN. By sending program messages and receiving response messages pertaining to measurement values and settings, the controller provides control identical to panel operation. The interface connectors are located on the back panel of the LI5645 / LI5650.

1.1 Remote control interface selection
The LI5645 / LI5650 remote control interface is used by selecting one of the USB, RS-232, GPIB, and LAN interfaces. Multiple interfaces cannot be used simultaneously.

- **[Utility screen]**
  First press the **UTIL** key to display the utility screen.

- **[INTERFACE]**
  
  ![Utility screen diagram]

  *Switches to the {interface configuration screen}.*

  In this instruction manual, square brackets ([ ]) are used to indicate soft keys during panel operation, or to show keyword that can be omitted when sending commands.

- **{Interface configuration screen}**

  ![Interface configuration screen diagram]

  **Main settings of selected interface**
  Remote: GPIB, Address 2
  
  - **[USB>]** Selects USB and switches to the {USB information screen}.
  - **[GPIB>]** Selects GPIB and switches to the {GPIB configuration screen}.
  - **[RS232>]** Selects RS-232 and switches to the {RS-232 configuration screen}.
  - **[LAN>]** Selects LAN and switches to the {LAN configuration screen}.
  - **[SCRN] / EXIT** Returns display to the {Other operation screen}. (Returns to the utility screen)
1.2 USB outline

1.2.1 Controller preparation
When using the USB interface, make sure that the controller (controlling computer) is equipped with a USB interface.

Install the USBTMC driver on the controller. Ordinarily, this driver supports the USB488 subclass, and makes practically the same control provided by GPIB with USB.

**USBTMC:** Universal Serial Bus Test and Measurement Class

This driver is included in all hardware and software products of companies that provide the VISA library. Users who do not have a VISA library license will need to obtain one separately.

**VISA:** Virtual Instrument Software Architecture

Examples of companies that provide the VISA library (no particular order, information current as of creation of this document)

- National Instruments Corporation
- Keysight Technologies, Inc.
- Tektronix, Inc.

Using the VISA library, operation can be unified with any of USB, RS-232, GPIB, LAN to the extent of the supports.
1.2.2 LI5645 / LI5650 preparation

■ {Interface configuration screen}
When USB is selected, the following information is displayed.

Serial number/vendor ID, product ID (For details See below)

[USB>] Switches to the {USB information screen}.

■ {USB information screen}

SN
Serial Number = 9123456 (example): 7-digit serial number unique to each device.

Vend
Vendor ID = 0x0D4A (hexadecimal notation): Number indicating NF corporation. In decimal notation, this is 3402.

Prod
Product ID = 0x0050 (hexadecimal notation): Product number of the LI5645. In decimal notation, this is 80.
Product ID = 0x004F (hexadecimal notation): Product number of the LI5650. In decimal notation, this is 79.

[Exec] USB is selected as the communication interface and display returns to the immediately preceding screen.

1.2.3 Identification of USB devices
Connect the LI5645 / LI5650 to a USB connector on the computer using an off-the-shelf USB cable. Proper operation may not result if connection is made via a USB hub.

When the LI5645 / LI5650 is connected by USB to a computer with a USBTMC-class driver installed, the LI5645 / LI5650 is recognized automatically. The LI5645 / LI5650 installed in a system are identified by the Vendor ID, Product ID, and Serial Number that are displayed in the {USB information
screen}. If the device is not recognized automatically, recognition can be achieved by entering these values directly.
1.3 RS-232 outline

1.3.1 Controller preparation
When using the RS-232 interface, make sure that the controller (controlling computer) is equipped with a serial communication (RS-232) connector.

Make the same settings for the following parameters on both the LI5645 / LI5650 and the controller.

- Communication speed 4800 to 230400 bps
- Data length 8 bits (*1)
- Stop bit length 1 during transmission, 1 during reception (*1)
- Parity None (*1)
- Flow control None / Software / Hardware
- Terminator LF / CR LF

*1: Fixed on the LI5645 / LI5650. Cannot be altered.

1.3.2 LI5645 / LI5650 preparation

■ {Interface configuration screen}
When RS-232 is selected, the following information is displayed.

![Interface configuration screen]

Current settings: Data rate/flow control, terminator

[RS232>] Switches to the {RS-232 configuration screen}.

■ {RS-232 configuration screen}

![RS-232 configuration screen]

Current settings: Data rate/selectable range

[BAUD RATE] Switches to the {Baud rate configuration screen}. 
1. Preparation Before Use

[ FLOW CONTROL ]
Switches to the {Flow control configuration screen}.

[TERMINATOR ]
Switches to the {Terminator configuration screen}.

[Exec]  
Saves settings and returns display to the {Interface configuration screen}
RS-232 is selected as the communication interface.

[ SCRN ] / EXIT  
Returns display to the {Interface configuration screen}.

■{Baud rate configuration screen}
Sets the baud rate (communication speed). The baud rate is the same for both transmission and reception.

Current settings / Selectable range
Selection from among the following is possible using the up/down keys or
the modify knob.
4800, 9600, 19200, 38400, 57600, 115200, 230400 bps

[BAUD RATE], [FLOW CONTROL], [TERMINATOR]
These switch display to the respective configuration screens.

At communication speeds greater than 19200 bps, a short and low-capacitance cable must be used.

■{Flow control configuration screen}
Configures flow control.

Current settings / Selectable range
Selection from among the following is possible using the up/down keys or
the modify knob.
NONE  
No flow control (the default setting)
SOFT  
Software flow control
Communication is managed using control codes (X-ON and X-OFF). Reliable communication can be achieved using a connection cable with just TxD, RxD, and GND lines. However, transfer of binary data is not possible. Further, effective communication speed may be reduced. In hexadecimal notation, X-ON is 11, and X-OFF is 13.

**HARD**

Communication is managed using hardware flow control (RTS and CTS).

**[ BAUD RATE], [ FLOW CONTROL], [ TERMINATOR]**

These switch display to the respective configuration screens.

When flow control is enabled, transmission is suspended when the receive buffer approaches capacity, then restarts when the receive buffer opens up.

- **(Terminator configuration screen)**

  A message terminator is required at the end of each set of commands or responses to signify termination.

  ![Terminator configuration screen](image)

  Current settings / Selectable range

  Selection from among the following is possible using the up/down keys or the modify knob.

  - **LF**
    
    Configures the terminator as a single LF (Line Feed) character.

  - **CRLF**
    
    Configures the terminator as the 2 characters CR (Carriage Return) and LF. In hexadecimal notation, CR is 0x0D and LF is 0x0A.

  **[ BAUD RATE], [ FLOW CONTROL], [ TERMINATOR]**

  These switch display to the respective configuration screens.

  - During LI5645 / LI5650 transmission,
    the selected terminator is added to the end of response messages.

  - During LI5645 / LI5650 reception,
    When the terminator that has been set for the LI5645 / LI5650 is received, the command is executed.

After completing configuration, save the settings with [Exec] to select RS-232 as the communication interface and return display to the {Interface configuration screen}.
1.3.3 Connection

For connection, use an off-the-shelf connection cable, which must be purchased separately. When making connection to a serial interface on a personal computer, use the following type of cable. 

Cable specifications: D-Sub, 9-pin, female-female, interlink cable using inch-standard screw. 

In order to avoid misoperation due to radiation and interference resulting from electromagnetic noise, be sure to use a shielded cable. Communication can be established if at least the three lines RxD, TxD, and GND are connected. The RTS and CTS lines are required in order to use hardware flow control. An interlink cable is required in order to use hardware flow control (Fig. 1-1(b)). Some cables have cross or reversed lines in which pins 7 and 8 are connected together (Fig. 1-1(c)). Communication is also possible with this type of cable, but hardware flow control is not possible.

![Interlink connection diagram](image)

(a) Rear panel RS-232 connector

<table>
<thead>
<tr>
<th>Signal</th>
<th>Pin no.</th>
</tr>
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<tbody>
<tr>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>RxD</td>
<td>2</td>
</tr>
<tr>
<td>TxD</td>
<td>3</td>
</tr>
<tr>
<td>DTR</td>
<td>4</td>
</tr>
<tr>
<td>GND</td>
<td>5</td>
</tr>
<tr>
<td>—</td>
<td>6</td>
</tr>
<tr>
<td>RTS</td>
<td>7</td>
</tr>
<tr>
<td>CTS</td>
<td>8</td>
</tr>
<tr>
<td>—</td>
<td>9</td>
</tr>
<tr>
<td>Frame</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Personal computer (PC/AT, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin no.</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
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<td>3</td>
</tr>
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<td>4</td>
</tr>
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<td>Frame</td>
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(b) Interlink connection

(c) Other cross connections

Fig. 1-1 RS-232 connection cable wiring diagram
1.3.4 Limitations and precautions

- RS-232 only allows the controller to be connected in a 1-to-1 configuration. It is not possible to connect multiple devices in parallel to a single port.

- Functions such as SRQ and Device Clear that are unique to GPIB cannot be used. The BREAK signal or Control-C (0x03 in hexadecimal notation) can be used as an alternate to the Device Clear function. However, Control-C cannot be used during binary transfer. The :SYSTem{:LOCal|:REMote|:RWLock} command can largely substitute for the remote local function. The :SYSTem:KLOCk can be used to lock operation from the panel.

- Clear the receive buffer before starting communication. If device power is turned on or off, or the RS-232 cable is connected or disconnected while the controller has the RS-232 communication path open, abnormal data may enter the controller's receive buffer. Therefore, before starting normal operation, the program on the controller should clear the controller's receive buffer (e.g., by initializing communication) upon starting or restarting communication.

In the same way, abnormal data can be left in the receive buffer of the LI5645 / LI5650. Clear the receive buffer using the BREAK signal or other equivalent of Device Clear.
1.4 GPIB outline
This interface is provided for use in environments that are well-suited to use of GPIB. It should not be used in environments that are exposed to high levels of electromagnetic noise.

1.4.1 Controller preparation
Install an off-the-shelf GPIB interface card in the controller (the controlling computer) and connect the LI5645 / LI5650 using a GPIB cable. See the manual included with the GPIB interface regarding GPIB driver software.

1.4.2 LI5645 / LI5650 preparation
With GPIB, devices included in the system are identified by device-specific addresses. Set different GPIB addresses for each device.

■ {Interface configuration screen}
When GPIB is selected, the following information is displayed.

Current setting: GPIB address

[GPIB>] Switches to the {GPIB configuration screen}.

■ {GPIB configuration screen}
Only the address can be set.

Current settings / Settable range

Select the GPIB address using the up/down keys or the modify knob.

[Exec] Saves the configuration, sets the communication interface to GPIB, and returns display to the {Interface configuration screen}. 
1. Preparation Before Use

Message terminator

A terminator is required at the end of each set of commands or responses to signify termination.
The response message terminator sent by the LI5645 / LI5650 is fixed to LF^EOI.
Any of the following can be used as program message terminators that are received by the LI5645 / LI5650.

- LF Line Feed code
- LF^EOI EOI (END message) accompanying LF
- (Last code)^EOI EOI (End message) appended to the last code

1.4.3 Precautions regarding GPIB use

- Before connecting or disconnecting the GPIB connector, turn off power to all devices connected to the bus.
- When using GPIB, turn on power to all devices connected to the bus.
- With GPIB, the maximum number of devices that can be connected to the same bus is 15, including the controller.

Further, length of the cable is subject to the following restrictions.

- Total cable length \( \leq (2 \times \text{number of devices or 20m, whichever is shorter}) \)
- Length of any single cable \( \leq 4 \text{ m} \)

- Set different GPIB addresses for each device. Output collisions arising when multiple devices with the same address are connected to the same bus can result in device damage.

1.4.4 Basic GPIB specifications

GPIB conforming standards

IEEE std 488.1-1987, IEEE std 488.2-1992

IEEE std 488.1-1987 interface functions

- SH1 Complete send flow source handshake function
- AH1 Complete receive accepter handshake function
- T6 Basic Talker, Serial Pole, and talker cancel function by listener-addressed provided
- No Talk-Only function
- L4 Basic Listener function, function to cancel the listener by talker-addressed provided
- No Listen-Only function
- SR1 Complete Service Request function
- RL1 Complete Remote-Local function
- PP0 No Parallel Poll function
- DC1 Complete Device Clear function
- DT1 Complete Device Trigger function
- C0 No Controller function
- E1 Open collector drive
1. Preparation Before Use

1.5 LAN outline

1.5.1 Controller preparation
When using the LAN interface, make sure that the controller (controlling computer) is equipped with a LAN interface. The LI5645 / LI5650 supports communication using TCP/IP protocol.

1.5.2 LI5645 / LI5650 preparation

■ {Interface configuration screen}
When LAN is selected, the following information is displayed.

```
UTIL > Interface
LAN  192.168.0.2
PORT 5025, MAC ADDR 00:00:00 00:00:00

Current main settings: IP address / port number / MAC Address

[LAN>] Switches to the {LAN configuration screen}.
```

■ {LAN configuration screen}

```
INTF > LAN Manual
STBY  192.168.0.2
PORT 5025, MAC ADDR 00:00:00 00:00:00

Current statuses: LAN status / IP address / IP configuration method (manual or auto)

STBY  Indicates any other interface has selected or waiting for LAN interface to start.
NFLT  Indicates the LAN interface is ready and possible to communicate.
FLT   Indicates the LAN interface is not possible to communicate.
The following are the reasons:
- Network cable is disconnected.
- Failure to obtain an IP address via DHCP server.
```
Detection of a duplicate IP address.

- [MANUAL>] Switches to the {Address Manual Setting screen}.
- [AUTO>] Switches to the {Address Auto Setting screen}.
- [RESET>] Switches to the {LAN Reset screen}.
- **SCRN** / EXIT Switches to the {LAN Reset screen}.

- **SCRN** / EXIT Switches to the {LAN Reset screen}.

■ {Address Manual Setting screen}

- Current setting: IP address

  - **IP ADDR** Switches to the {IP address configuration screen}.
  - **MASK** Switches to the {Subnet mask configuration screen}.
  - **GATEWAY** Switches to the {Default gateway configuration screen}.
  - **DNS** Switches to the {DNS configuration screen}.
  - **Exec** Saves the configuration, sets the communication interface to LAN, and returns display to the {LAN configuration screen}.
  - **SCRN** / EXIT Returns display to the {Interface configuration screen}. 
1. Preparation Before Use

- **{IP address configuration screen}**

  ![IP address configuration screen]

  **Current settings / settable range**
  
  Set individual octets (8 bits) as decimal numbers.
  
  Use the cursor keys or modifier knob.

  ![IP ADDR], [MASK], [GATEWAY], [DNS]

  These switches display to the respective configuration screens.

  Set the address (logical address) that identifies the device which under the Internet Protocol (IP).
  
  Addresses in the range 192.168.0.0 to 192.168.255.255 are private IP addresses available for free assignment in small-scale local networks (Class C).

- **{Subnet mask configuration screen}**

  ![Subnet mask configuration screen]

  **Current settings / settable range**
  
  Set individual octets (8 bits) as decimal numbers.

  ![IP ADDR], [MASK], [GATEWAY], [DNS]

  These switches display to the respective configuration screens.

  Set a mask that separates upper IP network addresses from lower IP host addresses.
1. Preparation Before Use

- **{Default gateway configuration screen}**

  Current settings / settable range
  Set individual octets (8 bits) as decimal numbers.

  - **[IP ADDR]**, **[MASK]**, **[GATEWAY]**, **[DNS]**
    These switches display to the respective configuration screens.

    Set the IP address of the gateway to be used implicitly when accessing an external network.

- **{DNS configuration screen}**

  Current settings / settable range
  Set individual octets (8 bits) as decimal numbers.

  - **[IP ADDR]**, **[MASK]**, **[GATEWAY]**, **[DNS]**
    These switches display to the respective configuration screens.

    Set the IP address of the DNS (Domain Name Server) to be used to resolve a host name to an IP address.

After completing configuration, save the settings with [Exec] to select LAN as the communication interface and return display to the {Interface configuration screen}. 
1. Preparation Before Use

■ (Address Auto Setting screen)  (Firmware version 1.50 or later)

[Exec ]  Saves the configuration, sets the communication interface to LAN, and returns display to the {LAN configuration screen}.

[SCRN] / EXIT  Returns display to the {Interface configuration screen}.

When the IP auto configuration is selected and executed, this device request to obtain an IP address to a DHCP server. If the device obtains a valid IP address from a DHCP server, it is possible to communicate.

However, if the device does not obtain a valid IP address, the device will assign a link-local address that is defined in the address block 169.254.0.0/16 by using APIPA (Automatic Private IP Addressing).

■ (LAN Reset screen)  (Firmware version 1.50 or later)

[Exec ]  Resets LAN settings and returns display to the {LAN configuration screen}. If the LAN setting reset is completed, the device start communication with the IP auto configuration.

[Cancel]  Cancels resetting LAN settings and returns display to the {LAN configuration screen}.

[SCRN] / EXIT  Returns display to the {LAN configuration screen}.
1.5.3 Connection
Use a straight cable when connecting the LI5645 / LI5650 to the network.
When connecting directly to a personal computer, use a cross cable.
However, if the device connected automatically discriminates between straight and cross connection, either type of cable may be used.

1.5.4 Limitations and precautions

- Functions such as SRQ and Device Clear that are unique to GPIB cannot be used.
  Control-C (03H in hexadecimal notation) can be used as an alternate to the Device Clear function.
  However, Control-C cannot be used during binary transfer.
  The :SYSTem[:LOCal|:REMote]:RWLock command can substitute for the Remote Local function.

1.5.5 Embedded web site
When the firmware version 1.50 or later and the LAN interface is enabled, you can access the built-in web site. Please refer to Chapter “10. Embedded Web Site” for details on the web site.
1.6 Precautions regarding communication

■ Input buffer
  - Commands received are placed in a buffer and interpreted and executed in the order received. The size of the input buffer is 100K bytes (1K=1024). Program messages exceeding this size are interpreted and executed in the order received.
  - If an disallowed command is discovered during interpretation, an error occurs upon execution and subsequent commands are not executed until the program message terminator is received.

■ Output buffer
  - The capacity of the output buffer is 100K bytes (1K=1024).
  - If the maximum capacity is exceeded, the output buffer is cleared and the Standard Event Status register's query error bit is set to 1. Interpretation and execution of subsequent commands may continue as normal, but all response messages generated are discarded until the program message terminator is reached.
  - A separate 4M bytes of memory is provided for use as measurement data buffer.

■ Error queue
  - The maximum number of error messages that can be queued is 16.
  - If this number is exceeded, the 16th message changes to "Queue overflow" to indicate that the error queue has overflowed. Subsequent error messages are discarded. The 15 error messages already in the queue are maintained.

■ Program message terminator
  When sending commands from the controller, append LF (Line Feed, 0x0A hex) to the end of the output character string as the program message terminator. Further, append EOI (End message) as the last byte. Some devices may not operate properly unless LF and EOI are appended to commands sent. Depending on the driver software used as the control computer, unless program message terminators are specified together with commands themselves, program message terminators may not be output. Although NL (New Line) is sometimes indicated instead of LF (Line Feed), the binary code is the same.
Since the concept of END messages do not apply in case of RS-232 and LAN, EOI is not appended.

■ Restrictions applicable to RS-232 and LAN
  Functions that are unique to GPIB cannot be used. Examples are shown below.
  - Reception of Device Clear (DCL, SDC) messages
  - Reception of GTL (Go To Local) messages
  - Reception of LLO (Local Lockout) messages
  - Reception of GET (Group Execute Trigger) messages
  - Reception of REN (Remote Enable) messages
  - Transmission of SRQ (Service Request) messages
  - Serial Poll (reception of SPE / SPD and transmission of status bytes)
  - Transmission of END message (the EOI signal as message terminator)
2. Switching between remote / local states
In regard to remote control, the LI5645 / LI5650 has a remote state and a local state.
In the local state, all panel operations are possible.
In the remote state, all panel operations are disabled except for the TRIG key and the operation that returns operation to the local state.

■ Switching to the remote state
Ordinarily, the remote state is used during operation through GPIB. This depends on driver functionality on the controller side. Under the communication standard, specifying a device as the listener when the REN message is TRUE puts that device in the remote state. The same applies to operation with USB (USBTMC).

■ Switching to the local state
Operation can be returned to the local state from the remote state by pressing the CLR / LOCAL key on the front panel (except during Local Lockout).
Operation can be returned to the local state from the controller by sending the GTL command or returning the REN line to FALSE. Since disconnecting the GPIB cable makes the REN line FALSE, operation returns to the local state.

■ Prohibiting local operation from the panel
Accidental local operation can be prevented by specifying Local Lockout from the controller. During Local Lockout, operation cannot be returned to the local state by pressing the CLR / LOCAL key.
From the controller, operation to return to the local state is possible from the controller even during Local Lockout.

■ Remote/local operation with RS-232 and LAN
When a command is sent to the LI5645 / LI5650, the LI5645 / LI5650 returns to the remote state.
When the local state is restored by pressing the CLR / LOCAL key, panel operation is enabled.
The following commands can be used with RS-232 or LAN.
:SYSTem:LOCal (switches to the local state)
:SYSTem:REMote (switches operation to the remote state)
:SYSTem:RWLock (switches to the remote state with Local Lockout)

REMOTE lamp
In the remote state, the REMOTE lamp lights, and in the Local Lockout state, it flashes (at a slow rate). After the power is turned on, remote control cannot be used while the REMOTE lamp is flashing (at a high rate).
3. Responses to interface messages
The principle IEEE-488.1 interface messages are as follows.

### Table 3-1 Responses to interface messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFC</td>
<td><code>&lt; InterFace Clear &gt;</code>&lt;br&gt;Initializes the GPIB interface.&lt;br&gt;Releases the specified listener and talker.</td>
</tr>
<tr>
<td>DCL, SDC</td>
<td><code>&lt; Device CLear &gt;, &lt; Selected Device Clear &gt;</code>&lt;br&gt;Clears the input buffer and cancels command interpretation / execution.&lt;br&gt;Clears the output buffer and clears bit 4 (MAV) of the Status Byte register.</td>
</tr>
<tr>
<td>LLO</td>
<td><code>&lt; Local Lockout &gt;</code>&lt;br&gt;Prohibits switching from the remote state to the local state by pressing the CLR/LOCAL key.</td>
</tr>
<tr>
<td>GTL</td>
<td><code>&lt; Go To Local &gt;</code>&lt;br&gt;Switches to the local state.</td>
</tr>
<tr>
<td>GET</td>
<td><code>&lt; Group Execute Trigger &gt;</code>&lt;br&gt;Executes a trigger. Works the same as the *TRG command.</td>
</tr>
</tbody>
</table>

The procedure for sending interface messages from the controller varies according to device driver. For details, see the relevant driver manual.

These functions cannot be used with RS-232 and LAN. However, alternate functions are provided for some of them.
4. Command list and command tree
The LI5645 / LI5650 commands can broadly be grouped into common commands as defined in IEEE488.2, and subsystem commands corresponding to device-specific functions.

