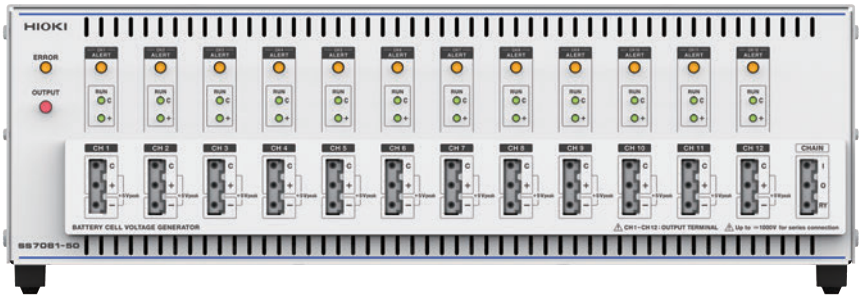
HIOKI

SS7081-50

Instruction Manual

BATTERY CELL VOLTAGE GENERATOR



Be sure to read this manual before using the instrument. ▶ p.2

When using the instrument for the first time

Name and Function of Each Part ▶ p.6

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EN

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Contents

Introduction

Thank you for purchasing the Hioki SS7081-50 Battery Cell Voltage Generator. To obtain maximum performance from the instrument over the long term, be sure to read this manual carefully and keep it handy for future reference.

Target audience

This manual has been written for use by individuals who use the product in question or who teach others to do so. It is assumed that the reader possesses basic electrical knowledge (equivalent to that of someone who graduated from the electrical program at a technical high school).

Accuracy

Hioki defines measurement accuracy in terms of percentages of the setting, the full scale, and the reading and digits.

Setting	Set value Indicates a value set so that the instrument can generate an output, such as voltage and current, whose magnitude is equal to the set value. “Percent of setting” means a percentage relative to the setting value.
Full scale	Maximum display value Indicates the maximum display value of each measurement range. As for this instrument, measurement ranges express maximum display values. “Percent of full scale (% f.s.)” means a percentage relative to the maximum display value.
Reading	Displayed value Indicates the value the instrument is presently displaying. “Percent of reading (% rdg)” means a percentage relative to the displayed value.
Digit(s)	Resolution “Digit(s) (dgt)” is a unit that represents the smallest change in the indication, which means the figure one at the least significant digit, on the digital measuring instrument.

Confirming Package Contents

- When you open the package, carefully inspect the instrument to ensure that everything is in good condition, and that no damage occurred during shipping. Carefully check the accessories and connectors. If the instrument seems to have been damaged or does not work as specified, contact your authorized Hioki distributor or reseller.
- Store the instrument packaging material after opening the instrument. Use the original packaging when shipping the instrument.

Confirm that these contents are provided.

☐ SS7081-50 Battery Cell Voltage Generator

Accessories

☐ Power cord
☐ Instruction Manual (this document)
☐ PC Application Instruction Manual (CD)
☐ Rack-mounting frames (Rack-mounting brackets for EIA-compliant rack)

Safety Information

The instrument is designed to conform to IEC 61010 Safety Standards and has been thoroughly tested for safety prior to shipment. However, using the instrument in a way not described in this manual may negate the provided safety features.
Carefully read the following safety notes before using the instrument.

⚠DANGER

Mishandling during use could result in injury or death, as well as damage to the instrument. Be certain that you understand the instructions and precautions in the manual before use.

⚠WARNING

With regard to the electricity supply, there are risks of electric shock, heat generation, fire, and arc discharge due to short circuits. If persons unfamiliar with electricity measuring instruments are to use the instrument, another person familiar with such instruments must supervise operations.

Protective gear

⚠WARNING

The instrument is used on a live line. To prevent an electric shock, use appropriate protective insulation and adhere to applicable laws and regulations.

Notations

In this manual, the risk seriousness and the hazard levels are classified as follows.

⚠ **DANGER**	Indicates an imminently hazardous situation that will result in death or serious injury to the operator.
⚠ **WARNING**	Indicates a potentially hazardous situation that may result in death or serious injury to the operator.
⚠ **CAUTION**	Indicates a potentially hazardous situation that may result in minor or moderate injury to the operator or damage to the instrument or malfunction.
IMPORTANT	Indicates information related to the operation of the instrument or maintenance tasks with which the operators must be fully familiar.

Symbols affixed to the instrument

	Indicates cautions and hazards. When this symbol is displayed on the instrument, refer to the “Usage Notes” section (p.3) in the Instruction Manual for more information.
	Indicates AC (Alternating Current).
	Indicates the ON side of the power switch.
	Indicates the OFF side of the power switch.

Symbols for various standards

	Indicates the Waste Electrical and Electronic Equipment Directive (WEEE Directive) in EU member states.
	Indicates that the product conforms to regulations required by the EU Directive.

Other Symbols

*	Additional information is presented below.
(p.)	Indicates the location of reference information.

Usage Notes

Observe the following precautionary information to ensure that the instrument can be used safely and in a manner that allows it to perform as described in its specifications.

Installing

To prevent overheating, be sure to leave the specified clearances around the instrument.
50 mm or more for the left side, right side, front, and back respectively

- The instrument should be operated only with the bottom side downwards.
- Vents must not be blocked.
- Do not tilt the instrument.
- If incorporating into a system, make sure not to exceed the instrument's use temperature range.

⚠CAUTION

Do not place the instrument on an unstable surface or inclined place. Dropping or knocking down the instrument could cause bodily injury or damage to the instrument.

Handling the instrument

⚠DANGER

Touching any of the high-voltage points inside the instrument is very dangerous.
Do not attempt to modify, disassemble, or try to repair the instrument. Doing so may cause a fire, electric shock, or injury.

⚠CAUTION

- To avoid damage to the instrument, avoid subjecting it to vibration or mechanical shock during transportation and handling. Exercise particular care to avoid subjecting the instrument to mechanical shock, for example by dropping.
- Remove the connection cable when carrying the instrument.

The instrument may cause interference if used in residential areas. Such use must be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent interference to the reception of radio and television broadcasts.

Handling the cables

⚠CAUTION

- Avoid stepping on or pinching the cable, which could damage the cable insulation.
- To prevent damage due to snapped wires, do not bend or pull the cables.

1 Overview

1.1 Overview

The instrument is a 12-channel constant voltage supply with each channel isolated and that is capable of independent control. In addition, the voltage and current can be measured for each channel. One battery cell can be simulated with one channel of the instrument. Connecting each channel in series enables the battery packs in which the cells have been stacked to be simulated. In addition, connecting multiple instruments in series enabled 13 or more channels to be connected. (1000 V max.)

1.2 Features

High-accuracy voltage generation

The instrument's voltage generator is accurate to within 0.015% of setting, making it ideal for testing today's increasingly accurate BMS ICs.

High-accuracy voltage measurement

The instrument measures the output voltage using an internal voltmeter with a resolution of 10 µV to an accuracy of 0.01% of reading.

Minuscule current measurement

The instrument has a minuscule current measurement range that's useful for measuring BMS boards' dark current and cell-balancing circuits' leakage current.

Free power supply

The free power supply accommodates supply voltages of 100 V to 240 V AC, making it easy to transfer the instrument to an overseas production line.

Anomaly simulation function

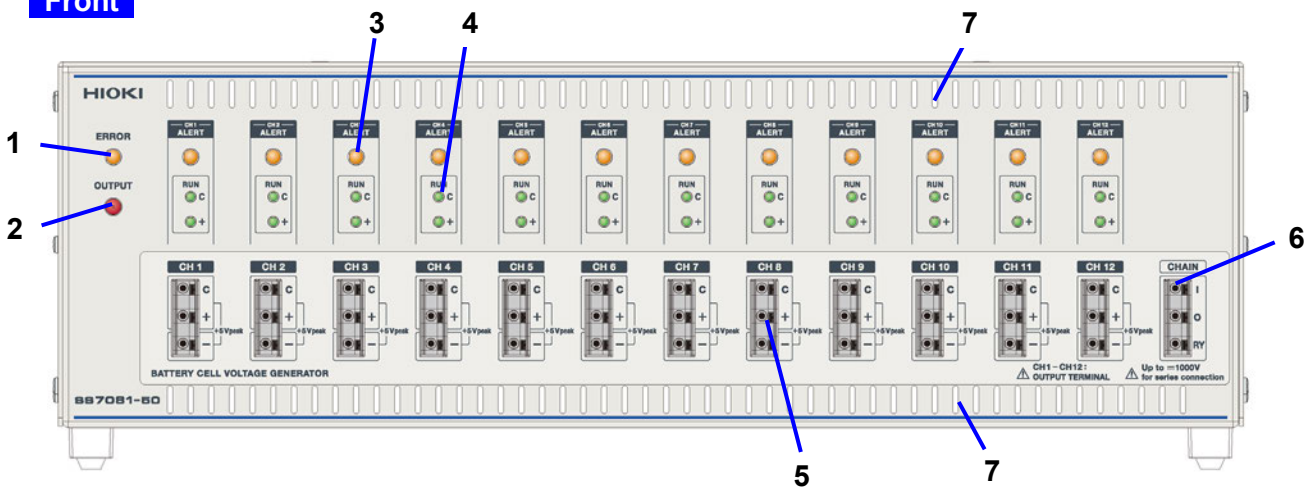
The instrument can simulate wire breaks in cables between the battery and BMS board as well as cell short-circuits.

Safety functionality

In the event a BMS board malfunction causes an abnormal current to flow, the instrument can stop output to prevent damage to the circuit under test.

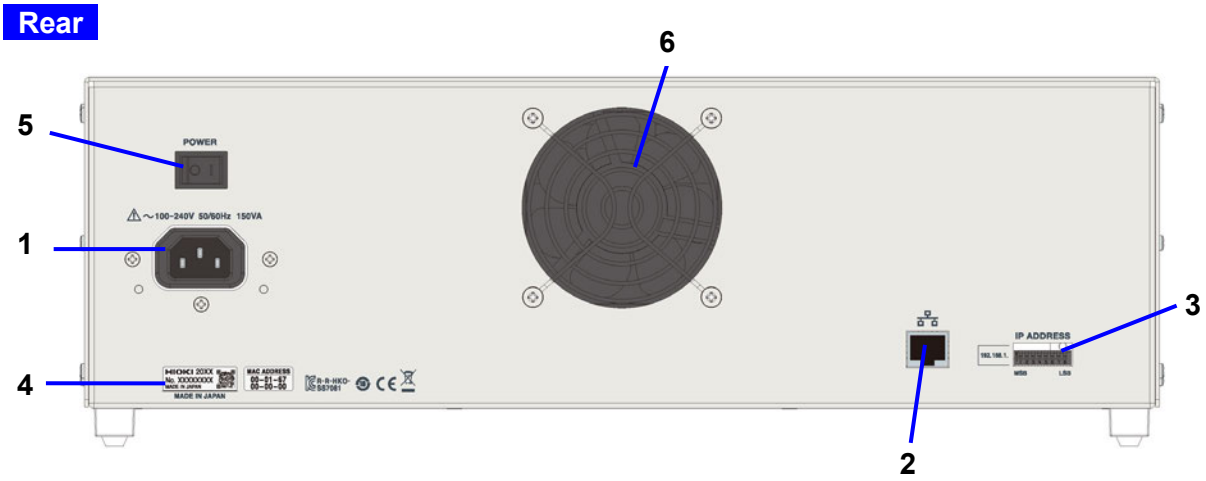
1.3 Name and Function of Each Part

Front



1	Command error display (ERROR)	Lamp turns orange if a command error occurs. Clear the error using either ∗CLS or ∗RST. Lamp blinks in orange if a failure occurs. For details, see “1.4 Lamp Display” (p. 8).
2	Output terminal status display (OUTPUT)	Shows the status of the output terminal (C or positive terminal). Red (lit): Output terminal is set to ON. White (lit): Output terminal is set to OFF. Red (blink): Warming up (30 minutes after the instrument is turned on) and the output terminal is set to ON. White (blink): Warming up (30 minutes after the instrument is turned on) and the output terminal is set to OFF. For details, see “3.2 Switching Output Terminals” (p. 21).
3	Alert display (ALERT)	Lamp turns orange if an anomaly is detected on any channel. Clear the alert using either ∗CLS or ∗RST. For details, see “1.4 Lamp Display” (p. 8).
4	Channel status display (RUN)	Terminal turns green when a voltage is detected. For details, see “1.4 Lamp Display” (p. 8).
5	Output terminals	C terminal: Connects the voltage source in series. Same potential as the positive terminal. Connecting to the negative terminal on another channel enables each channel to be connected in series. Positive terminal: Voltage is output. Negative terminal: Connects to the circuit ground. For details, see “3.2 Switching Output Terminals” (p. 21).
6	Connecting terminals for another unit of Model SS7081-50 and BMS board reference potential	I and O terminals are connected internally. I and RY terminals are connected via a relay. I terminal: Connects the voltage source in series. Connects the instrument output terminal. O terminal: Connects to the other unit of Model SS7081-50 output terminal. RY terminal: Connects to the measuring object or the other unit of Model SS7081-50 output terminal. For details, see “3.2 Switching Output Terminals” (p. 21).
7	Vent	Install the instrument so as not to block the vents.

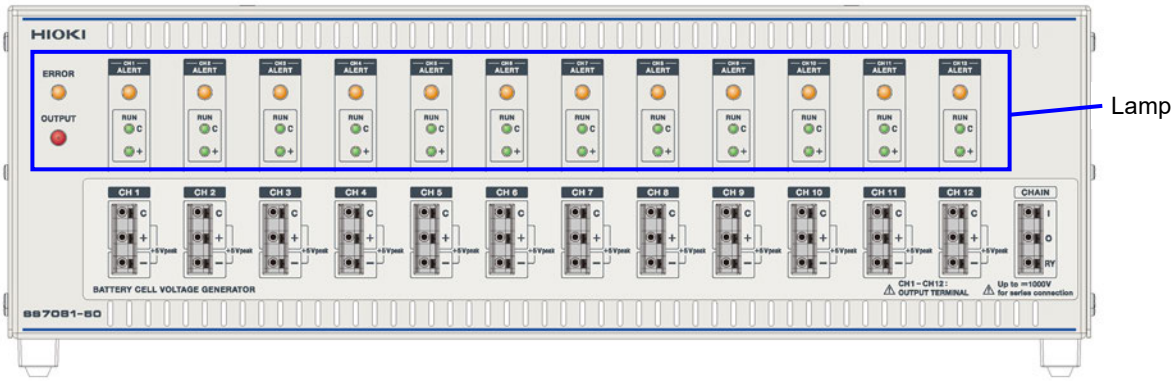
Rear



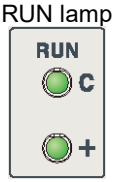
1	Power inlet	Used to connect the power cord. Reference: “2.2 Connecting the Power Cord” (p. 11).
2	LAN connector	Use a LAN cable to connect to the computer. Reference: “1.5 Control Methods” (p. 9).
3	IP address switch	Sets the lowest 8 bits of the IP address (host address) of the instrument when using a LAN connection. The uppermost 24 bits (network address) are fixed at 192.168.1. Reference: “2.4 Setting the IP Address” (p. 15)
4	Serial number	The 9-digit serial number indicates the year (first two digits) and the month of manufacture (next two digits). Do not remove this sticker as the number is important.
5	Main power switch	Turns on and off the instrument. Reference: “2.6 Turning the Instrument On and Off” (p. 17)
6	Vent (Fan)	Install the instrument so as not to block the vents.

1.4 Lamp Display

Channel status display



Lamp operation and instrument status

Lamp	Lightning up or blinking
ERROR lamp 	Lights up in the event of an error. • Command error • Query error • Execution error • Abnormal temperature inside the case (control board/output board)
ALERT lamp 	Lights up in the event of a malfunction. • Overcurrent error • Output voltage error • Abnormal temperature inside the case (output board) • Overrange
RUN lamp 	<table><tr><th>Output</th><th>Terminal status</th><th>C terminal</th><th>Positive terminal</th></tr><tr><td rowspan="3">ON</td><td>NORMAL</td><td>Lit</td><td>Lit</td></tr><tr><td>HIMPEDANCE</td><td>Lit</td><td>Unlit</td></tr><tr><td>ZERO</td><td>Unlit</td><td>Unlit</td></tr><tr><td rowspan="2">OFF</td><td>HIMPEDANCE</td><td>Blink</td><td>Unlit</td></tr><tr><td>ZERO</td><td>Unlit</td><td>Unlit</td></tr></table> For details, see “3.2 Switching Output Terminals” (p. 21).

