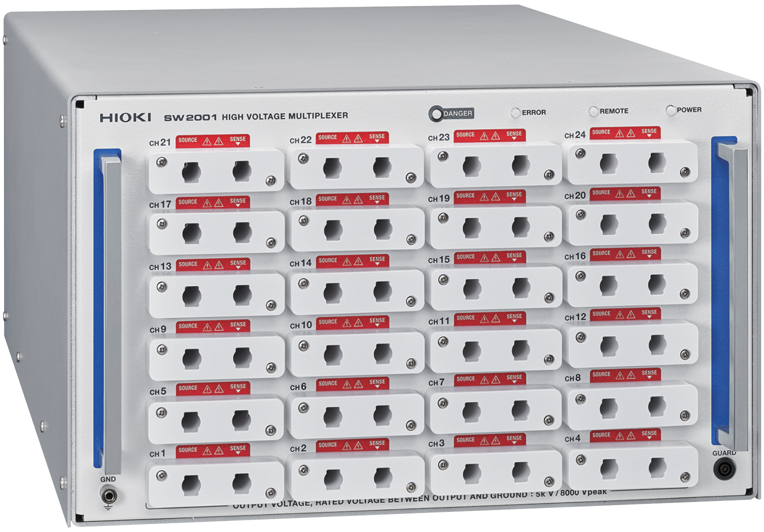
SW2001

SW2001-04
SW2001-08
SW2001-16
SW2001-24

Instruction Manual

HIGH VOLTAGE MULTIPLEXER



Check for the latest edition and other language versions.

Read carefully before use.
Keep for future reference.

When using the instrument for the first time

Troubleshooting

Oct. 2024 Revised edition 1
SW2001A971-01

EN

1 Introduction

1.1 Introduction

Thank you for choosing the Hioki SW2001 High Voltage Multiplexer.
Preserve this manual carefully and keep it handy to make full use of this instrument for a long time.

The latest edition of the instruction manual
The contents of this manual are subject to change, for example as a result of product improvements or changes to specifications.
The latest edition can be downloaded from Hioki's website.
https://www.hioki.com/global/support/download/

Product registration
Register your product in order to receive important product information.
https://www.hioki.com/global/support/myhioki/registration/

Read the following Operating Precautions carefully before using the instrument.
Refer to the instruction manuals below as relevant to your purpose.

Type	Contents	Format
Operating Precautions	This provides information on the instrument for safe operation.	Print
Startup Guide	This guide contains information on how to safely use the instrument, basic operating instructions, and specifications (excerpt).	Print
SW2001 Instruction Manual (this document)	This manual contains an product overview, operating instructions, function descriptions, and specifications. https://manual.hioki.com/en/SW2001.manual	HTML
ST4200 Instruction Manual	This manual contains an ST4200 product overview, operating instructions, function descriptions, and specifications. https://manual.hioki.com/en/ST4200.manual	HTML

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 an electrical program at a technical high school).

1.2 Confirming Package Contents

When the instrument arrives, inspect it carefully to ensure that everything is in good condition and there is no damage. If the instrument seems to have been damaged or does not work as specified, contact your authorized Hioki distributor or reseller.
Confirm that the package contents are correct.

Instrument

☐ SW2001 High Voltage Multiplexer

Included accessories

☐ Power cord

☐ Operating Precautions (0990A903)

☐ Startup Guide

☐ Feet (for installation) × 4

☐ EXT. I/O connector (with cover)

☐ Connector (with cover) for disengaging EXT. I/O interlock

1.3 Options (Sold Separately)

The following options are available for the instrument. To buy, contact your authorized Hioki distributor or reseller.
The options are subject to change without prior notice. Visit our website (https://www.hioki.com) for updated information.

PD sensor (Options available only at the time of purchase order issuance for the instrument)

The instrument is equipped with two types of PD sensors installed. Specify when ordering.

- ST9200 PD Sensor (for AC Partial Discharge)
- ST9201 PD Sensor (for Impulse Partial Discharge)

Connection Cables

- L2005 Connection Cable
- L2111 Connection Cable
- L2255 Connection Cable
- L2265 Unterminated Lead Cable
- L2270 Connection Cable
- L2271 Connection Cable
- L9218 Connection Cable
- L1002 USB cable (A-B)

1.4 Notations

Safety notations

In this document, risk levels are classified as follows.

Notation	Description
⚠ DANGER	Indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate injury or potential risks of damage to the supported product (or to other property).
IMPORTANT	Indicates information or content particularly important from the standpoint of operating or maintaining the product.
	Indicates a high-voltage hazard. Failure to verify safety or improper handling of the product could lead to an electric shock, a burn, an injury, or a death.
	Indicates a prohibited action.
	Indicates a mandatory action.

Symbols affixed to the instrument

Notation	Description
	Indicates the presence of a potential hazard. See the "Operation Precautions" and safety notes listed at the beginning of operating instructions in the instruction manual(s), and the accompanying document entitled "Operating Precautions".
	Indicates a terminal that is hazardous due to high voltages.
	Indicates the on side of the power switch.

Notation	Description
○	Indicates the off side of the power switch.
⏚	Indicates an eathing terminal.
	Indicates a ground terminal connected to the chassis of the instrument.
∼	Indicates that the product can be used for alternating current (AC).

Symbols for Standards

Notation	Description
	Indicates that the product is subject to the Directive on Waste Electrical and Electronic Equipment (WEEE) in EU member nations. Dispose of the product in accordance with local regulations.
CE	Indicates that the product complies with standards imposed by EU directives.

Notation of terms for partial discharge

Notation	Description
PD	Abbreviation for "partial discharge".
AC PD	Indicates partial discharge occurring when applying AC high voltage to the object under measurement.
Impulse PD	Indicates the partial discharge generated when impulse voltage is applied to the object under measurement.

Other notations

Notation	Description
Tips	Indicates useful functions and advice you should know.

Notation	Description
*	Indicates that additional information is described below.
POWER (bold-faced)	Indicates text printed on the instrument.
`*TRG`	Indicates a communications command.

1.5 Safety Information

The instrument is designed in accordance with the IEC 61010 international standard and their safety was confirmed during pre-shipment inspections.
However, using the instrument in a way not described in this manual may diminish their safety.
Read the following safety notes carefully before using the instrument.

⚠ DANGER

Mishandling the instrument could result in bodily injury or even death, as well as damage to the instrument. Familiarize yourself with the instructions and precautions in this manual before using the instrument.

⚠ WARNING

Electricity can cause potentially serious events such as an electric shock, heat generation, fire, and an arc flash due to a short-circuit. If you have not used electrical measuring instruments before, you should be supervised by a technician who has experience in electrical measurement.

Protective gear

⚠ WARNING

Insulation measurements, pressure resistance measurements, impulse measurements and PD measurements are performed using a live line. To prevent an electric shock, use appropriate protective insulation and adhere to applicable laws and regulations.

1.6 Operation Precautions

Follow these precautions to ensure safe operation of the instrument and to obtain the full benefits of its various functions. Ensure that your use of the instrument falls within the specifications not only of the instrument itself, but also of any included accessories and options being used.

Handling the instrument

⚠ CAUTION

Observe the following due to the risk of injury.

- The weight of the instrument is 31.5 kg for the SW2001-24, 27.0 kg for the SW2001-16, 22.5 kg for the SW2001-08 and 20.5 kg for the SW2001-04. When transporting the instrument, have it carried by two or more people by holding the handles on the front and rear.
- The instrument is heavy. Ensure safety during transportation in accordance with the work safety arrangements specified by each company. (e.g., wearing non-slip gloves and safety boots)

The instrument is an EN 61326 Class A product. When using in a home environment such as a residential area, it may interfere with the reception of radio and television broadcasts. In such cases, workers should implement appropriate measures.

Installing the instrument

⚠ WARNING

Installing the instrument in inappropriate locations could cause a malfunction of the instrument or an accident. Avoid locations that are:

- Exposed to direct sunlight or high temperatures
- Exposed to corrosive or combustible gases
- Exposed to strong electromagnetic fields or electrostatic charges
- Near induction heating systems (such as high-frequency induction heating systems and IH cooking equipment)
- Susceptible to vibration
- Exposed to water, oil, chemicals, or solvents
- Exposed to high humidity or condensation
- Exposed to high quantities of dust particles
- On top of unstable platforms or inclined surfaces

Unplugging the power cord kills power to the instrument. Be sure to provide enough unobstructed space to unplug the power cord immediately in an emergency.

- Do not stack multiple instruments.
- Place the instrument with the bottom side downwards.

Precautions during shipment

Store the packaging materials after unpacking. Use the packaging materials that came with instrument when transporting it.

⚠ CAUTION

To avoid damage to the instrument, protect it from physical shock when transporting and handling. Be especially careful to avoid physical shock due to dropping it.

- Do not use packaging or cushioning if torn or deformed.
  If not using packaging and cushioning when shipping the product, contact your authorized Hioki distributor or reseller. Hioki will send specialized packaging and cushioning.
- When packaging the instrument, be sure to remove connection cables and power cords from the instrument.

Before connecting cables

⚠ DANGER

Do not use any cables whose metal conductor is exposed. Doing so could result in an electric shock, burn, or other hazards.

Before performing a measurement, connect the instrument with the generator (AC power or impulse power) and check that connection cables are securely locked or screwed in at all connection terminals. The user may experience an electrical shock if connection cables are not connected.

⚠ WARNING

Do not step on cables or pinch them between other objects. Do not bend or pull on cords at their base, or repeatedly bend them. The cable may disconnect or short-circuit.

- To prevent an electric shock, confirm that the insulation layer inside the cable is not exposed. If a color inside the cable is exposed, do not use the cable.
- Use only the connection cables specified by Hioki when using the instrument. Using a non-specified cable may result in unsafe measurements. Using a non-specified cable may also result in incorrect measurements due to poor connection or other reasons.

⚠ CAUTION

The cable is hardened in freezing temperatures. Do not bend or pull it to avoid tearing its shield or cutting the cable.

Before connecting the instrument to external equipment

⚠ CAUTION

- Connect the ground terminal of the instrument and the ground terminal of connected equipment to a single grounding point with sufficiently low impedance. Using different ground circuits will result in a ground potential difference between the instrument and the connected equipment. If a cable is connected while such a potential difference between grounds exists, it may result in equipment malfunction or failure.
- Before connecting or disconnecting any cable, always turn off the instrument and your device to be connected. Failure to do so could result in an equipment malfunction or damage to the equipment.
- To prevent damage to the equipment, use the recommended type of wires to connect your external equipment to the external control terminals, or otherwise ensure that the wires have sufficient withstand voltage and current capacity.

Precautions during measurement

⚠ DANGER

Do not use the instrument to measure circuits that exceed those ratings or specifications. Damage to the instrument or overheating can cause bodily injury.

⚠ CAUTION

Connect the functional ground terminal to the ground if subject to the impact of noise.

2 Overview

2.1 Product Overview

The instrument is a multichannel circuit switcher optimal for tests during the motor production process and shipment tests.
The instrument is a dedicated relay box integrating all tests for motor stators. It is able to switch measurement points such as U, V, W and ground, and can automate measurements of up to 24 channels by control via computer and PLC.

Insulation/withstand voltage tester, impulse winding testers, resistance meters, LCR meters, and partial discharge detectors can be connected to the input channels.
Also, 4 to 24 channels can be selected as the number of output channels according to the number of channels you wish to connect to the object under measurement. (Available only at the time of purchase order issuance for the instrument)

2.2 Features

High-voltage measurements and 4-terminal measurements can be performed together

High-voltage measurements such as withstand voltage measurement and insulation resistance measurement required for measurement of motor coils, as well as low-voltage measurements such as winding resistance measurement are configured within the same system. This enables safe measurement without having to worry about voltage differences.