Common commands supported by the LI5645 / LI5650 are listed in Table 4-1. The LI5645 / LI5650 subsystem commands are listed in Table 4-2.

Symbols used in Tables 4-1 and 4-2 have the following meanings.

- Square brackets ([ ]) indicate optional keywords.
- A vertical bar ( | ) indicates that you should select one keyword from among a set of keywords.
- Lowercase characters in keywords indicates that those characters are optional.

### Table 4-1 Common command list

<table>
<thead>
<tr>
<th>Command</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>*CLS</td>
<td>Clear Status Command</td>
<td>Clears the status.</td>
</tr>
<tr>
<td>*ESE</td>
<td>Standard Event Status Enable Command / Query</td>
<td>Sets/queries the Standard Event Status Enable register.</td>
</tr>
<tr>
<td>*ESE?</td>
<td>Standard Event Status Register Query</td>
<td>Queries the Standard Event Status register.</td>
</tr>
<tr>
<td>*IDN?</td>
<td>Identification Query</td>
<td>Queries the device identification information (such as model name).</td>
</tr>
<tr>
<td>*OPC</td>
<td>Operation Complete Command / Query</td>
<td>Specifies that the OPC bit of the Standard Event Status register be set to 1 when all command processing has been completed. When all processing has been completed, 1 is returned in response to a query.</td>
</tr>
<tr>
<td>*RCL</td>
<td>Recall Command</td>
<td>Restores the contents of the specified configuration memory.</td>
</tr>
<tr>
<td>*RST</td>
<td>Reset Command</td>
<td>Resets the device and restores settings to default values.</td>
</tr>
<tr>
<td>*SAV</td>
<td>Save Command</td>
<td>Saves current settings to the specified configuration memory.</td>
</tr>
<tr>
<td>*SRE</td>
<td>Service Request Enable Command / Query</td>
<td>Sets and queries the Service Request Enable register.</td>
</tr>
<tr>
<td>*SRE?</td>
<td>Standard Event Register Command / Query</td>
<td>Queries the status byte.</td>
</tr>
<tr>
<td>*STB?</td>
<td>Read Status Byte Query</td>
<td>Reads the status byte.</td>
</tr>
<tr>
<td>*TRG</td>
<td>Trigger Command</td>
<td>While awaiting a trigger when the trigger source is BUS, measurement data is recorded in the measurement data buffer when a trigger event occurs.</td>
</tr>
<tr>
<td>*TST?</td>
<td>Self-Test Query</td>
<td>Always returns 0.</td>
</tr>
<tr>
<td>*WAI</td>
<td>Wait-to-Continue Command</td>
<td>Postpones execution of ensuing commands until execution of all commands has been completed.</td>
</tr>
</tbody>
</table>
## Table 4-2  Subsystem command list

<table>
<thead>
<tr>
<th>Command</th>
<th>Function / operational target</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABORt subsystem</td>
<td>Abort recording of measurement data</td>
</tr>
<tr>
<td>:ABORt</td>
<td></td>
</tr>
<tr>
<td>CALCulate1 subsystem</td>
<td>DATA1 output parameter selection</td>
</tr>
<tr>
<td>:CALCulate1:FORMat</td>
<td></td>
</tr>
<tr>
<td>:CALCulate1:MATH:CURRent[:LEVel] (*1)</td>
<td>Normalize calculation reference value (current)</td>
</tr>
<tr>
<td>:CALCulate1:MATH:EXPRession:NAME</td>
<td>Normalize calculation format selection</td>
</tr>
<tr>
<td>:CALCulate1:MATH:VOLTage[:LEVel]</td>
<td>Normalize calculation reference value (voltage)</td>
</tr>
<tr>
<td>:CALCulate1:MULTiplier</td>
<td>X, R EXPAND multiplier (primary PSD)</td>
</tr>
<tr>
<td>:CALCulate1:OFFSet</td>
<td>X offset amount (primary PSD)</td>
</tr>
<tr>
<td>:CALCulate1:OFFSet:AUTO:ONCE</td>
<td>X, Y auto offset cancel (primary PSD)</td>
</tr>
<tr>
<td>:CALCulate1:OFFSet:STATe</td>
<td>X offset enable (primary PSD)</td>
</tr>
<tr>
<td>CALCulate2 subsystem</td>
<td>DATA2 output parameter selection</td>
</tr>
<tr>
<td>:CALCulate2:FORMat</td>
<td></td>
</tr>
<tr>
<td>:CALCulate2:MULTiplier</td>
<td>Y EXPAND multiplier (primary PSD)</td>
</tr>
<tr>
<td>:CALCulate2:OFFSet</td>
<td>Y offset amount (primary PSD)</td>
</tr>
<tr>
<td>:CALCulate2:OFFSet:AUTO:ONCE</td>
<td>X, Y auto offset cancel (primary PSD)</td>
</tr>
<tr>
<td>:CALCulate2:OFFSet:STATe</td>
<td>Y offset enable (primary PSD)</td>
</tr>
<tr>
<td>CALCulate3 subsystem</td>
<td>DATA3 output parameter selection</td>
</tr>
<tr>
<td>:CALCulate3:FORMat</td>
<td></td>
</tr>
<tr>
<td>:CALCulate3:MULTiplier (*1)</td>
<td>X, R EXPAND multiplier (secondary PSD)</td>
</tr>
<tr>
<td>:CALCulate3:OFFSet (*1)</td>
<td>X offset amount (secondary PSD)</td>
</tr>
<tr>
<td>:CALCulate3:OFFSet:AUTO:ONCE (*1)</td>
<td>X, Y auto offset cancel (secondary PSD)</td>
</tr>
<tr>
<td>:CALCulate3:OFFSet:STATe (*1)</td>
<td>X offset enable (secondary PSD)</td>
</tr>
<tr>
<td>CALCulate4 subsystem</td>
<td>DATA4 output parameter selection</td>
</tr>
<tr>
<td>:CALCulate4:FORMat</td>
<td></td>
</tr>
<tr>
<td>:CALCulate4:MULTiplier (*1)</td>
<td>Y EXPAND multiplier (secondary PSD)</td>
</tr>
<tr>
<td>:CALCulate4:OFFSet (*1)</td>
<td>Y offset amount (secondary PSD)</td>
</tr>
<tr>
<td>:CALCulate4:OFFSet:AUTO:ONCE (*1)</td>
<td>X, Y auto offset cancel (secondary PSD)</td>
</tr>
<tr>
<td>:CALCulate4:OFFSet:STATe (*1)</td>
<td>Y offset enable (secondary PSD)</td>
</tr>
<tr>
<td>CALCulate5 subsystem</td>
<td>Calculation method selection</td>
</tr>
<tr>
<td>:CALCulate5:MATH</td>
<td></td>
</tr>
<tr>
<td>:CALCulate5:MATH:EXPRession:NAME (*1)</td>
<td>Ratio mode calculation format</td>
</tr>
<tr>
<td>:CALCulate5:MULTiplier</td>
<td>Ratio multiplier</td>
</tr>
</tbody>
</table>
### Table 4-2  Subsystem command list

<table>
<thead>
<tr>
<th>Command</th>
<th>Function / operational target</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DATA subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:DATA:COUN?</td>
<td>Queries measurement data buffer data count</td>
</tr>
<tr>
<td>:DATA:DATA?</td>
<td>Queries measurement data buffer data content</td>
</tr>
<tr>
<td>:DATA:DELETE</td>
<td>Clear measurement data buffer</td>
</tr>
<tr>
<td>:DATA:DELETE:ALL</td>
<td>Clear all measurement data buffers</td>
</tr>
<tr>
<td>:DATA:FEED</td>
<td>Select data to be recorded in measurement data buffer</td>
</tr>
<tr>
<td>:DATA:FEED:CONTROL</td>
<td>Enable measurement data buffer recording</td>
</tr>
<tr>
<td>:DATA:POINts</td>
<td>Specify buffer size and initialize measurement data buffer</td>
</tr>
<tr>
<td>:DATA:TIMER</td>
<td>Internal timer time interval</td>
</tr>
<tr>
<td>:DATA:TIMER:STATE</td>
<td>Enable internal timer</td>
</tr>
<tr>
<td><strong>DISPLAY subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:DISPLAY[:MENU][:NAME]</td>
<td>Select measurement screen</td>
</tr>
<tr>
<td>:DISPLAY:WINDOW[:STAT]</td>
<td>Display enable (on/off)</td>
</tr>
<tr>
<td><strong>FETCH subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:FETCH?</td>
<td>Queries latest measurement data</td>
</tr>
<tr>
<td><strong>FORMAt subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:FORMAt[:DATA]</td>
<td>Measurement data transfer format</td>
</tr>
<tr>
<td><strong>INITiate subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:INITiate[:IMMediate]</td>
<td>Start trigger system</td>
</tr>
<tr>
<td><strong>INPut[1] subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:INPut[1]:COUPling</td>
<td>Select signal input coupling</td>
</tr>
<tr>
<td>:INPut[1]:FILTER:NOTCh1:FREQuency</td>
<td>Power supply frequency (notch filter)</td>
</tr>
<tr>
<td>:INPut[1]:FILTER:NOTCh1[:STAT]</td>
<td>Enable fundamental wave removal</td>
</tr>
<tr>
<td>:INPut[1]:FILTER:NOTCh2[:STAT]</td>
<td>Enable second harmonic removal</td>
</tr>
<tr>
<td>:INPut[1]:GAIN (*1)</td>
<td>Current-voltage conversion gain</td>
</tr>
<tr>
<td>:INPut[1]:LOW</td>
<td>Enable signal input connector grounding</td>
</tr>
<tr>
<td>:INPut[1]:OFFSet:AUTO</td>
<td>PSD input offset auto adjust active</td>
</tr>
<tr>
<td>:INPut[1]:OFFSet:AUTO:ONCE</td>
<td>Auto-adjust PSD input offset just once</td>
</tr>
<tr>
<td>:INPut[1]:OFFSet:RST</td>
<td>Disable PSD input offset adjustment</td>
</tr>
<tr>
<td>:INPut[1]:OFFSet:STIMe</td>
<td>Continuous auto adjustment response time</td>
</tr>
<tr>
<td><strong>INPut2 subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:INPut2:TYPE</td>
<td>Reference signal input format selection</td>
</tr>
<tr>
<td><strong>MEMory subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:MEMory:STATE:DELETE</td>
<td>Clear configuration memory</td>
</tr>
<tr>
<td>:MEMory:STATE:DEFINE</td>
<td>Assign name to configuration memory</td>
</tr>
<tr>
<td><strong>OUTPut[1] subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:OUTPut[1][:STAT]</td>
<td>Enable DATA1 output</td>
</tr>
<tr>
<td><strong>OUTPut2 subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:OUTPut2[:STAT]</td>
<td>Enable DATA2 output</td>
</tr>
<tr>
<td><strong>OUTPut3 subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:OUTPut3[:STAT]</td>
<td>Enable DATA3 output</td>
</tr>
<tr>
<td><strong>OUTPut4 subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>:OUTPut4[:STAT]</td>
<td>Enable DATA4 output</td>
</tr>
</tbody>
</table>

2/4
### Table 4-2  Subsystem command list

<table>
<thead>
<tr>
<th>Command</th>
<th>Function / operational target</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROUTe[1] subsystem</td>
<td>:ROUTE[1][:TERMinals]</td>
</tr>
<tr>
<td>ROUTe2 subsystem</td>
<td>:ROUTE2[:TERMinals]</td>
</tr>
<tr>
<td>SENSE subsystem</td>
<td>[:SENSe]:AUTO:ONCE</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:CURRent[1]:AC:RANGe:AUTO ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:CURRent[1]:AC:RANGe[:UPPer] ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:CURRent2:AC:RANGe[:UPPer] ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:DATA</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:DETector[:FUNCTION] ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:DREServe</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FILTER[1]:LPAsss:AUTO:ONCE</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FILTER[1]:LPAsss:SLOPe</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FILTER[1]:LPAsss:TCONstant</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FILTER[1]:LPAsss:TYPE</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FILTER2[:LPAsss]:SLOPe ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FILTER2[:LPAsss]:TCONstant ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FILTER2[:LPAsss]:TYPE ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FREQuency[1]?</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FREQuency2? ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FREQuency2:HARMonics ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FREQuency2:SMultiplier</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:FREQuency2:MULTiplier ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:NOISe[:Smoother][:APERture]</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:PHASE[1]</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:PHASE2[:FUNCTION] :AUTO:ONCE ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:PHASE2:Auto:ONCE ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:ROSCillator:SOURce?</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:VOLTage[1]:AC:RANGe:AUTO</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:VOLTage[1]:AC:RANGe:AUTO:ONCE</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:VOLTage[1]:AC:RANGe[:UPPer]</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:VOLTage2:AC:RANGe[:UPPer] ( *1 )</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:VOLTage5[:DC]:STATe</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:VOLTage5[:DC]:TCONstant</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:VOLTage6[:DC]:STATe</td>
</tr>
<tr>
<td></td>
<td>[:SENSe]:VOLTage6[:DC]:TCONstant</td>
</tr>
</tbody>
</table>
## 4. Command list and command tree

### Table 4-2  Subsystem command list

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Command</th>
<th>Function / operational target</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOURce subsystem</strong></td>
<td>:SOURce:FREQuency[1]:CW</td>
<td>Internal oscillator frequency (fundamental wave, primary frequency)</td>
</tr>
<tr>
<td></td>
<td>:SOURce:FREQuency2:[CW]</td>
<td>Internal oscillator frequency (secondary frequency)</td>
</tr>
<tr>
<td></td>
<td>:SOURce:IOSCillator</td>
<td>Sine wave output oscillator selection</td>
</tr>
<tr>
<td></td>
<td>:SOURce:VOLTage:LEVEL:IMMediate:AMPLitude</td>
<td>Sine wave output voltage amplitude</td>
</tr>
<tr>
<td></td>
<td>:SOURce:VOLTage:RANGE</td>
<td>Sine wave output voltage range</td>
</tr>
<tr>
<td><strong>SOURce5 subsystem</strong></td>
<td>:SOURce5:VOLTage:LEVEL:IMMediate:OFFSet</td>
<td>AUX OUT 1 output voltage</td>
</tr>
<tr>
<td><strong>SOURce6 subsystem</strong></td>
<td>:SOURce6:VOLTage:LEVEL:IMMediate:OFFSet</td>
<td>AUX OUT 2 output voltage</td>
</tr>
<tr>
<td><strong>STATus subsystem</strong></td>
<td>:STATus:OPERation:CONDition?</td>
<td>Condition query (OPCR)</td>
</tr>
<tr>
<td></td>
<td>:STATus:OPERation:ENABLE</td>
<td>Event enable (OPEE)</td>
</tr>
<tr>
<td></td>
<td>:STATus:OPERation:ENCEnabled</td>
<td>Event query (OPER)</td>
</tr>
<tr>
<td></td>
<td>:STATus:OPERation:NTR</td>
<td>Negative transition filter (ONTR)</td>
</tr>
<tr>
<td></td>
<td>:STATus:OPERation:PTR</td>
<td>Positive transition filter (OPTR)</td>
</tr>
<tr>
<td></td>
<td>:STATus:QUESTionable:CONDition?</td>
<td>Queries the questionable condition register</td>
</tr>
<tr>
<td></td>
<td>:STATus:QUESTionable:ENABLE</td>
<td>Set questionable event enable register</td>
</tr>
<tr>
<td></td>
<td>:STATus:QUESTionable:ENCEnabled</td>
<td>Queries the questionable event register</td>
</tr>
<tr>
<td></td>
<td>:STATus:QUESTionable:NTR</td>
<td>Negative transition filter (QNTR)</td>
</tr>
<tr>
<td></td>
<td>:STATus:QUESTionable:PTR</td>
<td>Positive transition filter (QPTR)</td>
</tr>
<tr>
<td><strong>SYSTem subsystem</strong></td>
<td>:SYSTem:ERRor?</td>
<td>Queries the Error contents</td>
</tr>
<tr>
<td></td>
<td>:SYSTem:KLOCk</td>
<td>Key lock enable</td>
</tr>
<tr>
<td></td>
<td>:SYSTem:LOCal</td>
<td>Switch to local state</td>
</tr>
<tr>
<td></td>
<td>:SYSTem:REMote</td>
<td>Switch to remote state</td>
</tr>
<tr>
<td></td>
<td>:SYSTem:RST</td>
<td>Initialize configuration memory and settings</td>
</tr>
<tr>
<td></td>
<td>:SYSTem:RWLock</td>
<td>Switch to remote state with lock</td>
</tr>
<tr>
<td><strong>TRIGger subsystem</strong></td>
<td>:TRIGger:DELay</td>
<td>Trigger delay time</td>
</tr>
<tr>
<td></td>
<td>:TRIGger:[IMMediate]</td>
<td>Trigger (start recording)</td>
</tr>
<tr>
<td></td>
<td>:TRIGger:SOURce</td>
<td>Trigger source</td>
</tr>
</tbody>
</table>

*1) LI5650 only. Not supported with LI5645.
*2) RS-232, LAN only. An error occurs with other interfaces.

Note: Query commands end with a query symbol. This table does not include queries for functions that allow both setting and querying.
4. Command list and command tree

The LI5645 / LI5650 subsystem command tree is shown below.

To be continued

Square brackets ([ ]) indicate optional keywords.
Command list and command tree

Command tree 2/3

- INPut2 ——— TYPE
- MEMory ——— STATe ——— DELete
- OUTPut[1] ——— [STATe]
- OUTPut2 ——— [STATe]
- OUTPut3 ——— [STATe]
- OUTPut4 ——— [STATe]
- ROUTe[1] ——— [TERMinals]
- ROUTe2 ——— [TERMinals]
- [SENSe]
  - AUTO ——— ONCE
  - CURRent[1] ——— AC ——— RANGe ——— AUTO *1
  - CURRent2 ——— AC ——— RANGe ——— [UPPer] *1
  - DATA
  - DETector ——— [FUNCTION] *1
  - DREServe
  - FILTer[1] ——— [LPASs]
  - AUTO ——— ONCE
    - SLOPe
    - TCONstant
    - TYPE
  - FILTer2 ——— [LPASs]
    - SLOPe *1
    - TCONstant *1
    - TYPE *1
  - FREQuency[1]
    - HARMonics
    - MULTIplier
    - SMULtiplier
  - FREQuency2 *1
    - HARMonics *1
    - MULTIplier *1
  - NOISe ——— [SMOothing] ——— [APERture]
  - PHASE[1]
    - AUTO ——— ONCE
  - PHASE2 *1
    - AUTO ——— ONCE *1
  - ROSCillator ——— SOURce?
  - VOLTage[1] ——— AC ——— RANGe
  - VOLTage2 ——— AC ——— RANGe ——— AUTO
  - VOLTage5 ——— [DC] ——— STATe
  - VOLTage6 ——— [DC] ——— STATe

To be continued

Square brackets ([ ]) indicate optional keywords.
4. Command list and command tree

Command tree 3/3

- SOURce
  - FREQuency[1] [CW]
  - FREQuency2 [CW] *1
  - IOSCillator *1
  - VOLTage [LEVel] [IMMediate] [AMPLitude]
  - RANGE

- SOURce5
  - VOLTage [LEVel] [IMMediate] OFFSet

- SOURce6
  - VOLTage [LEVel] [IMMediate] OFFSet

- STATus
  - OPERation CONDITION?
    - ENABle [EVENt]?
    - NTR
    - PTR
    - QUESTIONable CONDITION?
      - ENABle [EVENt]?
      - NTR
      - PTR

- SYSTem
  - ERRor?
    - KLOCk
    - LOCal
    - REMote
    - RST
    - RWLock
  - DELay [IMMediate]
  - SOURce

*1) LI5650 only. Not supported with LI5645.

Square brackets ([ ]) indicate optional keywords.
4. Command list and command tree
5. Command explanation

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5.2 Sequential commands ................................. 37
5.3 Detailed command explanations ................. 38
5. Command explanation

5.1 Language outline
represents an outline of the language.

5.1.1 Subsystem commands
Commands are grouped according to function. Subsystem commands are ordered hierarchically, with the colon (:) defined as the path separator.

5.1.2 Path separator
The path separator (:) delimits the current keyword from keywords at the next lower level. Each time a colon (:) is detected in a command string, the current path shifts to the next lower level. Using a colon (:) at the beginning of a command string means "set the current path as root." The root path is also set when the power is turned on, or by the *RST command or a message terminator. Program messages always have the root at the beginning. Also, the colon (:) may be omitted from the beginning of command strings.

```
:SYST:KLOC 1
↑  ↑  ↑  ↑
① ② ③ ④
```

① Set current path as root (optional).
② SYSTem subsystem commands (SYSTem is a root command).
③ KLOCk command is included in the SYSTem subsystem.
④ A space is required between header and parameters.

Multiple command strings can be included in a single program message by delimiting them with semicolons (;).

```
:SENS:FILT1:LPAS:SLOP 12 ; :SENS:FILT1:LPAS:TCON 0.1
```

The above is the equivalent of the following two program messages.

```
:SENS:FILT1:LPAS:SLOP 12

Current path following execution is : SENS:FILT1:LPAS
```

Subsystem commands at the same level as the first command can be accessed by omitting the colon (:) from the beginning of the second and following command strings.

```
:SENS:FILT1:LPAS:SLOP 12 ; TCON 0.1
```

:SENS:FILT1:LPAS: can be omitted from the second command string

In any case, the concluding program message terminator can be omitted.

Note that the current path may change if a keyword is omitted.
5. Command explanation

5.1.3 Abbreviation of keywords
In this instruction manual, commands and parameters are described using combinations of upper and lowercase alphabetic characters. Uppercase characters indicate the short (abbreviated) form. Commands from which lowercase characters are omitted have the same functionality as long-form commands that include lowercase characters. However, omission of just part of lowercase letters is not possible. The use of upper and lowercase characters is a matter of presentation convenience, and there is no distinction between the two at the device level. Upper and lowercase letters can be freely mixed.

Example) Command notation  CALCulate1 FORMat?
→ :calculate1:format?  Valid - Long form, all lowercase letters
    :Calc1:Form?  Valid - Short form, mixed upper and lowercase letters
    :CALCUL1:FORM?  Invalid - Partially abbreviated
    :CALC1:FOR?  Invalid - Excessive abbreviation

5.1.4 Optional keywords
Keywords appearing in square brackets ([ ]) are optional. Device operation is the same regardless of optional keywords are all included or are partially or totally omitted. The two examples below both perform the same function on the device.

Example) Command notation  DISPlay[:MENU][:NAME]  NORMal
→ :DISP:MENU:NAME  NORM  No keywords omitted
    :DISP  NORM  Keywords omitted

5.2 Sequential commands
All LI5645 / LI5650 commands are sequential commands. Commands are executed in sequence, with execution of later commands following that of preceding commands. There are no overlapping commands.
5. Command explanation

5.3 Detailed command explanations
Functions and command syntax of commands shown in “Table 1 Common commands” and “Table 2 Subsystem command list” are explained below.