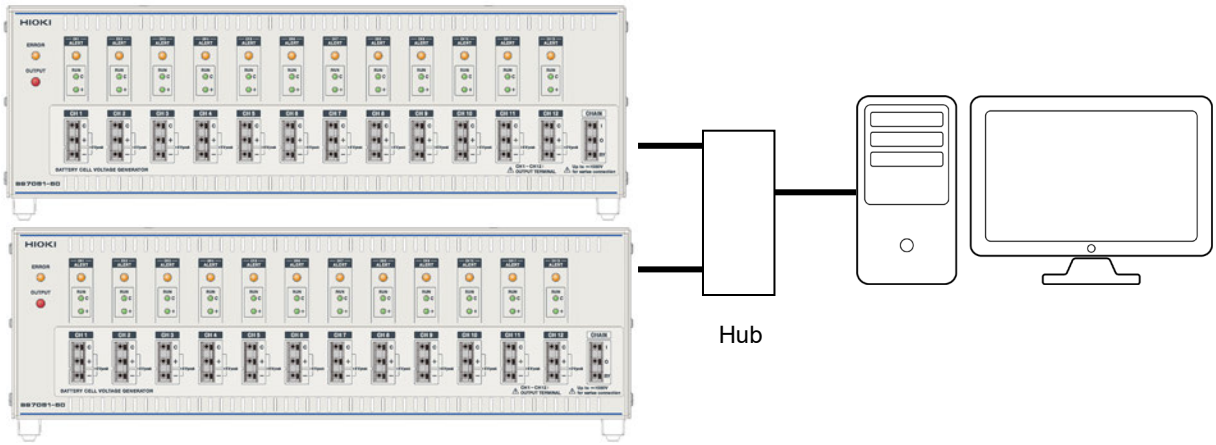
Other (error display)

If the ALERT lamps for all channels light up, or the ERROR lamp flashes, the instrument has experienced a malfunction.
For details, see “7.1 Error Display” (p. 61).

1.5 Control Methods

The instrument can be controlled using a LAN interface. Control using panel operations is disabled.
The instrument interface is an Ethernet 100BASE-TX. If using a 10BASE-T or 100BASE-TX-compatible LAN cable (30 m max.) to connect to a communications command port using TCP, the instrument can be controlled using communications commands.

If controlling multiple instruments, each one is controlled independently. There is no master/subordinate relationship.



2 Preparations

2.1 Preparation Process

Thoroughly read “Usage Notes” (p. 3) beforehand.

(1) Position the instrument as desired. (p. 3)
↓
(2) Connect the power cord. (p. 11)
↓
(3) Connect the output cable. (p. 12)
↓
(4) Set the IP address. (p. 15)
↓
(5) Connect the LAN cable. (p. 16)
↓
(6) Turn on the instrument. (p. 17)

2.2 Connecting the Power Cord

⚠WARNING

- Confirm the supply voltage to the instrument matches the supply voltage indicated on the instrument before connecting the power cord to the instrument. Connection to an improper supply voltage may damage the instrument and present an electrical hazard.
- To prevent an electric shock and to maintain the safety specifications of the instrument, connect the power cord provided only to an outlet.

Connect the power cord to the instrument power supply inlet and the outlet.
Item to prepare: Power cord (instrument accessory)

1. Set the main power supply switch to OFF.
2. Check that the outlet voltage and instrument power supply voltage match.
3. Connect the power cord to the instrument power supply inlet.
4. Connect the power cord to the outlet.

If power interrupts (a breaker tripped, etc.) while the instrument is on, the instrument will automatically start once the power supply is restored next time.

2.3 Connecting the Output Cable

⚠WARNING

To prevent an electric shock, always observe the following precautions:

- Connect the output cable while the instrument is off or otherwise in a state where outputs are disabled. In addition, use an insulated tool such as resin tool to make the connection.
- Connecting outputs in series creates high voltages. Observe the ratings commensurate to this voltage for the connected instrument inputs and cables.
- If connecting outputs in series, there may be high voltages in the connected instruments. To avoid electric shock, do not touch parts where voltage from the connected instruments flows.
- To avoid any electric shock accident, perform the wiring so that the stripped wire length of the output cable is up to 10 mm and no core wires are protruding from the terminals.
- Connect measurement lines to current input terminals securely. If a wiring is loose, the contact resistance will increase, resulting in overheating, equipment burnout, or fire.
- During series connections, make sure the output voltage is 1000 V max.
- Do not connect in parallel.

IMPORTANT

When outputting a current, there is a difference between the set voltage and the voltage detected across the circuit under test due to voltage drop caused by the output cable's wiring resistance and the load current. In order to limit the difference between the set voltage and the voltage detected across the circuit under test to about 1% with a load current of 1 A while outputting 5 V, it is recommended to use a cable length of 2 m or less.

Example calculation:

Cable wiring resistance Rcable: 0.013 Ω/m (annealed copper wire, AWG 16)

Allowable voltage drop ΔVdrop: 1% (with 5 V output, 50 mV)

Load current I: 1 A

Cable length = ΔVdrop / (Rcable × 2 × I) = 50 mV / (0.013 Ω × 2 × 1 A) ≒ 1.9 m

Connecting wires to the terminal block

⚠CAUTION

To prevent electrical accidents, use the recommended wire type to connect to the current input terminals, or otherwise ensure that the wire used has sufficient current handling capacity and insulation.

Acceptable limits: AWG 16 to 26

Button pressing tool: A flat-head screwdriver (with a tip width of 2.6 mm)

Required items: A flat-head screwdriver

1. Strip insulation from the wires (Maximum insulation stripping length: approx. 10 mm).
2. Press down on the terminal button with the flat-head screwdriver.
3. Insert the cable into the terminal hole while depressing the button.
4. Remove the flat-head screwdriver from the button.
   The cable will be locked in place. Pull gently on the cable and verify that it does not come out.

To remove the wire

Hold the button while pulling the wire out.

IMPORTANT

- When using wiring whose insulation has a low insulation resistance, the wire's leakage current may affect the accuracy of minuscule current measurement.
- When using the 100 µA range, it is recommend to use cables with either polyethylene (PE) or polytetrafluoroethylene (PTFE) insulation.

Connecting channels

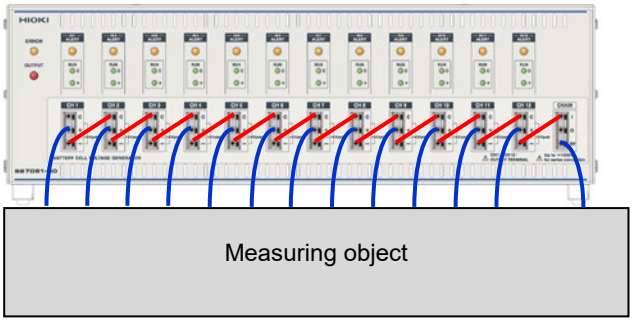
You can connect the channels and multiple units of Model SS7081-50 in series.

When connecting CH 1 to the cell with the highest potential

1 Connect the **CH 1** negative terminal to the **CH 2** C terminal.
2 Connect the **CH 2** negative terminal to the **CH 3** C terminal.
3 Connect the channels to be used in the same way.
4 Connect the negative terminal for the channel with the highest number (i.e., the channel with the lowest potential) used in the instrument to the **CHAIN** I terminal.
5 Connect the **CHAIN** RY terminal to the measuring object (standard potential).

Note: If it is not necessary to disconnect the standard potential connection terminal, the negative terminal or the **CHAIN** O terminal of the channel in use with highest number may be connected directly to the measuring object.

12-channel connection example



When connecting CH 1 to the cell with the lowest potential

1 Connect the **CH 1** C terminal to the **CH 2** negative terminal.
2 Connect the **CH 2** C terminal to the **CH 3** negative terminal.
3 Connect the channels to be used in the same way.
4 Connect the C terminal for the channel with the highest number (i.e., the channel with the highest potential) used in the instrument to the **CHAIN** RY terminal.
5 Connect the **CHAIN** I terminal to the measuring object (standard potential).

Note: If it is not necessary to disconnect the highest potential, the positive terminal or C terminal of the channel in use with the highest number may be connected directly to the measuring object.

Connecting multiple instruments

When connecting the CHAIN terminal to the highest-potential terminal

1 Connect the C terminal for the channel with the highest number (i.e., the channel with the highest potential) used in the instrument to the **CHAIN** RY terminal.

Note: If it is not necessary to disconnect the instruments, connect the terminal to the **CHAIN** O terminal.

2 Connect the **CHAIN** I terminal to the **CH 1** negative terminal of the instrument on the high-potential side.

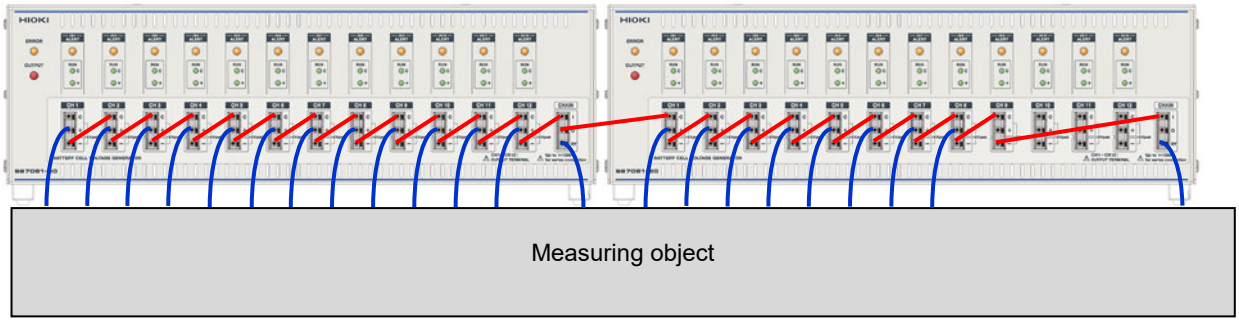
When connecting the CHAIN terminal to the lowest-potential terminal

1 Connect the negative terminal for the channel with the highest number (i.e., the channel with the lowest potential) used in the instrument to the **CHAIN** I terminal.

2 Connect the **CHAIN** RY terminal to the **CH 1** C terminal of the instrument on the low-potential side.

Note: If it is not necessary to disconnect the instruments, connect the terminal to the **CHAIN** O terminal.

20-channel connection example



For the output terminals, see “3.2 Switching Output Terminals” (p. 21).

2.4 Setting the IP Address

1 Check that the main power supply switch on the back is set to OFF (O).

2 Use the IP address switch on the back to set the IP.

Displays the values up to 255 using the most significant bit (MSB) and least significant bit (LSB). When the switch is set in the up position, the switch turns on.

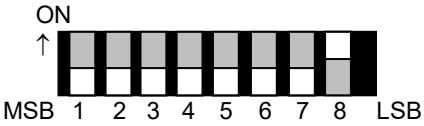
Set the switches so that the total of the values with the switches set to on equals to the number in the set IP address.

Value with switch-on	Number described by the switch
1 (2 to the power of 0)	8 (LSB)
2 (2 to the power of 1)	7
4 (2 to the power of 2)	6
8 (2 to the power of 3)	5
16 (2 to the power of 4)	4
32 (2 to the power of 5)	3
64 (2 to the power of 6)	2
128 (2 to the power of 7)	1 (MSB)

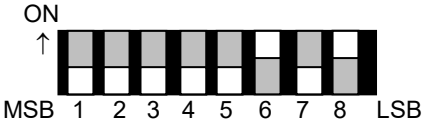
IMPORTANT

- The settable IP address is the lowest 8 bits (host address).The uppermost 24 bits (network address) are fixed at 192.168.1.
- Change the IP address switch when the instrument is off. No updates will occur if the changes are made while the instrument is on. If you change the IP address while the instrument is powered on, cycle the power.
- Make sure never to turn off (0) or on (255) all the IP address switches.
- Make sure not to connect instruments with the same IP address on the same network.
- Do not access via a router.

(Settings example 1) IP address 192.168.1.1 / Port No. 1024



(Settings example 2) IP address 192.168.1.5 / Port No. 1024



Description of setting items

When setting up a network connection, configure the following settings in addition to the IP address:

Subnet mask	This setting separates the IP address into the address part showing the network and the address part showing the instrument. The instrument's subnet mask is permanently set to 255.255.255.0.
Default gateway	When the communicating computer and the instrument are in different networks, specify the IP address of the device that becomes a gateway. The instrument does not have a default gateway setting.
Communication command port number	Specify the connected TCP/IP port number for communication commands. The instrument's communication command port number is permanently set to 1024.

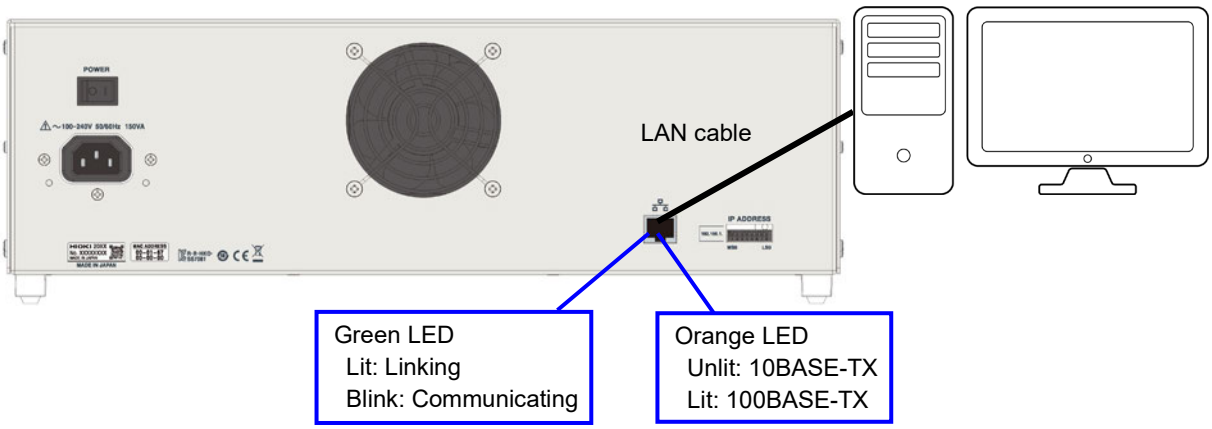
2.5 Connecting the LAN Cable

⚠CAUTION

- When connecting the instrument to your LAN with a LAN cable laid outdoors, take appropriate countermeasures that include installing a surge protector for LANs. Such signal wiring is susceptible to induced lighting, which can cause damage to the instrument.
- To avoid equipment failure, do not disconnect the LAN cable while communications are in progress.
- Use a common ground for both the instrument and the computer. Using different ground circuits will result in a potential difference between the instrument's ground and the computer's ground. If the LAN cable is connected while such a potential difference exists, it may result in equipment malfunction or failure.
- Before connecting or disconnecting any measurement cable or LAN cable, always turn off the instrument and the computer. Failure to do so could result in equipment malfunction or damage.

1 Connect a LAN cable to the LAN connector of the instrument.

Recommended cables:
9642 LAN Cable
100Base-TX or 10Base-T compatible LAN cable



If the lamp does not turn green when you connect a LAN cable, the instrument or connected device may be malfunctioning, or there may be a wire break in the LAN cable.

2 Make the network settings of the computer.

Make the TCP/IPv4 settings of the computer to be connected to the instrument as follows.

IP address: 192.168.1.X*
Subnet mask: 255.255.255.0
Default gateway: None

*: Set X to a different value than the instrument.

2.6 Turning the Instrument On and Off

⚠CAUTION

Do not operate the instrument on any of the power sources (UPS or uninterruptible power supply, DC/AC inverter) that provide rectangular-wave or pseudo-sine-wave power. Doing so may damage the instrument.

Turning on the instrument

1 Set the main power supply switch on the back to ON (|).

→ The instrument OUTPUT display will blink white. Do not send any communications commands before the blinking starts.

→ If the warming up time (30 minutes) is exceeded, the blinking instrument OUTPUT display will change to lit.

IMPORTANT

When the instrument is turned on, the power supply frequency for the instrument will be set to the power supply frequency automatically.

Turning off the instrument

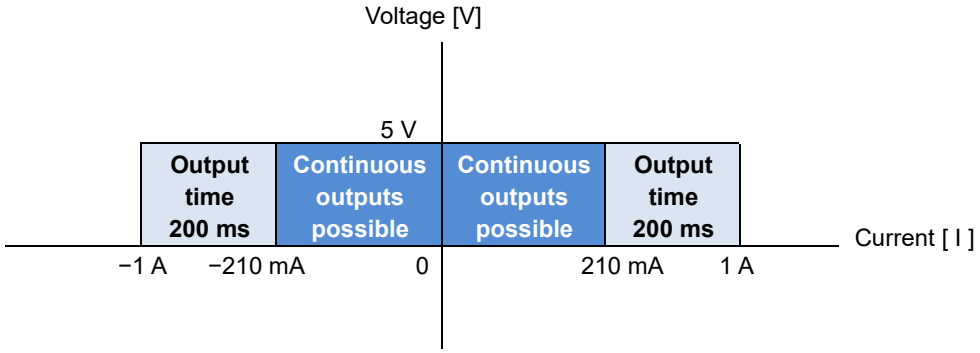
1 Set the main power supply switch on the back to OFF (○).

If power interruptes (a breaker tripped, etc.) while the instrument is on, the instrument will automatically start once the power supply is restored next time.
Settings are not backed up. When the instrument is turned on, all settings are at their default values. For the default values, see “Initialize the instrumen” (p. 40).