Maintenance-free relays

The high-voltage relays used internally use highly reliable lead relays with adequate leeway for the voltage used. When used to construct a motor inspection system, the instrument is designed with sufficient durability for the expected number of uses and without the need for maintenance*1.
*1. Five million uses have been recorded in operation tests by Hioki. (Reference value)

Input and output channel connection methods can be selected as desired

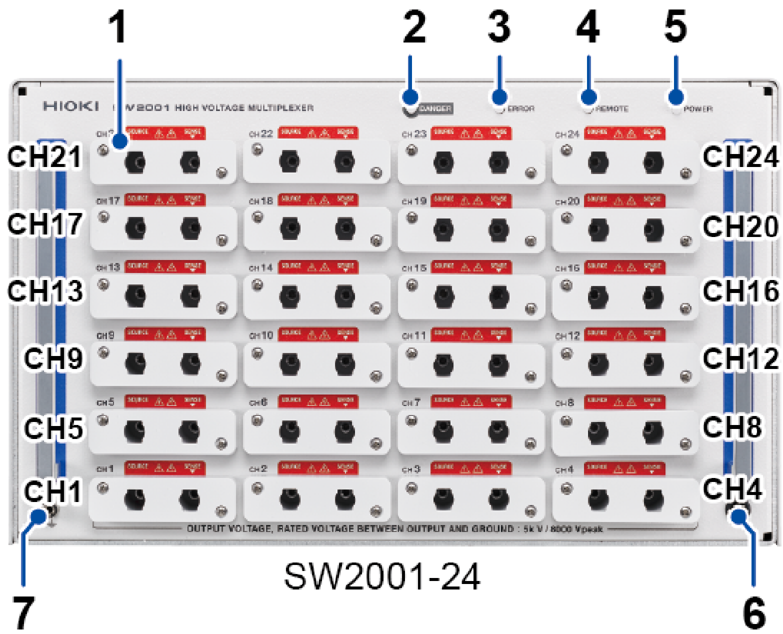
Multiple high-voltage and low-voltage measuring instruments can be connected to the instrument. There are also multiple output channels for connecting to the object under measurement. Multiple measurements can be performed on an object under measurement connected to these output channels using measuring instruments connected to the input.
For example, in a series of measurements where withstand voltage measurement is performed on the winding section followed by resistance measurement performed on the winding, the instrument can safely switch between measurements without the need to reconnect the cables to the object under measurement. Changes in polarity during measurement can also be performed while remaining connected.

Built-in PD SENSOR (Option available only at the time of purchase order issuance for the instrument)

To inspect partial discharge in the winding section, the ST9200 PD Sensor (for AC Partial Discharge) and ST9201 PD Sensor (for Impulse Partial Discharge) can be incorporated inside the instrument to conduct insulation voltage measurement and impulse measurement while also performing rapid inspection of each partial discharge.

2.3 Name and Function of Each Part

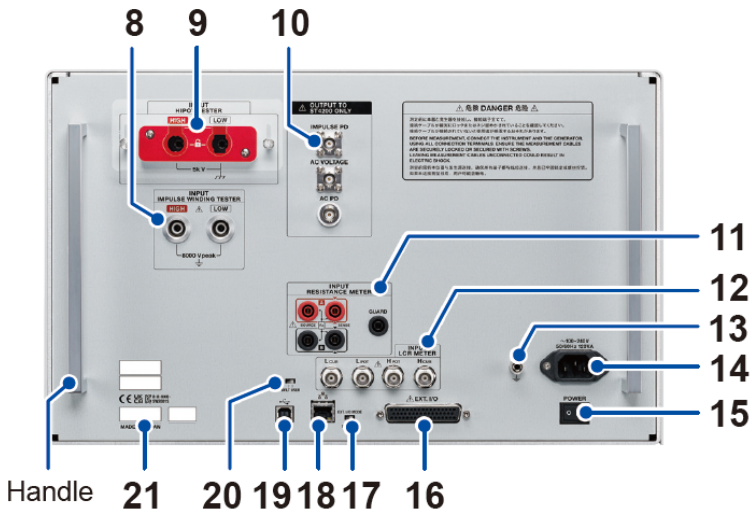
Front



SW2001-24

No.	Name	Function
1	Output channels (**CH1** to **CH24**) **SOURCE**, **SENSE**	Connect the optional L2265 Unterminated Lead Cable.
2	**DANGER** LED (red)	Turns on when the **HIPOT** or **IMPULSE** relay is ON.
3	**ERROR** LED (red)	Turns on during the self-test at startup or when there is an error during communication.
4	**REMOTE** LED (green)	Turns on when LAN communication is established or when a command is received by USB communication. Turns off when a remote release command is received.
5	**POWER** LED (green)	Turns on when the power is activated.
6	**GUARD** terminal	Used to avoid the effects of noise when measuring resistance.
7	**GND** terminal (functional earth terminal)	Ground this terminal.

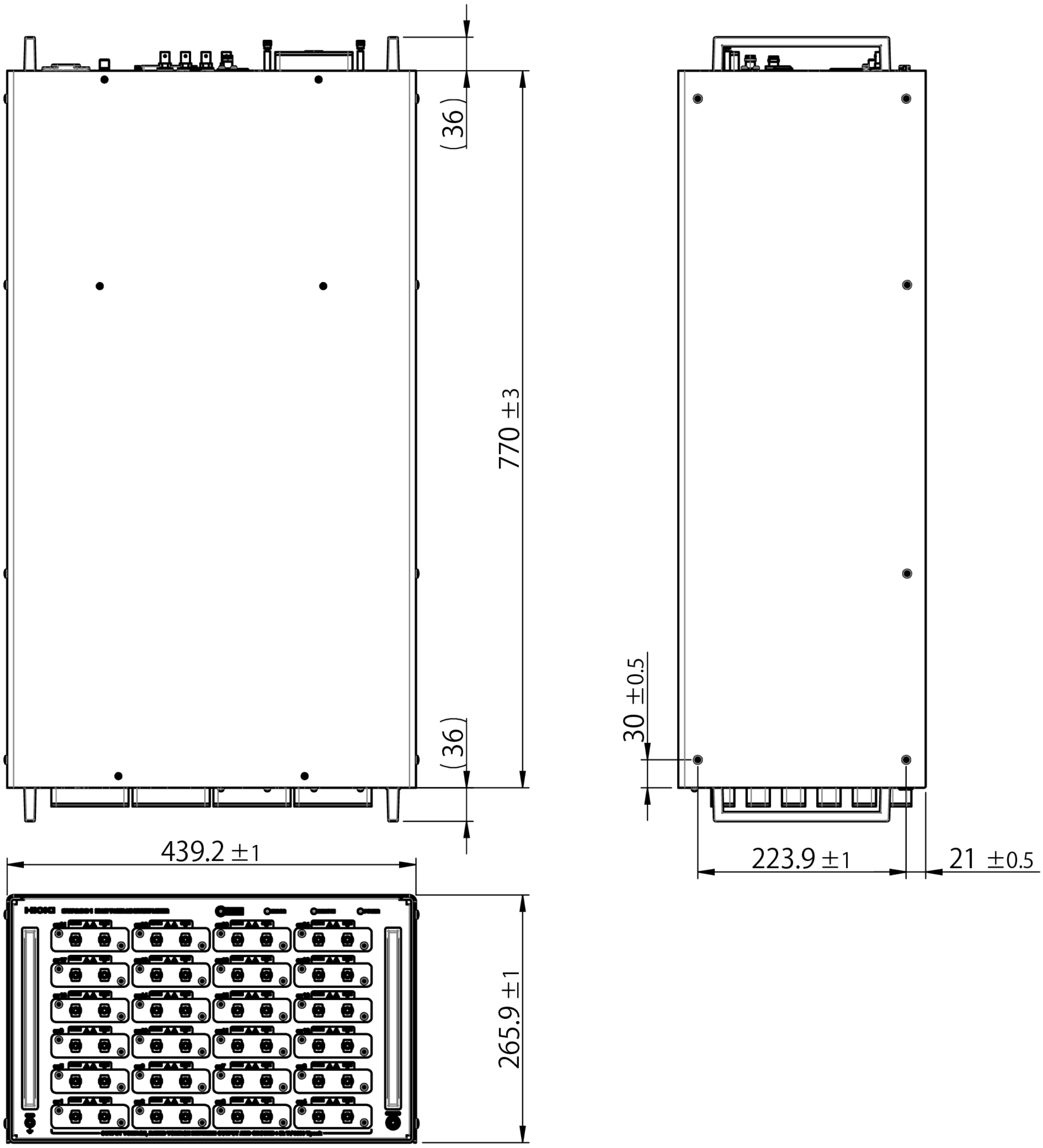
Rear



No.	Name	Function
8	**IMPULSE WINDING TESTER** terminal	Connect the ST4030A Impulse Winding Tester via L2255 Connection Cable.
9	**HIPOT TESTER** terminal	Connect the L2270 (HIGH side) and L2271 (LOW side) to 3153 Automatic Insulation/Withstanding HiTester or 3174 AC Automatic Insulation/Withstanding HiTester.
10	ST4200 output terminals	Connect to the ST4200 using L9218 Connection Cable.
11	**RESISTANCE METER** terminal	Connect to RM3545 Resistance Tester using L2111 Connection Cable.
12	**LCR METER** terminal	Connect to IM3533 LCR Meter using L2005 Connection Cable.
13	**GND** terminal	Ground this terminal.
14	Power inlet	Connects the power cord provided.
15	**POWER** switch	Used to turn the instrument on and off.
16	**EXT. I/O** terminal	Enables to control the instrument by inputting external signals, or output signals externally.
17	**EXT. I/O MODE** switch	Switches the type of PLC (programmable logic controller) to connect to (**NPN/PNP**) EXT. I/O.

No.	Name	Function
18	LAN connector	Connect a LAN cable.
19	USB connector	Connect a USB cable.
20	Communication setting mode switch	Switches the communication setting to **DFLT** (default setting) or **USER** (user setting). (See: "Configuring Communication Setting Modes")
21	Serial number	The serial number consists of nine digits. The first two digits from the left indicate the year of manufacture (last two digits of the year), and the next digits two indicate the month of manufacture. This label is needed for administrative purposes. Do not remove this label. Inform your authorized Hioki distributor or reseller of this number if required.

2.4 Dimensions



2.5 Measurement Procedure

Take measurements while switching the input channels and output channels on the instrument.
The three following methods can be used as control methods.

1. Connect a computer or PLC via LAN or USB to control using communications commands.
2. Control using **EXT. I/O** from a PLC.
3. Control using a sample application. (See: "Sample Applications")

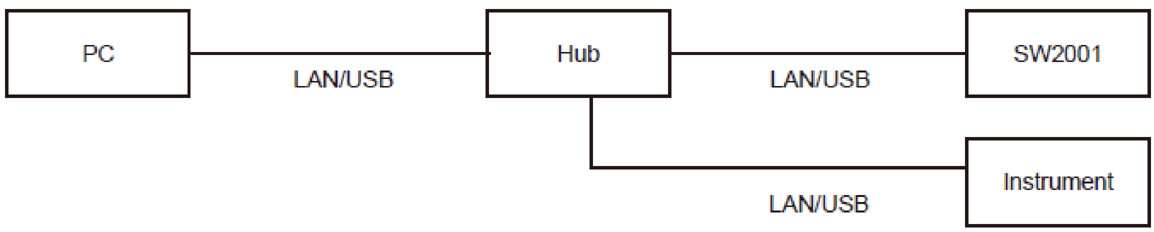
3 Preparing for Measurement

3.1 Control Method

It is necessary to connect a computer or PLC to control the instrument.
The following configurations and control methods can be used with the instrument.