[Meaning of symbols]

- Square brackets ([ ]) indicate optional keywords. (Implied keywords)
- Braces ({ }) enclose the parameters of the command string.
- Vertical bars ( | ) are used to indicate a choice from among multiple keywords.
- Angle brackets (< >) are used to indicate required parameters consisting of numerics or text.

These symbols are used purely for the sake of explanation, are must not be included in actual commands.

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Actual command</th>
</tr>
</thead>
<tbody>
<tr>
<td>:DISPlay:WINDow[:STATe] {ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>

[Parameter format]

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Format</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR1</td>
<td>Integer (numeric)</td>
<td>123</td>
</tr>
<tr>
<td>NR2</td>
<td>Decimal format without an exponent (numeric)</td>
<td>0.075</td>
</tr>
<tr>
<td>NR3</td>
<td>Decimal format with an exponent (numeric)</td>
<td>4.99E+06</td>
</tr>
<tr>
<td>CRD</td>
<td>Character string</td>
<td>ALL</td>
</tr>
<tr>
<td>SRD</td>
<td>Character string enclosed in double quotation marks</td>
<td>&quot;No error&quot;</td>
</tr>
<tr>
<td>bool</td>
<td>Logical value</td>
<td>ON, OFF, 1, 0</td>
</tr>
</tbody>
</table>

- Unless otherwise specified, numbers may be specified in any format, and values specified are rounded to the nearest value if the specified value exceeds the permitted resolution. Further, when a numerical value is set that is not included in the parameter options, it is rounded to the closest value.
- Unless otherwise specified, the minimum numeric value is assumed for numbers that are less than the minimum value, and the maximum numeric value is assumed for numbers that exceed the maximum.
- With numeric parameters for which specification of MAX / MIN is allowed, the maximum numeric value is set when MAX (or MAXIMUM) is specified, and the minimum numeric value is set for MIN (or MINIMUM).
- When the response is a numeric value and the range, resolution, and unit have not been specified, those parameters are the same as in the configuration. Unless otherwise specified, the mantissa of the NR3 format responses has 6 digits.
- For commands whose parameter type varies according to specification format, numbers specified that exceed the ranges indicated are lumped into the same range and resolution as for operation from the panel. For the actual range of numeric that can be set, refer to the panel operating instructions.
- Quotation marks used to enclose character strings can be either single quotation marks or double quotation marks.
5. Command explanation

[Notes]

- In this explanation, the work "command" refers to both commands and to queries.
  Keywords which conclude with a question mark (?) are queries.
- No headers are attached to messages sent in response to commands.
5. Command explanation

5.3.1 Common commands

*CLS

Explanation Clear the following statuses.
- Standard Event Status register
- Operation Event register
- Questionable Event register
- Status byte
- Error queue

Also clears the panel error display.

Setting example *CLS

Note The *CLS does not clear the Status Byte register directly. However, except for the MAV bit and RQS bit, the status byte is cleared indirectly. The MAV bit is cleared indirectly when the input buffer is cleared by Device Clear. The RQS bit can be cleared by reading the status through serial polling.

*ESE <mask>

Explanation Sets and queries the Standard Event Status Enable register.

Parameter(s) <mask> {numeric, range 0 to 255} An error results if range exceeded.

For details "6.3 Standard event status"

Setting example *ESE 32

Sets 32 to the Standard Event Status Enable register.

Response <mask> {numeric, format NR1, range 0 to 255}

Query example *ESE?

Response example 32

The Standard Event Status Enable register contains 32.

*ESR?

Explanation Queries content of the Standard Event Status register.

Upon querying the Standard Event Status register, all of its bits are cleared to 0.

Response <Register content> {numeric, format NR1, range 0 to 255}

For details "6.3 Standard event status"

Query example *ESR?

Response example 16

The Standard Event Status Enable register contains 16.
5. Command explanation

*IDN?
Explanation: Queries the model name.
Response: 
```
"<manufacturer name>, <model name>, <serial number>, <firmware version>"
```
Format: SRD
Query example: *IDN?
Response example: "NF Corporation, LI5650, 9097772, Ver1.00"

*OPC
*OPC?
Explanation: Verifies that execution of all preceding commands has been completed.
Setting example: *OPC
Specifies that the OPC bit of the Standard Event Status register be set to 1 when execution of all preceding commands has been completed. Completion of command execution can be verified by monitoring the status.
Explanation: 1
1 is returned when execution of all preceding commands has been completed.
Query example: *OPC?
Explanation: 1
Execution of all preceding commands has been completed.
Note: *OPC? does not clear the Standard Event Status register's OPC bit. To clear the bit, use Device Clear or the *CLS or *RST command.
The OPC bit can be used to trigger SRQ when it becomes 1.

*RCL  <memory number>
Explanation: Restores the settings stored in the specified configuration memory.
Parameter(s): 
```
<memory number> {numeric in range 0 to 9}
```
An error results if range exceeded.
When 0 is specified, settings are restored to the power-on settings (the settings at time of power-off). Default settings are written in configuration memories that have not been used to store settings.
Setting example: *RCL  5
Restores the settings stored in configuration memory 5.
Note: An error occurs if the contents of the specified configuration memory have been corrupted.

*RST
Explanation: Restores default settings.
Setting example: *RST

For details, refer to "LI5645 / LI5650 Instruction Manual (Operations)
Table 3-2 Settings and default values"
5. Command explanation

*SAV  <memory number>

Explanation  Saves current settings to the specified configuration memory.
Parameter(s)  <memory number>  {numeric in range 1 to 9}  An error results if range exceeded.
Setting example  *SAV 5
Note  Saves current settings to configuration memory 5.
Contents of configuration memory are not cleared by the *RST command.
To clear contents of configuration memory,  :SYSTem:RST command

*SRE  <SRQ mask>

*SRE?

Explanation  Sets and queries the Service Request Enable register.
Parameter(s)  <SRQ mask>  {numeric in range 0 to 255}  An error results if range exceeded.
Setting example  *SRE 128
Response  {numeric, format NR1, range 0 to 255}
Query example  *SRE?
Response example  128
The Service Request Enable register contains 128.

*STB?

Explanation  Queries content of the Status Byte register.
Response  <Register content>  {numeric, format NR1, range 0 to 255}
Query example  *STB?
Response example  128
The Status Byte register contains 128.

*TRG

Explanation  When the measurement data buffer is enabled, executes a trigger and records data in the measurement buffer.
When the internal timer is disabled, measurement data is recorded only once.
When the internal timer is enabled, starts recording measurement data according to the internal timer.
Enable the measurement data buffer  :DATA:FEED:CONTROL command
Set the internal timer  :DATA:TIMER command
Before using triggers, the awaiting trigger state must be set with the :INITiate[:IMMediate] command. An error will result if the awaiting trigger state has not been set.
Setting example  *TRG
Executes a trigger.
5. Command explanation

*TST?
Explanation: Queries results of the internal self-diagnostic.
Response: \{numeric, format NR1, range 0\}
Query example: TST?
Response example: 0
Note: With this device, the response is always 0. It is not possible to check the internal status by external control. Check on the panel operation.

For details: LI5645 / LI5650 Instruction Manual (Operations) "8.5 Self-diagnostic"

*WAI
Explanation: Postpones execution of ensuing commands until execution of all commands has been completed.
Example of use:
Command 1; command 2; *WAI; following commands <program message terminator>
Following commands are executed after completion of execution of both command 1 and command 2.
Note: The wait state applied by the *WAI command is cleared by Device Clear. With this equipment, there are no applicable overlapping commands.
5.3.2 Subsystem commands

:ABORt
Explanation Aborts recording to the measurement data buffer and puts the trigger system in the idle state.
Setting example :ABOR

:CALCulate1:FORMat {REAL|MLINear|IMAGinary|PHASE|NOISE|AUX1|REAL2|MLINear2}
:CALCulate1:FORMat?
Explanation Sets/queries the measurement parameters to be displayed and output as DATA1.
Parameter(s) REAL X (= R cos θ, primary PSD) 
Xp (= Rp cos θp, primary PSD) 
MLINear R (= \sqrt{X^2 + Y^2}, primary PSD) 
Rp (= \sqrt{Xp^2 + Yp^2}, primary PSD) 
IMAGinary Y (= R sin θ, primary PSD) 
Yp (= Rp sin θp, primary PSD) 
PHASE θ, θp (primary PSD) 
NOISE Input referred noise density (V / Hz or A / Hz) 
AUX1 AUX IN 1 voltage 
REAL2 *1 Xs (= Rs cos θs, secondary PSD) 
MLINear2 *1 Rs (= \sqrt{Xs^2 + Ys^2}, secondary PSD)

Relationship to panel display is as follows.

Detection mode→ SINGLE DUAL1 *1 DUAL2 *1, CASCADE *1
REAL X , Xn Xp , Xpn Xp
MLINear R , Rn Rp , Rpn Rp
IMAGinary *2 Yp , Ypn Yp
PHASE *2 0p , 0pn 0p
NOISE NOISE NOISE NOISE
AUX1 AUX1 AUX1 AUX1
REAL2 *1 *2 Xs , Xsn Xs
MLINear2 *1 *2 Rs , Rsn Rs

*1: LI5650 only. Not supported with LI5645.
*2: Setting not possible in SINGLE mode.

Setting example :CALC1:FORM MLIN
Set measurement parameter for DATA 1 to R (Rn, Rp, Rpn).
Response {REAL|MLIN|IMAG|PHASE|NOISE|AUX1|REAL2|MLIN2}
Query example :CALC1:FORM?
Response example MLIN
The DATA 1 parameter is R (Rn, Rp, Rpn).
Note  Measurement parameters REAL2 and MLIN2 cannot be selected with the LI5645.

:CALCulate1:MATH:CURRent[:LEVel]  <reference value>
:CALCulate1:MATH:CURRent[:LEVel]?

Explanation  Sets/queries the current reference value for normalize calculation.
Parameter(s)  <reference value>  {numeric, range +1E-15 to +1E-06, resolution 6 digits, unit Arms}
Setting example  :CALC1:MATH:CURR  1.23456E-6
Sets the current reference value for normalize calculation to 1.23456E-6 Arms.
Response  {numeric, format NR3}
Query example  :CALC1:MATH:CURR?
Response example  1.000000E-06
The current reference value for normalize calculation is 1µArms.
Note  This command cannot be used with the LI5645. An error will result.

:CALCulate1:MATH:EXPRession:NAME  {DB|PCNT|PCFS} [,"Unit"]
:CALCulate1:MATH:EXPRession:NAME?

Explanation  Sets/queries the normalize calculation format. Display and output of normalize results also requires enabling normalize calculation with the :CALCulate5:MATH NORM command. Reference values are set with
 :CALCulate:MATH:CURRent[:LEVel] command (current) and
 :CALCulate:MATH:VOLTage[:LEVel] command (voltage)
Parameter(s)  DB  The measured value is shown as a log ratio with respect to the reference value.
               20 × log₁₀ (measurement value / reference value), unit dB
PCNT  Measurement value displayed as percentage of reference value.
      (measurement value / reference value) × 100, unit %
PCFS  Measurement value displayed as percentage of sensitivity (full scale).
      (measurement value / sensitivity) × 100, unit % of FS (display is %FS)
"Unit"  Specify an alphanumeric character string of up to 3 characters.
When specified, the string is displayed instead of dB or %. Characters allowed are {A to Z, a to z, 0 to 9, #, @, -, (space)}
Setting example  :CALC1:MATH:EXPR:NAME  DB ,"dBv"
Sets dB as the normalize calculation format and dBv for unit display.
Response  {DB|PCNT|PCFS} [,"Unit"]
If a character string has been set for unit display, that string is included in the response.
Query example  :CALC1:MATH:EXPR:NAME?
5. Command explanation

Response  DB ,"dBv"
Normalize calculation format is dB, and unit display is dBv.

**:CALCulate1:MATH:VOLTage[:LEVel]  <reference value>**

**:CALCulate1:MATH:VOLTage[:LEVel]?**

Explanation  Sets/queries the voltage reference value for normalize calculation.
Parameter(s)  <reference value>  {numeric, range +1E-9 to +1E+1, resolution 6 digits, unit Vrms}
Setting example  :CALC1:MATH:VOLT  1.23456E-6  
Sets the voltage reference value for normalize calculation to 1.23456E-6 Vrms.
Response  {numeric, format NR3}
Query example  :CALC1:MATH:VOLT?
Response example  1.000000E-06  
The voltage reference value for normalize calculation is 1µVrms.

**:CALCulate1:MUltiplier  <multiplier>**

**:CALCulate1:MUltiplier?**

Explanation  Sets/queries the primary PSD R, X output common EXPAND multiplier.
Display and output of EXPAND results also requires enabling EXPAND calculation with the :CALCulate5:MATH EXP command.
Parameter(s)  <multiplier>:{1|10|100}
Setting example  :CALC1:MULT  10  
Sets primary PSD R, X output common EXPAND multiplier to 10.
The effective sensitivity (full scale) is 1/10 of the setting.
Response  <multiplier>  {numeric, format NR1}
Query example  :CALC1:MULT?
Setting example  10  
primary PSD R, X output common EXPAND multiplier is 10.
Note  The EXPAND multiplier only affects X, Y, R. It does not affect other parameters.
5. Command explanation

**:CALCulate1:OFFSet**  <offset>

**Explanation**
Sets/queries the offset for the primary PSD's X output.
For offset adjustment, also enable offset with the
**:CALCulate1:OFFSet:STATe ON** command.

**Parameters**
<offset>  {numeric, range -105 to +105, resolution 0.001, unit %}
% is with respect to sensitivity full scale.

**Setting example**
**:CALC1:OFFS  43**
The offset for X is 43% of sensitivity full scale.
The equivalent of 43% of full scale is subtracted from the original X value.

**Response**
<offset>  {numeric, format NR3}

**Query example**
**:CALC1:OFFS?**

**Response example**
4.30000E+01
The X offset is 43%.

**Note**
The EXPAND multiplier is applied after offset adjustment.
Unless otherwise specified, the mantissa of the NR3 format responses has 6 digits.

**:CALCulate1:OFFSet:AUTO:ONCE**

**Explanation**
Automatically sets the X offset and Y offset so that primary PSD's X output
and Y output at that point become zero, and enables offset adjustment.

**Setting example**
**:CALC1:OFFS:AUTO:ONCE**
Automatically adjusts offset so that X output and Y output become zero.

**Note**
If the range of possible adjustment is exceeded, adjustment is made within the
possible range.
It takes about 100ms from execution to completion of adjustment.

**:CALCulate1:OFFSet:STATe**  {ON|OFF|1|0}

**Explanation**
Sets whether offset is adjusted for the primary PSD's X output.

**Parameter(s)**
{ON|1}  Enables offset adjustment.
{OFF|0}  Disables offset adjustment.

**Setting example**
**:CALC1:OFFS:STAT  ON**
Enables X offset adjustment.

**Response**
{1|0}

**Query example**
**:CALC1:OFFS:STAT?**

**Response example**
1
X offset adjustment is enabled.
5. Command explanation

**:CALCulate2:FORMat** {IMAGinary|PHASe|AUX1|AUX2|REAL2|MLINear2|IMAGinary2|PHASe2}

**:CALCulate2:FORMat?**

**Explanation**
Sets/queries the measurement parameters to be displayed and output as DATA2.

**Parameter(s)**
- **IMAGinary**
  - Y (= R sin θ, primary PSD)
  - Yp (= Rp sin θp, primary PSD)
- **PHASe**
  - θ, θp (primary PSD)
- **AUX1**
  - AUX IN 1 voltage
- **AUX2**
  - AUX IN 2 voltage
- **REAL2**
  - *1 Xs (= Rs cos θs, secondary PSD)
  - MLINear2**1**
  - Rs (= \( R_s = \sqrt{X_s^2 + Y_s^2} \), secondary PSD)
  - IMAGinary2**1**
  - Ys (= Rs sin θs, secondary PSD)
  - PHASe2**1**
  - θ, θs (secondary PSD)

Relationship to panel display is as follows.

<table>
<thead>
<tr>
<th>Detection mode→</th>
<th>SINGLE</th>
<th>DUAL1<strong>1</strong></th>
<th>DUAL2<strong>1</strong>, CASCADE<strong>1</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>IMAGinary</td>
<td>Y, Yn</td>
<td>Yp, Ypn</td>
<td>Yp</td>
</tr>
<tr>
<td>PHASe</td>
<td>θ, θn</td>
<td>θp, θpn</td>
<td>θp</td>
</tr>
<tr>
<td>AUX1</td>
<td>AUX1</td>
<td>AUX1</td>
<td>AUX1</td>
</tr>
<tr>
<td>AUX2</td>
<td>AUX2</td>
<td>AUX2</td>
<td>AUX2</td>
</tr>
<tr>
<td>REAL2<strong>1</strong></td>
<td>Xs, Xsn</td>
<td>Xs</td>
<td>Xs</td>
</tr>
<tr>
<td>MLINear2<strong>1</strong></td>
<td>Rs, Rsn</td>
<td>Rs</td>
<td>Rs</td>
</tr>
<tr>
<td>IMAGinary2<strong>1</strong></td>
<td>Ys, Ysn</td>
<td>Ys</td>
<td>Ys</td>
</tr>
<tr>
<td>PHASe2<strong>1</strong></td>
<td>θs, θsn</td>
<td>θs</td>
<td>θs</td>
</tr>
</tbody>
</table>

**Note**
Measurement parameters REAL2, MLIN2, IMAG2 and PHAS2 cannot be selected with the LI5645.
5. Command explanation

:CALCulate2: MULTIplier <multiplier>

Explanation
Sets/queries the primary PSD's Y output EXPAND multiplier.
Display and output of EXPAND results also requires enabling EXPAND calculation with the :CALCulate5:MATH EXP command.

Parameter(s)
<multiplier>: [{1|10|100}]

Setting example
:CALC2:MULT 10
Sets primary PSD output EXPAND multiplier to 10.
The effective sensitivity (full scale) is 1/10 of the setting.

Response
<multiplier> {numeric, format NR1}

Query example
:CALC2:MULT?

Response example
10
primary PSD's Y output common EXPAND multiplier is 10.

Note
The multiplier only affects X, Y, R. It does not affect other parameters.

:CALCulate2:OFFSet <offset>

:CALCulate2:OFFSet?

Explanation
Sets/queries the offset for the primary PSD's Y output.
For offset adjustment, also enable offset with the :CALCulate2:OFFSet:STATe ON command.

Parameters
<offset> {numeric, range -105 to +105, resolution 0.001, unit %}
% is with respect to sensitivity (full scale).

Setting example
:CALC2:OFFS 43
The offset for Y is 43% of sensitivity full scale.
The equivalent of 43% is subtracted from the original Y value.

Response
<offset> {numeric, format NR3}

Query example
:CALC2:OFFS?

Response example
4.300000E+01
The Y offset is 43%.

Note
The EXPAND multiplier is applied after offset adjustment.

:CALCulate2:OFFSet:AUTO:ONCE

Explanation
Automatically sets the X offset and Y offset so that primary PSD's X output and Y output at that point become zero.

Setting example
:CALC2:OFFS:AUTO:ONCE
Automatically adjusts offset so that X output and Y output become zero.

Note
This function is the same as that of the :CALCulate1:OFFSet:AUTO:ONCE command. Both of these commands work on both X and Y. Automatic setting of just X or just Y is not possible.
It takes about 100ms from execution to completion of adjustment.
5. Command explanation

:CALCulate2:OFFSet:STATe {ON|OFF|1|0}
:CALCulate2:OFFSet:STATe?

Explanation
Sets whether offset is adjusted for primary PSD's Y output.

Parameter(s)
{ON|1} Enables offset adjustment.
{OFF|0} Disables offset adjustment.

Setting example
:CALC2:OFFS:STAT ON
Enables Y offset adjustment.

Response
{1|0}

Query example
:CALC2:OFFS:STAT?

Response example
1
Y offset adjustment is enabled.

:CALCulate3:FORMat {REAL|MLINear|IMAGinary|PHASe|REAL2|MLINear2}
:CALCulate3:FORMat?

Explanation
Sets/queries the measurement parameters to be displayed and output as DATA3.

Parameter(s)
REAL X , Xp (primary PSD)
MLINear R , Rp (primary PSD)
IMAGinary Y , Yp (primary PSD)
PHASE θ , θp (primary PSD)
REAL2 *1 Xs (secondary PSD)
MLINear2 *1 Rs (secondary PSD)

Relationship to panel display is as follows.

Detection mode→ SINGLE DUAL1 *1 DUAL2 *1, CASCADE *1
REAL X , Xn Xp , Xpn Xp
MLINear R , Rp Rp , Rpn Rp
IMAGinary *2 Yp , Ypn Yp
PHASE *2 θp , θpn θp
REAL2 *1 *2 Xs , Xsn Xs
MLINear2 *1 *2 Rs , Rsn Rs

*1: LI5650 only. Not supported with LI5645.
*2: Setting not possible in SINGLE mode.

Setting example
:CALC3:FORM REAL
Set measurement parameter for DATA 3 to X (Xn, Xp, Xpn).

Response
{REAL|MLIN|IMAG|PHAS|REAL2|MLIN2}

Query example
:CALC2:FORM?

Response example
REAL
Measurement parameter for DATA 3 is X (Xn, Xp, Xpn).

Note
Measurement parameters REAL2 and MLIN2 cannot be selected with the LI5645.
5. Command explanation

:CALCulate3 :MULTiplier  <multiplier>

Explanation
Sets/queries the secondary PSD’s R, X output common EXPAND multiplier.
Display and output of EXPAND results also requires enabling EXPAND calculation with the :CALCulate5:MATH EXP command.

Parameter(s)  <multiplier>:[{1|10|100}]

Setting example  :CALC3:MULT 10
Sets secondary PSD R, X output common EXPAND multiplier to 10.
The effective sensitivity (full scale) is 1/10 of the setting.

Response  <multiplier> {numeric, format NR1}

Query example  :CALC3:MULT?

Setting example  10
Secondary PSD R, X output common EXPAND multiplier is 10.

Note This command cannot be used with the LI5645. An error will result.

:CALCulate3:OFFSet  <offset>

:CALCulate3:OFFSet?

Explanation
Sets/queries the offset with respect to the secondary PSD’s X output.
For offset adjustment, also enable offset with the :CALCulate3:OFFSet:STATe ON command.

Parameters  <offset>  {numeric, range -105 to +105, resolution 0.001, unit %}
% is with respect to sensitivity full scale.

Setting example  :CALC3:OFFS 43
Sets the offset with respect to secondary PSD X output to 43% of sensitivity full scale.
The equivalent of 43% is subtracted from the original X value.

Response  <offset>  {numeric, format NR3}

Query example  :CALC3:OFFS?

Response example  4.300000E+01
The offset with respect to secondary PSD X output is 43% of sensitivity full scale.