3 Generation and Measurement

3.1 Voltage Outputs

Each channel can output 0 V to 5 V constant voltage.
The current output range is −1 A to 1 A. The continuous output range is −210 mA to 210 mA.
If the current is smaller than −210 mA or larger than 210 mA, the maximum possible output time is 200 ms. Allow an interval of 5 s to elapse before outputting a current that exceeds the continuous output range on a channel that has just exceeded the continuous output range. If the output range or maximum possible output time is exceeded, an overcurrent error will stop the outputs. If an overcurrent error occurs, query the Event Register of the Status Query Register Group (:STATus:QUEStionable[:EVENt]?) and check the error description. If the error is output again, it will be necessary to set the output voltage and turn on the output terminals.



Reference: Communication command “Status and event control commands *CLS” (p. 41)

Output constant voltage

Commands may be used to output the desired voltage for each channel.

Outputting a voltage

1 Issue a command to set the output voltage. (0.0000 V～5.0250 V)
2 Configure the setting to turn output on. (HIMPEDANCE / NORMAL / ZERO)
3 Issue a command to set the output terminal.
Reference: “3.2 Switching Output Terminals” (p. 21)

IMPORTANT
- Overshoot or undershoot may occur when connecting a capacitive load.
- If a capacitive load is connected while using the 100 µA range, it may take time to reach the set voltage.
- Securely wire the output cables to the terminals. Large load currents may increase the voltage drop due to contact resistance between the wires and terminals.

Stopping voltage output

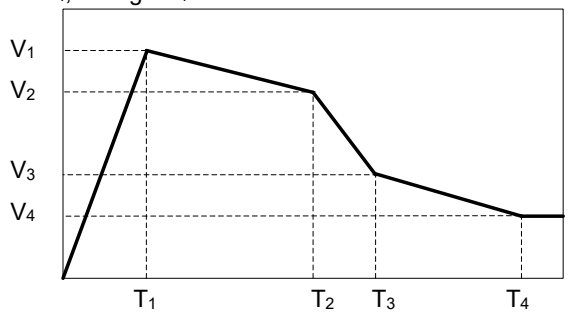
1 Configure the setting to turn output off.
2 Issue a command to set the output terminal.
Reference: “3.2 Switching Output Terminals” (p. 21)

Reference: Communication command “Output voltage” (p. 46)

Changing the output voltage at high-speed (memory output function)

If changing the output voltage at high speed, use the memory output function. The memory output function can change the voltage using 1 ms updates according to the point saved to memory beforehand. A maximum of 4 points can be saved to memory.
Set the voltage points and time to reach the voltage as shown in the example below.
The function starts from the voltage that is currently set, and after it has finished, the final memory output is held.

Example of 4-point memory output: Time T_1, voltage V_1 → Time T_2, voltage V_2 → Time T_3, voltage V_3 → Time T_4, voltage V_4



Setting memory output

1 Set the memory output value.
(:SOURce:VOLTage:MEMory:TABLe <Time 1,Voltage value1>,<Time,Voltage value2>,<Time3,Voltage value3>,<Time4,Voltage value4>,<Channel number>)

2 Start memory output.
(:SOURce:VOLTage:MEMory:STATe ON,<Channel number>)

> **IMPORTANT**
> When connecting a capacitive load, output may not reach the set voltage within the set amount of time.

Stopping memory output

1 Stop memory output.
(:SOURce:VOLTage:MEMory:STATe OFF,<Channel number>)

Reference: Communication command “Memory outputs” (p. 47)

3.2 Switching Output Terminals

⚠CAUTION

Using a setting of ZERO when the measurement target carries a voltage may cause the measurement target to short-circuit, damaging the instrument or the measurement target. Set to HIGH IMPEDANCE before connecting the measurement target to the instrument.

Output terminals for each channel

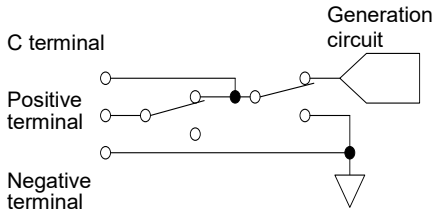
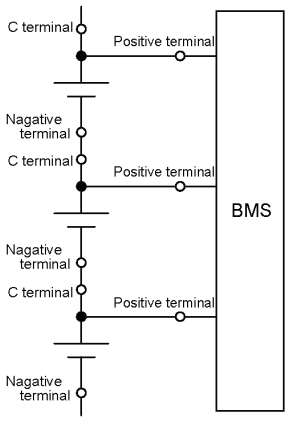
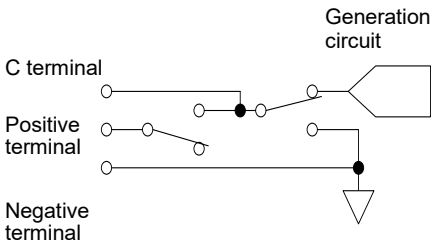
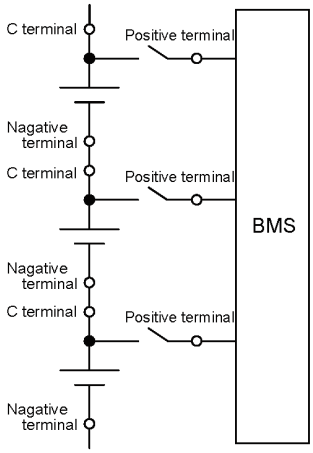
Reference: Communication command “Output terminals” (p. 45).

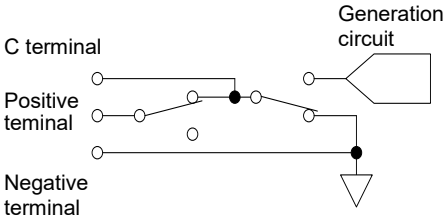
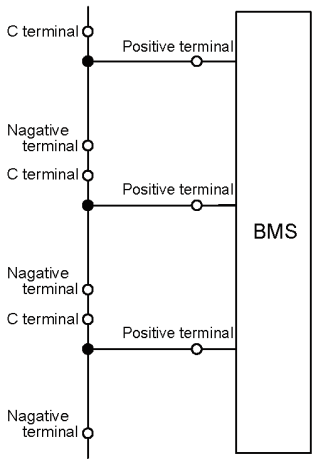
Output voltage from the terminal

This setting allows you to disconnect the positive terminal from the instrument’s internal circuitry or short it with the negative terminal while a voltage is being output from the terminal.

1 Set the terminal status to ON (a batch of all channels).
(:OUTPut:STATe ON)

2 Perform the setting when the terminal is set to ON (a batch of all channels or an arbitrary channel).
(:OUTPut:ON:MODE NORMal / HIMPedance / ZERO,<Channel number>)

Terminal status		Internal circuit	Connection image
:OUTPut:STATe	:OUTPut:ON:MODE		
ON OUTPUT (Red)	NORMAL (default value) C terminal: The set voltage will be output. Positive terminal: The set voltage will be output.  C: Lit Positive: Lit	 	
	HIMPEDANCE C terminal: The set voltage will be output. Positive terminal: The positive terminal will be disconnected from the instrument’s internal circuitry, placing it in an undefined state.  C: Lit Positive: Unlit	 	

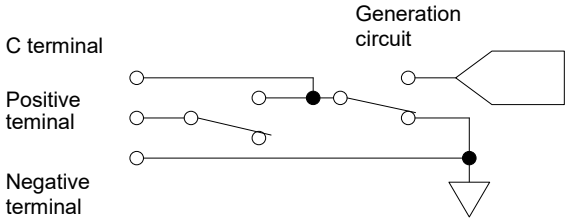
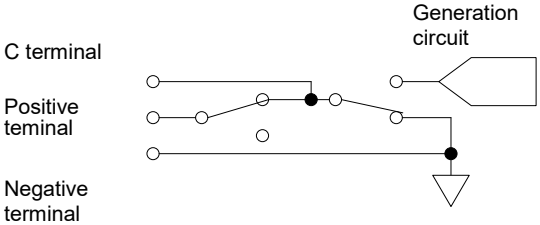
	ZERO C terminal: The C terminal will be shorted with the negative terminal. Positive terminal: The positive terminal will be shorted with the negative terminal.  C: Unlit Positive: Unlit		

Stopping the terminal output

Sets the state of the terminal when output is inactive. Perform the setting in accordance with the measuring object to be connected to the instrument.

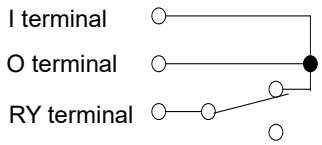
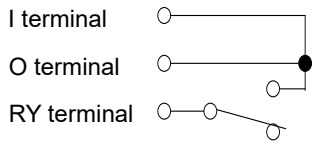
1 Set the terminal OFF status beforehand (a batch of all channels).
(:OUTPut:OFF:MODE HIMPedance / ZERO)

2 Set the terminal status to OFF (a batch of all channels).
(:OUTPut:STATe OFF)

Terminal status		Internal circuit
:OUTPut:STATe	:OUTPut:OFF:MODE	
OFF (default value)  (White)	HIMPEDANCE C terminal: The C terminal will be shorted with the negative terminal. Positive terminal: The positive terminal will be disconnected from the instrument's internal circuitry, placing it in an undefined state.  C: Blink Positive: Unlit	
	ZERO (default value) C terminal: The C terminal will be shorted with the negative terminal. Positive terminal: The positive terminal will be shorted with the negative terminal.  C: Unlit Positive: Unlit	

Output expansion terminal (CHAIN terminal)

The RY terminal of CHAIN terminal can be connected to and disconnected from the I terminal by using the ON/OFF settings.

Terminal status :OUTPut:STATe	Internal circuit
ON (default value) RY terminal: Connects the terminal to I terminal and O terminal	
OFF RY terminal: Disconnects the terminal from the instrument's internal circuitry and places it in an open state.	

3.3 Voltage and Current Measurements

The output voltage and output current can be acquired using query messages.
Reference: Communication command "Reading measurement data" (p. 48).

Switching the current measurement range

There are 2 current ranges: 1 A and 100 µA. Use each according to the application.

Range	Application
1 A (default value)	Suitable for measuring the cell balancing current.
100 µA	Suitable for measuring the dark current, standby current, and consumption current.

The current measurement range can be switched using commands.

When connecting the instrument using the 100 µA range

- The allowable resistance value for the 100 µA range is 50 kΩ or greater. When the connected resistance value is low, the current measured value will go overrange, and output will stop (reference value at which output will stop: 150 µA). In this case, use the 1 A range.
- Connecting a capacitive load may result in overshoot or understood. Additionally, it may take time for the voltage to reach the set level.
- When using wiring whose insulation has a low insulation resistance, the wire's leakage current may affect the accuracy of minuscule current measurement. When using the 100 µA range, it is recommend to use cables with either polyethylene (PE) or polytetrafluoroethylene (PTFE) insulation.

Reference: Communication command “Current measurement range” (p. 48)

Acquiring stable measured values (smoothing function)

This function averages and outputs measured values. You can use it to acquire stabilized measured values. The averaging count can be set to a value from 1 to 100. Larger average counts yield more stable measured values.

Voltage and current can be measured simultaneously in 1 PLC* units. If the averaging count is set to a value of 2 or greater, the set number of recent measured values will be averaged and displayed (moving average).

The measured value refresh speed will not change. If using the logging function, the measured value will be saved for each averaging iteration.

E.g., Measured value acquired if the averaging count is set to a value of 3 (D1 to D6: measured value for each PLC)

Number of measurements	1st	2nd	3rd	4th	5th	6th
Displayed value	D1	(D1 + D2) / 2	(D1 + D2 + D3) / 3	(D2 + D3 + D4) / 3	(D3 + D4 + D5) / 3	(D4 + D5 + D6) / 3
Logging Save	-	-	Save	-	-	Save

In the following settings are changed, the memory used for the integral time settings is automatically deleted.

- If the measurement range is switched
- If the output terminal is switched
- If the integral time setting is changed
- If the output voltage is changed

* PLC is an abbreviation of Power Line Cycle. 1 PLC is the time equivalent to 1 power supply period. In regions where the power supply is 50 Hz, 1 PLC = 1 / 50 = 20 ms, and in regions where the power supply is 60 Hz, 1 PLC = 1 / 60 = 16.7 ms.

Enabling the smoothing function

1 Enable the smoothing function.
(:[:SENSe]:AVERage[:STATe] 1,<Channel number>)

2 Set the averaging count.
(:[:SENSe]:AVERage:COUNt<Average number>,<Channel number>)
If the channel number is omitted, the same setting will be applied to all channels.

To acquire stabilized measured values after changing the settings
Verify that the setting change is completed with ＊OPC?.
When changing the output voltage or CHAIN terminal settings, wait [(smoothing count + 1) × 1 PLC + 3] ms before querying the voltage and current value. When changing other settings, wait [smoothing count × 1 PLC + 3] ms before querying the voltage and current value.

Disabling the smoothing function

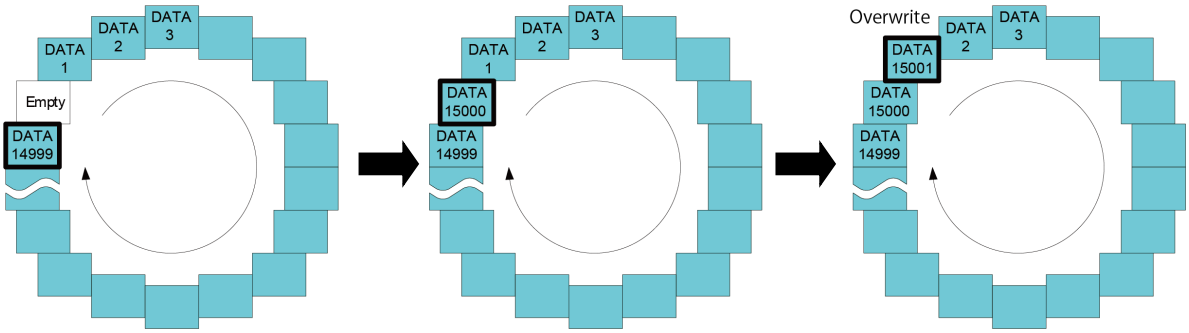
1 Disable the smoothing function.
(:[SENSe]:AVERage:STATe 0,<Channel number>)

Reference: Communication command “Smoothing function” (p. 48)

Saving, collating, and acquiring measured values (logging function)

You can save the measured values for each integral time that has been set. The measured values that have been saved can be read for each individual channel, voltage, and current.
Up to 15,000 data points can be saved. The saved data uses a ring buffer configuration, so when the maximum number of data points is exceeded, the oldest data is overwritten.

In the following cases, the saved data is deleted.
- When logging starts
- When the instrument is initialized (∗RST)
- When a self-test is performed (∗TST?)



In the following cases, logging stops automatically.*
- If the measurement conditions are changed

→ Execute logging again after finalizing the setting conditions.
- Once the maximum time (12 hours from the start of logging) has elapsed (if logging was started without setting a logging time)
- If ∗CLS is sent

* Changing the output voltage does not cause logging to stop

Starting/stopping logging

1. Start logging.
   (:DATA:STATe 1)
2. Stop logging.
   (:DATA:STATe 0)

Loading logging data

1. Output voltage logging data.
   (:DATA:VOLTage? <Channel number>,<Date count>)
2. Output current logging data.
   (:DATA:CURRent? <Channel number>,<Date count>)
   If no data count is specified, all data will be returned.

Reference: Communication command “Logging” (p. 49)

4 Error Detection Function

The instrument detects the following errors:

Overcurrent error

Overcurrent errors occur when the measured current value exceeds the overcurrent detection function's threshold.*

Checklist item	Solution
Is the connected load appropriate?	The instrument can output a maximum current of ±1 A. Ensure that the value obtained by dividing the output voltage by the load resistance does not exceed 1 A.
Is the output terminal shorted?	Check whether the connected load is shorted.
Is a current in excess of -210 mA to 210 mA being output for 200 ms or more?	If a current in excess of -210 mA to 210 mA is being output, configure the instrument so that the output time is less than 200 ms.
Is the instrument outputting a current in excess of the overcurrent detection function's threshold?	Set a threshold that is appropriate relative to the load current.

In the event an overcurrent error is detected, the instrument's settings will be changed as follows:

- Output off
- Set voltage of 0 V

In order to output a voltage, you will need to reset the error.
You can do so using the ＊CLS or :STATus:QUEStionable[:EVENTt]? query. Once the error has been reset, set the output voltage again and turn on output.

Reference: "3.1 Voltage Outputs" (p. 19)
"3.2 Switching Output Terminals" (p. 21)

Output voltage error

Output voltage errors occur when the difference between the set output voltage and the measurement voltage exceeds the output voltage error detection function's threshold. *

Checklist item	Solution
Has the output voltage error detection function's threshold been exceeded?	Set an appropriate threshold.
Is a capacitive load causing overshoot or undershoot?	Set an appropriate threshold after taking into account overshoot and undershoot.
Is a resistance that would cause the current measurement value to be greater than or equal to 120 µA or less than or equal to -120 µA in the 100 µA range connected between the output terminals?	If the current measurement range will be exceeded, set the instrument to the 1 A range.
Is a resistance less than 50 kΩ connected in the 100 µA range?	Use the 1 A range. Alternatively, connect a resistance that is greater than 50 kΩ.

* Detection is deactivated during the time listed below.