Control via communication commands

Control the instrument by connecting a computer via LAN or USB interface.
Control the instrument to switch channels, control and configure measuring instruments, and perform measurements.
See: "Overview of Switching Channels"

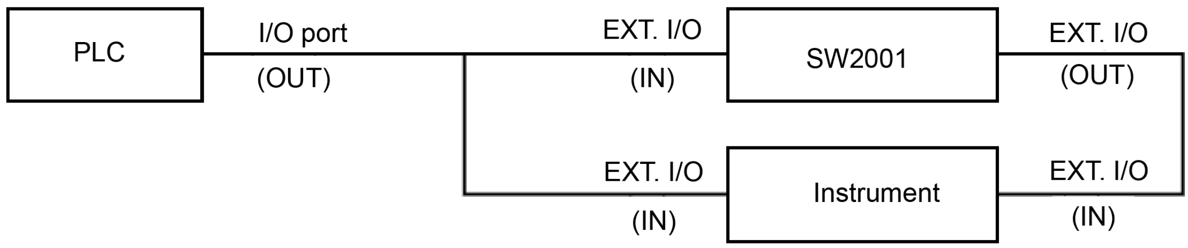


When using USB, a hub is not required if the computer has multiple USB ports.

Control via EXT. I/O

Control by connecting the I/O port of a PLC to the instrument's **EXT. I/O**.

Connection examples



3.2 Connecting Measurement Cables

Connect the instrument to the object under measurement with a measurement cable.

⚠ WARNING

Connect the measurement cable to the instrument while detached from the object under measurement. A short-circuit may occur in the object under measurement depending on the state of the relay switch circuit.

Cable used

L2265 Unterminated Lead Cable (optional, 3 m length)

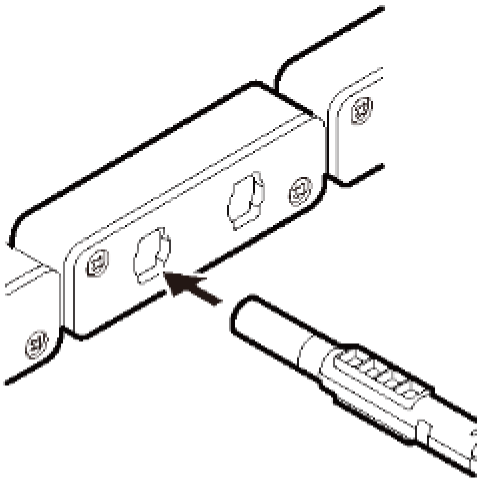
In factory default state, the "object under measurement" side of the unterminated lead cable is disconnected.
You must modify the tip of the cable to suit the object under measurement.

Connection procedure

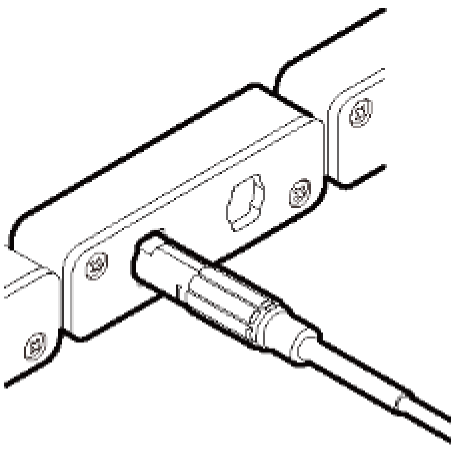
1 **Cut the power to the instrument.**

2 **Connect the unterminated lead cable connector to the instrument.**

Align the terminal holes with the unterminated lead cable connector.

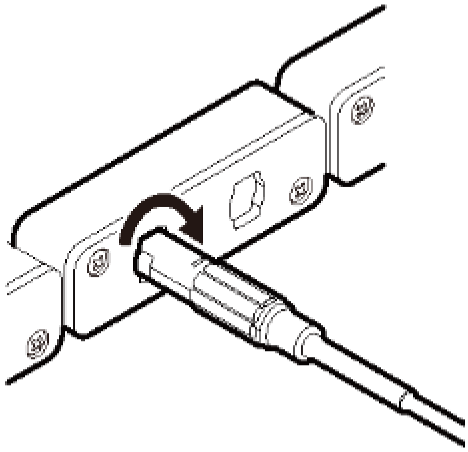


3 **Insert the unterminated lead cable connector all the way inside.**



4 Turn the unterminated lead cable connector 90 degrees and lock it.

This connector rotates 90 degrees or more in both directions.
However, turning it 180 degrees is dangerous as it will deactivate the lock.



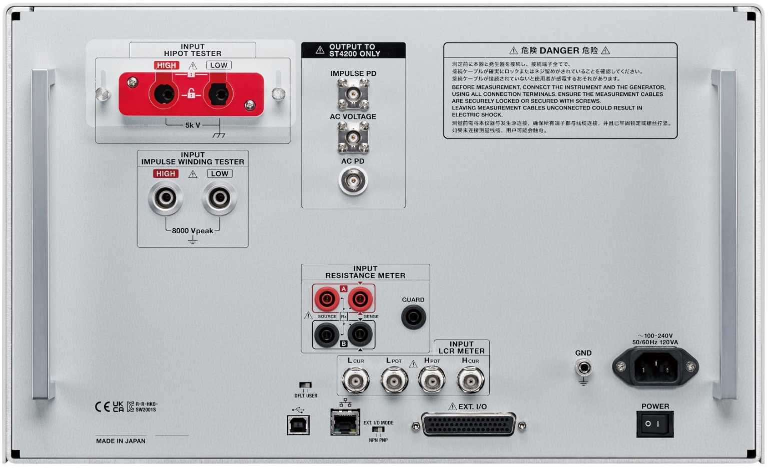
5 Check to ensure that the unterminated lead cable connector cannot be removed.

6 Connect the unterminated lead cable to the object under measurement.

3.3 Connecting Connection Cables

Connect the instrument to the measurement instrument with a connection cable.

See the instruction manual for each measuring instrument for how to connect the instrument with connection cables.



Select the connectors on the instrument side and the connection cables depending on the instrument being connected.

Measuring instrument	Model example	Instrument connector	Connection Cables
Automatic Insulation/Withstanding HiTester	3153 3174	**HIPOT TESTER** terminal	L2270 (H side) L2271 (L side)
Impulse Winding Tester	ST4030A	**IMPULSE WINDING TESTER** terminal	L2255
Resistance Meter	RM3545	**RESISTANCE METER** terminal	L2111
LCR Meter	IM3533	**LCR METER** terminal	L2005
ST4200 output terminals	ST4200	**IMPULSE PD**, **AC VOLTAGE**, **AC PD** terminals	L9218

HIPOT TESTER terminal

⚠ WARNING

Firmly lock the connection cable connector stoppers and ensure that they will not detach. A connector being pulled out may result in damage to the instrument or exposure to high voltage.

1 **Cut the power to the instrument.**

2 **Loosen the stopper plate screws.**

3 Slide the stopper plate upward.

4 Align the terminals with the connection cable connectors, and fully insert them.

5 **Slide the stopper plate downward until it comes in contact with the screws and locks the connectors in place.**

6 **Tighten the stopper plate.**

7 **Check to ensure that the connection cable connectors cannot be removed.**

How to remove connection cables

Turn off the instrument, and remove the cables in the reverse order of the above procedure.

IMPULSE WINDING TESTER terminal

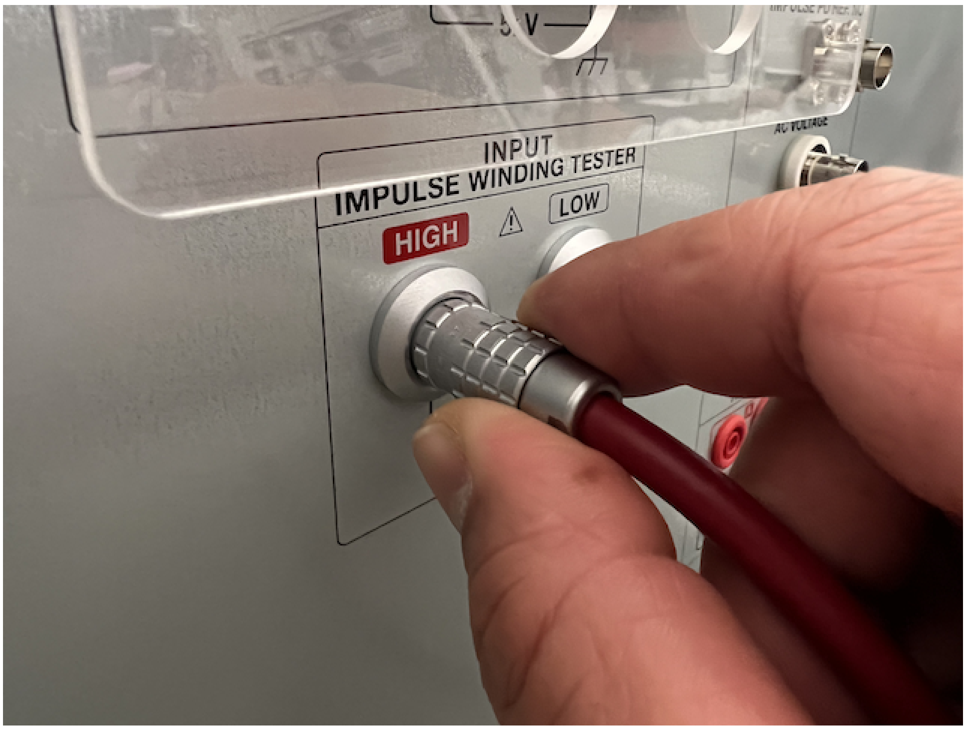
⚠ WARNING

Firmly lock the connection cable connector stoppers and ensure that they will not detach.
A connector being pulled out may result in damage to the instrument or exposure to high voltage.

1 **Cut the power to the instrument.**

2 **Insert the connection cable connector all the way into the instrument and confirm that it is locked.**

Push it in until there is a locking sound.



3 **Check to ensure that the connection cable connectors cannot be removed.**

4 **Connect the other end of the connection cable to the impulse winding tester.**

How to remove connection cables

Turn off the instrument, and pull the connection cable straight out by holding the locking mechanism of the connector. The lock will disengage, enabling the cable to be removed.