Note This command cannot be used with the LI5645. An error will result.

:CALCulate3:OFFSet:AUTO:ONCE

Explanation Automatically sets offset so that secondary PSD’s X and Y output become zero.

Setting example  :CALC3:OFFS:AUTO:ONCE
Automatically adjusts offset so that secondary PSD’s X and Y outputs become zero.

Note This command cannot be used with the LI5645. An error will result.
If the range of possible adjustment is exceeded, adjustment is made within the possible range.
It takes about 100ms from execution to completion of adjustment.
5. Command explanation

:CALCulate3:OFFSet:STATe \{ON\|OFF\|1\|0\}

:CALCulate3:OFFSet:STATe?

Explanation Sets whether offset is adjusted with respect to the secondary PSD's X output.

Parameter(s) \{ON\|1\} Enables offset adjustment.
\{OFF\|0\} Disables offset adjustment.

Setting example :CALC3:OFFS:STAT ON

Enables offset adjustment for the secondary PSD's X output.

Response \{1\|0\}

Query example :CALC3:OFFS:STAT?

Response example 1

Secondary PSD’s X offset adjustment is enabled.

Note This command cannot be used with the LI5645. An error will result.

:CALCulate4:FORMat \{IMAGinary|PHASE|REAL2|MLINear2|IMAGinary2|PHASE2\}

:CALCulate4:FORMat?

Explanation Sets/queries the measurement parameters to be displayed and output as DATA4.

Parameter(s) IMAGinary Y, Yp (primary PSD)
PHASE \(\theta, \theta_p\) (primary PSD)
REAL2 *1 Xs (secondary PSD)
MLINear2 *1 Rs (secondary PSD)
IMAGinary2 *1 Ys (secondary PSD)
PHASE2 *1 \(\theta_s\) (secondary PSD)

Relationship to panel display is as follows.

<table>
<thead>
<tr>
<th>Detection mode→</th>
<th>SINGLE</th>
<th>DUAL1 *1</th>
<th>DUAL2 *1, CASCADE *1</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMAGinary</td>
<td>Y, Yn</td>
<td>(Y_p, Y_{pn})</td>
<td>(Y_p)</td>
</tr>
<tr>
<td>PHASE</td>
<td>(\theta, \theta_n)</td>
<td>(\theta_p, \theta_{pn})</td>
<td>(\theta_p)</td>
</tr>
<tr>
<td>REAL2 *1</td>
<td>*2</td>
<td>(X_s, X_{sn})</td>
<td>(X_s)</td>
</tr>
<tr>
<td>MLINear2 *1</td>
<td>*2</td>
<td>(R_s, R_{sn})</td>
<td>(R_s)</td>
</tr>
<tr>
<td>IMAGinary2 *1</td>
<td>*2</td>
<td>(Y_s, Y_{sn})</td>
<td>(Y_s)</td>
</tr>
<tr>
<td>PHASE2 *1</td>
<td>*2</td>
<td>(\theta_s, \theta_{sn})</td>
<td>(\theta_s)</td>
</tr>
</tbody>
</table>

*1: LI5650 only. Not supported with LI5645.

*2: Setting not possible in SINGLE mode.

Setting example :CALC4:FORM IMAG
Set measurement parameter for DATA 4 to Y (Yn, Yp, Ypn).

Response \{IMAG\|PHAS\|REAL2\|MLIN2\|IMAG2\|PHASE2\}

Query example :CALC4:FORM?

Response example IMAG
Measurement parameter for DATA 4 is Y (Yn, Yp, Ypn).

Note Measurement parameters REAL2, MLIN2, IMAG2 and PHASE2 cannot be selected with the LI5645.
5. Command explanation

:CALCulate4:MUliplier  <multiplier>

:CALCulate4:MUliplier?

Explanation Sets/queries the secondary PSD's Y output EXPAND multiplier.
Display and output of EXPAND results also requires enabling EXPAND calculation with the :CALCulate5:MATH EXP command.

Parameter(s) <multiplier>: [1|10|100]

Setting example :CALC4:MULT 10
Sets secondary PSD output EXPAND multiplier to 10.
The effective sensitivity (full scale) is 1/10 of the setting.

Response <multiplier> {numeric, format NR1}

Query example :CALC4:MULT?

Response example 10
Secondary PSD's Y output common EXPAND multiplier is 10.

Note This command cannot be used with the LI5645. An error will result.

:CALCulate4:OFFSet  <offset>

:CALCulate4:OFFSet?

Explanation Sets/queries the offset for the secondary PSD's Y output.
For offset adjustment, also enable offset with the :CALCulate4:OFFSet:STATe ON command.

Parameters <offset> {numeric, range -105 to +105, resolution 0.001, unit %}
% is with respect to sensitivity full scale.

Setting example :CALC4:OFFS 43
Sets the offset with respect to secondary PSD Y output to 43% of sensitivity full scale.
The equivalent of 43% is subtracted from the original Y value.

Response <offset> {numeric, format NR3}

Query example :CALC4:OFFS?

Response example 4.300000E+01
The offset with respect to secondary PSD Y output is 43% of sensitivity full scale.

Note This command cannot be used with the LI5645. An error will result.
5. Command explanation

:CALCulate4:OFFSet:AUTo:ONCE

Explanation: Automatically sets offset so that secondary PSD’s X and Y output become zero.

Setting example: :

:CALC4:OFFS:AUTo:ONCE

Automatically adjusts offset so that secondary PSD’s X and Y outputs become zero.

Note: This command cannot be used with the L15645. An error will result.

This function is the same as that of the :CALCulate3:OFFSet:AUTo:ONCE command. Both of these commands work on both X and Y. Automatic setting of just X or just Y is not possible.

It takes about 100ms from execution to completion of adjustment.

:CALCulate4:OFFSet:STATe {ON|OFF|1|0}

:CALCulate4:OFFSet:STATe?

Explanation: Sets whether offset is adjusted for secondary PSD’s Y output.

Parameter(s): {ON|1} Enables offset adjustment.

{OFF|0} Disables offset adjustment.

Setting example: :

:CALC4:OFFS:STAT ON

Enables offset adjustment for the secondary PSD’s Y output.

Response: {1|0}

Query example: :

:CALC4:OFFS:STAT?

Response example: 1

Secondary PSD’s Y offset adjustment is enabled.

Note: This command cannot be used with the L15645. An error will result.

:CALCulate5:MATH {OFF|EXPand|NORMalize|RATio}

:CALCulate5:MATH?

Explanation: Sets/queries the calculation method for measurement value to be displayed and output.

One method can be selected from among EXPAND, normalize calculation, and ratio calculation.

Parameter(s): OFF No calculation is performed on the measurement value.

EXPand Enables EXPAND (enlarge).

NORMalize Enables normalize calculation

RATio Enables ratio calculation.

Setting example: :

:CALC5:MATH EXP

Enables EXPAND.

Response: {OFF|EXP|NORM|RAT}

Query example: :

:CALC5:MATH?

Response example: OFF

Calculation is not performed on measurement values.
5. Command explanation

:CALCulate5:MATH:EXPRession:NAME  {RATio|RATio2}

:CALCulate5:MATH:EXPRession:NAME?

Explanation
Sets/queries the ratio calculation format.
Display and output of results also requires enabling ratio calculation with the :CALCulate5:MATH RATio command.

Parameter(s)
RATio: Normal ratio calculation (denominator: AUX IN 1)
This can be used with every detection mode.
Result (In SINGLE, DUAL1, or DUAL2 mode) =
  Ratio multiplier
  × primary PSD output (X, Y, R [% of FS])
  / AUX IN 1 [% of FS]
Result (In CASCADE mode) =
  Ratio multiplier
  × secondary PSD output (X, Y, R [% of FS])
  / AUX IN 1 [% of FS]
RATio2: Expanded ratio calculation (denominator: secondary PSD output)
Can only be used with DUAL1 and DUAL2 detection modes.
Result =
  Ratio multiplier
  × primary PSD output (X, Y, R [% of FS])
  / secondary PSD output [X % of FS]

Setting example
:CALC5:MATH:EXPR:NAME  RAT
Sets RATio as the calculation format.

Response
{RAT|RAT2}

Query example
:CALC5:MATH:EXPR:NAME?

Response example
RAT
The ratio calculation format is RATio.

Note
When the ratio calculation is invalid, the ratio calculation is not carried, it does not result in an error.
5. Command explanation

**:CALCulate5 :MULTiplier <factor>**

**Explanation**
Sets/queries the ratio multiplier.

**Parameter(s)**
<factor> {numeric, range 0.10000 to 10.00000, resolution 0.00001}

**Setting example**
:CALC5:MULT 2
Sets the ratio multiplier to 2.

**Response**
{numeric, format NR3}

**Query example**
:CALC5:MULT?

**Response example**
2.000000E+00
The ratio multiplier is 2.

**:DATA:COUNt? {BUF1|BUF2|BUF3}**

**Explanation**
Queries the number of data sampling points recorded in the measurement data buffer.

**Parameter(s)**
BUF1 Indicates that measurement data buffer 1 is to be queried.
BUF2 Indicates that measurement data buffer 2 is to be queried.
BUF3 Indicates that measurement data buffer 3 is to be queried.

**Response**
<number of sample points>
BUF1, BUF2 {numeric, format NR1, range 0 to 8192}
BUF3 {numeric, format NR1, range 0 to 65536}

**Query example**
:DATA:COUN? BUF1

**Response example**
256
The number of measurement data samples recorded in measurement data buffer 1 is 256.

**Note**
When the measurement data buffer is empty, the response is 0.

Clearing the measurement data buffer **:DATA:DELe te** command
### :DATA:DATA? \{BUF1|BUF2|BUF3\} [, <block length>[, <start position>]]

**Explanation**  
Queries the contents of the measurement data buffer (the measurement values).

**Parameter(s)**  
- BUF1: Indicates that measurement data buffer 1 is to be queried.
- BUF2: Indicates that measurement data buffer 2 is to be queried.
- BUF3: Indicates that measurement data buffer 3 is to be queried.

- **<block length>**  
  \{numeric, format NR1, range 1 .. buffer size\}
  
  Sets the block length of measurement data to be acquired from the buffer (the number of sample points). Measurement data is separated into blocks for transmission. If the block length is omitted, all of the measurement data is returned as a single block.

- **<start position>**  
  \{numeric, format NR1, range 0 .. buffer size-1\}
  
  Specifies the start position of measurement data to be acquired. If omitted, data is acquired from the recording start position. This specification is invalid if used with BUF3.

**Response**  
Content of BUF1, BUF2, or BUF3

- **<measurement data block>**  
  
  \(<measurement data set a>[, <measurement data set a+1>, .. , <measurement data set a+(b-1)>] <message terminator>\)
  
  a: Specified record start position
  b: Specified block length
<measurement data set>

[STATUS], [DATA1], [DATA2], [DATA3], [DATA4], [FREQ]

This is a set of measurements for one sample point.

Content specification  :DATA:FEED command

STATUS  \{ numeric, range 0 to 31 \}
0  No abnormality
1  PROTECT
   Voltage a signal input connector A or B exceeds rated limit.
2  INPUT
   Over level somewhere from the signal input connector to the PSD
4  OUTPUT
   Over level at a time constant filter, amplification, or calculation
downstream from the PSD.
8  AUX
   Maximum input voltage exceeded at AUX IN 1 or 2.
16 UNLOCK
   The reference signal source is REF IN or SIGNAL and is not
   synchronized.

DATA1, DATA2, DATA3, DATA4, FREQ

Data transfer formats for each value  :FORMat[:DATA] command

The measurement data block and measurement data set above show the
format in ASCII. The sequence of values are the same for both real
numbers and integers, but commas are not used to delimit values, no
message terminator is appended, and a single measurement data block is
transferred as a single fixed length data block.

Note

If the number of measurement data sets from the specified start position do not
fill the specified block length, remaining places in the measurement data set
are filled with zeros.

When the content of BUF3 is queried, measurement data blocks are sent
starting with the oldest data. The data read is deleted from the measurement
data buffer, releasing a proportionate amount of space in the buffer (First In,
First Out).

Query example  :DATA:DATA?  BUF1

Response example  2.732512E-01, 1.215909E+02, 2.733309E-01, 1.215591E+02, ...

Deriving the actual value  :FORMat[:DATA] command

(When :DATA:FEED BUF1.6;:FORM ASC is set taking DATA1 as R, DATA2 as θ)
5. Command explanation

:DATA:DELe {BUF1|BUF2|BUF3}
Explanation: Clears the specified measurement data buffer.
Parameter(s):
BUF1  Clears measurement data buffer 1.
BUF2  Clears measurement data buffer 2.
BUF3  Clears measurement data buffer 3.
Setting example:
:DATA:DEL  BUF1
Clears measurement data buffer 1.

:DATA:DELe:ALL
Explanation: Clears all measurement data buffers.
Setting example:
:DATA:DEL:ALL
Clears measurement data buffers 1, 2, and 3.

Note: Clearing a specified measurement data buffer
:DATA:DELe command

:DATA:FEED  {BUF1|BUF2|BUF3}, <measurement data>
:DATA:FEED?  {BUF1|BUF2|BUF3}
Explanation: Sets/queries measurement data sets recorded in measurement data buffer 1, 2, or 3. Recording of measurement data is specified separately using the :DATA:FEED:CONT command.
Parameter(s):
BUF1  Indicates that measurement data buffer 1 is to be set/queried.
BUF2  Indicates that measurement data buffer 2 is to be set/queried.
BUF3  Indicates that measurement data buffer 3 is to be set/queried.
<measurement data>
{numeric, range 0 to 63}
1  STATUS (16 bits = 1 word)
   Records the measurement status.
   Measurement status content :DATA:DATA command
2  DATA1 (16 bits = 1 word)
   Records the value of DATA1.
4  DATA2 (16 bits = 1 word)
   Records the value of DATA2.
8  DATA3 (16 bits = 1 word)
   Records the value of DATA3.
16  DATA4 (16 bits = 1 word)
   Records the value of DATA4.
32  FREQ (32 bits = 2 words)
   Records the frequency value.
   The fundamental wave or primary frequency is recorded when the detection mode is SINGLE, DUAL1, or DUAL2, and the secondary frequency is recorded when the detection mode is CASCADE.

When recording multiple measurement data simultaneously, a maximum of 5
words can be selected. It is not possible to select the same parameter more than once. Data is recorded starting with the smallest value. It is not possible to change the recording sequence. Nothing is recorded if 0 is set.

**Setting example**

`:DATA:FEED  BUF1, 2

Set recording so that only the value of DATA1 is recorded in measurement data buffer 1.

**Response**

{numeric, format NR1, range 0 to 63}

**Query example**

`:DATA:FEED?  BUF1

Response example

3

Measurement data recorded in measurement data buffer 1 is STATUS and DATA1.

**Note**

Measurement data recording format and resolution

BUF1, BUF2, BUF3: 16-bit signed integer (-32,768 to +32,767)

Frequency recording format and resolution

32-bit unsigned integer (0 to 4,294,967,295)

Actual values can be calculated with reference to full scale.

**Derivation**

:FORMat[:DATA] command

When the measurement data set stored in a measurement data buffer is changed, that measurement data buffer is cleared. The maximum recording rate depends on the recording parameters and is limited.

**:DATA:FEED:CONTrol {BUF1|BUF2|BUF3}, {ALWays|NEVer}**

**:DATA:FEED:CONTrol? {BUF1|BUF2|BUF3}**

**Explanation**

Sets/queries whether measurement data is to be recorded in a measurement data buffer.

**Parameter(s)**

BUF1 Indicates that measurement data buffer 1 is to be set/queried.

BUF2 Indicates that measurement data buffer 2 is to be set/queried.

BUF3 Indicates that measurement data buffer 3 is to be set/queried.

ALWays Indicates that measurement data is to be recorded.

NEVer Indicates that measurement data is not to be recorded.

**Setting example**

`:DATA:FEED:CONT  BUF1,ALW

Sets recording of measurement in measurement data buffer 1.

**Response**

{ALW|NEV}

**Query example**

`:DATA:FEED:CONT?  BUF1

Response example

ALW

Measurement data buffer 1 is set for recording of measurement data.

**Note**

Details of measurement data to be recorded

:DATA:FEED command

Simultaneous recording to multiple measurement data buffers is not possible. When one of the buffer is set to ALWays, all other buffers are NEVer.

Once recording of measurement data to a measurement data buffer has been set, measurement data is not sent to the output buffer.
5. Command explanation

:DATA:POINts  {BUF1|BUF2|BUF3}, <buffer size>
:DATA:POINts?  {BUF1|BUF2|BUF3}

Explanation
Sets/queries measurement data buffer size.
When size is set, the specified measurement data buffer is cleared.
Size is specified in sample points.

Parameter(s)
BUF1  Indicates that measurement data buffer 1 is to be set/queried.
BUF2  Indicates that measurement data buffer 2 is to be set/queried.
BUF3  Indicates that measurement data buffer 3 is to be set/queried.

<buffer size>  Can be specified as MAX or MIN.

BUF1, BUF2  {numeric, range 16 to 8192}
BUF3  {numeric, range 16 to 65536}

Setting example
:DATA:POIN  BUF1, 100
Sets the size of measurement data buffer 1 to 100 (sample points).

Response  {numeric, format NR1}

Query example
:DATA:POIN?  BUF1
Response example  100
Measurement data buffer size is 100 (sample points).

Note
When the measurement data buffer becomes full, the full status is set and
further measurement data is not recorded.

☞  "6.4 Operation status"
After the buffer becomes full, clear it to resume recording.

:DATA:TIMer  <time interval>
:DATA:TIMer?

Explanation
Sets/queries the internal timer time interval.
The internal timer must be enabled with the :DATA:TIMer:STATE command.

Parameter(s)
<time interval>  {numeric, range 9.6E-6 to 20, unit s, resolution 640ns }
The suffix M (10^-3) and unit S may be used.

Setting example
:DATA:TIM  10E-3
Sets the time interval to 10 ms.

Response  {numeric, format NR3}

Query example
:DATA:TIM?
Response example  1.000000E-02
Time interval is 10ms.
5. Command explanation

**:DATA:TIMer:STATe** {ON|OFF|1|0}

*:DATA:TIMer:STATe?*

**Explanation**
Sets/queries the internal timer.

When recording to the measurement data buffer is enabled, measurement data is recorded at the set time interval when the internal timer is enabled.

Enabling measurement data buffer  :DATA:FEED:CONTrol command

Setting time interval  :DATA:TIMer command

**Parameter(s)**

{ON[1]} Enables the internal timer.
{OFF[0]} Disables the internal timer.

**Setting example**

:DATA:TIM:STAT  1

Enables the internal timer.

**Response**

{1|0}

**Query example**

:DATA:TIM:STAT?

**Response example**

1

Internal timer is disabled.

**:DISPlay[:MENU][:NAME]  {NORMal|LARGe|FINE}**

**:DISPlay[:MENU][:NAME]?

**Explanation**
Sets/queries the measurement screen.

**Parameter(s)**

NORMal Standard measurement screen
LARGe Enlarged measurement screen (displays measurement values in large size)
FINE Detailed measurement screen (displays as many settings as possible)

**Setting example**

:DISP  LARG

Displays measurement values in large size.

**Response**

{NORM|LARG|FINE}

**Query example**

:DISP?

**Response example**

LARG

Measurement values are displayed in large size mode.

**:DISPlay:WINDow[:STATe]  {ON|OFF|1|0}**

**:DISPlay:WINDow[:STATe]?**

**Example**
Sets/queries lamp/display on/off state.

**Parameter(s)**

{ON[1]} On
{OFF[0]} Off

**Setting example**

:DISP:WIND  OFF

Turns off the lamp and display.

**Response**

{1|0}

**Query example**

:DISP:WIND?

**Response example**

0

Lamp and display are off.
5. Command explanation

**:FETCh?*

**Explanation**
Queries the most recent measurement data.

**Response**
<measurement data set>

[STATUS], [DATA1], [DATA2], [DATA3], [DATA4], [FREQ]

Content specification

\[[:SENSe]:DATA\] command

**STATUS**

{numeric, range 0 to 31}

0  No abnormality
1  PROTECT
   Voltage a signal input connector A or B exceeds rated limit.
2  INPUT
   Over level somewhere from the signal input connector to the PSD
4  OUTPUT
   Over level at a time constant filter, amplification, or calculation downstream from the PSD.
8  AUX
   Maximum input voltage exceeded at AUX IN 1 or 2.
16 UNLOCK
   The reference signal source is REF IN or SIGNAL and is not synchronized.

**DATA1, DATA2, DATA3, DATA4, FREQ**
For data transfer formats for each value

\[[:FORMat[:DATA]]\] command

**Query example**
:FETC?

**Response example**
0, 3.456789E-06, 1.234567E+02
(with :DATA 7;:FORM ASC)
STATUS = 0 (no abnormality),
DATA1 = 3.456789E-06, DATA2 = 1.234567E+02 (123.4567)

**Note**
Correct measurement values cannot be obtained if INPUT is over-level. Verify STATUS and "6.5 Questionable status" along with measurement values.
Although the frequency value is indeterminate in the UNLOCK state, measurement values of DATA1 etc. can still be obtained.
There can be some displacement between measured values, measurement status, and sampling time of frequency values.
5. Command explanation

**:FORMat[:DATA] {ASCii|REAL|INTeger}**

**:FORMat[:DATA]?**

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Sets/queries the data transfer format. The set data transfer format applies to response messages returned to the :DATA:DATA? and FETCh? queries.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter(s)</td>
<td>ASCII     ASCII format (NR1, NR2, NR3, character string)</td>
</tr>
<tr>
<td></td>
<td>REAL       Real number format (double-precision floating point, 64-bit binary)</td>
</tr>
<tr>
<td></td>
<td>INTeger    Integer format (signed, 2's complement format, 16-bit binary)</td>
</tr>
<tr>
<td>Setting example</td>
<td>:FORM  ASC</td>
</tr>
<tr>
<td>Response</td>
<td>{ASC[REAL</td>
</tr>
<tr>
<td>Query example</td>
<td>:FORM?</td>
</tr>
<tr>
<td>Response example</td>
<td>ASC</td>
</tr>
</tbody>
</table>

■ ASCII format

Data is represented by characters, and characters are transferred as ASCII codes.

Depending on the parameter, numerics are transferred in one of the following formats.

- **NR1** Integer (example: 123)
- **NR2** Decimal format without an exponent (example: 0.123456)
- **NR3** Decimal format with an exponent (example: 1.234567E-07)

When multiple numeric values are transferred, they are delimited with commas (,). A message terminator (such as LF^EOI) is appended to the end.