- 0.1 s after a voltage settings change
- 0.1 s after an output terminal is switched
- For the set disabled time after the instrument is switched from the 100 µA range to the 1 A range (default value: 1 s)
- 0.1 s after switching from the 1 A range to the 100 µA range (Changes can be made using communications commands)

Abnormal temperature inside the case

Abnormal temperature errors occur when the temperature inside the instrument’s enclosure exceeds the threshold.

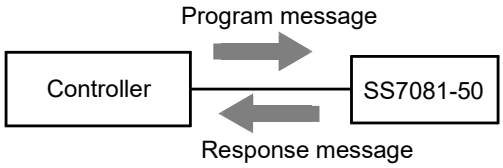
Checklist item	Solution
Has the ambient temperature exceeded the instrument's operating temperature range?	The instrument's operating temperature range is 0°C to 40°C. Use the instrument within the operating temperature and humidity range.
Has the instrument been installed in an appropriate manner?	Leave at least 50 mm of space to the left and right of the instrument, in front of the instrument, and behind the instrument.
Are the instrument’s vents blocked?	Verify that the instrument’s vents are not blocked.
Has the internal temperature error detection function’s threshold been set appropriately?	Set an appropriate threshold.

Reference: Communications Commands “Self-diagnosis” (p. 50)

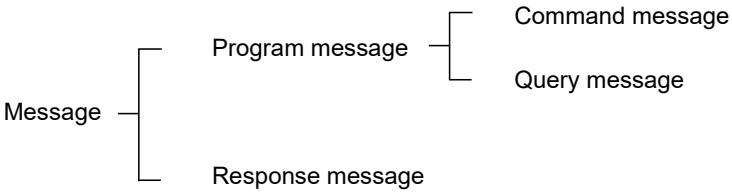
5 Communication Command

5.1 Commands Overview

Various messages are supported for controlling the instrument through the interfaces.
Messages include program messages sent to the instrument from the controller such as a PC, etc., and response messages sent to the controller from the instrument.



Message types are further categorized as follows.



Enter data commands using the designated data format.

Message format

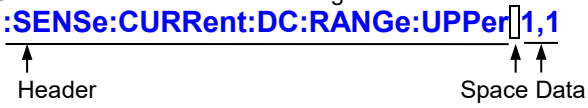
■ Program message

Program messages can be divided into command messages or query messages.

(1) Command messages

Instructions to control the instrument, such as to change or reset the instrument settings

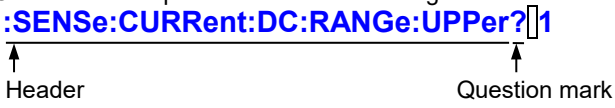
(E.g.) Command to set the current range.



(2) Query messages

Requests for responses relating to results of operation or measurement, or the state of instrument settings

(E.g.) Command to inquire after the current range.



■ Response message

When a query message is received, its syntax is checked and a response message is generated.
If an error occurs when a query message is received, no response message is generated for that query.

Command Syntax

Command names are chosen to mnemonically represent their function, and can be abbreviated. The full command name is called the “long form”, and the abbreviated name is called the “short form”.
The command references in this manual indicate the short form in upper-case letters, extended to the long form in lower case letters, although the commands are not case-sensitive in actual usage.

:FETCH:VOLTAGE? 1 OK (long form)
:FETC:VOLT? 1 OK (short form)
:FET:VOLT? 1 Error

Response messages generated by the instrument are in long form and in upper case letters.

Header

Headers must always be prefixed to program messages.

(1) Command program headers

There are 3 types: Simple command format, compound command format, and standard command format.

- Headers for simple commands

  This header type is a sequence of letters and digits.

  :OUTPut

- Headers for compound commands

  These headers consist of multiple simple command type headers separated by colons (**:**).

  [:SENSe]:CURRent[:DC]:RANGe[:UPPer]

  Characters within square brackets [ ] may be omitted.

  Either form is valid.

  [:SENSe]:CURRent[:DC]:RANGe[:UPPer] → **:SENSe:CURRent:DC:RANGe:UPPer**
  :CURRent:RANGe

- Headers for standard commands

  This header type begins with an asterisk (*****), indicating that it is a standard command.

  ***RST**

(2) Query program headers

These commands are used to interrogate the instrument about the results of operations, measured values, and the present states of instrument settings.
As shown in the following examples, a question mark “**?**” is added after the program header.

:FETCh:VOLTage? 1

Message terminators

The instrument recognizes the following message terminators (delimiters).

- CR
- CR+LF

In addition, the terminator for response messages is as described below.

- CR+LF

Separators

(1) Message unit separators

Multiple messages can be written in one line by separating them with semicolons “;”.

:OUTPut:ON:MODE NORMal;*IDN?

• When messages are combined in this way and if one command contains an error, all subsequent messages up to the next message terminator will be ignored.

(2) Header separators

In a message consisting of both a header and data, the header is separated from the data by a space “ ” (ASCII code 20H).

:OUTPut:ON:MODE NORMal

(3) Data separators

In a message containing multiple data items, commas “,” are required to separate the data items from one another.

:OUTPut:ON:MODE NORMal,1

■ Data format

The instrument uses commands to separate data into “character data,” “decimal numeric data,” and “string data.”

(1) Character data

Character data always begins with an alphabetic character, and subsequent characters may be either alphabetic or numeric. Character data is not case-sensitive, although response messages from the instrument are only upper case. When the command data portion contains **<1/0/ON/OFF>**, the operation will be similar to when 0 is OFF and 1 is ON.

:SENSe:AVERage:STATe ON,1 ⟶ Either form is valid.
:SENSe:AVERage:STATe ON,1
:SENSe:AVERage:STATe 1,1

Characters within square brackets [ ] may be omitted.

:SENSe:AVERage:STATe ON[,1] ⟶ Either form is valid.
:SENSe:AVERage:STATe ON,1
:SENSe:AVERage:STATe ON

Omit the CH information, the instrument is make all channels the same setting.
Omit logging time with the logging function, logging does not stop automatically.
Omit the number of data with the logging function, the instrument reply all saving data.

(2) Decimal numeric data

Three formats are used for numeric data, identified as NR1, NR2, and NR3. Numeric values may be signed or unsigned. Unsigned numeric values are handled as positive values. Values exceeding the precision handled by the instrument are rounded to the nearest valid digit.

- NR1: Integer data (e.g.: +12, −23, 34)
- NR2: Fixed-point data (e.g.: +1.23, −23.45, 3.456)
- NR3: Floating-point exponential representation data (e.g.: +1.0E−2, −2.3E+4)

The term “NRf format” includes all three of the above numeric decimal formats.
The instrument accepts NRf format data. The format of response data is specified for each command, and the data is sent in that format.

:FETCh:VOLTage? 1
+1.00056E+00

■ Compound Command Header Omission

When several commands having a common header are combined to form a compound command (e.g., **FETCh:VOLTage?**、**:FETCh:CURRent?**) if they are written together in sequence, the common portion (here, **:FETCh**) can be omitted after its initial occurrence.
This common portion is called the “current path” (analogous to the path concept in computer file storage), and
until it is cleared, the interpretation of subsequent commands presumes that they share the same common portion.

This usage of the current path is shown in the following example:
Full expression

:FETCh:VOLTage? 1;:FETCh:CURRent? 1

Compacted expression

:FETCh:VOLTage? 1;CURRent? 1

This portion becomes the current path, and can be omitted from the messages immediately following.

The current path is cleared when the power is turned on, when reset by key input, by a colon “:” at the start of a command, and when a message terminator is detected.
Standard command messages can be executed regardless of the current path. They have no effect upon the current path.

A colon “:” is not required at the start of the header of a simple or compound command. However, to avoid confusion with abbreviated forms and operating mistakes, Hioki recommend always placing a colon at the start of a header.

Output queue and input buffer

Output queue

Response messages are stored in the output queue. The output queue will be cleared in the following cases:

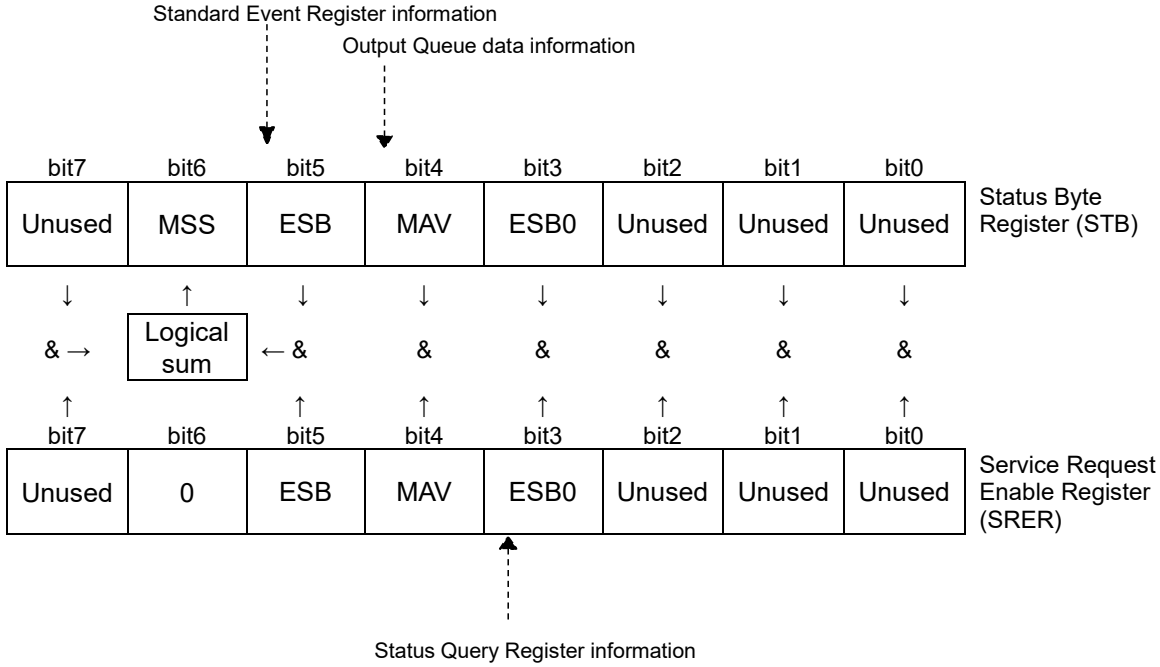
- When the controller reads data
- When the instrument is turned on
- Query error

Input buffer

The input buffer capacity of the instrument is 512 bytes.
If data exceeding 512 bytes is sent and the input buffer is full, the system will wait until space becomes available.

Note: Make sure that the length of 1 command line is less than 512 bytes.

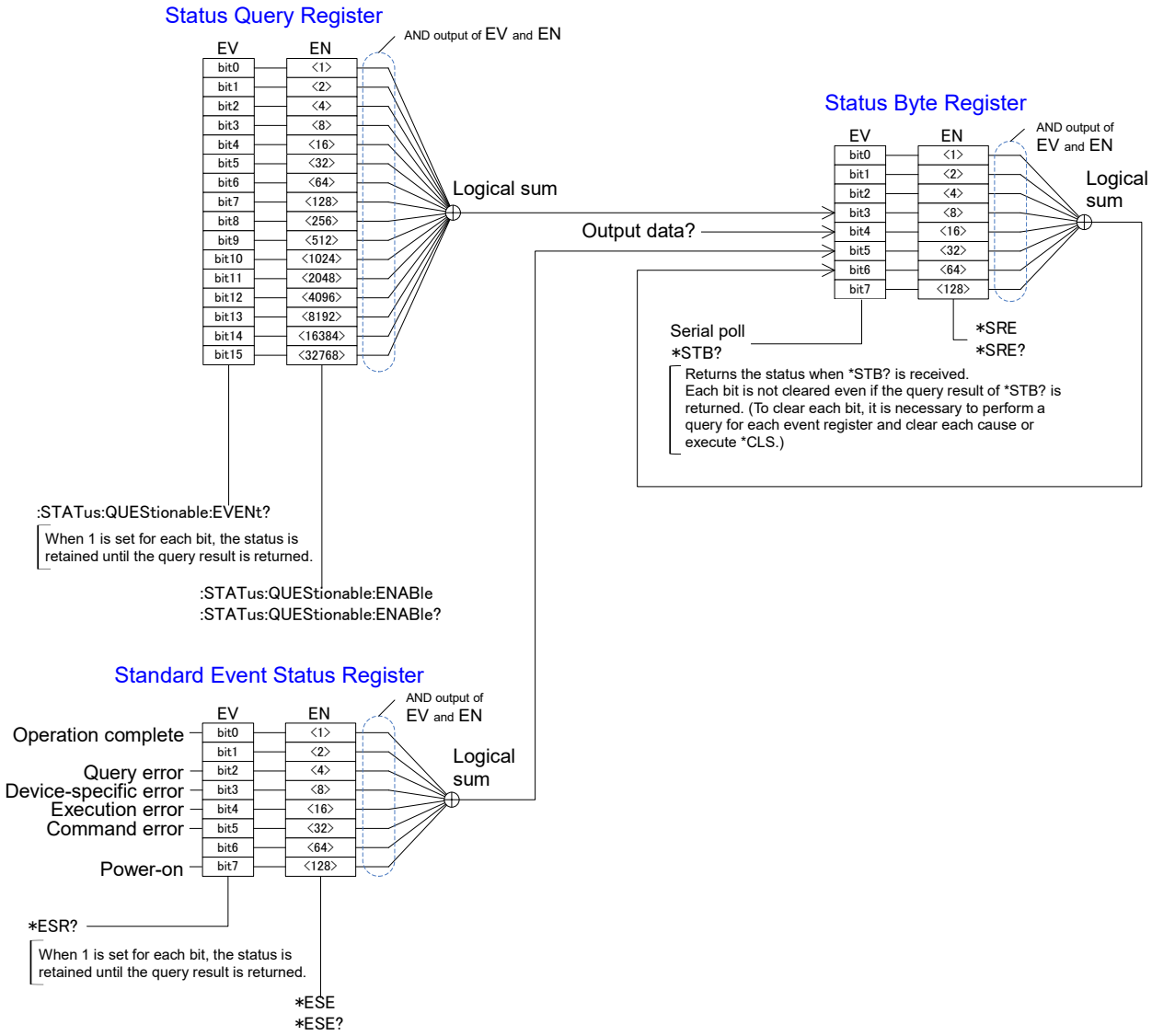
Status byte registers



Overview of service request occurrence

The information about the event registers and the output queue is set to the Status Byte Register. Required items are selected from this information by masking with the Service Request Enable Register. When any bit selected by the mask is set, bit 6 (MSS; Master Summary Status bit) of the Status Byte Register is also set.

Event registers



Standard Event Status Register (SESR)

The Standard Event Status Register is an 8-bit register. If any bit of those in the Standard Event Status Register that are enabled by the Standard Event Status Enable Register is set to “1”, bit 5 (ESB) of the Status Byte Register is also set to “1”.

See: “Standard Event Status Register (SESR) and Standard Event Status Enable Register (SESER)” (p.35)

The contents of the Standard Event Status Register are cleared in the following situations.

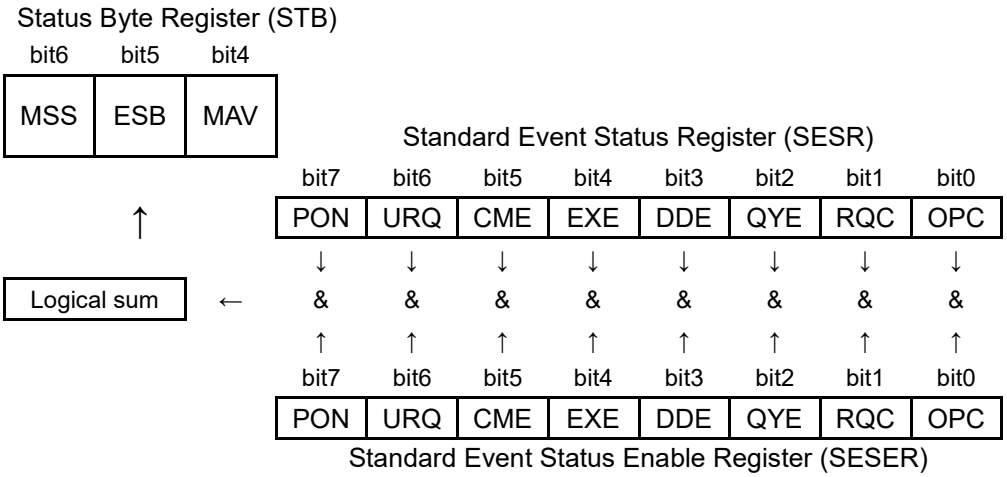
- When a ***CLS** or ***RST** command is executed
- When an event register query (***ESR?**) is executed
- When the power is turned off then on again

Bit 7	PON	**Power-On Flag** This bit is set to “1” when the power is turned on, or upon recovery from an outage.
Bit 6	URQ (Unused)	Not used by the instrument. **User Request**
Bit 5	CME	**Command error (The command to the message terminator is ignored.)** This bit is set to “1” when a received command contains a syntactic or semantic error. • Program header error • Incorrect number of data parameters • Invalid parameter format • Received a command not supported by the instrument
Bit 4	EXE	**Execution error** This bit is set to “1” when a received command cannot be executed for some reason. • The specified data value is outside of the set range • The specified setting data cannot be set • Execution is prevented by some other operation being performed
Bit 3	DDE (Unused)	Not used by the instrument. **Device-dependent error** This bit is set to “1” when a command cannot be executed due to some reason other than a command error, a query error, or an execution error.
Bit 2	QYE	**Query error (The output queue is cleared.)** This bit is set to “1” when an error occurs in the process related to the output queue. • When the data overflows the output queue • When data in the output queue has been lost
Bit 1	RQC (Unused)	Not used by the instrument. **Request control**
Bit 0	OPC	**Operation complete** • When an “***OPC**” command is executed • When operations of all messages up to an “***OPC**” command are completed

Standard Event Status Enable Register (SESER)

Setting any bit of the Standard Event Status Enable Register to “1” enables access to the corresponding bit of the Standard Event Status Register.