RESISTANCE METER terminal

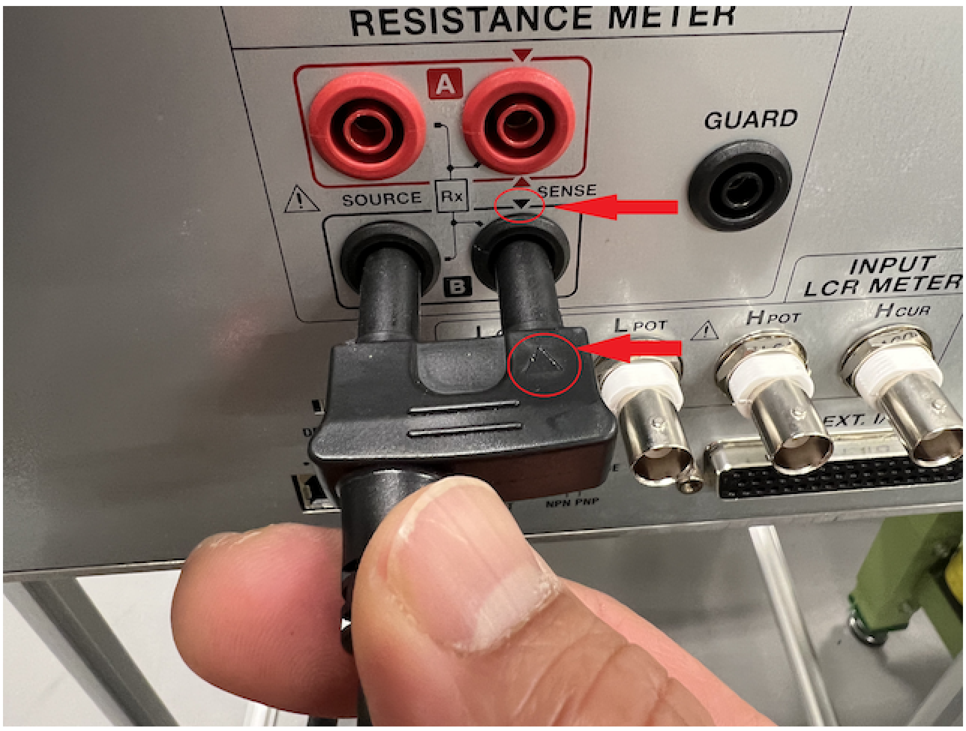
IMPORTANT

Firmly connect the four connection cables to the instrument. Accurate measurements cannot be performed if the cable is insufficiently inserted.

1 **Cut the power to the instrument.**

2 **Connect the H terminals (red) and L terminals (black) of the connection cable to the RESISTANCE METER terminals of the instrument.**

The terminals are the same for L2111 connector.
Align the direction of the connection cable connector so that the ▼ mark on the instrument matches the ▲ mark on the connection cable.



3 **Connect the GUARD terminal of the connection cable to the GUARD terminal of the instrument.**

4 **Connect the other connection cable to the resistance meter.**

Tips

The rear **GUARD** terminal is short-circuited with the front **GUARD** terminal through the interior of the instrument. To use the GUARD function, such as for avoiding the impact of disturbance noise in resistance measurement, use the front **GUARD** terminal.

LCR METER terminals

IMPORTANT

- Firmly connect the four connection cables to the instrument. Accurate measurements cannot be performed if the cables are insufficiently connected.
- To reduce the impact of noise, connect the GUARD terminal of the LCR meter and the functional ground terminal of the SW2001 with a cable with a length of 3 m or less. (Recommended: 1.5 m)

⚠ CAUTION

When removing a connection cable, pull it out by holding the head of the BNC connector (other than the cable) after being sure to disengage the lock to prevent damage to the BNC connector or the contact.

1 Cut the power to the instrument.

2 Connect the BNC terminals of the connection cables to the LCR METER terminals of the instrument.

The terminals are the same for L2005 connector.
Descriptions of terminal names on the instrument and the corresponding cable names (marking tube descriptions) on the connection cables are as follows.
Insert the BNC terminals to the instrument connectors, rotate the lock rings 90 degrees clockwise, and firmly lock them.

Instrument terminal	Cable name
L_{CUR}	SOURCE-L
L_{POT}	SENSE-L
H_{POT}	SENSE-H
H_{CUR}	SOURCE-H

3 Connect the other connection cable to the LCR meter.

⚠ DANGER

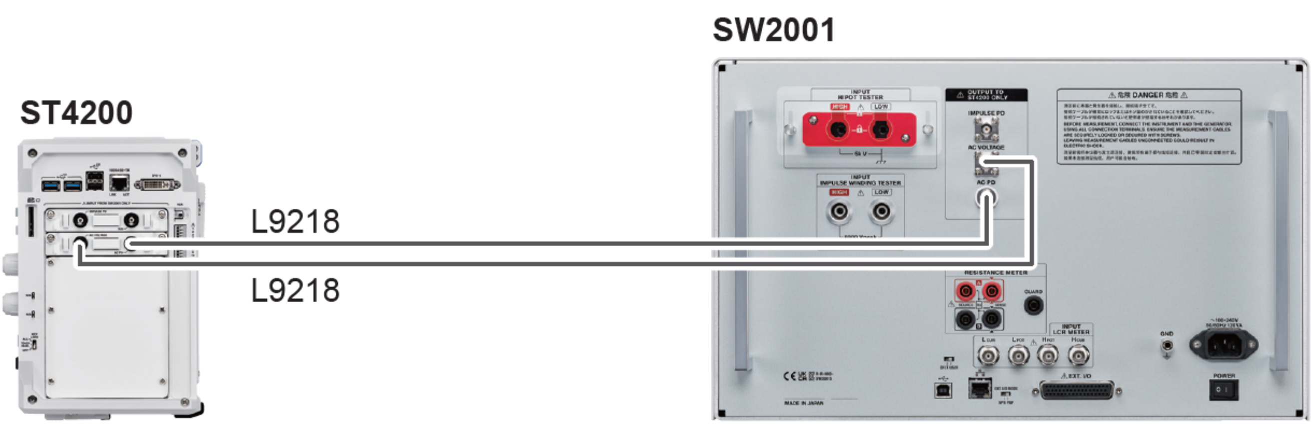
Connect the cable after confirming that the **DANGER** LED light on the instrument is off.
Failure to do so may cause the user to experience an electrical shock.

⚠ CAUTION

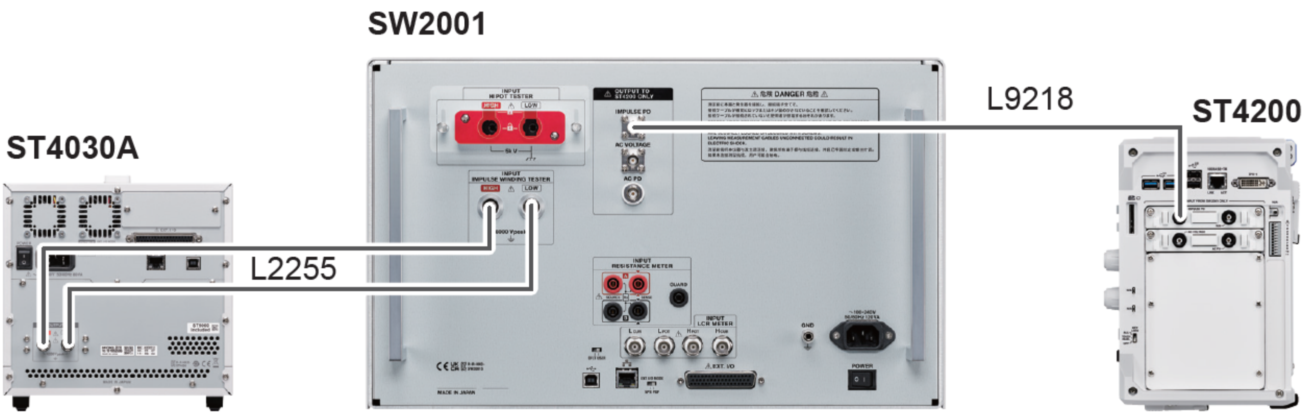
- Connect the plastic connector (black) or L9218 Connection Cable to the input terminal (green BNC connector) of the ST4200.
  Connecting a metal connector to an insulated BNC connector may cause the insulated BNC connector to be damaged.
- When removing the cable, remove the lock and hold the head (not the cable) of the BNC connector before pulling it out.
  This may damage the BNC connector.

Measuring AC PD

Connect the instrument's **AC PD** terminal to the **AC PD** terminal on the right side of the ST4200 using L9218 Connection Cable.
Connect the instrument's **AC VOLTAGE** terminal to the **AC VOLTAGE** terminal on the right side of the ST4200 using L9218 Connection Cable.
Connect the metal connectors to the SW2001 and the plastic connectors (black) to the ST4200.



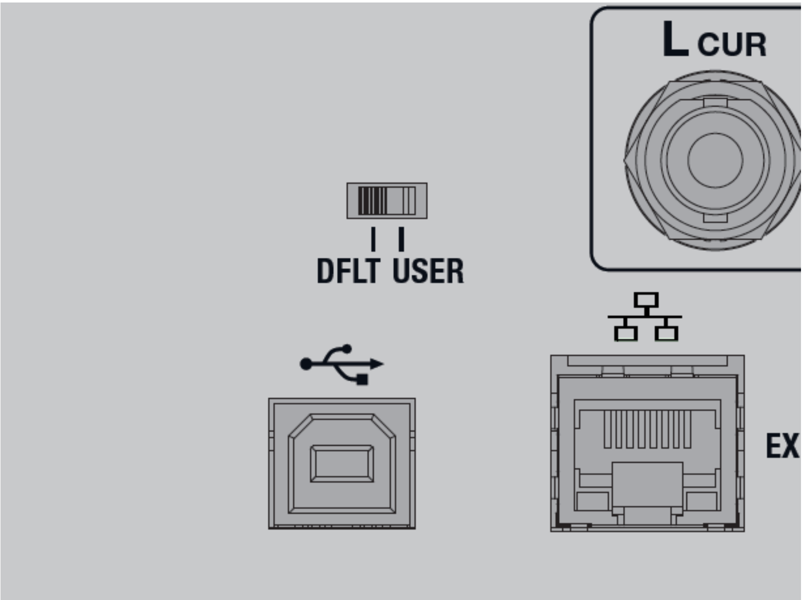
Connect the instrument's **IMPULSE PD** terminal to the **IMPULSE PD** terminal on the right side of the ST4200 using L9218 Connection Cable.
Connect the metal connectors to the SW2001 and the plastic connectors (black) to the ST4200.



3.4 Communication Setting Mode

Overview

Control the instrument using a LAN or USB communication interface.
When using LAN communication, **DFLT** (default setting mode) or **USER** (user setting mode) can be selected using the switch located on the rear of the instrument.



Communication via USB is possible regardless of the communication setting mode.

How to configure

1 **Check that the POWER switch is set to OFF (◯).**

2 **Switch the communication setting mode with the communication setting mode switch.**

See: "Configuring Communication Setting Modes"

3.5 Connecting the Power Cord

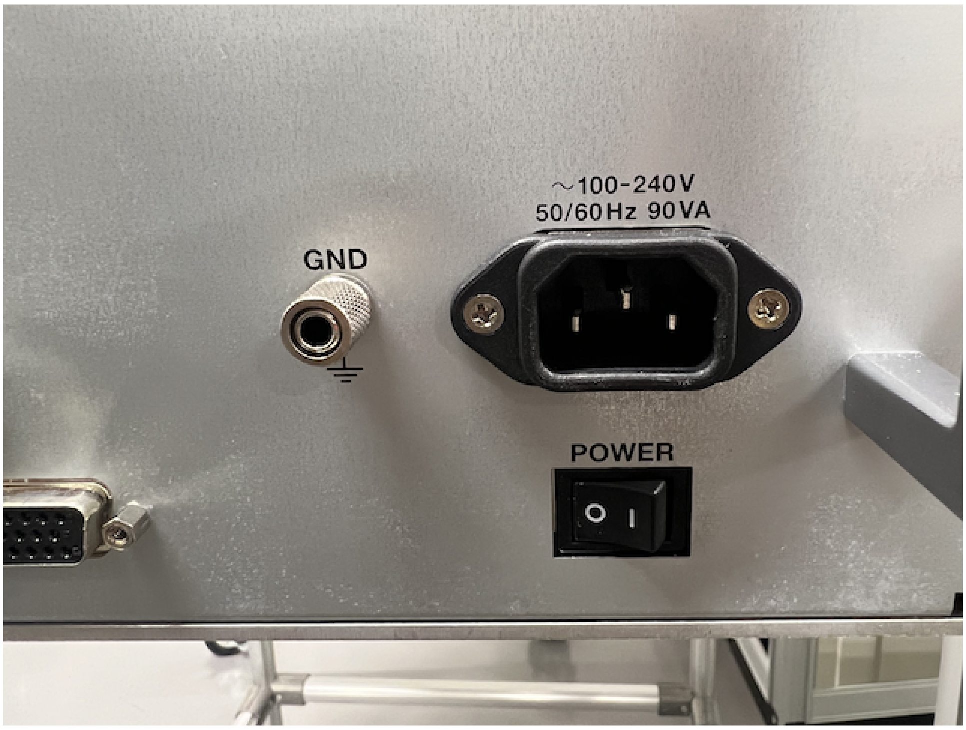
⚠ WARNING

To prevent electrical shock and to maintain the safety specifications of this instrument, connect the accompanying power cord only to a 3-prong grounded-type (2-pole) power outlet.