■ Real number format

Data is transferred in 64-bit double-precision floating point format conforming to IEEE 754. If there are multiple numeric data, they are all transferred in double-precision floating point format.

```
# <number of digits> <number of bytes> <data>

# is attached at the beginning.
<number of digits> Indicates the number of digits in the character string indicating the number of bytes (1 byte).
<number of bytes> Indicates the number of bytes of all data (a multiple of 8).
<data> A double-precision floating point number (8 bytes).
```

From the most significant bit, the sign bit, an 11-bit exponent, and a 52-bit mantissa. Data is transferred in sequence from the most significant byte to the least significant byte.

When transferring multiple numeric data, the data is transferred continuously without delimiters (such as commas). The structure above is for formulated length data blocks in IEEE 488.2. No message terminator is appended.
5. Command explanation

- Integer format

Data is transferred in 16-bit signed integer format (-32,768 to +32,767).

If there are multiple numeric data, they are all transferred in 16-bit signed integer format.

```
# <number of digits> <number of bytes> <data>
```

- # is attached at the beginning.
- <number of digits> Indicates the number of digits in the character string indicating the number of bytes (1 byte).
- <number of bytes> Indicates the number of bytes of all data (an even number).
- <data> 16-bit signed integer (two's complement).

Data is transferred in sequence from the most significant byte to the least significant byte.

When transferring multiple numeric data, the data is transferred continuously without delimiters (such as commas).

The structure above is for formulated length data blocks in IEEE 488.2. No message terminator is appended.

The actual value of parameters acquired in integer format can be obtained by the following expression.

The same applies to 16-bit data recorded in the measurement data buffer.

Measured value = output data × 2^-15 × 1.2 × meter full scale (see below)

<table>
<thead>
<tr>
<th>Parameter(s)</th>
<th>meter full scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>X, Y, R, NOISE</td>
<td>sensitivity/enlargement ratio (EXPAND)</td>
</tr>
<tr>
<td>RATIO</td>
<td>2</td>
</tr>
<tr>
<td>dB</td>
<td>100 dB</td>
</tr>
<tr>
<td>%</td>
<td>200 %</td>
</tr>
<tr>
<td>%FS</td>
<td>100 %</td>
</tr>
<tr>
<td>AUX IN1</td>
<td>12.5 V / 1.2</td>
</tr>
<tr>
<td>AUX IN2</td>
<td>12.5 V / 1.2</td>
</tr>
<tr>
<td>θ</td>
<td>180° / 1.2</td>
</tr>
</tbody>
</table>

(If the converted result is greater or equal to 180°, 360° is subtracted to bring it within the range -180.000 to +179.999).

Frequency (32-bit data, see below)

Proper measurement results cannot be obtained if the sensitivity setting specified when querying data recorded in the measurement data buffer differs from that specified for recording.

The 32-bit data (frequency) is split into two unsigned 16-bit integers (0 to 65,535) for transfer in the sequence: upper part, lower part. The actual value can be obtained by the following expression.

\[
\text{Frequency} = (A \times 2^{10} + B) \times 2^{-32} \times 300kHz
\]
5. Command explanation

:INITiate[:IMMediate]

Explanation When recording to the measurement data buffer is enabled and the trigger system is in the idle state, the system transitions to the awaiting trigger state.

Enabling measurement data buffer :DATA:FEED:CONTrol command

Setting example :INIT
Sets the awaiting trigger state.

Note If the measurement data buffer becomes full during recording, the trigger system enters the idle state. Transition to the awaiting trigger state is not possible as long as the measurement data buffer remains full. As necessary, the buffer must be cleared.

Clearing the measurement data buffer :DATA:DELeTe fcommand

:INPut[1]:COUPling {AC|DC}

:INPut[1]:COUPling?

Explanation Sets/queries the signal input result method.

Parameter(s) AC AC coupling (cutoff frequency approx. 0.1 Hz)
DC DC coupling

Setting example :INP:COUP AC
Sets AC coupling.

Response {AC|DC}

Query example :INP:COUP?

Response example AC
Input is AC coupled.

Note With current input, coupling takes place after current-voltage conversion.
5. Command explanation

:INPut[1]:FILTer:NOTCh1:FREQuency  {50|60}

:INPut[1]:FILTer:NOTCh1:FREQuency?

Explanation  Sets/queries the notch filter (fundamental wave) center frequency. The notch filter removes power supply frequency noise.

Parameter(s)  {numeric, range {50|60} }  Specifiable in Hz.

50  50 Hz

60  60 Hz

Setting example  :INP:FILT:NOTC:FREQ  60
Sets the center frequency to 60 Hz.

Response  {numeric, format NR1, range  {50|60} }

Query example  :INP:FILT:NOTC:FRE

Response example  60
The center frequency is 60 Hz.

:INPut[1]:FILTer:NOTCh1[:STATe]  {ON|OFF|1|0}

:INPut[1]:FILTer:NOTCh1[:STATe]?

Explanation  Sets/queries the notch filter (fundamental wave). The power supply fundamental wave (50 or 60 Hz) can be removed.

Parameter(s)  {ON|1}  Enables the notch filter.

{OFF|0}  Disables the notch filter (thru setting).

Setting example  :INP:FILT:NOTC  ON
Enables the notch filter.

Response  {1|0}

Query example  :INP:FILT:NOTC?

Response example  1
The notch filter is enabled.

:INPut[1]:FILTer:NOTCh2[:STATe]  {ON|OFF|1|0}

:INPut[1]:FILTer:NOTCh2[:STATe]?

Explanation  Sets/queries the notch filter (second harmonic). The power supply second harmonic (100 or 120 Hz) can be removed.

Parameter(s)  {ON|1}  Enables the notch filter (second harmonic).

{OFF|0}  Disables the notch filter (second harmonic) (thru setting).

Setting example  :INP:FILT:NOTC2  ON
Enables the notch filter (second harmonic).

Response  {1|0}

Query example  :INP:FILT:NOTC2?

Response example  1
The notch filter (second harmonic) is enabled.
5. Command explanation

:INPut[1]:GAIN  {IE6|IE8}

Explanation Sets/queries the current-voltage conversion gain for current input. For current input measurement, the I terminal is enabled with the :ROUTe[1]:TERMinals I command.

Parameter(s)  
IE6  Conversion gain 1 MV/A, 1 µAmax
IE8  Conversion gain 100 MV/A, 10 nAmax

Setting example :INP:GAIN  IE6
Sets the current-voltage conversion gain to 1MV/A

Response  
:INP:GAIN?  

Response example  
IE6  
The current-voltage conversion gain is 1MV/A.

Note  
This command cannot be used with the LI5645. An error will result.

:INPut[1]:LOW  {FLOat|GROund}

Explanation Sets/queries grounding of the signal input connector's outer conductor.

Parameter(s)  
FLOat  Sets the input connector's outer conductor to float.
GROund  Grounds the input connector's outer conductor to the chassis.

Setting example :INP:LOW  FLO
Sets the input connector's outer conductor to float.

Response  
:INP:LOW?  

Response example  
FLO  
The input connector's outer conductor is floating.
5. Command explanation

:INPut[1]:OFFSet:AUTO  {ON|OFF|1|0}

Explanation: Sets/queries the PSD input offset continuous auto adjustment function.

Parameter(s):
{ON|1} Enables continuous automatic adjustment of PSD input offset.
{OFF|0} Disables continuous automatic adjustment of PSD input offset.

The automatic adjustment setting is retained.

To disable adjustment (the factory default setting), execute the :INPut[1]:OFFSet:RST command.

Setting example: :INP:OFFS:AUTO  ON

The PSD input offset is continuously automatically adjusted.

Response: {1|0}

Query example: :INP:OFFS:AUTO?

Response example: 0 Continuous automatic adjustment of PSD input offset disabled.

:INPut[1]:OFFSet:AUTO:ONCE

Explanation: PSD input offset is automatically adjusted just once.

Setting example: :INP:OFFS:AUTO:ONCE

Note: It takes about 100ms from execution to completion of adjustment.

:INPut[1]:OFFSet:RST

Explanation: Disables PSD input offset adjustment and restores the factory default setting.

This sets :INPut[1]:OFFSet:AUTO OFF.

Setting example: :INP:OFFS:RST

Disables PSD input offset adjustment.

:INPut[1]:OFFSet:STIMe  <response time>

:INPut[1]:OFFSet:STIMe?

Explanation: Sets/queries response time for the PSD input offset continuous auto adjustment function.

Parameter(s): <time constant> {numeric, range {200E-3|750E-3|3000E-3}, unit s}

Rounding is applied to arbitrary values specified.

Setting example: :INP:OFFS:STIM  200E-3

Sets the response time to 200ms.

Response: {numeric, format NR3}

Query example: :INP:OFFS:STIM?

Response example: 2.00000E-01 The response time is 200ms.
5. Command explanation

:INPut2:TYPE {SINusoid|TPOS|TNEG}

:INPut2:TYPE?

Explanation Sets/queries the reference signal waveform.

Parameter(s)  
SINusoid  Sine wave (reference phase: point at which the rising slope intersects the average value.)
TPOS  TTL level rising edge
TNEG  TTL level falling edge

Operation is the same with square or pulse waveforms, but phase may differ somewhat from that with the sine wave.

Setting example  
:INP2:TYPE  SIN  
Sets sine wave as the reference signal waveform.

Response {SIN|TPOS|TNEG}

Query example  
:INP:TYPE?

Response example  
SIN  
The reference signal waveform is sine wave.

:MEMory:STATe:DELete <memory number>

Explanation Clears the contents of the specified configuration memory.

Parameter(s)  
<memory number>  {numeric, range 1 to 9}

An out-of-range value will result in an error.

Setting example  
:MEM:STAT:DEL  1  
Clears the contents of configuration memory 1.

Note  
Clearing configuration memory restores the factory default values.
The memory name changes to “memory#N” (when N is the memory number).

:MEMory:STATe:DEFine "Name", <memory number>

:MEMory:STATe:DEFine? <memory number>

Explanation Changes the name of the specified configuration memory.
Also queries the memory name of the specified configuration memory.

Parameter(s)  
<memory number>  {numeric, range 1 - 9} An error results if range exceeded.
"Name"  Can be set as a string of alphanumerics of up to 8 characters.

Characters allowed are {A to Z, a to z, 0 to 9, #, @, -, (space)}

Setting example  
:MEM:STAT:DEF "name",5  
Changes the current name setting of configuration memory 5 to "name".

Response "Name"  alphanumerics, up to 8 characters

Query example  
:MEM:STAT:DEF?  5  
Response example  
"name"  
The memory name of configuration memory 5 is "name".
5. Command explanation

**:OUTPut[1]:STATE**  {ON|OFF|1|0}

**Explanation**
Sets/queries the output state of the DATA1 terminal.

**Parameter(s)**
- ON[1] Enables output of the DATA1 terminal.
- OFF[0] Disables output of the DATA1 terminal.

**Setting example**
:OUTP  ON
DATA1 terminal output is enabled.

**Response**
{1|0}

**Query example**
:OUTP?

**Response example**
1
DATA1 terminal output is enabled.

**Note**
Display will continue showing output as enabled even when it is disabled.

**:**OUTPut2[:STATE]  {ON|OFF|1|0}

**Explanation**
Sets/queries the output state of the DATA2 terminal.

**Parameter(s)**
- ON[1] Enables output of the DATA2 terminal.
- OFF[0] Disables output of the DATA2 terminal.

**Setting example**
:OUTP2  ON
DATA2 terminal output is enabled.

**Response**
{1|0}

**Query example**
:OUTP2?

**Response example**
1
DATA2 terminal output is enabled.

**Note**
Display will continue showing output as enabled even when it is disabled.

**:**OUTPut3[:STATE]  {ON|OFF|1|0}

**Explanation**
Sets/queries the output state of the DATA3 terminal.

**Parameter(s)**
- ON[1] Enables output of the DATA3 terminal.
- OFF[0] Disables output of the DATA3 terminal.

**Setting example**
:OUTP3  ON
DATA3 terminal output is enabled.

**Response**
{1|0}

**Query example**
:OUTP3?

**Response example**
1
DATA3 terminal output is enabled.

**Note**
Display will continue showing output as enabled even when it is disabled.
5. Command explanation

:OUTPut4[:STATe] {ON|OFF|1|0}

:OUTPut4[:STATe]?

Explanation: Sets/queries the output state of the DATA4 terminal.

Parameter(s): {ON|1} Enables output of the DATA4 terminal.
{OFF|0} Disables output of the DATA4 terminal.

Setting example: :OUTP4 ON

DATA4 terminal output is enabled.

Response: {1|0}

Query example: :OUTP4?

Response example: 1

DATA4 terminal output is enabled.

Note: Display will continue showing output as enabled even when it is disabled.

:ROUTEe[1][:TERMinals] {A|AB|I}

:ROUTEe[1][:TERMinals]?

Explanation: Sets/queries the signal input connector.

Parameter(s): A Single end voltage (terminal A, 1 V max)
AB Differential voltage (terminal A-B, 1 V max)
I Current (terminal I, 1 μA max when conversion gain is 1MV/A
10 nA max when conversion gain is 100MV/A)

Setting example: :ROUT AB

Sets the terminal A-B differential voltage as the input signal.

Response: {A|AB|I}

Query example: :ROUT?

Response example: AB

The input signal is the terminal A-B differential voltage.

Note: Signal input connector I cannot be selected with the LI5645.

:ROUTE2[:TERMinals] {RINPut|IOSC|SINPut}

:ROUTE2[:TERMinals]?

Explanation: Sets/queries the reference signal source.

Parameter(s): RINPut REFERENCE INPUT Connector
IOSC Internal oscillator
SINPut SIGNAL input connector

Setting example: :ROUT2 RINP

Sets the reference signal source to the REFERENCE INPUT connector.

Response: {RINP|IOSC|SINPut}

Query example: :ROUT2?

Response example: RINP

The reference signal source is the REFERENCE INPUT connector.
5. Command explanation

[:SENSe]:AUTO:ONCE

Explanation  Automatically sets the sensitivity and time constant once to match the reference signal for the signal being measured at the time.
This corresponds to the panel operation AUTO \rightarrow [ MEASURE ].

Setting example  :AUTO:ONCE
Performs auto setting one time.

[:SENSe]:CURRent[1]:AC:RANGe:AUTO  {ON|OFF|1|0}

[:SENSe]:CURRent[1]:AC:RANGe:AUTO?

Explanation  Sets/queries the current sensitivity continuous automatic selection function.
When current sensitivity is set automatically, dynamic reserve is also set automatically.

Parameter(s)  {ON[1]} Enables continuous automatic selection of current sensitivity.
{OFF[0]} Disables continuous automatic selection of current sensitivity.

Setting example  :CURR:AC:RANG:AUTO  ON
Continuous automatic selection of current sensitivity is enabled.

Response  {1|0}

Query example  :CURR:AC:RANG:AUTO?

Response example  0
Continuous automatic selection of current sensitivity is disabled.

Note  This command cannot be used with the LI5645. An error will result.
With voltage input, the voltage sensitivity is set automatically.

[:SENSe]:CURRent[1]:AC:RANGe:AUTO:ONCE

Explanation  Automatically sets current sensitivity one time.
When current sensitivity is set automatically, dynamic reserve is also set automatically.

Setting example  :CURR:AC:RANG:AUTO:ONCE
Automatically sets current sensitivity one time.

Note  This command cannot be used with the LI5645. An error will result.
With voltage input, the voltage sensitivity is set automatically.
[:SENSe]:CURRent[1]:AC:RANGe[:UPPer]  <current sensitivity>
[:SENSe]:CURRent[1]:AC:RANGe[:UPPer]?

Explanation
Sets/queries the current sensitivity (primary PSD).

Parameter(s)
- <current sensitivity>  {numeric, range {10E-15|20E-15..|1E-6}, unit Arms}
  Rounding is applied to arbitrary values specified.
  The unit A can be used.

Current sensitivity is the product of the current-voltage conversion gain and the voltage sensitivity.

The range of current sensitivity that can be selected is dependent on the current-voltage conversion gain that is set with the ROUT[1] command.

1MV/A  100E-15(1E-12) to 1E-6 A
100MV/A  10E-15(100E-15) to 10E-9 A

Values in parentheses apply when DATA1 is NOISE.

Setting example
:CURR:AC:RANG  1E-9
Sets current sensitivity (full scale) to 1nA.

Response
<current sensitivity> : {numeric, format NR3, unit A}

Query example
:CURR:AC:RANG?
Response example
1.000000E-09
Current sensitivity (full scale) is 1nA.

Note
This command cannot be used with the LI5645. An error will result.

When in dual mode, the current sensitivity of the secondary PSD is changed to match that of the primary PSD if the sensitivity set for the primary PSD is lower than that of the secondary PSD.

[:SENSe]:CURRent2:AC:RANGe[:UPPer]  <current sensitivity>
[:SENSe]:CURRent2:AC:RANGe[:UPPer]?

Explanation
Sets/queries the current sensitivity (secondary PSD).

Parameter(s)
- <current sensitivity>  {numeric, range {10E-15|20E-15..|1E-6}, unit Arms}
  Rounding is applied to arbitrary values specified.
  The unit A can be used.

Current sensitivity is the product of the current-voltage conversion gain and the voltage sensitivity.

The range of current sensitivity that can be selected is dependent on the current-voltage conversion gain that is set with the ROUT[1] command.

1MV/A  100E-15(1E-12) to 1E-6 A
100MV/A  10E-15(100E-15) to 10E-9 A

Values in parentheses apply when DATA1 is NOISE.

Setting example
:CURR2:AC:RANG  1E-9
Sets current sensitivity (full scale) to 1nA.

Response
<current sensitivity> : {numeric, format NR3}

Query example
:CURR2:AC:RANG?
Response example
1.000000E-09
Secondary PSD current sensitivity (full scale) is 1nA.

Note
This command cannot be used with the LI5645. An error will result.

When in dual mode, the current sensitivity of the secondary PSD cannot be set to a higher level than that of the primary PSD. An error will result.
[:SENSe]:DATA  <measurement data>

[:SENSe]:DATA?

Explanations
Sets/queries measurement data sets that are read by the :FETCh? query.

Parameter(s)
<measurement data>
{numeric, range 0 to 63}

1  STATUS (16 bits = 1 word)
   Reads the measurement status.

Measurement status content
* :FETCh? command

2  DATA1 (16 bits = 1 word)
   Reads the value of DATA1.

4  DATA2 (16 bits = 1 word)
   Reads the value of DATA2.

8  DATA3 (16 bits = 1 word)
   Reads the value of DATA3.

16 DATA4 (16 bits = 1 word)
   Reads the value of DATA4.

32  FREQ (32 bits = 2 words)
   Records the frequency value.

   The fundamental wave or primary frequency is read when the
detection mode is SINGLE, DUAL1, or DUAL2, and the
secondary frequency is read when the detection mode is
CASCADE.

When reading multiple measurement data simultaneously, a maximum of 5
words can be selected. It is not possible to select the same parameter more than
once.

Data is read starting with the smallest value. It is not possible to change the
reading sequence. Nothing is read if 0 is set.

Setting example
:DATA  7
Sets the measurement data set to STATUS, DATA1, and DATA2.

Response
{numeric, format NR1, range 0 to 63}

Query example
:DATA?

Response example
7
The measurement data is STATUS, DATA1, and DATA2.
5. Command explanation

[:SENSe]:DETector[:FUNCtion]  {SINGle|DUAL1|DUAL2|CASCade}

[:SENSe]:DETector[:FUNCtion]?

Explanation  Sets/queries the detection mode.
Parameter(s)  
SINGLE  1 frequency × 2 phases (single mode)
  Only the primary PSD is used. Measure at fundamental wave F or harmonic (n/m) F of fundamental wave.
DUAL1  2 frequencies × 2 phases (2-frequency harmonic mode)
  primary PSD: Fundamental wave F or fundamental wave harmonic (n/m) F
  Secondary PSD: Fundamental wave F or fundamental wave harmonic nF
DUAL2  2 frequencies × 2 phases (2-frequency independent mode)
  primary PSD: primary frequency Fp
  Secondary PSD: secondary frequency Fs
CASCade  2-frequency cascade connection (2-frequency cascade mode)
  primary PSD: primary frequency Fp
  Secondary PSD: secondary frequency Fs
  Further detection on the detection result Xp of Fp is performed using secondary frequency Fs.

Setting example  :DET  DUAL2
Sets the DUAL2 detection mode.
Response  {SING|DUAL1|DUAL2|CASC}
Query example  :DET?
Response example  DUAL2
The detection mode is DUAL2.

Noe  This command cannot be used with the LI 5645. LI 5645 is fixed in SINGLe.

[:SENSe]:DREServe  {HIGH|MEDium|LOW}
[:SENSe]:DREServe?

Explanation  Sets/queries dynamic reserve.
Parameter(s)  
HIGH  High dynamic reserve (when noise level is high)
MEDium  Medium dynamic reserve
LOW  Low dynamic reserve (when noise level is low)

Setting example  :DRES  LOW
Sets low dynamic reserve.
Response  {HIGH|MED|LOW}
Query example  :DRES?
Response example  LOW
The dynamic reserve level is LOW.
5. Command explanation

`:SENSe[:FILTer][1]:LPASs]:AUTO:ONCE
Explanation
Automatically sets the filter time constant according to frequency.
When the synchronous filter is selected, switching to the time constant filter takes place automatically.
The attenuation slope will be 24 dB/oct.
Setting example
:FILT:AUTO:ONCE
Automatically sets the filter time constant.
Note
It takes about 100ms from execution to completion of adjustment.

`:SENSe[:FILTer][1]:LPASs]:SLOPe  {6|12|18|24}
`:SENSe[:FILTer][1]:LPASs]:SLOPe?
Explanation
Sets/queries the filter attenuation slope (primary PSD).
Parameter(s)
{numeric, range {6|12|18|24}, unit dB/oct}
Setting example
:FILT:SLOP  24
Sets the filter attenuation slope to 24 dB/oct.
Response
{numeric, format NR1}
Query example
:FILT:SLOP?
Response example
24
The filter attenuation slope is 24 dB/oct.

`:SENSe[:FILTer][1]:LPASs]:TCONstant  <time constant>
`:SENSe[:FILTer][1]:LPASs]:TCONstant?
Explanation
Sets/queries the filter time constant (primary PSD).
Parameter(s)
<time constant> {numeric, range 5E-6 to 50E+3 1-2-5 sequence, unit s}
Rounding is applied to arbitrary values specified.
Setting example
:FILT:TCON  10E-3
Sets the filter time constant to 10 ms.
Response
{numeric, format NR3}
Query example
:FILT:TCON?
Response example
1.000000E-02
Filter time constant is 10ms.

`:SENSe[:FILTer][1]:LPASs]:TYPE  {EXPonential|MOVing}
`:SENSe[:FILTer][1]:LPASs]:TYPE?
Explanation
Sets/queries the filter type.
Parameter(s)
EXPonential
Time constant filter
MOVing
Synchronous filter (moving average type)
Setting example
:FILT:TYPE  MOV
Sets the synchronous filter.
Response
{EXP|MOV}
Query example
:FILT:TYPE?
Response example
MOV
Synchronous filter is set.
5. Command explanation
5. Command explanation

`:SENSe]:FILTer2[:LPASs]:SLOPe  {6|12|18|24}

Explanation  Sets/queries the filter attenuation slope (secondary PSD).
Parameter(s)   {numeric, range {6|12|18|24}, unit dB/oct}
Setting example  :FILT2:SLOP  24
    Sets the filter attenuation slope to 24 dB/oct.
Response       {numeric, format NR1}
Query example  :FILT2:SLOP?
Response example  24
    The filter attenuation slope is 24 dB/oct.
Note          This command cannot be used with the LI5645. An error will result.