Standard Event Status Register (SESR) and Standard Event Status Enable Register (SESER)



Instrument-specific Event Status Register

The instrument provides one Event Status Register for controlling events. The Event Status Register is a 16-bit register.
When any bit in one of these Event Status Registers enabled by its corresponding Enable Register is set to “1”, the following happens:

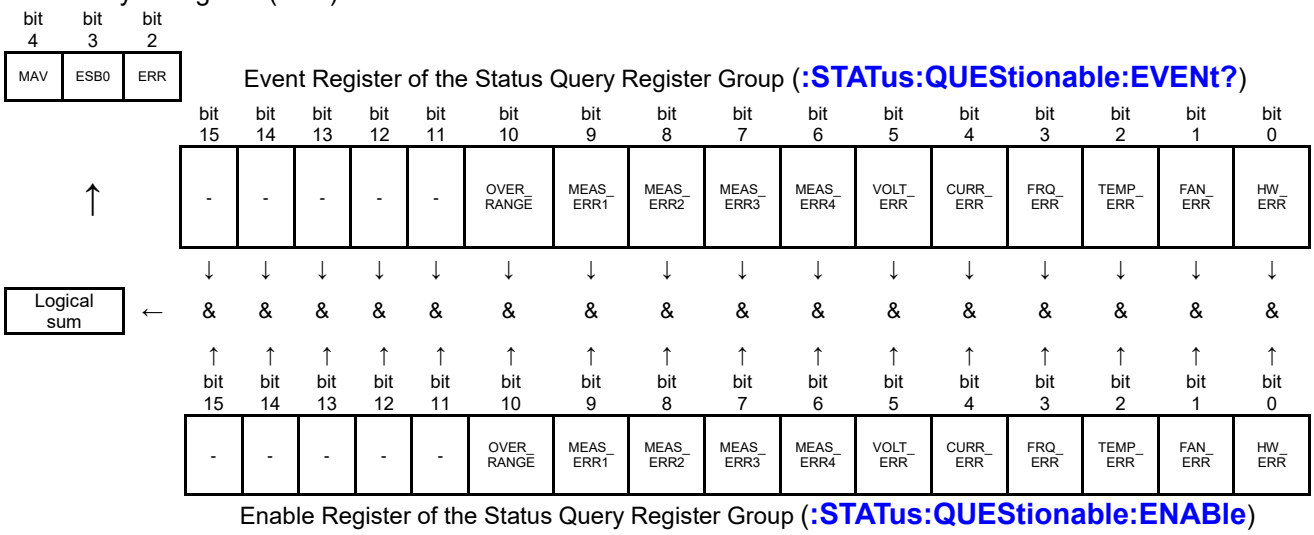
- For Status Query Register: Bit 3 (ESB0) of the Status Byte Register is set to “1”.

The contents of Event Status Register 0 are cleared in the following situations.

- When a ***CLS** or ***RST** command is executed
- When an Event Status Register query is executed
  (**:STATus: QUEStionable: EVENt?**)

Status Query Register		
Bit 15	-	Unused
Bit 14	-	Unused
Bit 13	-	Unused
Bit 12	-	Unused
Bit 11	-	Unused
Bit 10	OVER_RANGE	Overrange (100 µA range)
Bit 9	MEAS_ERR1	Measurement error
Bit 8	MEAS_ERR2	Measurement error
Bit 7	MEAS_ERR3	Measurement error
Bit 6	MEAS_ERR4	Measurement error
Bit 5	VOLT_ERR	Output voltage error
Bit 4	CRR_ERR	Overcurrent error
Bit 3	FRQ_ERR	Power supply frequency error
Bit 2	TEMP_ERR	Temperature error
Bit 1	FAN_ERR	Fan stop
Bit 0	HW_ERR	Hardware error

Event Register of the Status Query Register Group (**:STATus:QUEStionable:EVENt?**) and
Enable Register of the Status Query Register Group (**:STATus:QUEStionable:ENABle**)



When CURR_ERR is set to “1”, use **:STATus:QUEStionable:CURRent:EVENt?** to find the channel that is causing the error.
When VOLT_ERR is set to “1”, use **:STATus:QUEStionable:VOLTage:EVENt?** to find the channel that is causing the error.
When OVER_RANGE is set to “1”, use **:STATus:QUEStionable:RANGe:EVENt?** to find the channel that is causing the error.

Communications errors

In the following cases, an error occurs if a message is implemented.

- Command error
  If the message orthography is incorrect
  If the command or clear data format is incorrect
- Query error
  If the controller cannot receive, or if the instrument cannot send response messages
- Execution error
  If other than the designated character data or numerical data has been set

5.2 Message List

Message [ ]: Omissible	Data format [ ]: Omissible, ( ): Response data	Description
Standard commands		
*IDN?	(<Manufacturer name>,<Model name>,<Serial number>,<Software version>)	Queries the device ID.
*RST		Initializes the device.
*TST?	(<PASS/FAIL>)	Initiates a self-test and queries the result.
*OPC		Sets OPC of SESR after all operations that are being executed are completed.
*OPC?	(1)	Responds with ASCII “1” after all operations that are being executed are completed.
*WAI		Executes subsequent commands after command processing is completed.
*CLS		Clears the Event Registers and the Status Byte Register.
*ESE	0 to 255	Writes the Standard Event Status Enable Register (SESER).
*ESE?	(0 to 255)	Reads the Standard Event Status Enable Register (SESER).
*ESR?	0 to 255	Reads and clears the Standard Event Status Register (SESR).
*SRE	0 to 255	Writes the Standard Event Status Enable Register (SRER).
*SRE?	(0 to 255)	Reads the Standard Event Status Enable Register (SRER).
*STB?	(0 to 255)	Reads the status byte and MSS bit.
Event Registers		
:STATus:QUEStionable[:EVENt]?	(0 to 2047)	Queries the total bit number of the Event Register of the Status Query Register Group.
:STATus:QUEStionable:ENABle	0 to 65535	Sets the Enable Register of the Status Query Register Group.
:STATus:QUEStionable:ENABle?	(0 to 2047)	Queries the Enable Register of the Status Query Register Group.
:STATus:QUEStionable:CURRent[:EVENt]?	(0 to 4095)	Queries the over current error channels.
:STATus:QUEStionable:VOLTage[:EVENt]?	(0 to 4095)	Queries the output error channels.
:STATus:QUEStionable:RANGe[:EVENt]?	(0 to 4095)	Queries the overrange channels.
Output terminals		
:OUTPut[:STATe]	<1/0/ON/OFF>	Sets the output terminal.
:OUTPut[:STATe]?	(1/0)	Queries the output terminal.
:OUTPut:ON:MODE	<NORMal/HIMPedance/ZERO>[,<Channel number 1 to 12>]	Sets the output terminal during output on.
:OUTPut:ON:MODE?	[<Channel number 1 to 12>]* (NORMAL/HIMPEDANCE/ZERO)	Queries the output terminal during output on.
:OUTPut:OFF:MODE	<HIMPedance/ZERO>	Sets the output terminal during output off.
:OUTPut:OFF:MODE?	(HIMPEDANCE/ZERO)	Queries the output terminal during output off.
:OUTPut:CHAin[:STATe]	<1/0/ON/OFF>	Sets the output expansion terminal (CHAIN terminal).
:OUTPut:CHAin[:STATe]?	(1/0)	Queries the output expansion terminal (CHAIN terminal).
Output voltage		
[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]	<0.0000E+00 to 5.0250E+00>[,<Channel number 1 to 12>]	Sets the output voltage.
	<0.0000E+00 to 5.0250E+00>,<0.0000E+00 to 5.0250E+00>,・・・<0.0000E+00 to 5.0250E+00>	Sets the output voltage.
[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]?	[<Channel number 1 to 12>]* (0.0000E+00 to 5.0250E+00)	Queries the output voltage.
Memory outputs		
[:SOURce]:VOLTage:MEMory:TABLe	<Time 1,Voltage value 1>[,<Time 2,Voltage value 2>] [,<Time 3,Voltage value 3>] [,<Time 4,Voltage value 4]>] [, <Channel number 1 to 12>] Time:0.001 to 9.999 Voltage value:0.00000E+00 to 5.02500E+00	Sets the memory output value.
[:SOURce]:VOLTage:MEMory:TABLe?	<Channel number 1 to 12> (Time 1,Voltage value 1, Time 2,Voltage value 2, Time 3,Voltage value 3, Time 4,Voltage value 4)	Queries the memory output value.
[:SOURce]:VOLTage:MEMory:STATe	<1/0/ON/OFF>[,<Channel number 1 to 12>]	Starts or stops memory output.
[:SOURce]:VOLTage:MEMory:STATe?	<Channel number 1 to 12> (1/0)	Query during memory output operations
Current range		
[:SENSe]:CURRent[:DC]:RANGe[:UPPer]	<0/1/Current value to be measured>[,<Channel number 1 to 12>]	Sets the current measurement range.
[:SENSe]:CURRent[:DC]:RANGe[:UPPer]?	[<Channel number 1 to 12>]* (+1.00000E-04/+1.00000E+00)	Queries the current measurement range.
Reading measurement data		
:FETCh:VOLTage?	[<Channel number 1 to 12>]* (Voltage measured value)	Queries the voltage measured value.
:FETCh:CURRent?	[<Channel number 1 to 12>]* (Current measured value)	Queries the current measured value.

Message [ ]: Omissible	Data format [ ]: Omissible, ( ): Response data	Description
Smoothing function		
[:SENSe]:AVERage[:STATe]	<1/0/ON/OFF>[,<Channel number 1 to 12>]	Sets the smoothing function.
[:SENSe]:AVERage[:STATe]?	[<Channel number 1 to 12>]* (1/0)	Queries the smoothing function.
[:SENSe]:AVERage:COUNt	1 to 100[,<Channel number 1 to 12>]	Sets the average number of times.
[:SENSe]:AVERage:COUNt?	[<Channel number 1 to 12>]* (1 to 100)	Queries the average number of times.
Logging		
:DATA:STATe	<1/0/ON/OFF>[,1.00 to 99.99]	Starts or stops recording of the voltage and current values.
:DATA:STATe?	(1/0)	Queries the recording status.
:DATA:POINts?	<Channel number 1 to 12> (0 to 15000)	Queries the number of recordings.
:DATA:VOLTage?	<Channel number 1 to 12>[,1 to 15000] (Voltage recorded value)	Queries the recorded data of voltage.
:DATA:CURRent?	<Channel number 1 to 12>[,1 to 15000] (Current recorded value)	Queries the recorded data of current.
Self-diagnosis		
:SYSTem:TEMPerature?	<Channel number 1 to 12/CPU> (Internal temperature)	Queries the internal temperature.
[:SOURce]:VOLTage:ILIMit[:LEVel]	<0.10000 to 1.00000/OFF >	Sets the overcurrent detection threshold value.
[:SOURce]:VOLTage:ILIMit[:LEVel]?	(<0.10000 to 1.00000/OFF >)	Queries the overcurrent detection threshold value.
[:SOURce]:VOLTage:TLIMit[:LEVel]	30 to 80,<AMP/CPU>	Sets the abnormal temperature threshold value.
[:SOURce]:VOLTage:TLIMit[:LEVel]?	<AMP/CPU> (30 to 80)	Queries the abnormal temperature threshold value.
[:SOURce]:VOLTage:DEViation[:LEVel]	0.0010 to 0.0099	Sets the output voltage error threshold value.
[:SOURce]:VOLTage:DEViation[:LEVel]?	(0.0010 to 0.0099)	Queries the output voltage error threshold value.
[:SOURce]:VOLTage:LIMit:DELay	<Error detection Invalid time 0.001 to 60 s>	Sets the error detection disabled time to be used when switching from the 1 A range to the 100 µA range.
[:SOURce]:VOLTage:LIMit:DELay ?	(Error detection Invalid time 0.001 to 60 s)	Queries the error detection disabled time to be used when switching from the 1 A range to the 100µA range.
:SYSTem:UP?	(1/0)	Query during warm-up.
Line Frequency		
:SYSTem:LFRequency?	(50/60)	Queries the commercial power supply frequency.
Communication settings		
:SYSTem[:COMMunicate:LAN]:MAC?	(MAC address)	Queries the MAC address.

If the parameters of the channel number are ommitted, all channels data will be responded as separated by "," (comma).

5.3 Message Reference

Guide to the message references

< >: Indicates the contents (character or numeric parameters) of the data portion of a message. Character parameters are returned as all capital letters.

Numeric parameters:

- NRf Number format may be any of NR1, NR2, and NR3.
- NR1 Integer data (e.g.: +12, −23, 34)
- NR2 Fixed-point data (e.g.: +1.23, −23.45, 3.456)
- NR3 Floating-point exponential representation data (e.g.: +1.0E−2, −2.3E+4)

Displays the command details.

Set and query the output voltage

Syntax

Command **[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]**
<0.0000E+00 to 5.0250E+00 (NRf)[,<1 to 12 (NR1)>]

Query **[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]?**
<1 to 12 (NR1)>

Response <+0.0000E+00 to +5.0250E+00>

Shows the message syntax. Describes the command data portion or response message.

Describes the message.

Description

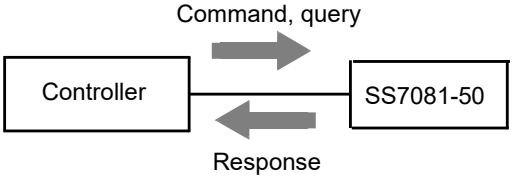
Sets or queries the output voltage for the channel specified using the last parameter.
Command: If channel numbers are omitted, the same settings are made in all the channels.
Query: If parameters are omitted, the settings of all channels separated by commas are returned.
To output the voltage after an overcurrent error has occurred, execute this command after executing *CLS, *RST or :STATus:QUEStionable:EVENt?.

Shows an example of an actual command application.

Example

```
:VOLT 2.5,1          Sets channel 1 to 2.5 V.
:VOLT 3.5            Sets all 12 channels to 3.5 V.
:VOLT? 1
3.5000
```

The channel 1 output voltage is set to 3.5 V.



Standard commands

(1) System data command

Query the instrument version

Syntax Query **∗IDN?**
Response <Manufacturer name>,<Model name>,<Serial No.>,<Software version>

Example ∗IDN?
HIOKI,SS7081-50,123456789,V2.00
Returns the model version.

(2) Internal operation commands

Initialize the instrument

Syntax Command **∗RST**

Description Command Initializes the instrument.
[Common to all channels]

Setting items	Default setting
Output terminals	OFF
Output terminal when the output terminal is set to ON.	NORMAL
Output terminal when the output terminal is set to OFF.	ZERO
Output expansion terminal (CHAIN terminal)	ON
Output voltage	0.0000 V
Memory outputs	OFF
Output time	0.001 s
Output voltage	0.0000 V
Measurement range	1 A
Smoothing	OFF
Logging measurement	OFF
Overcurrent error threshold value	1 A
Output voltage error threshold value	2.0 mV
Threshold value of temperature error inside the case (control board)	50 ºC
Threshold value of temperature error inside the case (output board)	70 ºC
Interval for which error detection is disabled after switching to the 100 µA range	1.000 s

Note
- Implementing this command while data is being transferred using the logging acquisition query will delete the saved data.
- Implementing this command during overcurrent detection will cancel the output stop status.
  Implement :VOLT, and set the desired output voltage.

Initiate a self-test and queries the result

Syntax Query **∗TST?**
Response <PASS/FAIL>

Description Performs the instrument self-test and returns the result.
Returns PASS when no error occurs and FAIL when an error occurs.
An execution error occurs during logging. Performing ∗TST? after logging completes will cause all saved data to be cleared.

Example ∗TST?
FAIL
An error occurs. The correct measurement may not be performed. Stop using the instrument and send it for repair.

(3) Synchronized commands

Set OPC of SESR after all operations that are being executed are completed

Syntax Command ***OPC**

Description When the command processing before the *OPC command of the sent commands has been completed, the OPC (bit 0) of the SESR (Standard Event Status Register) is set to 1.

Respond with ASCII "1" after all operations that are being executed are completed

Syntax Query ***OPC?**

Response 1 (NR1)

Description When the command processing before the *OPC command of the sent commands has been completed, ASCII code 1 is returned.