⚠ CAUTION

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

Before turning the instrument on, make sure the supply voltage matches that indicated on its power connector. Connection to an improper supply voltage may damage the instrument and present an electrical hazard.



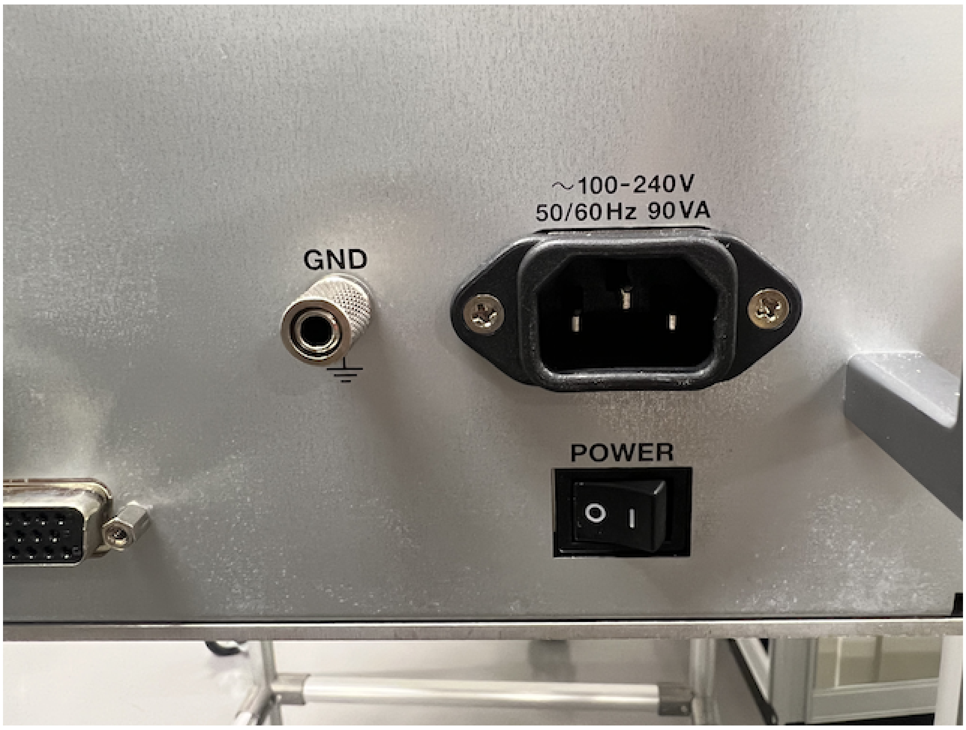
1. **Check that the POWER switch is set to OFF (◯).**

2. **Confirm that the power supply voltage is within the voltage range stated on the rear of the instrument, and connect the power cord to the power inlet.**

3. **Connect the power cord plug to an outlet.**

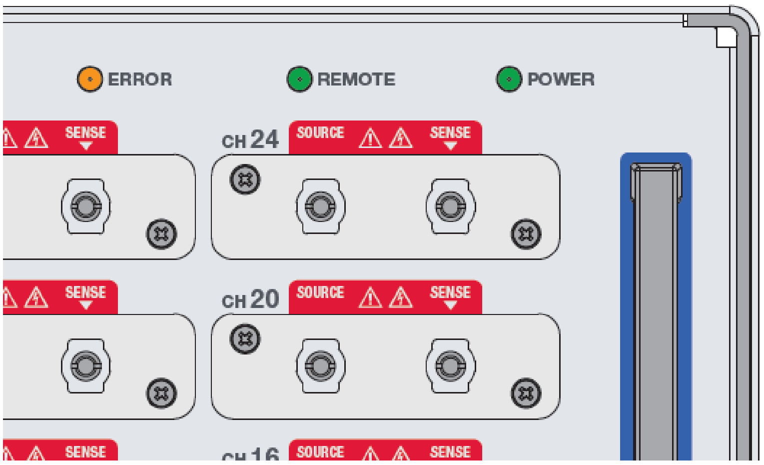
3.6 Turning the Power Supply ON/OFF

The rear POWER switch is used to turn the power supply ON and OFF.



The **POWER** LED on the front lights up when the power is turned on, and a self-test is executed. When an error occurs during a self-test, the front **ERROR** LED lights up or flashes.

See: "When the **ERROR** LED lights up or flashes"



3.7 Conditions When the Instrument is Turned On

When the instrument is turned on, it starts initialized in the following state.

Item	Initialization details
Input relays	All relays open
Output relays	All relays open
AC PD relays	Open
EXT. I/O SWITCHED output signal	OFF
Channel delay setting	Retains setting recorded by backup command
Protective discharge setting	Retains setting recorded by backup command
Speed discharge setting	Retains setting recorded by backup command
Communication setting	Retains setting recorded by backup command

See: "Default Settings"

4 Switching Channels

4.1 Inspection Before Measurement

⚠ DANGER

If the connection cords or the instrument is damaged, there is a risk of an electric shock. Perform the following inspection before using the instrument:

- Check that the insulation of the connection cords is neither ripped nor torn and that no metal parts are exposed. Replace the connection cords with those specified by Hioki.
- Check if there is any damage to the instrument occurred during storage or shipping and verify that it operates normally before using the instrument. If you find any damage, contact your authorized Hioki distributor or reseller.

Checking the instrument and peripheral devices

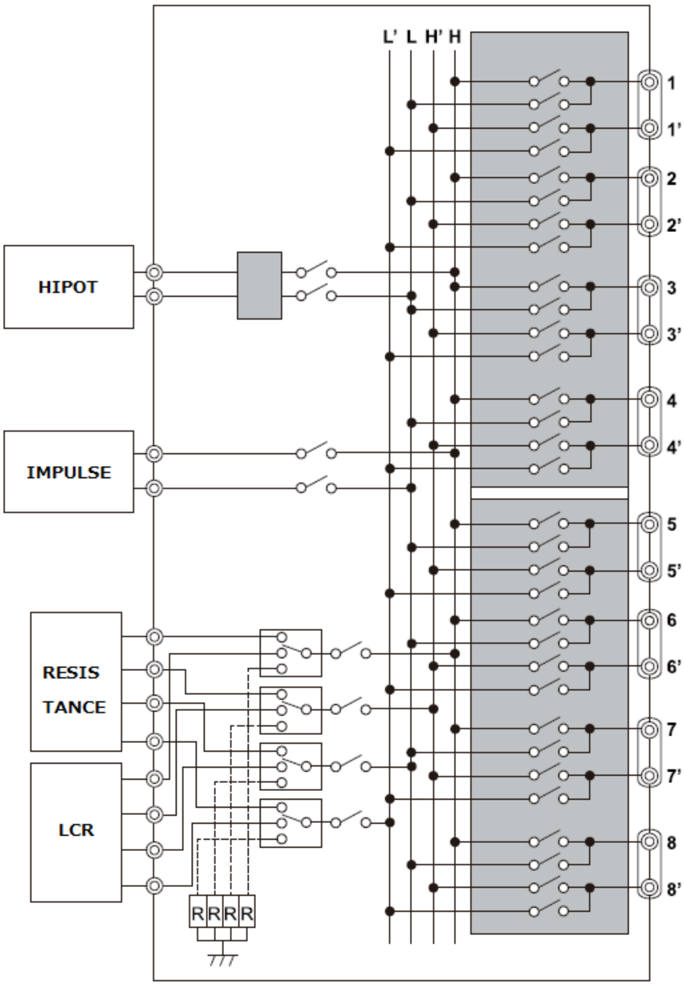
Inspection item	Solution
The insulation of the power cord is neither ripped nor torn and no metal parts are exposed.	If damaged, do not use them because it may cause an electric shock or short-circuit. Contact your authorized Hioki distributor or reseller.
The insulation of measurement cables or connection cables is not damaged and no metal parts are exposed.	If damaged, do not use it because it may cause an electric shock.
The instrument is not damaged.	If the instrument is damaged, request repairs. Contact your authorized Hioki distributor or reseller.

Checking output channel relays

Check that the output channel relays are not damaged according to the self-test procedures for "Checking output channel relay welds" and "Checking output channel relay OPEN failures".
See: "Self-tests"

4.2 Overview of Switching Channels

The instrument switches the relays of each input and output channel and connects them to the internal bus. Any channel can be measured with any measuring instrument by using the input relays to select which input channel to connect to the internal bus, and using the output relays to select the channels to measure (multiple channels can be selected).
The instrument is entirely controlled by communications commands. See the explanation for each item for the specific commands.



Channels not marked with ' indicate **SOURCE** and those marked with ' indicate **SENSE**.

Only one input channel can be selected. This prevents simultaneous connections to multiple measuring instruments.

4.3 Procedure for Switching Channels

The settings and procedure for switching channels are as follows.

- Input channel selection
- Output channel selection
- Configuring the AC PD sensor connection (if equipped with ST9200)
- Executing closing by switching relays

Select the input channel and output channels in advance, configure the AC PD sensor connection, and then switch the relays and execute closing to close the selected relays.

Input channel selection

Select the input channel.
If many measuring instruments are connected and there are not enough input terminals, output channels CH1 and CH2, CH3 and CH4, CH5 and CH6, and CH7 and CH8 can be used as input terminals. In this case, odd-numbered channels are HIGH and even-numbered channels are LOW.

<table>
<tr><th>Item</th><th>Communications command</th></tr>
<tr><td>How to configure</td><td>:RELay:INPut
{OFF|HIPot|IMPulse|RESistance|LCR|CH1_2|CH3_4|CH5_6|CH7_8}</td></tr>
<tr><td>Example setting</td><td>:RELay:INPut HIPot
Sets the input channel to HIPOT</td></tr>
</table>

Output channel selection

Select the output channel.
Although multiple channels can simultaneously be set to HIGH or LOW, if the input channel is set to LCR or RESistance, only the lowest numbered channel set for HIGH and LOW respectively is enabled, and other channels are not connected.
Also, if CH1 through CH8 are set as input channels, those channels cannot be set to HIGH or LOW.

<table>
<tr><th>Item</th><th>Communications command</th></tr>
<tr><td>How to configure</td><td>:RELay:CH <ch>,{OFF|HIGH|LOW}</td></tr>
<tr><td>Example setting</td><td>:RELay:CH 1,HIGH
Sets output channel 1 to HIGH
:RELay:CH 2,LOW
Sets output channel 2 to LOW</td></tr>
</table>

Tips

Multiple channels can be configured at once using a single command.
`:RELay:CHALL {OFF|HIGH|LOW},{OFF|HIGH|LOW}`... (List the number of output channels from CH1)
If the number of parameters is less than the number of output channels, all channels after the channel set by the parameters are set to OFF.