`:SENSe]:FILTer2[:LPASs]:TCONstant  <time constant>

Explanation  Sets/queries the filter time constant (secondary PSD).
Parameter(s)   <time constant> {numeric, range 5E-6 to 50E+3  1-2-5 sequence, unit s}
    The unit S can be used.
Setting example  :FILT2:TCON  1E-3
    Sets the filter time constant to 1 ms.
Response       {numeric, format NR3}
Query example  :FILT2:TCON?
Response example  1.00000E–03
    Filter time constant is 1ms.
Note          This command cannot be used with the LI5645. An error will result.

`:SENSe]:FILTer2[:LPASs]:TYPE  {EXPonential|MOVing}

Explanation  Sets/queries the filter type (secondary PSD).
Parameter(s)   EXPonential   Time constant filter
                MOving       Synchronous filter (moving average type)
Setting example  :FILT2:TYPE  MOV
    Sets the synchronous filter.
Response       {EXP|MOV }
Query example  :FILT2:TYPE?
Response example  MOV
    Synchronous filter is set.
Note          This command cannot be used with the LI5645. An error will result.
5. Command explanation

[:SENSe]:FREQuency[1]?

**Explanation**
Queries the frequency (Fp fundamental wave, primary frequency).

**Response**
<br/>

```
<frequency>
```
<br/>

{numeric, format NR3, range 5.0E-4 to 2.6E+5, resolution 7 digits, unit Hz}

**Query example**
`:FREQ?`

**Response example**
`1.234567E+05`

The frequency is 123.4567 kHz.

**Note**
When harmonics measurement is enabled, harmonic order = n, and subharmonic order = m, then

\[
\text{actual measurement frequency} = \frac{\text{response value} \times n}{m} \quad \text{(primary PSD)}
\]

\[
= \text{response value} \times n \quad \text{(secondary PSD)}
\]

[:SENSe]:FREQuency[1]:HARMonics {ON|OFF|1|0}

[:SENSe]:FREQuency[1]:HARMonics?

**Explanation**
Sets/queries harmonics measurement (enabled or disabled) (primary PSD).

**Parameter(s)**

```
{ON|1} Enables harmonics measurement.
{OFF|0} Disables harmonics measurement.
```

**Setting example**
`:FREQ:HARM ON`

Enables harmonics measurement.

**Response**

```
{1|0}
```

**Query example**
`:FREQ:HARM?`

**Response example**
`1`

Harmonics measurement is enabled.

[:SENSe]:FREQuency[1]:MULTiplier <harmonic order>

[:SENSe]:FREQuency[1]:MULTiplier?

**Explanation**
Sets/queries the harmonic order n for measurement (primary PSD).

The signal that has n times frequency of the reference signal can be measured.

Harmonics measurement must be enabled with the [:SENSe]:FREQuency[1]:HARMonics ON command.

**Parameter(s)**

```
<harmonic order> {numeric, range 1 to 63}
```

**Setting example**
`:FREQ:MULT 2`

Sets the harmonic order to 2.

**Response**

```
{numeric, format NR1}
```

**Query example**
`:FREQ:MULT?`

**Response example**
`2`

The harmonic order is 2.

**Note**
When harmonic order n and subharmonic order m are set, fractional harmonic n / m is measured. When measuring the n-th harmonic, set sub-harmonic order m = 1 (the default value). When measuring the 1/m-th subharmonic, set harmonic order n = 1 (the default value).
[:SENSe]:FREQuency[1]:SMULtiplier  <subharmonic order>
[:SENSe]:FREQuency[1]:SMULtiplier?

**Explanation**
Sets/queries the subharmonic order m for measurement (primary PSD).
The signal that is 1/m-th the reference signal can be measured.
Harmonics measurement must be enabled with the [:SENSe]:FREQuency[1]:HARMonics ON command.

**Parameter(s)**
<subharmonic order>  {numeric, range 1 to 63}

**Setting example**
:FREQ:SMUL  7
Sets the subharmonic order to 7.

**Response**
numeric, format NR1

**Query example**
:FREQ:SMUL?

**Response example**
7
The subharmonic order is 7.
5. Command explanation

[:SENSe]:FREQuency2?
Explanation
Queries the secondary frequency used with detection modes DUAL2 and CASCADE.
Response
<Frequency>
{numeric, range 5.0E-4 to 2.6E+5, resolution 7 digits, unit Hz}
Query example
:FREQ2?
Response example
1.000000E+05
The secondary frequency is 100 kHz.
Note
This command cannot be used with the LI5645. An error will result.

[:SENSe]:FREQuency2:HARMonics {ON|OFF|1|0}
[:SENSe]:FREQuency2:HARMonics?
Explanation
Sets/queries harmonic measurement (enabled or disabled) (secondary PSD).
Parameter(s)
{ON|1} Enables harmonics measurement.
{OFF|0} Disables harmonics measurement.
Setting example
:FREQ2:HARM ON
Enables secondary PSD harmonic measurement.
Response
{1|0}
Query example
:FREQ2:HARM?
Response example
1
Secondary PSD harmonic measurement is enabled.
Note
This command cannot be used with the LI5645. An error will result.
Secondary PSD harmonic measurement is forcibly disabled in detection modes other than DUAL1.

[:SENSe]:FREQuency2:MULTiplier <harmonic order>
[:SENSe]:FREQuency2:MULTiplier?
Explanation
Sets/queries harmonic order n for measurement in detection mode DUAL1 (secondary PSD). The signal that is n times frequency of the reference signal can be measured. Harmonics measurement must be enabled with the [:SENSe]:FREQuency2:HARMonics ON command.
Parameter(s)
<harmonic order> {numeric, range 1 to 63}
Setting example
:FREQ2:MULT 2
Sets the harmonic order to 2.
Response
{numeric, format NR1}
Query example
:FREQ2:MULT?
Response example
2
The harmonic order is 2.
Note
This command cannot be used with the LI5645. An error will result.
5. Command explanation

[:SENSe]:NOISe[:SMOothing][:APERture]  {1|4|16|64}

[:SENSe]:NOISe[:SMOothing][:APERture]?

Explanation
Sets/queries the output smoothing coefficient for noise density measurement.
Setting the coefficient to 4 roughly halves variations in output, but roughly quadruples response time.

Parameter(s)
{numeric, range {1|4|16|64}}

Setting example
:nois 16
Sets the output smoothing coefficient to 16.

Response
{numeric, format NR1}

Query example
:nois?
Response example
16
The output smoothing coefficient is 16.

[:SENSe]:PHASe[1]  <phase shift amount>

[:SENSe]:PHASe[1]?

Explanation
Sets/queries the phase shift amount (primary PSD).

Parameter(s)
<phase shift amount>
{numeric, range -180.000 to +179.999, resolution 0.001, unit °}
Values in the range ± 720° are accepted, but are normalized to the range indicated above.
An error results if a value outside the range ± 720° is specified.

Setting example
:phas 90
Sets the phase shift amount to 90°.

Response
{numeric, format NR3}

Query example
:phas?
Response example
9.000000E+01
The phase shift amount is 90°.

[:SENSe]:PHASe[1]:AUTO:ONCE

Explanation
Automatically adjusts the phase shift amount so that phase θ (primary PSD) becomes zero.

Setting example
:phas:auto:once
Performs automatic phase adjustment.

Note
Upon making θ = 0, the signal amplitude can be determined from X. Since Y becomes 0, the phase change can be determined from Y.
It takes about 100ms from execution to completion of adjustment.
5. Command explanation

[:SENSe]:PHASe2 <phase shift amount>

[::SENSe]:PHASe2?

Explanation
Sets/queries the phase shift amount (secondary PSD).

Parameter(s)
<phase shift amount>

{numeric, range \(-180.000\) to \(+179.999\), resolution 0.001, unit °}

Values in the range ± 720° are accepted, but are normalized to the range indicated above.

An error results if a value outside the range ± 720° is specified.

Setting example
:PHAS2 90

Sets the phase shift amount to 90°.

Response
{numeric, format NR3}

Query example
:PHAS2?

Response example
9.000000E+01

The phase shift amount is 90°.

Note
This command cannot be used with the LI5645. An error will result.

[:SENSe]:PHASe2:AUTO:ONCE

Explanation
Automatically adjusts the phase shift amount so that phase \(\theta\) (secondary PSD) becomes zero.

Setting example
:PHAS2:AUTO:ONCE

Performs automatic phase adjustment.

Note
This command cannot be used with the LI5645. An error will result.

It takes about 100ms from execution to completion of adjustment.

[:SENSe]:ROSCillator:SOURce {INTernal|EXTernal}

[::SENSe]:ROSCillator:SOURce?

Explanation
Sets/queries the reference frequency source for frequency synthesis.

Parameter(s)
INTernal internal
EXTernal external (10 MHz IN terminal)

Setting example
:ROSC:SOUR EXT

The reference frequency source is set to external.

Response
{INT|EXT}

Query example
:ROSC:SOUR?

Response example
INT

The reference frequency source is internal.

Note
Even when the reference frequency source is set to external, operation continues with the internal reference frequency source until a 10 MHz signal is applied to the 10 MHz IN terminal.

☞ "6.4 Operation status"
5. Command explanation

[:SENSe]:VOLTage[1]:AC:RANGe:AUTO  {ON|OFF|1|0}

[:SENSe]:VOLTage[1]:AC:RANGe:AUTO?

Explanation
Sets/queries the voltage sensitivity continuous automatic selection function.
When voltage sensitivity is set automatically, dynamic reserve is also set automatically.

Parameter(s)
{ON}[1] Enables continuous automatic selection of voltage sensitivity.
{OFF}[0] Disables continuous automatic selection of voltage sensitivity.

Setting example
:VOLT:AC:RANG:AUTO  ON
Continuous automatic selection of voltage sensitivity is enabled.

Response
{1|0}

Query example
:VOLT:AC:RANG:AUTO?

Response example
0
Continous automatic selection of voltage sensitivity is disabled.

Note
With current input of LI5650, the current sensitivity is set automatically.

[:SENSe]:VOLTage[1]:AC:RANGe:AUTO:ONCE

Explanation
Automatically set voltage sensitivity one time.
When voltage sensitivity is set automatically, dynamic reserve is also set automatically.

Setting example
:VOLT:AC:RANG:AUTO:ONCE
Automatically sets voltage sensitivity one time.

Note
With current input of LI5650, the current sensitivity is set automatically.
[:SENSe]:VOLTage1:AC:RANGe[:UPPer]  <sensitivity>
[:SENSe]:VOLTage1:AC:RANGe[:UPPer]?

Explanation
Sets/queries the voltage sensitivity (primary PSD).

Parameter(s)
<sensitivity> : {numeric, range 10E-9 to 1 1-2-5 sequence, unit Vrms}
Rounding is applied to arbitrary values specified.
The unit V can be used.

Setting example
:VOLT:AC:RANG 1E-3
Sets voltage sensitivity to 1 mV.

Response
{nologic, format NR3, range {same as setting range}, unit Vrms}

Query example
:VOLT:AC:RANG?

Response example
1.000000E-03
Voltage sensitivity is 1 mV.

Note
Disabled when using current input of L15650.
When in dual detector mode of L15650, the voltage sensitivity of the
secondary PSD is changed to match that of the primary PSD if the sensitivity
set for the primary PSD is lower than that of the secondary PSD.
When NOISE is selected with DATA1, the sensitivity setting range is {20E-9
to 1}

[:SENSe]:VOLTage2:AC:RANGe[:UPPer]  <sensitivity>
[:SENSe]:VOLTage2:AC:RANGe[:UPPer]?

Explanation
Sets/queries the voltage sensitivity (secondary PSD).

Parameter(s)
<sensitivity>  {numeric, range same as primary PSD, unit Vrms}
Range is the same as with [:SENSe]:VOLTage1:AC:RANGe[:UPPer].
The unit V can be used.

Setting example
:VOLT2:AC:RANG 1E-3
Sets voltage sensitivity to 1 mV.

Response
{nologic, format NR3, range {same as setting range}, unit Vrms}

Query example
:VOLT2:AC:RANG?

Response example
1.000000E-03
Voltage sensitivity is 1 mV.

Note
This command cannot be used with the L15645. An error will result.
Disabled when using current input of L15650.
When in dual detector mode of L1 5650, the voltage sensitivity of the
secondary PSD cannot be set to a higher level than that of the primary PSD. An
error will result.
5. Command explanation

[:SENSe]:VOLTage5[:DC]:STATE  {ON|OFF|1|0}

[:SENSe]:VOLTage5[:DC]:STATE?

Explanatıon  Sets/queries the AUX IN 1 terminal state (enabled or disabled).
Parameter(s)  {ON|1} Enables voltage measurement for the AUX IN 1 terminal.
            {OFF|0} Disables voltage measurement for the AUX IN 1 terminal.
Setting example  :VOLT5:STAT  ON
Response      Enables voltage measurement for the AUX IN 1 terminal.
Query example  :VOLT5:STAT?
Response example 1
Note  When voltage measurement is disabled, the display shows 0.000V.

[:SENSe]:VOLTage5[:DC]:TCONstant  <time constant>
[:SENSe]:VOLTage5[:DC]:TCONstant?

Example  Sets/queries the AUX IN 1 filter time constant.
Parameter(s)  <time constant>
            THRU Sets the filter OFF.
            numeric, range : {2E-3|500E-6|125E-6}, unit s
Rounding is applied to arbitrary values specified.
The unit s can be used.
Cutoff frequencies are, respectively, about 80 Hz, 320 Hz, and 1.27 kHz.
Setting example  :VOLT5[:DC]:TCON  2E-3
Response      THRU or {numeric, format NR3}
Query example  :VOLT5[:DC]:TCON?
Response example  THRU
Note  AUX IN 1 filter is OFF.

[:SENSe]:VOLTage6[:DC]:STATE  {ON|OFF|1|0}
[:SENSe]:VOLTage6[:DC]:STATE?

Explanatıon  Sets/queries the AUX IN 2 terminal state (enabled or disabled).
Parameter(s)  {ON|1} Enables voltage measurement for the AUX IN 2 terminal.
            {OFF|0} Disables voltage measurement for the AUX IN 2 terminal.
Setting example  :VOLT6:STAT  ON
Response      Enables voltage measurement for the AUX IN 2 terminal.
Query example  :VOLT6:STAT?
Response example 1
Note  When voltage measurement is disabled, the display shows 0.000V.
5. Command explanation

[:SENSe]:VOLTage6[:DC]:TCONstant  <time constant>
[:SENSe]:VOLTage6[:DC]:TCONstant?

Example
Sets/queries the AUX IN 2 filter time constant.

Parameter(s)
<time constant>

THRU  Sets the filter OFF.

{numeric, range : {2E-3|500E-6|125E-6}, unit s}
The unit S can be used.

Cutoff frequencies are, respectively, about 80 Hz, 320 Hz, and 1.27 kHz.

Setting example
:VOLT6[:DC]:TCON   2E-3
Sets the AUX IN 2 filter time constant to 2 ms.

Response
THRU or {numeric, format NR3}

Query example
:VOLT6[:DC]:TCON?

Response example
2.000000E-03
The AUX IN 2 filter time constant is 2ms.
5. Command explanation

:SOURce:FREQuency[1]:[CW]  <frequency>

Explanation
Sets/queries the internal oscillator (primary PSD) frequency.

Parameter(s)

<frequency>

{numeric, range 5E-4 to 2.6E+5, resolution 6 digits (0.1 mHz under 100 Hz),
unit Hz}

Suffixes M (10^-3), K(10^3) and MA (10^6), unit HZ can be used.
Example: 1KHZ (= 1E3).

Setting example
:SOUR:FREQ  1000
Sets the internal oscillator frequency to 1 kHz.

Response
{numeric, format NR3}

Query example
:SOUR:FREQ?

Response example
1.000000E+03
The internal oscillator frequency is 1.000000E+03 Hz (1 kHz).

Note
Depending on the selected reference signal source and detection mode, the
actual frequency (fundamental wave, primary frequency) may differ from that
set.

Querying the frequency (fundamental wave, primary frequency)
☞ [:SENSe]:FREQuency[1]?

:SOURce:FREQuency2:[CW]  <frequency>

:SOURce:FREQuency2:[CW]?

Explanation
Sets/queries the internal oscillator (secondary PSD) frequency used with
detection modes DUAL2 and CASCADE.

Parameter(s)

<frequency>

{numeric, range 5E-4 to 2.6E+5, resolution 6 digits (0.1 mHz under 100 Hz),
unit Hz}

Suffixes M (10^-3), K(10^3) and MA (10^6), unit HZ can be used.
Example: 1KHZ (= 1E3).

Setting example
:SOUR:FREQ2  1E+5
Sets the internal oscillator frequency to 100 kHz.

Response
{numeric, format NR3}

Query example
:SOUR:FREQ2?

Response example
1.000000E+05
The internal oscillator frequency is 1.000000E+05 Hz (100 kHz).

Note
This command cannot be used with the LI5645. An error will result.

Depending on the selected reference signal source and detection mode, the
actual frequency (secondary frequency) may differ from that set.

Querying the secondary frequency
☞ [:SENSe]:FREQuency2? command
5. Command explanation

:SOURce:IOSCillator  {PRImary|SECondary}
:SOURce:IOSCillator?

Explanation  Sets/queries the oscillator output from the OSC OUT terminal.
Parameter(s)  PRImary  Sets the primary PSD oscillator.
SECondary  Sets the secondary PSD oscillator. Setting takes effect when
detection mode is DUAL2, CASCADE.
Setting example  :SOUR:IOSC  PRI
               Sets output to the primary PSD oscillator.
Response  {PRI|SEC}
Query example  :SOUR:IOSC?
Response example  SEC
               Secondary PSD oscillator.
Note  This command cannot be used with the LI5645. An error will result.
Querying the primary PSD oscillator frequency
               [:SENSe]:FREQuency[1]? command
Querying the secondary PSD oscillator frequency
               [:SENSe]:FREQuency2? command

:SOURce:VOLTage[:LEVel][:IMMediate][:AMPLitude]  <amplitude>
:SOURce:VOLTage[:LEVel][:IMMediate][:AMPLitude]?

Explanation  Sets/queries the internal oscillator output voltage AC amplitude.
Parameter(s)  <amplitude>  {numeric, range 0.00000 to 1.000, setting resolution 4 digits (at
output voltage range full scale), unit Vrms}  Suffix M (10^{-3}), unit V, MAX, and MIN can be used.
Example: 100M (= 0.1)
Setting example  :SOUR:VOLT  0.5
                Sets output voltage amplitude to 0.5 V.
Response  {numeric, format NR3}
Query example  :SOUR:VOLT?
Response example  5.000000E-01
Output voltage amplitude is 0.5 V.
Note  Values exceeding the output voltage range cannot be set.
               :SOURce:VOLTage:RANGe command
5. Command explanation

:SOURce:VOLTage:RANGe  <voltage range>
:SOURce:VOLTage:RANGe?

Explanation  Sets/queries the internal oscillator output voltage range.
Parameter(s)  
<voltage range>  {numeric, range {10E-3|100E-3|1}, unit V}
Rounding is applied to arbitrary values specified.
Suffix M (10^-3), unit V, MAX, and MIN can be used.
Example: 100M (= 0.1), 500MV (= 0.5)

Setting example  :SOUR:VOLT:RANG  100E-3
Sets the output voltage range to 100mV.

Response  
<voltage range> : {numeric, format NR3, unit V}

Query example  :SOUR:VOLT:RANG?

Response example  1.000000E-01
Output voltage range is 100 mV.

Note  Raising the output voltage range does not change the output voltage amplitude,
but it does discard any part below the minimum resolution.
If reducing the output voltage range would cause the output voltage amplitude
setting to go out of range, it is set to the range maximum.
5. Command explanation

:SOURce5:VOLTage[:LEVel][:IMMediate]:OFFSet  <DC voltage>
:SOURce5:VOLTage[:LEVel][:IMMediate]:OFFSet?

Explanation
Sets/queries the AUX OUT 1 output voltage.

Parameter(s)
<DC voltage>
{numeric, range -10.5 to +10.5, resolution 0.001 digits, unit V}  
Suffix M (10^{-3}), unit V, MAX, and MIN can be used.
Example: 500MV (= 0.5)

Setting example
:SOUR5:VOLT:OFFS  2.5
Sets AUX OUT 1 output voltage to +2.5 V.

Response
{numeric, format NR3}

Query example
:SOUR5:VOLT:OFFS?

Response example
2.5000 00E+00
The AUX OUT 1 output voltage is +2.5 V.

:SOURce6:VOLTage[:LEVel][:IMMediate]:OFFSet  <DC voltage>
:SOURce6:VOLTage[:LEVel][:IMMediate]:OFFSet?

Explanation
Sets/queries the AUX OUT 2 output voltage.

Parameter(s)
<DC voltage>
{numeric, range -10.5 to +10.5, resolution 0.001 digits, unit V}  
Suffix M (10^{-3}), unit V, MAX, and MIN can be used.
Example: 500MV (= 0.5)

Setting example
:SOUR6:VOLT:OFFS -2.5
Sets the AUX OUT 1 output voltage to -2.5 V.

Response
{numeric, format NR3}

Query example
:SOUR6:VOLT:OFFS?

Response example
-2.500000E+00
The AUX OUT 2 output voltage is -2.5 V.
Operation status details

"6.4 Operation status"

:STATus:OPERation:CONDition?

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Queries the Operation Condition register (OPCR).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>{numeric, format NR1, range 0 to 65535}</td>
</tr>
<tr>
<td>Query example</td>
<td>:STAT:OPER:COND?</td>
</tr>
<tr>
<td>Response example</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>The Operation Condition register contains 0.</td>
</tr>
</tbody>
</table>

:STATus:OPERation:ENABle <mask>

:STATus:OPERation:ENABle?

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Sets/queries the Operation Event Enable register (OPEE).</th>
</tr>
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<tbody>
<tr>
<td>Parameter(s)</td>
<td>&lt;mask&gt; {numeric, range 0 to 65535} An error results if range exceeded.</td>
</tr>
<tr>
<td></td>
<td>Regardless of the value specified, the uppermost bit of the 16-bit binary value is 0.</td>
</tr>
<tr>
<td>Setting example:</td>
<td>:STAT:OPER:ENAB 0</td>
</tr>
<tr>
<td></td>
<td>Disables occurrence of operation events.</td>
</tr>
<tr>
<td>Response</td>
<td>{numeric, format NR1, range 0 to 65535}</td>
</tr>
<tr>
<td>Query example</td>
<td>:STAT:OPER:ENAB?</td>
</tr>
<tr>
<td>Response example</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>The Operation Condition register contains 0 (all disabled).</td>
</tr>
</tbody>
</table>

:STATus:OPERation[:EVENT]??