Execute subsequent commands after command processing is completed

Syntax Command ***WAI**

Description Puts the instrument in the waiting status until all of the previous command operations have been completed.

(4) Status and event control commands

Clear status byte

Syntax Command ***CLS**

Description Clears the status byte.

Note
- Implementing this command while data is being transferred using the logging acquisition query will stop the data transfer.
  The saved data is not cleared.
- Implementing this command during overcurrent detection will cancel the output stop status.
  You can output a voltage by setting the desired output voltage with :VOLT and then turning on the output terminal with :OUTPut ON.

Read and write the Standard Status Enable Register (SESER).

Syntax Command ***ESE** <0 to 255 (NR1)>

Query ***ESE?**

Response <0 to 255 (NR1)>

Description Command Sets the SESER mask pattern to a numerical value from 0 to 255. The initial value (when the power is turned on) is 0.

Query Returns the contents of the SESER set by the *ESE command using a NR1 numerical value from 0 to 255.

128	64	32	16	8	4	2	1
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
PON	URQ	CME	EXE	DDE	QYE	RQC	OPC

Since bit 0 and bit 6 are not used, they are always 0.

Example *ESE 36

Sets bit 5 and bit 2 of the SESER.

Read and clear the Standard Event Status Register (SESR)

Syntax

Query ***ESR?**

Response <0 to 255 (NR1)>

Description

Returns the contents of the SESR using a NR1 numerical value from 0 to 255 and clears the contents.

128 bit 7	64 bit 6	32 bit 5	16 bit 4	8 bit 3	4 bit 2	2 bit 1	1 bit 0
PON	Unused	CME	EXE	DDE	QYE	Unused	OPC

Example

*ESR?

32

Bit 5 of the SESR has been set to 1.

Write and read Service Request Enable Register (SRER)

Syntax

Command ***SRE** <0 to 255 (NR1)>

Query ***SRE?**

Response <0 to 255 (NR1)>

Description

Command: Sets the SRER mask pattern to a numerical value from 0 to 255.
A numerical value in the NRf format is accepted, but it is rounded to the nearest integer.
The value of the unused bit (expressed by -) such as bit 6 is ignored.
When the power is turned on, such bit is initialized to 0.

Query: Returns the contents of the SRER set by the *SRE command using a NR1 numerical value from 0 to 255. The value of the unused bit such as bit 6 is always 0.

128 bit 7	64 bit 6	32 bit 5	16 bit 4	8 bit 3	4 bit 2	2 bit 1	1 bit 0
-	0	ESB	MAV	Status Query Register	-	-	-

Example

*SRE 8

Sets bit 3 of the SRER to 1.

*SRE?

8

Bit 3 of the SRER has been set to 1.

Read the status byte and MSS bit

Syntax

Query ***STB?**

Response <0 to 255 (NR1)>

Description

Returns the set contents of the STB using a NR1 numerical value from 0 to 255.

128 bit 7	64 bit 6	32 bit 5	16 bit 4	8 bit 3	4 bit 2	2 bit 1	1 bit 0
-	MSS	ESB	MAV	ESB0	-	-	-

Example

*STB?

16

Bit 4 of the STB has been set to 1.

Instrument-specific commands

(1) Event status registers

For details about the relationship with the Status Byte Register, see the following.
• Status and event control commands (p.41)

Query the event register of the status query register group

Syntax

Query **:STATus: QUEStionable[:EVENt]?**
Response <0 to 65535 (NR1)>

Description

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8
-	-	-	-	-	OVER_ RANGE	MEAS_ ERR1	MEAS_ ERR2

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
MEAS_ ERR3	MEAS_ ERR4	VOLT_ ERR	CURR _ERR	FRQ_ ERR	TEMP_ ERR	FAN_ ERR	HW_ ERR

Example

:STAT: QUES?
2
The fan has stopped.

Note

• When an event occurs, 1 is set for the bit corresponding to each event. This bit is not cleared unless ∗CLS or ∗RST is executed, this query is executed, or the power is turned off then on again.
• Executing this command after an overcurrent has been detected will cancel the output stopped state.

Set and query the Enable Register of the Status Query Register Group

Syntax

Command **:STATus: QUEStionable: ENABle** <0 to 65535 (NR1)>
Query **:STATus: QUEStionable: ENABle?**
Response <0 to 2047 (NR1)>

Description

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8
-	-	-	-	-	OVER_ RANGE	MEAS_ ERR1	MEAS_ ERR2

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
MEAS_ ERR3	MEAS_ ERR4	VOLT_ ERR	CURR _ERR	FRQ_ ERR	TEMP_ ERR	FAN_ ERR	HW_ ERR

Example

:STAT: QUES: ENAB 1
Sets bit 1 of the Status Query Enable Register.
:STAT: QUES: ENAB?
1
Bit 1 of the Status Query Enable Register has been set to 1.

Note

• When the power is turned on, the data is initialized to 0.
• When 1 is set for an unused bit (expressed by -), a command is accepted, but it does not affect the query result.

Query the overcurrent error channel of the Status Query Register Group

Syntax Query :STATus: QUEStionable: CURRent[:EVENt]?
Response <0 to 4095 (NR1)>

Description

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8
-	-	-	-	CH12	CH11	CH10	CH9

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1

Example :STAT: QUES: CURR?
1
An overcurrent error has occurred in channel 1.

Note When bit 4 (CURR_ERR) of the Status Query Register is set to 1, the bit for the channel that causes the error is also set to 1. This bit is not cleared unless ∗CLS, ∗RST or :STATus:QUEStionable[:EVENt]? is executed, or the power is turned off then on again.

Query the output voltage error channel of the Status Query Register Group

Syntax Query :STATus: QUEStionable: VOLTage[:EVENt]?
Response <0 to 4095 (NR1)>

Description

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8
-	-	-	-	CH12	CH11	CH10	CH9

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1

Example :STAT: QUES: VOLT?
1
An output voltage error has occurred in channel 1.

Note When bit 5 (VOLT_ERR) of the Status Query Register is set to 1, the bit for the channel that causes the error is also set to 1. This bit is not cleared unless ∗CLS, ∗RST or :STATus:QUEStionable[:EVENt]? is executed, or the power is turned off then on again.

Query the overrange channel of the Status Query Register Group

Syntax Query :STATus:QUEStionable:RANGe[:EVENt]?
Response <0 to 4095 (NR1)>

Description

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8
-	-	-	-	CH12	CH11	CH10	CH9

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1

Example :STAT:QUES:RANG?
1
An overrange event has occurred while using the 100 µA range in channel 1.

Note When bit 10 (OVER_RANGE) of the Status Query Register is set to 1, the bit for the channel that causes the error is also set to 1. This bit is not cleared unless ∗CLS, ∗RST or :STATus:QUEStionable[:EVENt]? is executed, or the power is turned off then on again.

(2) Reading the measured value

The query response that returns the measured value has the format shown below.

Format of the measured value

Measured value	±OvrRng is displayed	Measurement error occurs
± □.□□□□□E±□□	±9.00000E+34	+9.10000E+34

(3) Output terminals

Set and query the output terminal

Syntax
Command : **OUTPut[:STATe]** <1/0/ON/OFF>
Query : **OUTPut[:STATe]?**
Response <1/0(NR1)>

Description
Sets or queries the output terminal.
When set to ON: Put in the status set by OUTPut:ON:MODE.
When set to OFF: Put in the status set by OUTPut:OFF:MODE.

Example
:OUTP 0 Sets the output terminal to OFF.
:OUTP?
0
The output terminal is set to OFF.

Set and query when the output terminal is ON

Syntax
Command : **OUTPut: ON: MODE** <NORMal/HIMPedance/ZERO>[,<1 to 12(NR1)>]
Query : **OUTPut: ON: MODE?** [<1 to 12(NR1)>]
Response <NORMAL/HIMPEDANCE/ZERO>

Description
Makes the setting or query when the output terminal for the channel specified using the last parameter is set to ON.
Command: If channel numbers are omitted, the same settings are made in all the channels.
Query: If parameters are omitted, the settings of all channels separated by commas are returned.

Example
:OUTP: ON: MODE NORM,1
When the output terminal is set to ON, the set voltage is output to the C and positive terminals for channel 1.
:OUTP: ON: MODE NORM
When the output terminal is set to ON, the set voltage is output to the C and positive terminals for all 12 channels.
:OUTP: ON: MODE? 1
NORMAL
The setting is made so that the set voltage is output to the C and positive output terminals for channel 1 when the output terminal is set to ON.

Set and query when the output terminal is OFF

Syntax
Command : **OUTPut: OFF: MODE** <HIMPedance/ZERO>
Query : **OUTPut: OFF: MODE?**
Response <HIMPEDANCE/ZERO>

Description
Makes the setting or query when the output terminals for all channels are set to OFF.

Example
:OUTP: OFF: MODE ZERO
When the output terminal is set to OFF, the C and positive terminals for all 12 channels, and the negative terminal are short-circuited.
:OUTP: OFF: MODE?
ZERO
The setting is made so that the C and positive terminals for all 12 channels, and the negative terminal are short-circuited when the output terminal is set to OFF.

Set and query the output expansion terminal (CHAIN terminal)

Syntax
Command : **:OUTPut: CHAin[:STATe]** <1/0/ON/OFF>
Query : **:OUTPut: CHAin[:STATe]?**
Response <1/0(NR1)>

Description
Sets or queries the ON/OFF of the output expansion terminal (RY terminal).

Example
:OUTP: CHA 1 Enables the output expansion terminal.
:OUTP: CHA?
1
The output expansion terminal is set to ON.

(4) Output voltage

Set and query the output voltage

Syntax

Command **[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]** <0.0000E+00 to 5.0250E+00 (NRf)[,<1 to 12 (NR1)>]

[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude] <0.0000E+00 to 5.0250E+00 (NRf), <0.0000E+00 to 5.0250E+00 (NRf),••• <0.0000E+00 to 5.0250E+00 (NRf)

Query **[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]?** [<1 to 12 (NR1)>]

Response <+0.0000E+00 to +5.0250E+00(NR3)>

Description

Sets or queries the output voltage for the channel specified using the last parameter.
In addition, separating the output voltage for 12 channels by commas sets an arbitrary output voltage for all channels at the same time.

Command: If channel numbers are omitted, the same settings are made in all the channels.
The minimum resolution of the voltage setting is 0.0001 V.
To output the voltage after an overcurrent error has occurred, execute this command after executing ∗CLS or ∗RST.

Query: If parameters are omitted, the settings of all channels separated by commas are returned.

Example

:VOLT 2.5,1 Sets channel 1 to 2.5 V.

:VOLT 3.5 Sets all 12 channels to 3.5 V.

:VOLT 3.5,3.4,3.5,3.4,3.4,3.6,3.5,3.4,3.6,3.5,3.5,3.6

Channel 1 is set to 3.5 V and channel 2 is set to 3.4 V. ••• (In the same manner, each channel is set to a specified voltage.)

:VOLT? 1

+2.50000E+00

The channel 1 output voltage is set to 2.5 V.

(5) Memory outputs

Set and query the memory output value

Syntax

Command **[:SOURce]:VOLTage: MEMory: TABLe** <Time 1>,<Voltage value 1>[,<Time 2>,<Voltage value 2>][,<Time 3>,<Voltage value 3>][,<Time 4>,<Voltage value 4>][,<1 to 12 (NR1)>]
Time [s]: <0.001 to 9.999(NR2)>
Voltage value [V]: <0.00000E+00 to 5.02500E+00(NRf)>

Query **[:SOURce]:VOLTage: MEMory: TABLe?** <1 to 12 (NR1)>

Response <Time 1, Voltage value 1>,[<Time 2, Voltage value 2>][,<Time 3, Voltage value 3>][,<Time 4, Voltage value 4>]
Time [s]: <0.001 to 9.999(NR2)>
Voltage value [V]: <0.00000E+00 to 5.02500E+00(NR3)>

Description

Sets or queries the memory output voltage value and the time until the desired voltage value is reached for the channel specified using the last parameter. Sets and queries up to 4 memories. Memories other than the first memory can be omitted. When memories are omitted in the command, they are also omitted in the query response.

Command: If channel numbers are omitted, the same settings are made in all the channels.
An execution error occurs during memory outputs. Stop memory outputs before implementing.

Example

Sets 4 memory output values for channel 1.
:VOLT: MEM: TABL 0.5,0, 2.0,4.2,3.0,2.0,1.0,0,1
Memory 1: Output for 0.0 V in 0.5 s interval
Memory 2: Output for 4.2 V in 2.0 s interval
Memory 3: Output for 2.0 V in 3.0 s interval
Memory 4: Output for 0.0 V in 1.0 s interval
:VOLT: MEM: TABL? 1
0.500,+0.00000E+00,2.000,+4.20000E+00,3.000,+2.00000E+00,1.000,+0.00000E+00
Returns the memory output value for channel 1.

Sets 2 memory output values for channel 1.
:VOLT: MEM: TABL 0.01,3.2, 0.01,3.0,1
Memory 1: Output for 3.2 V in 0.01 s interval
Memory 2: Output for 3.0 V in 0.01 s interval
:VOLT: MEM: TABL? 1
0.010,+3.20000E+00,0.010,+3.00000E+00
Returns the memory output value for channel 1.

:VOLT: MEM: TABL 0.5,0,2.0,4.2,3.0,4.2,1.0,0
Sets the memory output value for all channels.
Memory 1: Output for 0.0 V in 0.5 s interval
Memory 2: Output for 4.2 V in 2.0 s interval
Memory 3: Retain 4.2 V in 3.0 s interval
Memory 4: Output for 0.0 V in 1.0 s interval

Start or stop the memory output

Syntax

Command **[:SOURce]:VOLTage: MEMory: STATe** <1/0/ON/OFF> [,<1 to 12(NR1)>]

Query **[:SOURce]:VOLTage: MEMory: STATe?** <1 to 12 (NR1)>

Response <1/0>

Description

Command: Starts or stops the voltage output according to the memory output value that has been set for the channel specified using the last parameter. If channel numbers are omitted, the outputs of all channels are started or stopped. Attempting to start during memory outputs will cause an execution error.

Query: Returns 0 during memory output stop. Returns 1 during memory outputs.

Example

:VOLT: MEM: STAT 1,1
Starts the memory outputs for channel 1.
:VOLT: MEM: STAT? 1
1
Channel 1 is performing the memory outputs.

(6) Current measurement range

Set and query the current measurement range

Syntax
Command **[:SENSe]:CURRent[:DC]:RANGe[:UPPer]** <0/1/Current value for which you want to measure (NRf)> [,<1 to 12 (NR1)>]
Query **[:SENSe]:CURRent[:DC]:RANGe[:UPPer]?** [<1 to 12(NR1)>]
Response <+1.00000E+00/+1.00000E-04 (NR3)>

Description
Sets or queries the current measurement range for the channel specified using the last parameter.
Command: If channel numbers are omitted, the same settings are made in all the channels.
Query: If parameters are omitted, the settings of all channels separated by commas are returned.

Example
:CURR: RANG 0.0001,1 Sets channel 1 to the 100 µA range.
:CURR: RANG 0.0001 Sets all 12 channels to the 100 µA range.
:CURR: RANG? 1
+1.00000E-04
Channel 1 is set to the 100 µA range.

(7) Reading measurement data

Query the output voltage value

Syntax
Query **:FETCh: VOLTage?** [<1 to 12(NR1)>]
Response <Measured value>

Description
Returns the voltage measured value for the channel specified using the parameters.
If parameters are omitted, the voltage measured values of all channels separated by commas are returned.
The minimum effective resolution of the voltage data is 0.00001 V.

Example
:FETC: VOLT? 1
+1.50000E+00

Query the output current value

Syntax
Query **:FETCh: CURRent?** [<1 to 12(NR1)>]
Response <Measured value>

Description
Returns the current measured value for the channel specified using the parameters.
If parameters are omitted, the current measured values of all channels separated by commas are returned.
The minimum effective resolution of the current data is 0.00001 A for 1 A range, and 0.0001 µA for 100 µA range.

Example
:FETC: CURR? 1
+1.00000E-01

(8) Smoothing function

Set and query the smoothing function

Syntax
Command **[:SENSe]:AVERage[:STATe]** <1/0/ON/OFF>[,<1 to 12(NR1)>]
Query **[:SENSe]:AVERage[:STATe]?** [<1 to 12(NR1)>]
Response <1/0(NR1)>

Description
Sets or queries the smoothing function for the channel specified using the last parameter.
Command: If channel numbers are omitted, the same settings are made in all the channels.
Query: If parameters are omitted, the settings of all channels separated by commas are returned.

Example
:AVER 1,1 Makes the setting so that channel 1 performs the smoothing.
:AVER 1 Makes the setting so that all 12 channels perform the smoothing.
:AVER? 1
1
The setting is made so that channel 1 performs smoothing.

Set and query the smoothing function

Syntax Command **[:SENSe]:AVERage: COUNt** <1 to 100(NR1)> [,<1 to 12(NR1)>]
Query **[:SENSe]:AVERage: COUNt?** [<1 to 12(NR1)>]
Response <1 to 100(NR1)>

Description Sets or queries the average number of times for the channel specified using the last parameter.
Command: If channel numbers are omitted, the same settings are made in all the channels.
Query: If parameters are omitted, the settings of all channels separated by commas are returned.