Selecting AC PD sensor connection ON/OFF (if equipped with ST9200)

Item	Communications command
How to configure	`:RELay:ACPD {OFF|ON}`
Example setting	`:RELay:ACPD ON` Sets the AC PD relay to ON

Executing relay switching

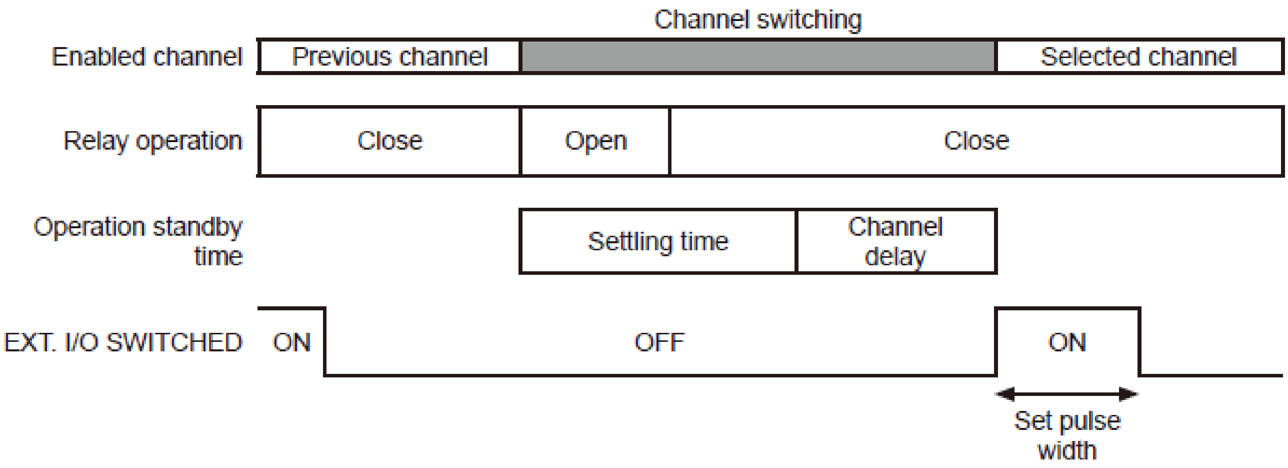
Item	Communications command
How to configure	`:RELay {CLOSE|OPEN}`
Example setting	`:RELay CLOSE` Executes the closing of the relay

Tips

It can be closed with the `*TRG` command and opened with the `:ABORt` command.
When the `:ABORt` command is received, priority is given to opening all relays over all processes. (Equivalent to emergency stop)
Meanwhile, `:RELay OPEN` executes opening once any processes waiting to be executed are completed.
Even if closing is executed and then opened, the input channel, output channel, and AC PD relay settings are retained until a setting command is received again, and remain enabled when the next closing is executed.

4.4 Channel Switching Operations

After setting the input channel and output channels, execute closing of the relay switch to switch according to the flow in the following diagram.



- If the following closing is executed before the SWITCHED signal pulse reaches the set pulse width, the SWITCHED signal pulse is automatically turned OFF.
- After the previous channel relays are opened, the selected channel relay is closed. (Break before make)
- Channel switching cannot be overlapped (make before break).
- After the channel relay is closed, once the automatically set settling time and the channel delay time designated by the user have elapsed, the channel switching operation is completed and the **EXT. I/O** SWITCHED output signal turns ON. (Pulse output using set pulse width)

4.5 Precautions During Measurement

Controlling while avoiding hot switching

When a measuring instrument is in an output state, do not operate output channel relays connected to the measurement target.
(Turn on the relays for the output channels to be connected before outputting from the measuring instrument.)
Hot switching operations drastically reduces relay service life.

Staying below the rated flowing current

Even when hot switching operation is avoided, a large inrush current may flow at the instant a signal is output by the measuring instrument, such as when the measurement target is inductive. Do not apply a current exceeding the rated value at the relay contact under any circumstances. A contact weld will occur due to the inrush current and may reduce service life. The maximum current that can be applied to the relays used in the instrument is 3 A.
If performing impulse measurement, the current flowing through the relay can be checked by viewing the output current waveform when there is optional impulse PD output.
See: "Basic Specifications - Maximum allowable impulse current"

Low capacitance measurements such as using an LCR meter

Perform the following to accurately measure small capacitance (C) values of the measurement target with an LCR meter.
Fix the measurement cable closest to the measurement target so that the wiring path of the 4-terminal measurement configuration does not change, and perform "OPEN compensation"" without connecting the object under measurement.
Connect the object under measurement and perform measurement.
The measurement value may differ if the output channel used for measurement is different. (This is because the stray capacitance of the measurement cable varies depending on the wiring path.)

Cable routing for partial discharge measurement

Take care of the following when wiring to reduce the susceptibility of partial discharge in the cable.

- Cable (L2270) connected to **HIPOT** side of instrument from withstand voltage tester
- Wire (L2265) between the channel set to high on the output terminal of the instrument and the object under measurement

Wire these cables in a manner that minimizes contact with other cables and any surrounding metal (including the main unit housing).
Fix the wiring to enable stable measurement to be maintained. (Use non-metallic plastic material for fixing.)

4.6 Channel Delay Function

A delay period after switching channels can be set. The **EXT. I/O** SWITCHED signal is output once the set delay time has elapsed after the input/output relays are closed.
Set a delay time when it is necessary to ensure there is time for measurement responses by measuring instruments. The necessary delay time varies depending on the instrument used and the object under measurement.

Example of setting channel delay time

Communications command

Item	Communications command
How to configure	`:IO:DELay <0 to 9999>` (Unit: ms)
Example setting	`:IO:DELay 100` Sets channel delay to 100 ms.

5 Other Functions

5.1 Panel Functions

Panel functions are function that enable settings related to relay switching operations to be saved and loaded.

Overview

Executing panel save saves the settings at the time in the panel with the number or name designated with the panel save command.
Executing panel load loads the settings with the number or name designated with the panel load command from the panel, and overwrites the current settings on the instrument.
Up to 1,000 panels can be saved.

Settings saved in panel

- Input relay selection
- Output relay selection
- AC PD relay ON/OFF
- SWITCHED signal output time band
- Channel delay time
- Protective discharge time
- Speed discharge time
- Speed discharge channel

Panel save

This saves the content of the settings in the panel with the designated number or name.
When designating a new name that has not previously been saved on the instrument, the smallest unused panel number is automatically assigned.

Item	Communications command
Execution method	`*SAV <1~1000>` (designated with panel number) or `*SAV "Name"` (designated with panel name)

Execution example	`*SAV 4`
	Saves settings to panel number 4.
	`*SAV "MODEL A"`
	Saves settings to the panel name "MODEL A"

Panel load

Loads the settings from the panel with the designated number or name, and overwrites the current settings on the instrument.

Item	Communications command
Execution method	*RCL <1~1000> (designated with panel number) or *RCL "Name" (designated with panel name)
Execution example	*RCL 4 Loads settings from panel number 4. *RCL "MODEL A" Loads settings from the panel name "MODEL A"

Panel clear

Clears the panel with the designated number or name.

Item	Communications command
Execution method	:PANel:CLEar <1~1000> (designated with panel number) :PANel:CLEar "Name" (designated with panel name)
Execution example	:PANel:CLEar 4 Clears panel number 4 :PANel:CLEar "MODEL A" Clears panel name "MODEL A"

Panel name setting

This sets the name of the panel with the designated number.

Item	Communications command
Execution method	:PANel:NAME <1~1000> "Name" (Name is up to eight characters)
Execution example	:PANel:NAME 4 "MODEL A" Sets the name of panel number 4 to "MODEL A"

Panel name query

This acquires the panel name for the designated number.

Item	Communications command

Execution method	`:PANel:NAME? <1~1000>`
	Response
	`"Name"`

Execution example	`:PANel:NAME? 4`
	Response
	`"MODEL A"`

Panel number query

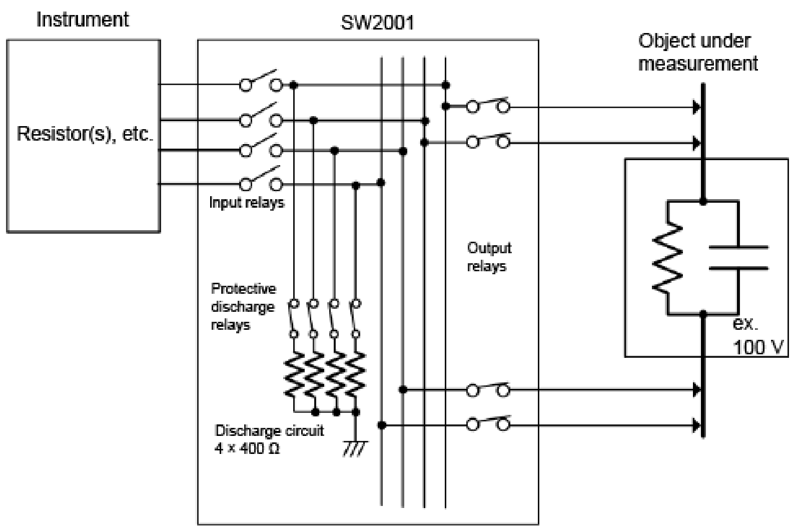
This acquires the panel number for the designated name.

Item	Communications command
Execution method	`:PANel:NO? "Name"` Response `<0～1000>` (If there is no panel with the designated name: 0)

Execution example	`:PANel:NO? "MODEL A"`
	Response
	`4`

5.2 Protective Discharge Function

When input and output relays are closed, the residual charge of the measuring instruments connected to input channels and the object under measurement connected to the output channels causes an inrush current.
The protective discharge function prevents damage from inrush current.



When the closing of relay switches is executed on the instrument, the output relays and protective discharge relays are closed, and the object under measurement is connected to the discharge circuit and a charge is discharged for the duration of the protective discharge time set in advance.
Next, the input relays are closed after the protective discharge relays are opened and the object under measurement is detached from the discharge circuit.

Example of protective discharge settings

Item	Communications command
How to configure	`:DISCharge:PROTect <0~1000>` (Unit: ms) Protective discharge is not performed if set to 0. The default setting is 0.
Example setting	`:DISCharge:PROTect 500` Sets the protective discharge time to 500 ms.

- Protective discharge is performed in channels set to output each time closing of relay switches is executed.
- The maximum voltage that can be discharged with the protective discharge function is 100 V. Use it with the discharge function of each measuring instrument when performing withstanding measurement or insulation resistance measurement.

5.3 Speed Discharge Function

The speed discharge function enables the discharge time after measurement to be shortened by allowing the electric charge remaining in the measurement target to flow to an external resistor.

⚠ DANGER

Never short-circuit the output channel used for speed discharge. If there is a short-circuit, the residual charge will suddenly flow, possibly damaging the object under measurement, measurement cables, and internal circuits in the instrument, and may cause a fire.

Example of discharge function

In general, DC withstand voltage testers and insulation resistance testers have functions for discharging the applied charge when measurement ends to avoid electric shock.
When using the resistance discharge method, it takes time to discharge using this resistance, which may lengthen overall measurement time. Measurement time can be shortened by using the speed discharge function.

For example, it takes around 3.9 seconds to discharge to 30 V when the measurement voltage is 1500 V, load capacity is 50 μF, and discharge resistance is 20 kΩ. (Example of resistance discharge method)
In contrast, this can be shorted to 0.3 seconds when a discharge resistor (1500 Ω) is provided and the speed discharge function is used.