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Queries the Operation Event register (OPER).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>{numeric, format NR1, range 0 to 65535}</td>
</tr>
<tr>
<td>Query example</td>
<td>:STAT:OPER?</td>
</tr>
<tr>
<td>Response example</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>The Operationable Event register contains 0 (no event).</td>
</tr>
</tbody>
</table>
5. Command explanation

**:STATus:OPERation:NTR **<filter>**

**Explanation**
Sets/queries the Operation Status Negative Transition Filter.

**Parameter(s)**
<filter> {numeric, range 0 to 65535}

**Setting example**
:STAT:OPER:NTR  256
Sets bit 8 of the Operation Status Negative Transition Filter to 1.

**Response**
{numeric, format NR1, range 0 to 65535}

**Query example**
:STAT:OPER:NTR?

**Response example**
256
Bit 8 of the Operation Status Negative Transition Filter is set to 1.

**:STATus:OPERation:PTR **<filter>**

**Explanation**
Sets/queries the Operation Status Positive Transition Filter.

**Parameter(s)**
<filter> {numeric, range 0 to 65535}

**Setting example**
:STAT:OPER:PTR  256
Sets bit 8 of the Operation Status Positive Transition Filter to 1.

**Response**
{numeric, format NR1, range 0 to 65535}

**Query example**
:STAT:OPER:PTR?

**Response example**
256
Bit 8 of the Operation Status Positive Transition Filter is set to 1.
Questionable Status details

"6.5 Questionable Status"

:STATus:QUEStionable:CONDition?

**Explanation**
Queries the Questionable Condition register (QUCR).

**Response**
{numeric, format NR1, range 0 to 65535}

**Query example**
:STAT:QUES:COND?

**Response example**
0
The Questionable Condition register contains 0.

:STATus:QUEStionable:ENABle <mask>

:STATus:QUEStionable:ENABle?

**Explanation**
Sets/queries the Questionable Event Enable register (QUEE).

**Parameter(s)**
<mask> {numeric, range 0 to 65535} An error results if range exceeded.

Regardless of the value specified, the uppermost bit of the 16-bit binary value is 0.

**Setting example**
:STAT:QUES:ENAB 0
Inhibits occurrence of all questionable events.

**Response**
{numeric, format NR1, range 0 to 65535}

**Query example**
:STAT:QUES:ENAB?

**Response example**
0
The Questionable Event Enable register contains 0 (all disabled).

:STATus:QUEStionable[:EVENt]?

**Explanation**
Queries the Questionable Event register (QUER).

**Response**
{numeric, format NR1, range 0 to 65535}

**Query example**
:STAT:QUES?

**Response example**
0
The Questionable Event register contains 0 (no event).
### :STATus:QUEStionable:NTR <filter>

**Explanation**
Sets/queries the Questionable Status Negative Transition Filter.

**Parameter(s)**
<filter> {numeric, range 0 to 65535}

**Setting example**
:STAT:OPER:NTR 64
Sets bit 6 of the Questionable Status Negative Transition Filter to 1.

**Response**
{numeric, format NR1, range 0 to 65535}

**Query example**
:STAT:QUES:NTR?

**Response example**
64
Bit 6 of the Questionable Status Negative Transition Filter is set to 1.

### :STATus:QUEStionable:PTR <filter>

**Explanation**
Sets/queries the Questionable Status Positive Transition Filter.

**Parameter(s)**
<filter> {numeric, range 0 to 65535}

**Setting example**
:STAT:OPER:PTR 64
Sets bit 6 of the Questionable Status Positive Transition Filter to 1.

**Response**
{numeric, format NR1, range 0 to 65535}

**Query example**
:STAT:QUES:PTR?

**Response example**
64
Bit 6 of the Questionable Status Positive Transition Filter is set to 1.
5. Command explanation

:SYSTem:ERRor?

Explanation  Queries the error content.
Response  <error number>, <error message>
          <error number>  [numeric, format NR1, range -32768 to +32767]
          <error message>  format SRD
For details  "9. Error Messages"
Query example  :SYST:ERR?
Response example  0,"No error"
There is no error.
Note  The error read is the oldest one in the error queue.
      Once the content of an error has been read, that error is removed from the error queue.
      The error queue can hold up to 16 errors. If this number is exceeded, the 16th error message changes to "Queue overflow" and subsequent errors are discarded.

:SYSTem:KLOCk  {ON|OFF|1|0}

:SYSTem:KLOCk?

Explanation  Sets/queries the front panel key lock function.
Parameter(s)  {ON|1}  Enables key lock (disables key operation).
              {OFF|0}  Disables key lock (enables key operation).
Setting example  :SYST:KLOC  1
Response  {1|0}
Query example  :SYST:KLOC?
Response example  1
Key lock is enabled (key operation is disabled).

:SYSTem:RST

Explanation  Initializes settings.
Unlike the *RST command, this command also clears the contents of configuration memories 1 to 9.
For details  "LI5645 / LI5650 Instruction Manual (Operations)"
"Table 3-1 Settings and default values"
Parameter(s)  None
Setting example  :SYST:RST
Initializes settings.
5. Command explanation

**:TRIGger:DELay <delay time>**

**Explanation**
Sets/queries the trigger delay time.
Trigger delay time: Time that elapses between trigger execution and recording of data or starting of the internal timer.

**Parameter(s)**
{numeric, range 0 to 100, unit s, resolution 640ns }
The suffix M \( (10^{-3}) \) and unit S may be used.
Example: 200MS \( (=0.200) \).

**Setting example**
:TRIG:DEL  20E-3
Sets the trigger delay time to 20 ms.

**Response**
{numeric, format NR3}

**Query example**
:TRIG:DEL?

**Response example**
2.000000E-02
Trigger delay time is 20 ms.

**:TRIGger[:IMMediate]**

**Explanation**
When the measurement data buffer is enabled, executes a trigger and records data in the measurement buffer.
When the internal timer is disabled, measurement data is recorded only once.
When the internal timer is enabled, starts recording measurement data according to the internal timer.
Enable the measurement data buffer \( \mathcal{F} \) :DATA:FEED:CONTrol command
Set the internal timer \( \mathcal{F} \) :DATA:TIMer command
Before using triggers, the awaiting trigger state must be set with the :INITiate[:IMMediate] command. An error will result if the awaiting trigger state has not been set.

**Setting example**
:TRIG
Executes a trigger.

**:TRIGger:SOURce {MANual|EXTernal|BUS}**

**Explanation**
Sets/queries the trigger source.

**Parameter(s)**
MANual  Front panel \([\text{ ]}) / TRIG key
EXTernal  Rear panel TRIG IN signal
BUS  Remote control \( *\text{TRG} \) or :TRIGger[:IMMediate] command, or the GET message

**Setting example**
:TRIG:SOUR  EXT
Sets the trigger source to EXT.

**Response**
{MAN|EXT|BUS}

**Query example**
:TRIG:SOUR?

**Response example**
EXT
Trigger source is EXT (TRIG IN).

**Note**
The \([\text{ ]}) / TRIG key is enabled only when in the remote state.
RS-232/LAN dedicated commands

The three commands shown on this page will provide control functions that can be realized in GPIB and USBTMC. An error results if these commands are used with GPIB or USBTMC.

:**SYSTem:LOCal**

Explanation: Switches to the local state.
While in local state, operation can be controlled from the panel.
Local Lockout is cancelled.

Parameter(s): None

Setting example: :SYST:LOC
Switches to the local state.

Note: Sending any command or query other than this one using RS-232 or LAN RS-232 causes the LI5645 / LI5650 to enter the remote state. When key lock mode is enabled, operation can be controlled from the panel.

:**SYSTem:REMoTe**

Explanation: Switches operation to remote state.
While in remote state, operation cannot be controlled from the panel.
However, as long as Local Lockout is disabled, only the CLR / LOCAL key can be used.

Parameter(s): None

Setting example: :SYST:REM
Switches to the remote state.

Note: This command does not affect the enabled/disabled status of Local Lockout.

:**SYSTem:RWLock**

Explanation: Switches to remote state with Local Lockout.
During Local Lockout, operation cannot be returned to the local state by pressing the CLR / LOCAL key.

Parameter(s): None

Setting example: :SYST:RWL
Switches to remote state with Local Lockout.

Note: When cancelling Local Lockout, use the :SYSTem:LOCal command to enter local state.
5. Command explanation
6. Status system

6.1 Status system outline ........................................ 102
6.2 Status Byte .................................................. 103
6.3 Standard Event status ................................. 104
6.4 Operation status ........................................ 106
6.5 Questionable Status .............................. 109
6. Status system

6.1 Status system outline

The status system of the LI5645 / LI5650 is shown in Fig. 6-1.
6. Status system

6.2 Status Byte
Definition of the Status Byte register is shown in Table 6-1. The status byte can be read by serial polling. At this time, bit 6 is RQS (Request Service).

<table>
<thead>
<tr>
<th>Bit</th>
<th>Weight</th>
<th>Condition for setting 1</th>
<th>Condition for setting 0</th>
</tr>
</thead>
</table>
| OPE | 7      | When any of the effective bits in the Operation Status Event register becomes 1 | • Upon receiving Device Clear  
• After the Status Byte is read |
| RQS / MSS | 6 | When SRQ is send. | • Upon receiving Device Clear  
• RQS is cleared when the Status Byte is read by serial polling.  
• MSS is cleared when the original summary bits are all cleared to 0. |
| ESB | 5      | When any of the effective bits in the Standard Event Status register becomes 1 | When all of the effective bits in the Standard Event Status register become 0 |
| MAV | 4      | When the response to a query has been prepared and is ready for output | When all responses have been output and there are no further responses to output |
| QUE | 3      | When any of the effective bits in the Questionable Event register becomes 1 | When all of the effective bits in the Questionable Event register become 0 |
|     | 2      | 4  | —  | Always 0 (not used) |
|     | 1      | 2  | —  | Always 0 (not used) |
|     | 0      | 1  | —  | Always 0 (not used) |

■ Related commands/queries

*STB?
Queries content of the Status Byte register.
Bit 6 is MSS (Master Summary Status).

*SRE, *SRE?
Sets and queries the Service Request Enable register.
The register is cleared to 0 immediately after turning on the power. Set 0 to clear to 0. The Status Byte Register is enabled when 1 is set to the Service Request Enable register, and a Service Request is issued when one of the effective bits is set to 1.

The setting and response message parameter for the respective registers is the value that is the sum of weights of bits that are 1.

■ Status verification when querying
Ordinarily, a correct response can be obtained by receiving a response message after sending a query. There is no need to check the MAV bit of the Status Byte. If processing performed includes checking of the MAV bit, read the response message after verifying that the MAV bit of the Status Byte is 1 by serial polling, and then continue with the next operation after verifying that the MAV bit has changed to 0.
6.3 Standard Event status

The structure of the Standard Event status is shown in Fig. 6-2. Details on the status are shown in Table 6-2. When a bit in the Standard Event Status Enable register is set to 1, the corresponding bit in the Standard Event Status register becomes effective, and when any effective bit in that register becomes 1, the ESB bit in the Status Byte register is set to 1.

![Standard Event status structure](image)

Table 6-2 Standard Event status structure

<table>
<thead>
<tr>
<th>Bit</th>
<th>Weight</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>PON</td>
<td>7</td>
<td>Power on 1 is set when the power is turned on. Once this register has been cleared to 0 by reading it, it remains 0 after the power is turned back on.</td>
</tr>
<tr>
<td>URQ</td>
<td>6</td>
<td>User request Always 0 (not used)</td>
</tr>
<tr>
<td>CME</td>
<td>5</td>
<td>Command error Always 0 (not used)</td>
</tr>
<tr>
<td>EXE</td>
<td>4</td>
<td>Execution error Set to 1 when there is a syntax error in the program code.</td>
</tr>
<tr>
<td>DDE</td>
<td>3</td>
<td>Device-specific error Set to 1 when the error queue overflows.</td>
</tr>
<tr>
<td>QYE</td>
<td>2</td>
<td>Query error Set to 1 when an attempt is made to read the output buffer used for storing response messages while the buffer is empty, or when data is lost from the buffer used for storing response messages.</td>
</tr>
<tr>
<td>RQC</td>
<td>1</td>
<td>Request control Always 0 (not used)</td>
</tr>
<tr>
<td>OPC</td>
<td>0</td>
<td>Operation complete Set to 1 when processing of all commands has been completed up to the *OPC command.</td>
</tr>
</tbody>
</table>
Related commands/queries

*ESR?
Queries content of the Standard Event Status register.
Querying the register clears it to 0. The register can also be cleared with the *CLS command.
The register is cleared to 0 immediately after turning on the power. However, the PON bit is set to 1.

*ESE, *ESE?
Sets/queries the Standard Event Status Enable register.
Set 0 to this register to clear it to 0.
There are no other commands to clear it.
The register is cleared to 0 immediately after turning on the power.

The setting and response message parameter for the respective registers is the value that is the sum of weights of bits that are 1.
6.4 Operation status

The structure of the Operation status is shown in Fig. 6-3.

The Operation Condition register indicates the status of the LI5645 / LI5650 as shown in Table 6-3.

The transition filter detects changes in condition and generates events. Generation of events requires setting the transition filter. Events generated are maintained by the Operation Event register. When a bit in the Operation Event Enable register is set to 1, the bits in the Operation Event register become effective, and when any effective bit in that register becomes 1, the OPE bit in the Status Byte is set to 1.
6. Status system

Table 6-3 Operation Condition register, Event register content

<table>
<thead>
<tr>
<th>Bit</th>
<th>Weight</th>
<th>Condition register content (1 in specified state)</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>15</td>
<td>32768 Always 0 (not used)</td>
</tr>
<tr>
<td>—</td>
<td>14</td>
<td>16384 Always 0 (not used)</td>
</tr>
<tr>
<td>—</td>
<td>13</td>
<td>8192 Always 0 (not used)</td>
</tr>
<tr>
<td>ULOC</td>
<td>12</td>
<td>4096 Not in sync with external reference frequency (10 MHz)</td>
</tr>
<tr>
<td>—</td>
<td>11</td>
<td>2048 Always 0 (not used)</td>
</tr>
<tr>
<td>BUF3</td>
<td>10</td>
<td>1024 BUF3 full</td>
</tr>
<tr>
<td>BUF2</td>
<td>9</td>
<td>512 BUF2 full</td>
</tr>
<tr>
<td>BUF1</td>
<td>8</td>
<td>256 BUF1 full</td>
</tr>
<tr>
<td>CORR</td>
<td>7</td>
<td>128 DC input offset auto adjust active</td>
</tr>
<tr>
<td>—</td>
<td>6</td>
<td>64 Always 0 (not used)</td>
</tr>
<tr>
<td>WTRG</td>
<td>5</td>
<td>32 Awaiting trigger</td>
</tr>
<tr>
<td>MEAS</td>
<td>4</td>
<td>16 Measuring by timer</td>
</tr>
<tr>
<td>—</td>
<td>3</td>
<td>8 Always 0 (not used)</td>
</tr>
<tr>
<td>RANG</td>
<td>2</td>
<td>4 In adjusting the range and dynamic reserve by one-time automatic range selectin function.</td>
</tr>
<tr>
<td>—</td>
<td>1</td>
<td>2 Always 0 (not used)</td>
</tr>
<tr>
<td>—</td>
<td>0</td>
<td>1 Always 0 (not used)</td>
</tr>
</tbody>
</table>

Related commands/queries

:STATus:OPERation:CONDition?
Queries the Operation Condition register.
Querying this register does not clear its content to 0.
It constantly indicates the device status.

:STATus:OPERation[:EVENt]?
Queries the Operation Event register.
Querying the event register clears it to 0.
The event register can also be cleared with the *CLS command.
The register is cleared to 0 immediately after turning on the power.

:STATus:OPERation:ENABle, STATus:OPERation:ENABle?
Set/queries the Operation Event Enable register.
Set 0 to this register to clear it to 0. There are no other commands to clear it.
The register is cleared to 0 immediately after turning on the power.

:STATus:OPERation:NTR, STATus:OPERation:NTR?

:STATus:OPERation:PTR, STATus:OPERation:PTR?
Sets/queries the Operation Status Transition Filter.
The relationship between transition filter settings and transition of the event register is shown in Table 6-4.
6. Status system

Table 6-4 Operation Transition Filter and Event register transition

<table>
<thead>
<tr>
<th>Positive transition</th>
<th>Negative transition</th>
<th>Condition register transition to set Event register to 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>filter bit settings</td>
<td>filter bit settings</td>
<td>transition to set</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0 → 1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1 → 0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0 → 1 or 1 → 0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Event register not set to 1.</td>
</tr>
</tbody>
</table>

The setting and response message parameter for the respective registers is the value that is the sum of weights of bits that are 1.
6.5 Questionable Status

The structure of the Questionable Status is shown in Fig. 6-4.

The Questionable Status register indicates abnormal status of the LI5645 / LI5650 as shown in Table 6-4. The transition filter detects changes in condition and generates events. Generation of events requires setting the transition filter. Events generated are maintained by the Questionable Event register. When a bit in the Event Enable register is set to 1, the corresponding bits in the Event register become effective, and when any effective bit in that register becomes 1, the QUE bit in the Status Byte is set to 1.

![Questionable Status structure diagram]

Fig. 6-4 Questionable Status structure
6. Status system

### Table 6-5 Questionable Condition register, Event register content

<table>
<thead>
<tr>
<th>Bit</th>
<th>Weight</th>
<th>Condition register content (1 in specified state)</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>15</td>
<td>32768 Always 0 (not used)</td>
</tr>
<tr>
<td>—</td>
<td>14</td>
<td>16384 Always 0 (not used)</td>
</tr>
<tr>
<td>—</td>
<td>13</td>
<td>8192 Always 0 (not used)</td>
</tr>
<tr>
<td>—</td>
<td>12</td>
<td>4096 Always 0 (not used)</td>
</tr>
<tr>
<td>AIN</td>
<td>11</td>
<td>2048 AUX IN 1 or AUX IN 2 is over level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over level status: AUX</td>
</tr>
<tr>
<td>THR</td>
<td>10</td>
<td>1024 Internal overheat condition</td>
</tr>
<tr>
<td>PROT</td>
<td>9</td>
<td>512 Protection operating against over-input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over level status: PROTECT</td>
</tr>
<tr>
<td>—</td>
<td>8</td>
<td>256 Always 0 (not used)</td>
</tr>
<tr>
<td>—</td>
<td>7</td>
<td>128 Always 0 (not used)</td>
</tr>
<tr>
<td>PHAS</td>
<td>6</td>
<td>64 Not synchronized with external reference signal or measurement signal input</td>
</tr>
<tr>
<td>—</td>
<td>5</td>
<td>32 Always 0 (not used)</td>
</tr>
<tr>
<td>—</td>
<td>4</td>
<td>16 Always 0 (not used)</td>
</tr>
<tr>
<td>—</td>
<td>3</td>
<td>8 Always 0 (not used)</td>
</tr>
<tr>
<td>—</td>
<td>2</td>
<td>4 Always 0 (not used)</td>
</tr>
<tr>
<td>IN</td>
<td>1</td>
<td>2 Analog signal is over level in the previous PSD stage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over level status: INPUT</td>
</tr>
<tr>
<td>OUT</td>
<td>0</td>
<td>1 Over level in DC gain or processing after the PSD stage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over level status: OUTPUT</td>
</tr>
</tbody>
</table>

- **Related commands/queries**
  - **:STATus:QUEStionable:CONDition?**
    Queries the Questionable Condition register.
    Querying this register does not clear its contents to 0.
    It constantly indicates the device status.
  - **:STATus:QUEStionable[:EVENt]?**
    Queries the Questionable Event register.
    Querying the event register clears it to 0.
    The event register can also be cleared with the *CLS command.
    The register is cleared to 0 immediately after turning on the power.
  - **:STATus:QUEStionable:ENABle, STATus:QUEStionable:ENABle?**
    Set/queries the Questionable Event Enable register.
    Set 0 to to this register to clear it to 0. There are no other commands to clear it.
    The register is cleared to 0 immediately after turning on the power.
  - **:STATus:QUEStionable:NTR, STATus:QUEStionable:NTR?**
  - **:STATus:QUEStionable:PTR, STATus:QUEStionable:PTR?**
    Sets/queries the Questionable Event Status Transition Filter.
    The relationship between transition filter settings and transition of the event register is shown in Table 6-6.
### Table 6-6 Questionable Transition Filter and Event register transition

<table>
<thead>
<tr>
<th>Positive transition filter bit settings</th>
<th>Negative transition filter bit settings</th>
<th>Condition register transition to set Event register to 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0 → 1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1 → 0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0 → 1 or 1 → 0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Event register not set to 1.</td>
</tr>
</tbody>
</table>

The setting and response message parameter for the respective registers is the value that is the sum of weights of bits that are 1.
6. Status system
7. Trigger system
The LI5645 / LI5650 trigger system is shown below.

- **Trigger system**

  **Power on initialize operation**
  
  *RST

  **Buffer full**
  
  **Idle state**
  (triggers disabled)

  **:ABOR**
  If measurement being recorded, recording aborted.

  **:INIT command**

  **Awaiting trigger**
  (triggers enabled)

  **Trigger signal (one of the following)**
  1) Panel TRIG key
     (with :TRIG:SOUR MAN)
  2) Rear panel TRIG IN signal
     (with :TRIG:SOUR EXT)
  3) *TRG, :TRIG, or GET
     (with :TRIG:SOUR BUS)

  **Trigger delay (:TRIG DEL)**
  (triggers disabled)

  **Timer measurement OFF**

  **Measurement being recorded**
  (triggers disabled)

  **Delay time elapsed**

  **Timer measurement ON**

Fig. 7-1 Trigger system
The following operations cannot be performed during measurement data recording (while awaiting trigger).

- Setting the output signal
  ◆ :CALCulate1:FORMat
  ◆ :CALCulate2:FORMat
  ◆ :CALCulate3:FORMat
  ◆ :CALCulate4:FORMat

- Changing the recording buffer
  ◆ :DATA:FEED:CONTROL

- Changing the data to be recorded
  ◆ :DATA:FEED

- Changing the number of recording points
  ◆ :DATA:POINTS

- Clearing the measurement data buffer
  ◆ :DATA:DELETE
  ◆ :DATA:DELETE:ALL

- Changing the timer
  ◆ :DATA:TIMER
  ◆ :DATA:TIMER:STATE

- Changing the trigger source
  ◆ :TRIGger:SOURce

- Changing the trigger delay time
  ◆ :TRIGger:DELAY

- Changing the detection mode
  ◆ [:SENSe]:DETeCTOR[:FUNCTION]

The following events/operations change the mode from the awaiting trigger state to the idle state.