Example
```
:AVER: COUN 10,1   Set the number of averaging iterations for channel 1 to 10.
:AVER: COUN 10     Set the number of averaging iterations for all channels to 10.
:AVER: COUN? 1
10
```
The setting is made so that channel 1 performs the averaging 10 times.

(9) Logging

Start saving the voltage and current values

Syntax Command **:DATA: STATe** <1/0/ON/OFF>[,<1.00 to 99.99 (NR2)>]
Query **:DATA: STATe?**
Response <1/0(NR1)>

Description Starts saving the current and voltage values for all channels to the instrument memory. Specifying the saving time (1.00 s to 99.99 s) will stop the saving after the specified time has elapsed from the start of saving. When the saving time is omitted, the current and voltage values are saved for 12 hours continuously until the operation stops.
In addition, an execution error occurs during saving.

Example
```
:DATA: STAT 1,5.00   Starts saving and stops it after 5 seconds.
:DATA: STAT?
1
```

Query the number of saved data

Syntax Query **:DATA: POINts?** <1 to 12 (NR1)>
Response <0 to 15000(NR1)>

Description Returns the number of data that is currently saved by the channel specified using the parameter.

Example
```
:DATA: POIN? 1
120
```

Query the saved voltage data

Syntax Query **:DATA: VOLTage?** <1 to 12 (NR1)> [,<1 to 15000 (NR1)>]
Response <Measured value (NR3)>, <Measured value (NR3)>••••<Measured value (NR3)>

Description Specifies the channel and the number of data, and reads the voltage values that have been saved.
All data points are returned if the number of data is not specified.
If any of the following occurs, an execution error occurs.

- While saving
- If the number of read data points is greater than the number of data points saved
- If no saved data is found

Do not issue commands or queries while data is being transferred. To cancel a data transfer, execute ∗CLS.

Example
```
:DATA: VOLT? 1,10
+4.20001E+00,+4.19999E+00•••+4.20000E+00
```

Query the saved current data

Syntax Query **:DATA: CURRent?** <1 to 12 (NR1)> [,<1 to 15000 (NR1)>]
Response <Measured value (NR3)>, <Measured value (NR3)>••••<Measured value (NR3)>

Description Specifies the channel and the number of data, and reads the current values that have been saved.
All data points are returned if the number of data is not specified.
If any of the following occurs, an execution error occurs.
- While saving
- If the number of read data points is greater than the number of data points saved
- If no saved data is found

Do not issue commands or queries while data is being transferred. To cancel a data transfer, execute ∗CLS.

Example
```
:DATA: CURR? 1,10
+2.00001E-04,+1.99999E-04•••+1.99998E-04
```

(10) Self-diagnosis

Query the internal temperature

Syntax Query **:SYSTem: TEMPerature?** <1 to 12 (NR1)/CPU>
Response <Measured value>

Description Returns the internal temperature for the channel specified using the parameters.
When CPU is specified, the temperature of the control board is returned.

Example
```
:SYST: TEMP? 1
+4.26875E+01
```

Set and query the overcurrent detection threshold value

Syntax Command **[:SOURce]:VOLTage: ILIMit[:LEVel]** <0.10000 to 1.00000(NR2)/OFF>
Query **[:SOURce]:VOLTage: ILIMit[:LEVel]?**
Response <0.10000 to 1.00000(NR2)/OFF>

Description Sets or queries the overcurrent detection threshold value.
When the overcurrent detection threshold value is set to OFF, the threshold value judgment using the overcurrent is not performed.

Example
```
:VOLT: ILIM 0.5
```
Sets the overcurrent detection threshold value to 0.5 A.
```
:VOLT: ILIM?
0.50000
```
The overcurrent detection threshold value is set to 0.5 A.

Set and query the temperature error threshold value

Syntax Command **[:SOURce]:VOLTage: TLIMit[:LEVel]** <30 to 80 (NR1)> ,<AMP/CPU>
Query **[:SOURce]:VOLTage: TLIMit[:LEVel]?** <AMP/CPU>
Response <30 to 80 (NR1)>

Description Sets or queries the threshold value that gives a warning of the temperature error.
When CPU is set for the last parameter, the temperature error threshold value of the control board is set. When AMP is specified, the temperature error threshold value of the output board is set.

Example
```
:VOLT: TLIM 45,AMP
```
Sets 45°C for the temperature error threshold value of the output board.
```
:VOLT: TLIM? AMP
45
```
The threshold value of the output board that gives a warning of the temperature error has been set to 45°C.

Set and query the output voltage error threshold value

Syntax Command **[:SOURce]:VOLTage: DEViation[:LEVel]** <0.0010 to 0.0099 (NR2)>
Query **[:SOURce]:VOLTage: DEViation[:LEVel]?**
Response <0.0010 to 0.0099 (NR2)>

Description Sets or queries the tolerance amount for the deviation between the set voltage and the output voltage.

Example :VOLT: DEV 0.005 Sets the deviation tolerance for the set voltage and output voltage to 5 mV, and detects an output voltage error at 5 mV or greater, or -5 mV or lower.

:VOLT: DEV?
0.0050
The deviation tolerance between the set voltage and output voltage is set to 5 mV.

Set and query the error detection disabled time when switching to the 100 µA range

Syntax Command **[:SOURce]:VOLTage: LIMit: DELay** <0.001 to 60 (NRf)>
Query **[:SOURce]:VOLTage: LIMit: DELay?**
Response <0.001 to 60.000 (NR2)>

Description Sets or queries the error detection disabled time when switching from the 1 A range to the 100 µA range.

Example VOLT: LIM: DEL 1 Sets the error detection time to 1 second.
VOLT: LIM: DEL?
1.000
The error detection time has been set to 1 s.

Query the warming up

Syntax Query **SYSTem: UP?**
Response <1/0 (NR1)>

Description Queries the warming up.
Returns 1 during warming up. Returns 0 when the warming up is completed.

Example :SYST: UP?
0
The warming up has been completed.

(11) Commercial power supply frequency

Query the commercial power supply frequency

Syntax Query **:SYSTem: LFRequency?**
Response <50/60>

Description Queries the commercial power supply frequency.

Example :SYSTem: LFRequency?
60
The commercial power supply frequency is 60 Hz.

(12) Communication settings

Query the MAC address

Syntax Query **:SYSTem[:COMMunicate:LAN]:MAC?**
Response <MAC address>

Description Returns the MAC address of the instrument.

Example :SYST:COMM:LAN:MAC?
“00-01-67-07-03-85”
The instrument MAC address is 00-01-67-07-03-85.

5.4 Command Examples

Set the output for all channels and acquire the measured values

OUTP ON	Sets the output terminal to ON.
CURR: RANG 1	Sets all channels to the 1 A range.
VOLT 3.3	Outputs 3.3 V to all channels.
FETC: VOLT?	Acquires the measured voltage values for all channels.
+3.30003E+00,+3.30000E+00,+3.29999E+00, +3.30001E+00,+3.29998E+00,+3.30000E+00, +3.30002E+00,+3.30002E+00,+3.30001E+00, +3.30003E+00,+3.29999E+00,+3.30000E+00	
FETC: CURR?	Acquires the measured current values for all channels.
+5.20000E-03,+5.00000E-05,+1.00000E-05, +1.00000E-05,+3.00000E-05,+2.00000E-05, +3.00000E-05,+1.00000E-05,+1.00000E-05, +1.00000E-05,+2.00000E-05,+1.00000E-05	
VOLT 3.3,3.2,3.1,3.0, 3.3,3.2,3.1,3.0, 3.3,3.2,3.1,3.0	Outputs a different voltage to each channel.

Set the output for channel 1 and acquire the measured values

OUTP ON	Sets the output terminal to ON.
CURR: RANG 1,1	Sets channel 1 to the 1 A range.
VOLT 3.3,1	Outputs 3.3 V to channel 1.
FETC: VOLT? 1	Acquires the measured voltage value for channel 1.
+3.30003E+00	
FETC: CURR? 1	Acquires the measured current value for channel 1.
+5.20000E-03	

Simulate a wire break on channel 2 and then simulate a short-circuit on all channels

CURR:RANG 1	Set all channels to the 1 A range.
VOLT 3.3	Set all channels to 3.3 V.
OUTP ON	Set the output terminal to ON.
OUTP:ON:MODE HIMP,2	Set channel 2 to HIMPEDANCE.
OUTP:ON:MODE ZERO	Set all channels to ZERO.

Enable the smoothing function and set channels to the 100 µA range

CURR:RANG 0	Set all channels to the 100 µA range.
AVER 1	Turn on the smoothing function for all channels.
AVER:COUN 100	Set the averaging count to 100 for all channels.
VOLT 3.3	Set all channels to 3.3 V.
OUTP ON	Set the output terminal to ON.
FETC:CURR?	Acquire the measured current for all channels.
+3.00000E-10,+7.00000E-10,+5.00000E-10, +4.00000E-10,+7.00000E-10,+5.00000E-10, +6.00000E-10,+3.00000E-10,+4.00000E-10, +5.00000E-10,+6.00000E-10,+4.00000E-10	

Enable the logging function and acquire current values using the 100 µA range

CURR:RANG 0	Set all channels to the 100 µA range.
VOLT 3.3	Set all channels to 3.3 V.
DATA:STAT 1	Start logging.
DATA:STAT 0	Stop logging.
DATA:POIN? 1 4	Query the logging data count.
DATA:CURR? 1 +2.00000E-10,+2.00000E-10,+2.00000E-10,+3.00000E-10	Acquire logged current values for channel 1.
DATA:VOLT? 1 +3.30003E+00,+3.30003E+00,+3.30003E+00,+3.30003E+00	Acquire logged voltage values for channel 1.

6 Specifications

6.1 General Specifications

Operating environment	Indoors, Pollution degree 2, altitude up to 2000 m (6562 ft.)	
Operating temperature and humidity	Temperature: 0°C to 40°C (32ºF to 104ºF) Humidity: 80% RH or less (no condensation)	
Storage temperature and humidity	Temperature: -10°C to 50°C (14ºF to 122ºF) Humidity: 80% RH or less (no condensation)	
Standards	Safety: EN61010 EMC: EN61326 Class A	
Dielectric strength	1500 V AC for 1 minute (Sensitivity current: 10 mA), between a batch of L and N power terminals and the protective ground 5200 V AC for 1 minute (Sensitivity current: 10 mA), between a batch of the positive and negative terminals and the interface 3270 V AC for 1 minute (Sensitivity current: 10 mA), between a batch of the positive and negative terminals and the protective ground	
Power supply	Rated power voltage	Commercial power supply 100 V to 240 V AC (Voltage fluctuations of up to ±10% centered on the rated supply voltage are allowed.) (Anticipated transient overvoltage: 2500 V)
	Rated power frequency	50 Hz/60 Hz
	Maximum rated power	150 VA
Display	LED (ERROR, OUTPUT, ALERT×12, RUN_C×12, RUN_ positive×12)	
Switch	Power switch, IP address assigning switch	
Interface	LAN	
Dimensions	Approx. 430W × 132H × 483D mm (16.93″W× 5.20″D × 19.02″H) (excluding protrusions)	
Mass	Approx. 10.3 kg (363.3 oz.)	
Product warranty period	1 year	
Accessories	Reference: “Accessories” (p.1)	

6.2 Specifications of Input, Output, and Measurement

Basic specifications

Number of channels	12 channels		
Maximum series connections	The instruments can be connected in series with a serial output voltage of up to 1000 V.		
Output terminals	Terminals for voltage output and series connection with another channel Screw-less terminal block (3 terminals per channel: positive, negative, and C terminals) AWG 16 to 26		
Output expansion terminal (CHAIN terminal)	Terminals for series connection with the other instrument Screwless terminal for expansion connection (3 terminals: I, O, and RY terminals) AWG 16 to 26		
Output type	Floating constant-voltage output		
Output range	DC voltage	0.0000 V to 5.0250 V (all channels independent)	
	Maximum output current	±1.00000 A (all channels independent) Continuous output: 210 mA or less and -210 mA or greater Continuous output with limitations: Greater than 210 mA or less than -210 mA Continuous output limitations Maximum continuous output time: 200 ms Time to next output (reference value): 5 s (when outputting 1 A at 5 V for 200 ms)	
Output settling time	Time until output reaches 99.9% of final value: 10 ms (reference value: 1 µF connection, 100 µA range)		
Overshoot	Less than 5% (reference value: 1 µF connection, 100 µA range)		
Measurement parameters	DC voltage, DC current (simultaneous measurement of all channels for each)		
Measurement ranges	DC voltage	-0.00100 V to 5.10000 V	
	DC current	±120.0000 µA (100 µA range), ±1.20000 A (1 A range) 2 range	
Measurement method	ΔΣ conversion		
Integration time	1 PLC (50 Hz: 20 ms; 60 Hz: 16.7 ms) × smoothing setting count		
Measurement time	Integration time + 3 ms		
Noise rejection ratio	Voltage output	CMRR	Signal source resistance: 1 kΩ DC CMRR: 140 dB or greater AC CMRR: 100 dB or greater (with power frequency set to ±1%)
	Voltage measurement	CMRR	Signal source resistance: 1 kΩ DC CMRR: 140 dB or greater AC CMRR: 100 dB or greater (with power frequency set to ±1%)
		NMRR	With power supply frequency set to ±0.1%: 55 dB or more With power supply frequency set to ±1%: 35 dB or more
	Current measurement	NMRR	With power supply frequency set to ±0.1%: 55 dB or more With power supply frequency set to ±1%: 35 dB or more

Insulation resistance	Between a batch of positive and negative terminals and the case: 1000 MΩ or greater Between any two of the channels: 1000 MΩ or greater
Capacity to ground	1000 pF or less for each channel

Accuracy specifications

Conditions of guaranteed accuracy	Guaranteed accuracy period: 1 year Guaranteed accuracy period from adjustment made by Hioki: 1 year Accuracy guarantee temperature and humidity range: 23°C±5°C (73°F±9°F), 80% RH or less Warm-up time: at least 30 minutes Power supply frequency : 50 Hz /60 Hz ±2 Hz	
Voltage output accuracy	±0.0150% of setting ±500 μV Additional error (temperature coefficient) From 0°C to 18°C and from 28°C to 40°C, add following value: ±0.05 × output accuracy per °C	
	Output resistance	3 mΩ or less (Does not include terminal's contact resistance)
Voltage measurement accuracy	±0.0100% of reading ±100 μV Additional error (temperature coefficient) From 0°C to 18°C and from 28°C to 40°C, add following value: ±0.05 × measurement accuracy per °C	
Current measurement accuracy	1 A range	±0.0700% of reading ±100 μA Additional error (temperature coefficient) From 0°C to 18°C and from 28°C to 40°C, add following value: ±0.05 × measurement accuracy per °C
	100 μA range	±0.0350% of reading ±10 nA Additional error (temperature coefficient) From 0°C to 18°C and from 28°C to 40°C, add following value: ±0.05 × measurement accuracy per °C

6.3 Specifications of Functions

Current range switching	Settings	1 A range, 100 µA range	
	Default setting	1 A range	
Overrange	If the measured current value exceeds about ±150% of full scale of 100 µA range, the instrument detects overrange, stops output. When it detects an overrange, the state is kept and are cleared using the CLEAR ERROR STATUS command ∗CLS or the RESET command ∗RST.		
Smoothing function	Operation	The moving average is calculated from the measured value for each integration time. $M_{\mathrm{avg}} = \frac{1}{A}\sum_{k=n}^{n+A-1} M_k$ M_{avg}: Average value; A: Set count; n: Number of measurements; M_k: kth measured value	
	Setting	1 to 100	
	Default value	1	
Logging measurement function	Operation	Average values are stored in the equipment's internal memory at the cycle specified by the smoothing function's set count setting from the start of measurement until measurement stops. The internal memory is overwritten, starting with the oldest value. Number of data points: 15,000 (for each channel) Memory contents: Measured voltage value, measured current value	
	Settings	Logging measurement: ON/OFF Automatic stop time: 1.00 s to 99.99 s	
	Default setting	Logging measurement: OFF	
Memory output function	Operation	Output will vary automatically in response to the value stored in the internal memory. Number of memory points: 4 (for each channel) Linear interpolation is performed between memory values. Refresh rate: 1 ms	
	Settings	Memory contents Transition time: 0.001 s to 9.999 s Output value (value reached after transition time elapses): 0.0000 V to 5.0250 V	
	Default values	Transition time: 0.001 s Output value: 0 V	
Output terminal switching	Operation	ON	The following settings can be made for each channel: NORMAL: Set voltage output to positive and C terminals HIGH IMPEDANCE: Positive terminal open, set voltage output to C terminal ZERO: Positive and C terminals shorted to circuit ground
		OFF	HIGH IMPEDANCE: Positive terminal open and C terminal shorted to circuit ground ZERO: Positive and C terminals shorted to circuit ground
	Settings	ON (NORMAL/HIGH IMPEDANCE/ZERO) OFF (HIGH IMPEDANCE/ZERO)	
	Default setting	OFF (NORMAL when ON, ZERO when OFF)	
Output expansion terminal (CHAIN terminal) switching	Setting	ON/OFF	
	Default setting	ON	

Power supply frequency setting	Automatically detected at power-on (50 Hz or 60 Hz)		
Warm-up time detection	Operation	The equipment determines that it has warmed up once 30 minutes have passed since it was powered on and notifies the operator of that status via commands and the LED.	
Error detection functions	Operation	The equipment detects errors via a series of error detection functions. Detected states are held and may be cleared using the CLEAR ERROR STATUS command. Error states detected by error detection functions as well as the no-output state are cleared using the CLEAR ERROR STATUS command ∗CLS or the RESET command ∗RST.	
	Overcurrent detection	Operation	If the measured current exceeds a user-configured threshold at the 1 A range or the continuous output limitation is exceeded, the overcurrent detection function will detect an overcurrent state. When it detects an overcurrent state, the overcurrent detection function will set output to 0 V and trigger the no-output state. No voltage output will be generated while in the no-output state.
		Setting	Threshold: 0.1 A to 1.0 A
		Default value	1.0 A
	Output voltage error detection	Operation	If the difference between the output setting value V_{out} and the measured value V_{in} ($\lvert V_{out} - V_{in} \rvert$) exceeds a user-configured threshold, the output voltage error detection function will detect an output voltage error. Detection is not performed for a period of 0.1 s, after the voltage setting is changed or after the output terminal or output expansion terminal is switched.
		Setting	Threshold: 1 mV to 9 mV
		Default value	2 mV
	Internal temperature error detection	Operation	If the temperature inside the equipment exceeds a user-configured threshold, the internal temperature error detection function will set internal temperature error. There is a temperature sensor located on each channel's output board, and there are 4 sensors on the control board, for a total of 16 sensors.
		Settings	Output board threshold: 30°C to 80°C Control board threshold: 30°C to 80°C
		Default values	Output boards: 70°C Control board: 50°C
Reset	Resets all settings to the factory defaults.		