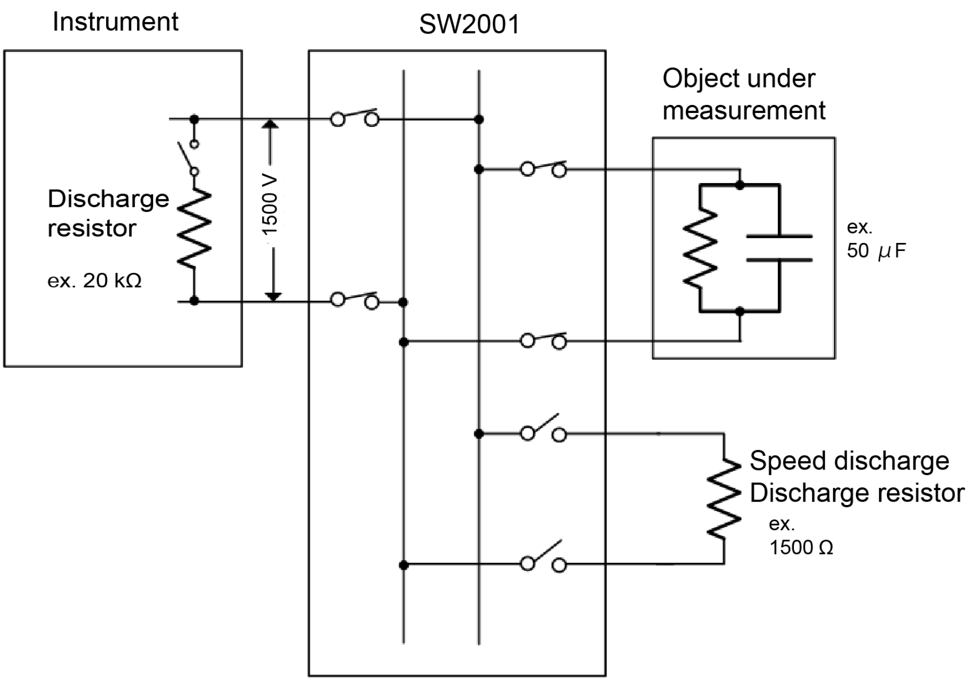
Principle

The discharge model is treated as a transient phenomenon in a series RC circuit.
A capacitor charged to V_0 [V] is discharged with a resistor R [Ω] , and the time t [s] until it reaches V_t [V] is shown with the following equation.

$$t = R \cdot C \cdot \log_e \left(\frac{V_t}{V_0} \right)$$

Speed discharge function

- To use the speed discharge function, two unused channels are required in addition to the number of channels required for measurement.
- The maximum current that can be applied to the relays used in the instrument is **3 A**. Ensure that the current flowing to the discharge resistor does not exceed **3 A**.
- The maximum resistance between relay contacts is 0.15 Ω (relay specifications). Ensure that the contact power does not exceed **10 W**.



Selecting a discharge resistance (for speed discharge)

Select an appropriate discharge resistance according to the residual charge anticipated to be in the object under measurement.

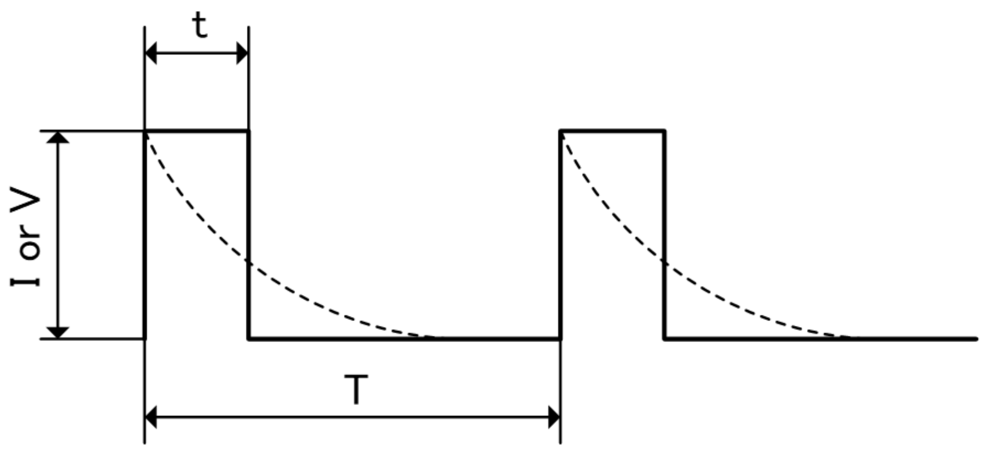
Example: Resistor when performing speed discharge after 1500 V DC withstand measurement

The capacity of the object under measurement is assumed to be 50 μF.
To give leeway, the discharge current is 1 A.
Resistance value: $R = 1500V / 1A = 1500\Omega$
Required power: $P = 1500V \times 1A = 1500W$
1500 W resistance is very large, but the discharge current is instantaneous, and a resistor able to calculate the average power is used.

Approach to average power

The condition when connecting 50 μF capacitance charged to 1500 V a 1500 Ω resistor is considered.
When V_0 = 1500 V, V_t = 30 V, C = 50 μF, and R = 1500 Ω are applied to the equation shown in the principle, t = 0.293 seconds.
Average power is shown using the following equation.

Average power: $\mathrm{P_A} = \mathrm{I} \times \mathrm{I} \times \mathrm{R} \times \frac{\mathrm{t}}{\mathrm{T}}$ or $\mathrm{V} \times \frac{\mathrm{V}}{\mathrm{R}} \times \frac{\mathrm{t}}{\mathrm{T}}$



The average power is as follows when one discharge (test) is performed every 2 seconds.

$\mathrm{P_A} = 1500 \times 1500 \div 1500 \times (0.293 \div 2) = 219.75\mathrm{W}$

By connecting two resistors with a rated power of 200 W at 750 Ω in series, the average power per resistor can be kept to around 110 W.
At this time, the power applied to relay contacts is as follows assuming that a current of 1 A flows instantaneously if the contact resistance is 0.15 Ω.

$1\mathrm{A} \times 1\mathrm{A} \times 0.15 = 0.15\mathrm{W}$

Strictly speaking, the average power is smaller than the above calculation because the actual current applied is as shown by the dashed line.

Select the discharge resistor based not only on the above calculation, but also after measuring under actual usage conditions.

Connecting the discharge resistor

Connect the discharge resistor selected above to two unused channels.

Example of speed discharge settings

Selecting output channels connected to discharge resistor

Example: Connect the discharge resistor to CH7 and CH8.

Item	Communications command
How to configure	`:DISCharge:CH <1~24>,{OFF|HIGH|LOW}`
Example setting	`:DISCharge:CH 7,HIGH;CH 8,LOW` Sets CH7 to HIGH and CH8 to LOW as discharge channels

Setting speed discharge time

Item	Communications command
How to configure	`:DISCharge:SPEed <100~9999>` (Unit: ms)
Example setting	`:DISCharge:SPEed 1000` Sets the speed discharge time to 1000 ms

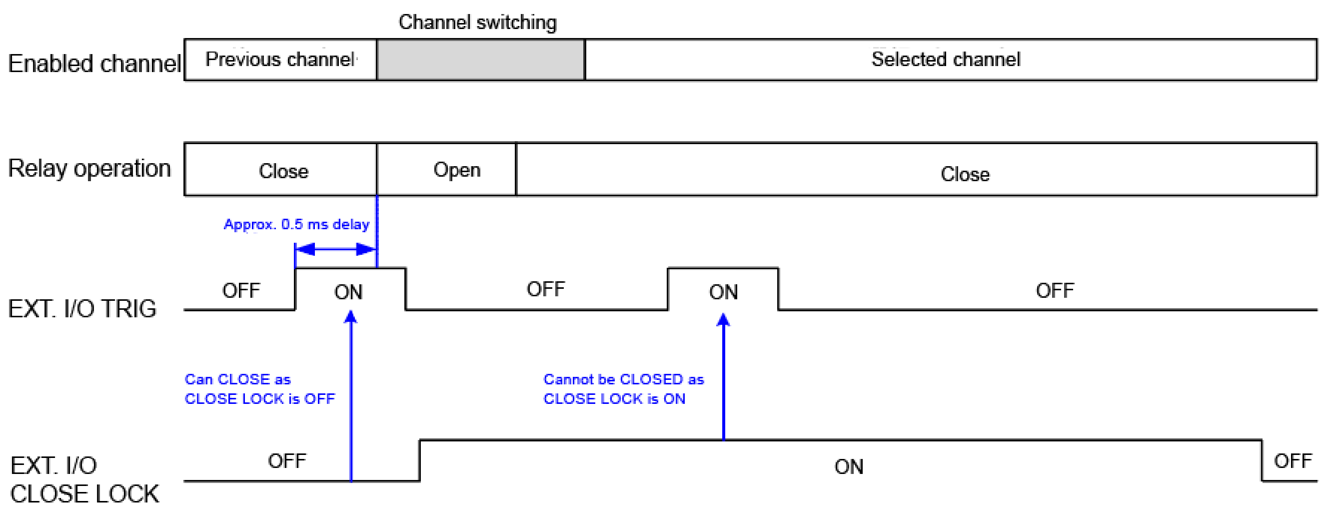
Executing speed discharge

Item	Communications command
Start speed discharge	`:DISCharge:STARt`
Acceptable conditions	Relays must be closed

When this command is executed, the set channel turns ON for the set time.
Once the speed discharge channel and discharge time have been set, they are enabled until set again.
Speed discharge is executed each time the `:DISCharge:STARt` command is sent.

5.4 Close Lock Function

The close lock function prevents hot switching (closing relays while voltage is applied) in combination with a signal output indicating high voltage is being generated by a high voltage generating instrument, such as an Insulation/withstand voltage tester or impulse winding tester.



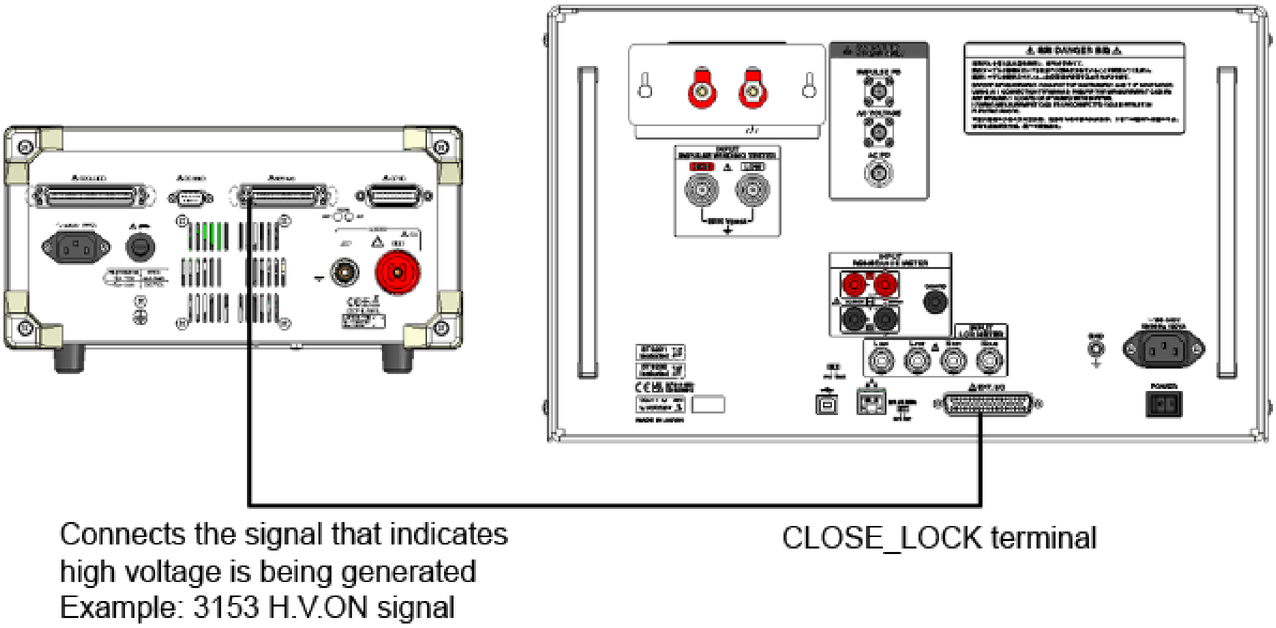
Operations with close lock terminals

Pin No. 45 of **EXT. I/O** is the close lock terminal.
If this pin is connected to a common terminal, the instrument is in a close lock state, and the following operations to open and close relays cannot be performed.