- Power on
- Executing the :ABORt command
- Filling up the buffer
- Switching to local state
- Reset operation
  ◆ *RST
  ◆ :SYSTem:RST
- Operating on configuration memory
  ◆ *RCL
  ◆ *SAV
  ◆ :MEMory:STATE:DELETE
- Executing AUTO or AUTO ONCE
  ◆ :CALCulate1:OFFSET:AUTO:ONCE
  ◆ :CALCulate2:OFFSET:AUTO:ONCE
  ◆ :CALCulate3:OFFSET:AUTO:ONCE
  ◆ :CALCulate4:OFFSET:AUTO:ONCE
  ◆ :INPut[1]:OFFSET:AUTO
  ◆ :INPut[1]:OFFSET:AUTO:ONCE
  ◆ [:SENSe]:AUTO:ONCE
  ◆ [:SENSe]:CURRent[1]:AC:RANGe:AUTO
  ◆ [:SENSe]:CURRent[1]:AC:RANGe:AUTO:ONCE
  ◆ [:SENSe]:FILTER[1]:LPASS:AUTO:ONCE
  ◆ [:SENSe]:PHASe[1]:AUTO:ONCE
  ◆ [:SENSe]:PHASe2:AUTO:ONCE
  ◆ [:SENSe]:VOLTage[1]:AC:RANGe:AUTO
  ◆ [:SENSe]:VOLTage[1]:AC:RANGe:AUTO:ONCE
The following operations clear the buffer.

- Change the data to be recorded: :DATA:FEED
- Changing the number of recording points: :DATA:POINts
- Reset operation: *RST :SYSTem:RST
- Clearing the measurement data buffer: :DATA:DELete
  :DATA:DELete:ALL

With BUF3 only, data is deleted from the measurement data buffer when it is read.
8. Data acquisition using the measurement data buffers
Multiple sample points can be stored in the measurement data buffers as a measurement data set, and then the buffer contents can be read later. The following schematically illustrates use of the measurement data buffer for measurement.

**Example 1** Reading all measurement data out of BUF1 at once after recording it into the buffer at arbitrary timing.

Send ("ABOR")
  'Any recording currently in progress is aborted.
Send ("DATA:FEED BUF1, 7")
  'Set the measurement data set for recording.
Send ("DATA:POIN BUF1, 100")
  'Set capacity of the measurement data buffer.
  'At this time, the contents of the specified buffer are cleared.
Send ("DATA:FEED:CONT BUF1, ALW")
  'Enable recording into the specified measurement data buffer.
Send ("DATA:TIM:STAT OFF")
  'Disable the internal timer.
Send ("TRIG:SOUR BUS")
  'Set the trigger source to remote control.
  'Other trigger sources can also be used.
  'If necessary, specify a trigger delay time.  
  TRIG:DEL command
Send ("INIT")
  'Transition to the awaiting trigger state.

Send ("TRIG")
  'Apply the trigger to repeatedly record measurement data.
  'If the measurement data buffer becomes full during recording, the trigger system enters the idle state and further triggers are not accepted.

Send ("STAT:OPER:COND")
Receive (OPCR)
  'When the trigger source is other than BUS, completion of measurement can be determined from the operation status full flag.
  'SRQ can also be used to generate an interrupt when the buffer becomes full.

Send ("FORM ASC")
  'Set the data transfer format to be used for reading out data.
Send ("DATA:DATA? BUF1, 100, 0")
  'Request transfer of data from the measurement data buffer.
  'It is also possible to check the number of sample points recorded in the measurement data buffer.  
  DATA:COUN command
Receive (STAT_1, DATA1_1, DATA2_1, STAT_2, DATA1_2, DATA2_2, …)
  'Reads out a block of measurement data starting at the specified starting position.
Example 2  
Reading measurement data from BUF3 in parallel with recording.

Send (";ABOR")
  ' Any recording currently in progress is aborted.
Send (";DATA:FEED  BUF3, 3")
  ' Set the measurement data set for recording.
Send (";DATA:POIN  BUF3, 100")
  ' Set capacity of the measurement data buffer.
  ' At this time, the contents of the specified buffer are cleared.
Send (";DATA:FEED:CONT  BUF3, ALW")
  ' Enable recording into the specified measurement data buffer.
Send (";DATA:TIM  1E-3")
  ' Set the interval of the internal timer.
Send (";DATA:TIM:STAT  ON")
  ' Enable the internal timer.
Send (";TRIG:SOUR  EXT")
  ' Set the trigger source to the external input signal.
  ' Other trigger sources can also be used.
  ' If necessary, specify a trigger delay time.  \TRIG:DEL command
Send (";INIT")
  ' Transition to the awaiting trigger state.
  ' Upon trigger application, measurement data recording starts at equal time intervals.
Send (";FORM  ASC")
  ' Set the data transfer format.
Send (";DATA:DATA?  BUF3, 2")
  ' Request transfer of data from the measurement data buffer.

Receive (STAT_1, DATA1_1, STAT_2, DATA1_2)
  ' Repeat requesting and receiving measurement data.
  ' If readout is faster than recording, the buffer will never become full and recording can
  ' continue indefinitely.
  ' If readout falls behind, further recording is not possible once the buffer becomes full.
Send (";DATA:FEED:CONT  BUF3, NEV")
  ' Once the required data has been obtained, stop recording to the buffer to
  ' avoid degradation of device performance due to unnecessary operation.
Example 3  Record and read out data in parallel using BUF1 and BUF2 in alternation.

Send (";ABOR")
  ' Any recording currently in progress is aborted.
Send (";DATA:FEED  BUF1, 6")
Send (";DATA:FEED  BUF2, 6")
  ' Set the measurement data set to be recorded to the respective buffers.
Send (";TRIG:SOUR  EXT")
  ' Set the trigger source.
Send (";FORM  ASC")
  ' Set the data transfer format to be used for reading out data.
Send (";DATA:POIN  BUF1, 256")
  ' Clear BUF1.
Send (";DATA:FEED:CONT  BUF1, ALW")
  ' Direct recording to BUF1.
Send (";INIT")
  ' Transition to the awaiting trigger state.
  ' Thereafter, apply as many triggers as needed to obtain samples corresponding to the buffer capacity.

Send (";STAT:OPER:COND?")
Receive (OPCR)
  ' Monitor the BUF1 full flag for completion of recording.
Send (";DATA:POIN  BUF2, 256")
  ' Clear BUF2.
Send (";DATA:FEED:CONT  BUF2, ALW")
  ' Direct recording to BUF2.
Send (";INIT")
  ' Transition to the awaiting trigger state.
  ' Thereafter, apply the trigger in correspondence with buffer capacity while reading out data in parallel.
Send (";DATA:DATA?  BUF1, 256, 0")
Receive (DATA1_1, DATA2_1, DATA1_2, DATA2_2, DATA1_3, DATA2_3 …)
  ' In parallel with recording data to BUF2, read out data recorded in BUF1.

Send (";STAT:OPER:COND?")
Receive (OPCR)
  ' Monitor the BUF2 full flag for completion of recording.
Send (";DATA:POIN  BUF1, 256")
  ' Clear BUF1.
Send (";DATA:FEED:CONT  BUF1, ALW")
  ' Direct recording to BUF1.
Send (";INIT")
  ' Transition to the awaiting trigger state.
  ' Thereafter, apply the trigger in correspondence with buffer length while reading out data in parallel.
Send (";DATA:DATA?  BUF2, 256, 0")
Receive (DATA1_1, DATA2_1, DATA1_2, DATA2_2, DATA1_3, DATA2_3 …)
  ' In parallel with recording data to BUF1, read out data recorded in BUF2.

  ' Repeat recording and reading out data as much as necessary.
9. Error Messages
This section shows the content of the main errors that can occur during remote control.

Table 9-1 Error messages

<table>
<thead>
<tr>
<th>Error number</th>
<th>Error message</th>
<th>Error content</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No error</td>
<td>———</td>
</tr>
<tr>
<td>-102</td>
<td>Syntax error</td>
<td>Received an unrecognizable command or data.</td>
</tr>
<tr>
<td>-103</td>
<td>Invalid separator</td>
<td>Problem with command separators.</td>
</tr>
<tr>
<td>-104</td>
<td>Data type error</td>
<td>Problem with the parameter format.</td>
</tr>
<tr>
<td>-108</td>
<td>Parameter not allowed</td>
<td>Too many parameters, or there is a parameter where one is not allowed.</td>
</tr>
<tr>
<td>-109</td>
<td>Missing parameter</td>
<td>Too few parameters.</td>
</tr>
<tr>
<td>-110</td>
<td>Command header error</td>
<td>Command header contains an error (no detailed classification).</td>
</tr>
<tr>
<td>-113</td>
<td>Undefined header</td>
<td>Command header is undefined.</td>
</tr>
<tr>
<td>-115</td>
<td>Unexpected number of parameters</td>
<td>Too many parameters.</td>
</tr>
<tr>
<td>-120</td>
<td>Numeric data error</td>
<td>Numeric data contains an error (no detailed classification).</td>
</tr>
<tr>
<td>-123</td>
<td>Exponent too large</td>
<td>Specified exponent is too large. (Example :SOURe:VOLTage 1E+000001)</td>
</tr>
<tr>
<td>-124</td>
<td>Too many digits</td>
<td>Too many digits (more than 255 digits).</td>
</tr>
<tr>
<td>-130</td>
<td>Suffix error</td>
<td>Suffix (multiplier, unit) contains an error (no detailed classification).</td>
</tr>
<tr>
<td>-134</td>
<td>Suffix too long</td>
<td>Too many auxiliary unit characters or unit characters (more than 7).</td>
</tr>
<tr>
<td>-140</td>
<td>Character data error</td>
<td>Character data contains an error (no detailed classification).</td>
</tr>
<tr>
<td>-144</td>
<td>Character data too long</td>
<td>Character data is too long.</td>
</tr>
<tr>
<td>-200</td>
<td>Execution error</td>
<td>Command could not be executed (no detailed classification).</td>
</tr>
<tr>
<td></td>
<td>• Set a parameter that cannot be set while in the trigger idle state.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Execute &quot;:ABORt&quot; while in the trigger idle state.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Set a value that exceeds 5 words to the data set.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Any of the following states were present during &quot;:INIT&quot; execution.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other than the trigger idle state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Continuous automatic setting state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Situation where no buffer has been specified for recording</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Situation in which the specified buffer is full</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• When a command that only works with USB or GPIB is used with LAN or RS-232.</td>
<td></td>
</tr>
<tr>
<td>-206</td>
<td>Auto-once failed due to unlock</td>
<td>When the UNLOCK state results upon one-time automatic setting.</td>
</tr>
<tr>
<td>-207</td>
<td>X,Y out of range</td>
<td>When X or Y measurement values are outside the adjustment range.</td>
</tr>
</tbody>
</table>
9. Error Messages

<table>
<thead>
<tr>
<th>Error number</th>
<th>Error message</th>
<th>Error content</th>
</tr>
</thead>
<tbody>
<tr>
<td>-211</td>
<td>Trigger ignored</td>
<td>Trigger command received, but execution not possible.</td>
</tr>
<tr>
<td>-221</td>
<td>Settings conflict</td>
<td>Command execution not possible due to constraints between multiple settings.</td>
</tr>
<tr>
<td>-222</td>
<td>Data out of range</td>
<td>Data out of valid range.</td>
</tr>
<tr>
<td>-224</td>
<td>Illegal parameter value</td>
<td>Parameter is invalid (invalid for reason other than &quot;-104 Data type error&quot;). (Example :SOUR:VOLTage %1)</td>
</tr>
<tr>
<td>-310</td>
<td>System error</td>
<td>A device-specific internal error occurred (no detailed classification).</td>
</tr>
<tr>
<td>-350</td>
<td>Queue overflow</td>
<td>New errors cannot be saved due to error queue overflow.</td>
</tr>
<tr>
<td>-410</td>
<td>Query INTERRUPTED</td>
<td>The following command was received before finishing transmission of all requested responses. A response was interrupted and the output buffer cleared.</td>
</tr>
<tr>
<td>-420</td>
<td>Query UNTERMINATED</td>
<td>A response was requested, but the query received was incomplete and could not be fulfilled. The output buffer was cleared.</td>
</tr>
<tr>
<td>-440</td>
<td>Query UNTERMINATED after indefinite response</td>
<td>A character string included a query following &quot;*IDN?&quot;. (<strong>IDN?</strong> must be the final query in the received character string.)</td>
</tr>
</tbody>
</table>

Remote control errors are recorded in the error queue and can be read out in sequence by :SYSTem:ERRor? starting with the oldest. Once all errors have been read out, 0,"No error" is returned if the query is sent again. The error queue can be cleared with the *CLS command. Data remaining in the input buffer or output buffer at the time a problem occurs can be cleared using a device clear interface message (DCL, SDC). If the interface being used does not support the device clear function, use the corresponding substitute function instead.

Under some circumstances, errors other than the above may occur. In such cases, check the error message for a summary.

For operations that can be controlled from the panel, error messages are the same as with panel operation. Refer to the explanations of panel operations related to the various commands and queries. Errors that occur during ordinary measurement are displayed in the same manner during remote control.
10. Embedded Web Site

10.1 Preparation ................................................. 126
10.2 Requirements ............................................. 126
10.3 How to access web pages ............................... 126
10.4 About web pages ...................................... 127
This section shows the content of the embedded web site. The embedded web site can be used with firmware version 1.50 or later.

10.1 Preparation
It is necessary to enable the LAN interface of the LI5645 / LI5650 to access embedded web pages. When it is enabled, the built-in web server is launched. After launching web server, it is possible to access web pages. Please refer to the section “1.5 LAN outline” for the way to enable the LAN interface.

10.2 Requirements
- OS: Windows 7
- Web Browser: Microsoft Internet Explorer (version 11 or later), Google Chrome, Mozilla Firefox

10.3 How to access web pages
It is necessary to get the IP address of the LI5645 / LI5650 to access web pages. The way to get the IP address, to confirm on the screen of the LI5645 / LI5650 or to use the discovery tool that is based on LXI discovery.

For example, the IP address of the LI5645 / LI5650 is 192.168.0.2, it is able to access web site to directly input http://192.168.0.2/ to a web browser.

Note: The built-in web server does not support Hyper Text Transfer Protocol Secure (HTTPS).
10.4 About web pages

10.4.1 Navigation Menu

Navigation menu includes "Top Menu" and "Sub Menu". To navigate between a page to other page, click an icon of the menu.

![Welcome Page](image)

*Fig. 10-1 Navigation Menu*

10.4.2 Descriptions of Menu

The following table shows the relation of menu icons to the feature.

<table>
<thead>
<tr>
<th>Top Menu</th>
<th>Sub Menu</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Home)</td>
<td>None</td>
<td>Transition to &quot;Welcome Page&quot;</td>
</tr>
<tr>
<td>(App)</td>
<td>(Remote Control)</td>
<td>Transition to &quot;Remote Control&quot; page that provides the front panel control of the LI5645 / LI5650.</td>
</tr>
<tr>
<td></td>
<td>(Logging)</td>
<td>Transition to &quot;Logging&quot; page that provides the feature for logging measurement data.</td>
</tr>
<tr>
<td>(Configuration)</td>
<td>(LAN Configuration)</td>
<td>Transition to &quot;LAN configuration&quot; page, you can change the LAN settings at this page.</td>
</tr>
<tr>
<td>(Configuration)</td>
<td>(Security)</td>
<td>Transition to &quot;Security&quot; page, you can change password at this page.</td>
</tr>
<tr>
<td>(Configuration)</td>
<td>(Update)</td>
<td>Transition to &quot;Update&quot; page that provides the feature to update the LI5645 / LI5650.</td>
</tr>
<tr>
<td>(Help)</td>
<td>(Glossary)</td>
<td>Transition to &quot;Glossary&quot; page that shows glossaries about LXI.</td>
</tr>
</tbody>
</table>
10.4.3 Welcome Page

This page is home page. This page shows the information about the LI5645 / LI5650, e.g. serial number, LAN settings.

The following table shows the parameters of this page.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>This parameter indicates the manufacturer name.</td>
</tr>
<tr>
<td>Instrument Model</td>
<td>This parameter indicates the model name and the description.</td>
</tr>
<tr>
<td>Serial Number</td>
<td>This parameter indicates the serial number.</td>
</tr>
<tr>
<td>Firmware Revision</td>
<td>This parameter indicates the firmware revision.</td>
</tr>
<tr>
<td>Current Time</td>
<td>This parameter indicates the current date and time. Notation of date and time depends on your web browser.</td>
</tr>
<tr>
<td>Current Source of Time</td>
<td>This parameter indicates the source of date and time.</td>
</tr>
<tr>
<td>Description</td>
<td>This parameter indicates the service name for mDNS (multicast Domain Name System) and DNS-SD (DNS Service Discovery).</td>
</tr>
<tr>
<td>LXI Extended Functions</td>
<td>This parameter indicates the LXI Extended Functions that are supported by the LI5645 / LI5650. If there is no supported function, it will be blank.</td>
</tr>
<tr>
<td>LXI Version</td>
<td>This parameter indicates the LXI version that is supported by the LI5645 / LI5650.</td>
</tr>
<tr>
<td>Host Name</td>
<td>This parameter indicates the host name. It is used to be access to the LI5645 / LI5650 without an IP address.</td>
</tr>
<tr>
<td>MAC Address</td>
<td>This parameter indicates the MAC address.</td>
</tr>
<tr>
<td>TCP/IP Address</td>
<td>This parameter indicates the IP address.</td>
</tr>
<tr>
<td>LXI Address String</td>
<td>This parameter indifactes the resource name to access by using VISA.</td>
</tr>
<tr>
<td>Instrument Identification</td>
<td>“On” and “Off” buttons are used to turn on and off the identificate dialogue that is displayed on the LI5645 / LI5650.</td>
</tr>
</tbody>
</table>

The following figure is shows the image that the identification dialogue is enable.

![Identification dialogue](image-url)
10.4.4 Remote Control

You can control the LI5645 / LI5650 by using this page.

By clicking Capture “START” and “STOP” button, it is possible to toggle between the start and stop capturing a screen shot and display refreshing.

By clicking Refresh Cycle “1.0s” or “2.0s” button, it is possible to change the refresh cycle.

For explanation about other buttons, please refer to the LI 5645 / LI 5650 Instruction Manual (Operations).

■ Note

When the page loading is completed, the screen capturing is automatically started.

If the processing load of the LI5645 / LI5650 is increased, the frequency of refreshing is decreased or stop refreshing.

A remote command is executed when accessing this page, refreshing of the display will be stopped.

![Fig. 10-3 Control Panel](image-url)
10.4.5 Logging

This page provides to obtain measurement data from the LI5645 / LI5650.

![Logging Page](image)

**Fig. 10-4 Logging**

<table>
<thead>
<tr>
<th>Button</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Play</td>
<td>Start measurement.</td>
</tr>
<tr>
<td>Stop</td>
<td>Stop measurement.</td>
</tr>
<tr>
<td>Download</td>
<td>Download measurement data in CSV format.</td>
</tr>
<tr>
<td>Clear</td>
<td>Clear the data in the table.</td>
</tr>
</tbody>
</table>

**Table 10-3 List of the Buttons at Logging Page**

■ Note

The refreshing cycle is 1 second. If the processing load of the LI5645 / LI5650 is increased, the cycle is not guaranteed.

The measured values are stored in the temporary storage of the web browser. Then the maximum number of the measured values that can be stored is 1024. If the window is closed, screen transition or reloading occurs, the stored data will be deleted.

The accessing this or other page at the same time or the executing a remote command causes to stop logging.
10.4.6 LAN Configuration

You can confirm and change the LAN settings of the LI5645 / LI5650.

To change setting is as follows:
- Click "Modify" button to change the forms to writeable.
- Enter new parameter to the form.
- Click "Submit" button.

And clicking “Reset” button, the settings are revert to the values before change.

The way to revert the settings to the factory default, see the section “1.5.2 LI5645 / LI5650 preparation” and reset by the {LAN Reset screen}.

The following table are the values that are shown in this page.

<table>
<thead>
<tr>
<th>Items</th>
<th>Description</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host Name</td>
<td>This parameter is used to access the LI5645 / LI5650 without an IP address by using mDNS and DNS-SD. If a hostname conflict occurs, a new host name, e.g. &lt;Host Name&gt;-1, &lt;Host Name&gt;-2, ..., is self-resolved by the LI5645 / LI5650. Up to 63 characters including alphabet and numeric characters and hyphens can be entered.</td>
<td>If this parameter has been changed other than the factory default value, this parameter can not be reverted to the factory default by the {LAN Reset Screen}. In this case, this parameter blank and clicking “Submit” button, it may be reverted to the default value.</td>
</tr>
<tr>
<td>Domain</td>
<td>This parameter is not to be used. Please set “1”.</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>This parameter is used as a service name for mDNS and DNS-SD. If a service name conflict occurs, a new service name, e.g. &lt;Description&gt;(1), &lt;Description&gt;(2), ..., is self-resolved by the LI5645 / LI5650. Up to 63 characters including alphabet and numeric characters, hyphens and spaces can be entered.</td>
<td>If this parameter has been changed other than the factory default value, this parameter can not be reverted to the factory default by the {LAN Reset Screen}. In this case, this parameter blank and clicking “Submit” button, it may be reverted to the default value.</td>
</tr>
<tr>
<td>TCP/IP Mode</td>
<td>This parameter is used to select the method for IP address assignment.</td>
<td></td>
</tr>
<tr>
<td>IP Address</td>
<td>This parameter is the static IP address.</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
<td>Details</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Subnet Mask</td>
<td>This parameter is the subnet mask.</td>
<td></td>
</tr>
</tbody>
</table>
10.4.7 Security

You can enable/disable web page protection and change password. The pages to be protected are “Remote Control”, “LAN Configuration”, “Update” and this page.

If you want to enable protection, enter the letters on the “New Password” and “Confirm Password” form and press “Submit” button. And if you want to enable disable protection, press "Submit" button with leaving the form "New Password" and "Confirm Password" blank.

The factory default password is blank. In other words, web page protection is disabled.

The following dialogue image is shown when you access web page that is protected. In the dialogue you should input "user" to "User Name:" field.

![Authentication Dialogue](image)

Fig. 10-5 Authentication Dialogue

Password reset can be done with the following procedure:

```
[UTIL] \rightarrow [INTERFACE>] \rightarrow [LAN>] \rightarrow [RESET>] \rightarrow [Exec]
```

Note : If you reset password with the above procedure, also reset other settings, e.g, IP address.

10.4.8 Update

You can update the LI5645 / LI5650.

Please refer to the manual that comes with the firmware updater of the LI5645 / LI5650.

10.4.9 Glossary

This page contains the glossary about LXI.
Notes

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- The content of this instruction manual is subject to change without notice in the future.
- Although we commit our best efforts to provide correct information in this manual, we assume no responsibility for any damage resulting from the contents.

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