6.4 Interface Specifications

LAN	Standard compliance	IEEE802.3
	Transfer method	10BASE-T/100BASE-TX automatic detection Full duplex
	Protocol	TCP/IP
	Connector	RJ-45
	Communications	Configuration, equipment status acquisition, settings acquisition via communication commands
	Settings	IP address: 192.168.1.xxx (only the “xxx” portion can be changed) Subnet mask: 255.255.255.0 (fixed) Default gateway: None (fixed) Communications command port: 1024 (fixed)
	Default setting	IP address: 192.168.1.1

7 Maintenance and Service

Calibration

The calibration period varies with the conditions and environment of use. It is recommended to determine a calibration period based on those factors and to have the instrument regularly calibrated by Hioki. Please contact your Hioki distributor to have your instrument periodically calibrated.

Shipping Precautions

- To ensure safe handling, when transporting the instrument, please use the original box and packing materials.
  Do not use if the box is damaged or warped, or if the packing materials are in poor condition or incomplete. Contact your authorized Hioki distributor or reseller.
- If shipping without using the packing boxes and buffer material from the time of purchase, and the product is damaged, please note that Hioki cannot be responsible for any repair costs even if still within the warranty period.
- When packing the instrument, make sure to disconnect the cables from the instrument.
- When transporting, avoid dropping or other excessive impacts.

Cleaning

- If the instrument becomes dirty, slightly moisten a soft cloth moistened with water or a neutral detergent and wipe the instrument clean. Wipe the display gently with a soft, dry cloth.
- Clean the vents periodically to avoid blockage.

7.1 Error Display

If the lamps light up or flashes as shown below, an equipment malfunction has occurred.

Display	Meaning
No lamp operation	Main controller operations error
ERROR lamp: Blink ALERT lamp: All channels lit RUN C lamp and RUN Positive lamp: Only CH 1 lit	Main controller control error
ERROR lamp: Blink ALERT lamp: All channels lit RUN C lamp and RUN Positive lamp: Only CH 2 lit	CPU ROM error
ERROR lamp: Blink ALERT lamp: All channels lit RUN C lamp and RUN Positive lamp: Only CH 3 lit	CPU SRAM error
ERROR lamp: Blink ALERT lamp: All channels lit RUN C lamp and RUN Positive lamp: Only CH 4 lit	SRAM error
ERROR lamp: Blink ALERT lamp: All channels lit RUN C lamp and RUN Positive lamp: Only CH 5 lit	Adjustment value error
ERROR lamp: Blink ALERT lamp: All channels lit RUN C lamp and RUN Positive lamp: Only CH 6 lit	FPGA error
ERROR lamp: Blink ALERT lamp: All channels lit RUN C lamp and RUN Positive lamp: Only CH 7 lit	Analog board error
ERROR lamp: Blink ALERT lamp: All channels lit RUN C lamp and RUN Positive lamp: Only CH 8 lit	Fan error

8 License Information

The instrument uses lwIP open source.

lwIP's License

lwIP is licensed under the BSD license:

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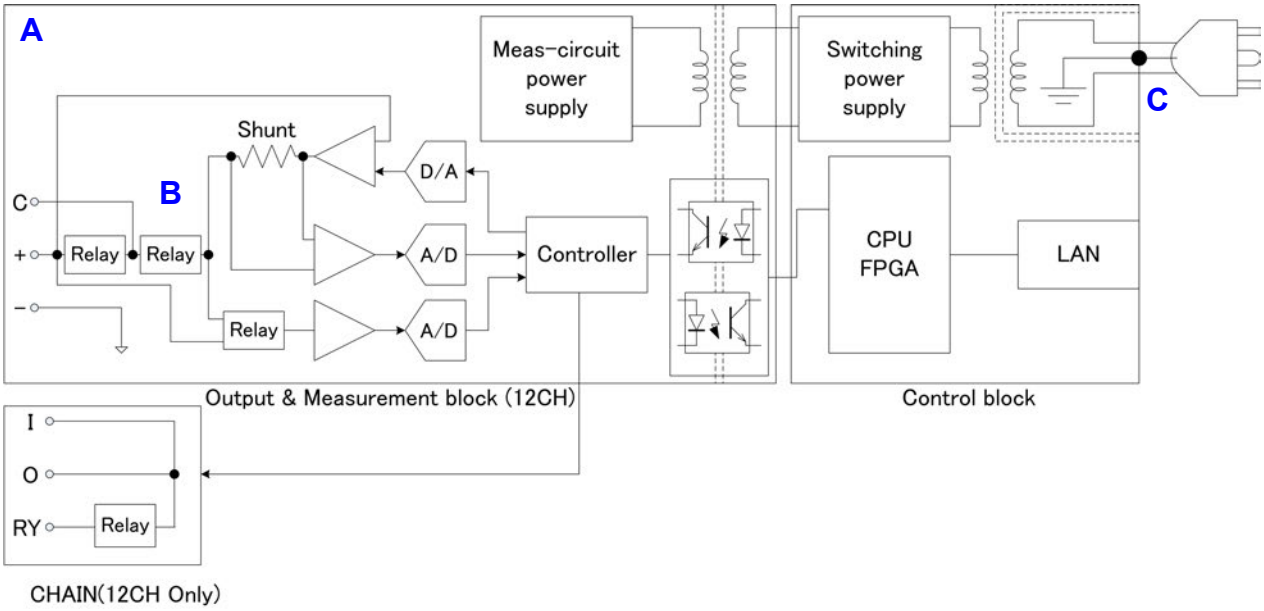
Appendix

Appx. 1 Internal Circuit Configuration

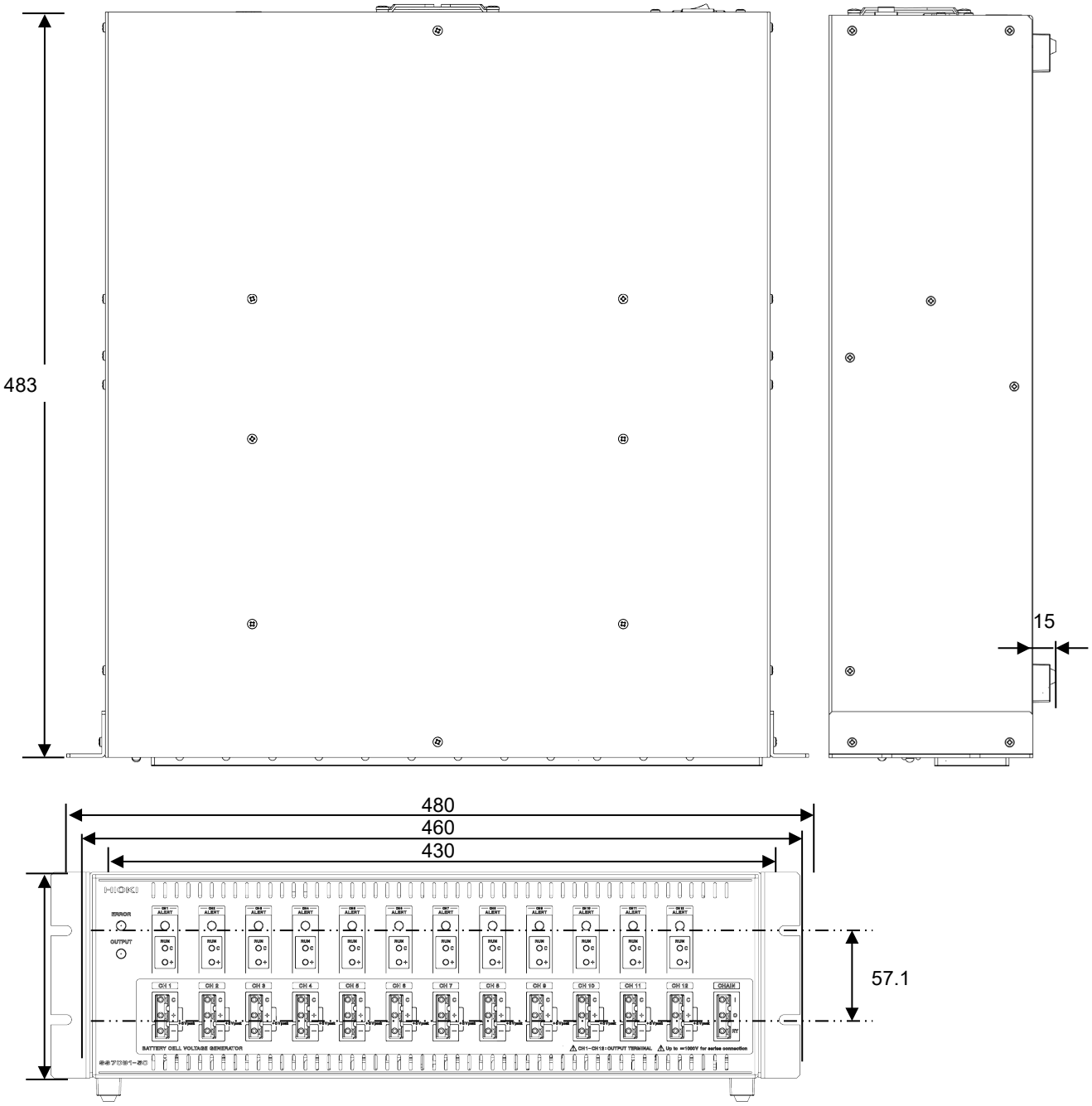


A This is a 12-channel constant voltage supply with each channel isolated and that is capable of independent control. Viewing each channel as one battery cell and directly connecting each channel enables the battery packs in which the cells have been stacked to be imitated. In addition, connecting multiple instruments in series enabled 13 or more channels to be connected. (1000 V max.)
As the output voltage and output current for each channel are measured simultaneously, no measured values are unexpectedly lost.

B The output terminal can be switched according to the test mode of the measuring object. For the relay configuration, see “3.2 Switching Output Terminals (p. 21)”.

C A wide input switching power supply of 100 V to 240 V is used in the power supplier to enable stable measurements even in an environment where the power supply is unstable.

Appx. 2 Dimensions Diagram



(Unit: mm)

Appx. 3 Mounting the Instrument in the Rack

The screws can be removed from the side of the instrument so that the enclosed rack mounting tool (for EIA standards) can be attached to the instrument using the screws that come with it.
Use a separately purchased stand or other surface to reinforce the installation when mounting the instrument in rack.

Carefully store any parts removed from the instrument for when they are reused.

⚠WARNING

Note the following screw usage precautions to prevent damage to the instrument and electric shock.

If mounting the rack mount tool to the side

- Use screws with a nominal length shorter than the sum of a board thickness and 6 mm so that the screws inside the instrument do not penetrate further than 6 mm.
- When removing the rack mounting tool and restoring the original configuration, use the same screws as were used for the original mounting. (M3 × 6 mm)

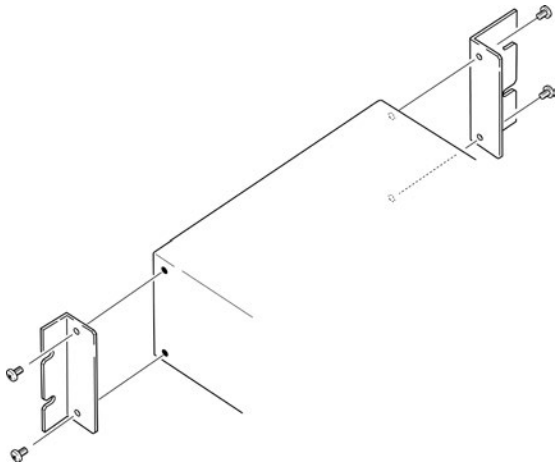
If installing the instrument on a separately purchased stand or other surface

- When removing the supports on the bottom of the instrument and installing it on a separately purchased stand or other surface, use screws with a nominal length shorter than the sum of a board thickness and 5 mm so that the screws inside the instrument do not penetrate further than 5 mm.
- If removing the instrument from a stand and restoring the original configuration, use the same screws as were used for the original mounting. (M3 × 8 mm)

If you have lost a screw or find that a screw is damaged, please contact your authorized Hioki distributor or reseller.

1 Remove the screws from the instrument side cover
M3 × 6 mm screws ×4

2 Mount the rack mounting tool
M3 × 8 mm screws ×4



Warranty Certificate

HIOKI

Model	Serial number	Warranty period One (1) year from date of purchase (___ / ___)

Customer name: _____

Customer address: _____

Important

- Please retain this warranty certificate. Duplicates cannot be reissued.
- Complete the certificate with the model number, serial number, and date of purchase, along with your name and address. The personal information you provide on this form will only be used to provide repair service and information about Hioki products and services.

This document certifies that the product has been inspected and verified to conform to Hioki's standards.
Please contact the place of purchase in the event of a malfunction and provide this document, in which case Hioki will repair or replace the product subject to the warranty terms described below.

Warranty terms

1. The product is guaranteed to operate properly during the warranty period (one [1] year from the date of purchase). If the date of purchase is unknown, the warranty period is defined as one (1) year from the date (month and year) of manufacture (as indicated by the first four digits of the serial number in YYMM format).
2. If the product came with an AC adapter, the adapter is warrantied for one (1) year from the date of purchase.
3. The accuracy of measured values and other data generated by the product is guaranteed as described in the product specifications.
4. In the event that the product or AC adapter malfunctions during its respective warranty period due to a defect of workmanship or materials, Hioki will repair or replace the product or AC adapter free of charge.
5. The following malfunctions and issues are not covered by the warranty and as such are not subject to free repair or replacement:
   -1. Malfunctions or damage of consumables, parts with a defined service life, etc.
   -2. Malfunctions or damage of connectors, cables, etc.
   -3. Malfunctions or damage caused by shipment, dropping, relocation, etc., after purchase of the product
   -4. Malfunctions or damage caused by inappropriate handling that violates information found in the instruction manual or on precautionary labeling on the product itself
   -5. Malfunctions or damage caused by a failure to perform maintenance or inspections as required by law or recommended in the instruction manual
   -6. Malfunctions or damage caused by fire, storms or flooding, earthquakes, lightning, power anomalies (involving voltage, frequency, etc.), war or unrest, contamination with radiation, or other acts of God
   -7. Damage that is limited to the product's appearance (cosmetic blemishes, deformation of enclosure shape, fading of color, etc.)
   -8. Other malfunctions or damage for which Hioki is not responsible
6. The warranty will be considered invalidated in the following circumstances, in which case Hioki will be unable to perform service such as repair or calibration:
   -1. If the product has been repaired or modified by a company, entity, or individual other than Hioki
   -2. If the product has been embedded in another piece of equipment for use in a special application (aerospace, nuclear power, medical use, vehicle control, etc.) without Hioki's having received prior notice
7. If you experience a loss caused by use of the product and Hioki determines that it is responsible for the underlying issue, Hioki will provide compensation in an amount not to exceed the purchase price, with the following exceptions:
   -1. Secondary damage arising from damage to a measured device or component that was caused by use of the product
   -2. Damage arising from measurement results provided by the product
   -3. Damage to a device other than the product that was sustained when connecting the device to the product (including via network connections)
8. Hioki reserves the right to decline to perform repair, calibration, or other service for products for which a certain amount of time has passed since their manufacture, products whose parts have been discontinued, and products that cannot be repaired due to unforeseen circumstances.

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