- Closing relays via the TRIG terminal
- Speed discharge via the DISCHARGE_TRIG terminal
- Closing and opening relays via the *TRG and :RELay {CLOSE|OPEN} commands
- Speed discharge via the :DISCharge:STARt terminal

Reference: "External Control Connection"

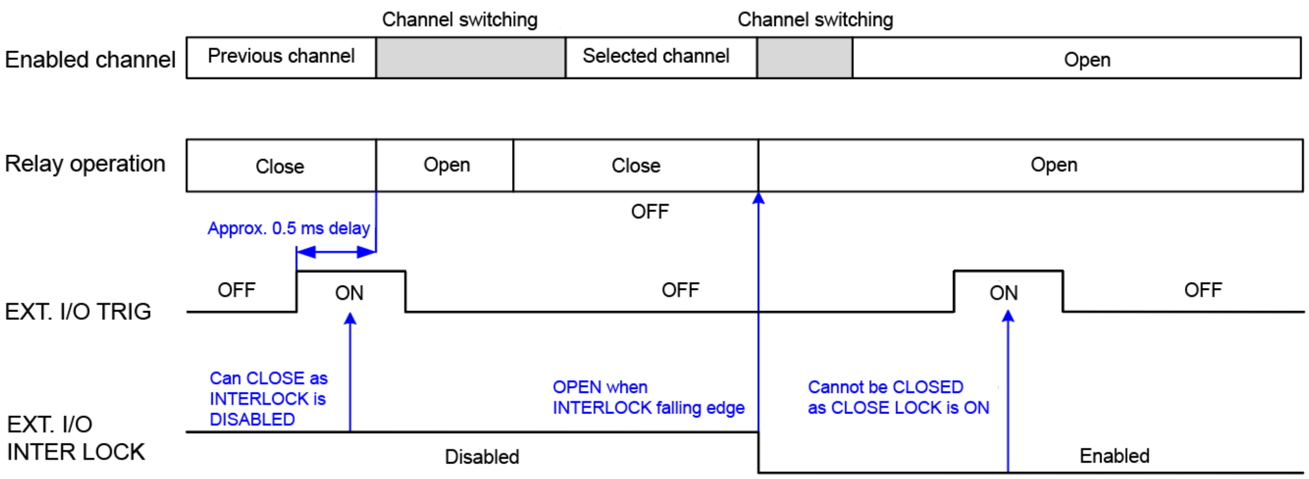
Example of connected circuit



Connect a signal indicating high voltage is being generated (H.V.ON for Model 3153, etc.), and connect the close lock terminal generating high voltage to COM.

5.5 Interlock Function

The interlock function prevents relays from closing or forces them open by combining the instrument with safety devices such as area sensors, phototubes, and door sensors.



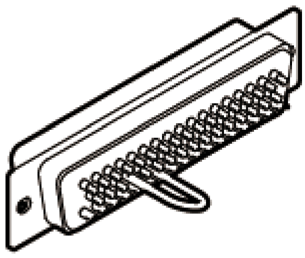
Operation with interlock terminal

Pin No. 44 of **EXT. I/O** is the interlock terminal.
If this pin is connected to a common terminal, the interlock is disengaged, and relay operations become possible.
If this pin is left open, the instrument enters an interlock state, and all relays are immediately opened.
Furthermore, relay operation commands are not accepted until the interlock is disengaged.

Reference: "External Control Connection"

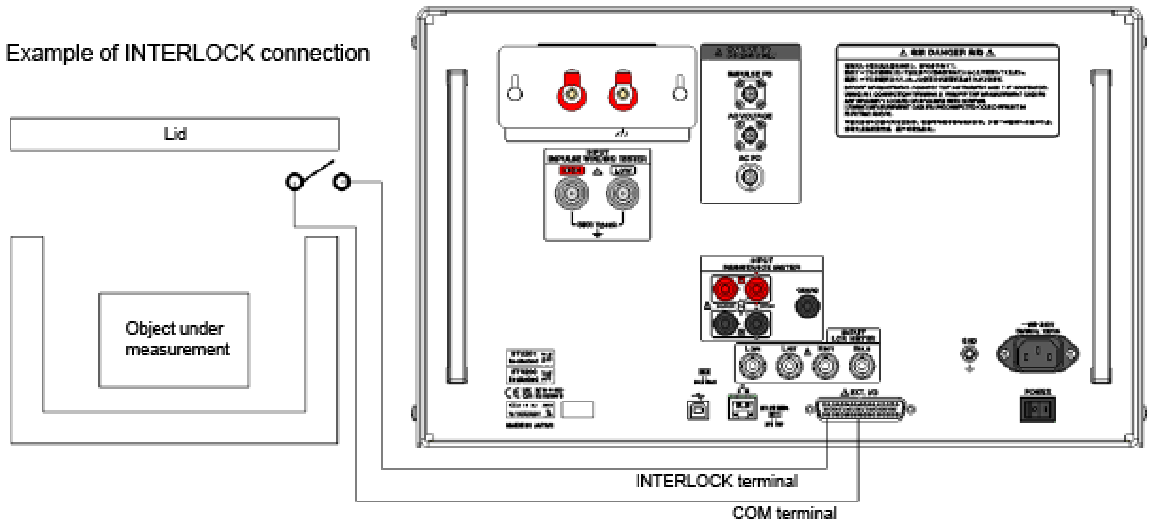
When not using the interlock function

The instrument is accompanied by an EXT. I/O interlock disengagement connector (jumper) for connecting the interlock terminal to a common terminal.
When this connector is connected to the **EXT. I/O** terminal, the interlock function is permanently disengaged.
When not using the interlock function, connect this connector to use the instrument.



Example of connected circuit

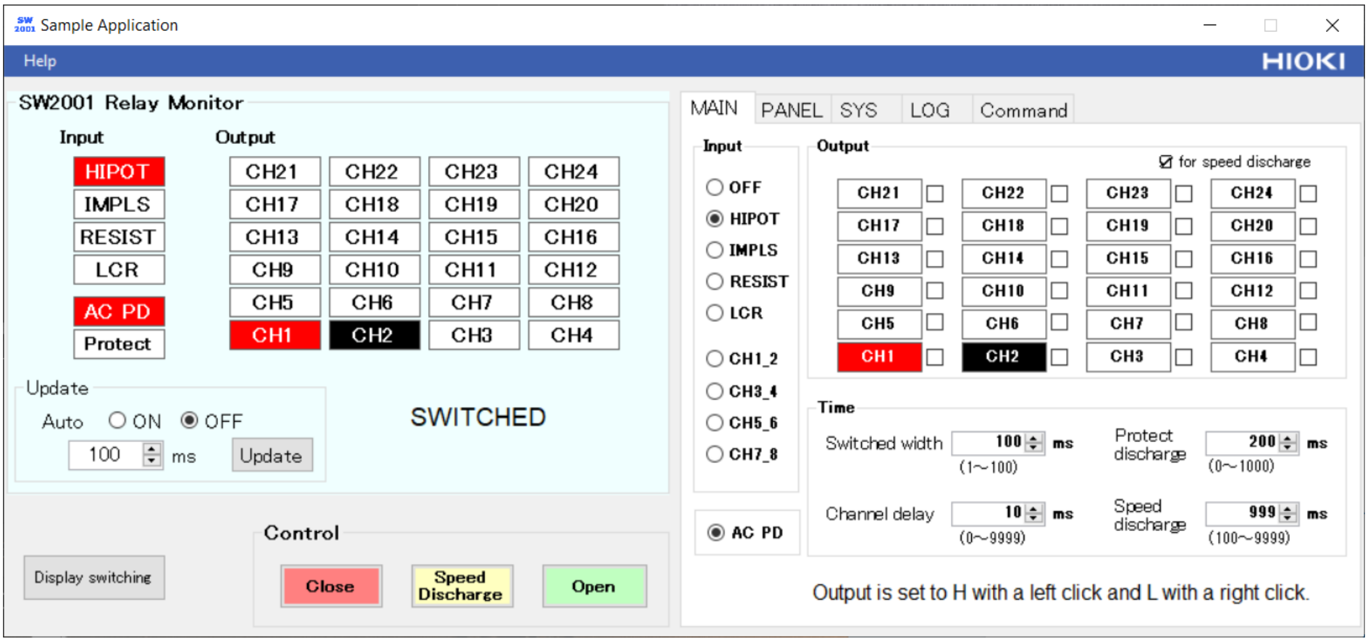
Prepare a box to hold the object under measurement to ensure the users do not touch the object under measurement during high-voltage measurement. Install a switch on the opening of the box and link it to the interlock function. The interlock engages when the lid of the box is opened and disengages to enable measurement when closed.



5.6 Sample Application

A sample application enabling configuration and control of the instrument using a computer is available.
The latest version of the sample application can be downloaded from Hioki's website.

SW2001 sample application download



6 External Control (EXT. I/O)

6.1 Overview

The instrument can be controlled using I/O functions of devices such as a PLC.
All signals are insulated from the measurement circuit, communication circuit, and ground (the common terminals for input and output are shared).
The input circuit can switch to current sync output (NPN) or current source output (PNP) using the **EXT. I/O MODE** switch.
Check the input/output rating at the internal circuit configuration, and connect to and correctly use upper-level systems with an understanding of the safety precautions.

⚠ WARNING

To avoid an electric shock or damage to the equipment, always observe the following precautions when connecting your external equipment to **EXT. I/O** terminals.

- Always turn off the instrument and any equipment to be connected before making connections.
- Be careful to avoid exceeding the ratings of the **EXT. I/O** terminals.
- Wires becoming detached and touching other conductive parts during operation is dangerous. Firmly affix the connection to the connector with a screw.
- Appropriately isolate the devices and systems to be connected to the **EXT. I/O** terminals from one another.

6.2 External Control Flow

The flow for external control of the instrument is as follows.

- Check the input and output specifications of the equipment to be connected.
- Set the instrument's **EXT. I/O** to NPN or PNP.
- Connect the instrument with the external equipment.

> When the **REMOTE** LED on the instrument is lit (when controlling using communications functions with a computer or PLC), control cannot be performed using **EXT. I/O**.
> When the remote disengagement command (`:LOCal`) is sent from a computer or PLC, the **REMOTE** LED turns off and control by **EXT. I/O** becomes possible.

Check the input and output specifications of the equipment to be connected.

Check the input and output specifications in the instruction manuals of equipment to be connected to the instrument.

Main check items

- Current sync (NPN) / current source (PNP)
- Voltage level
- Current capacity

6.3 Current Sync (NPN) / Current Source (PNP) Settings

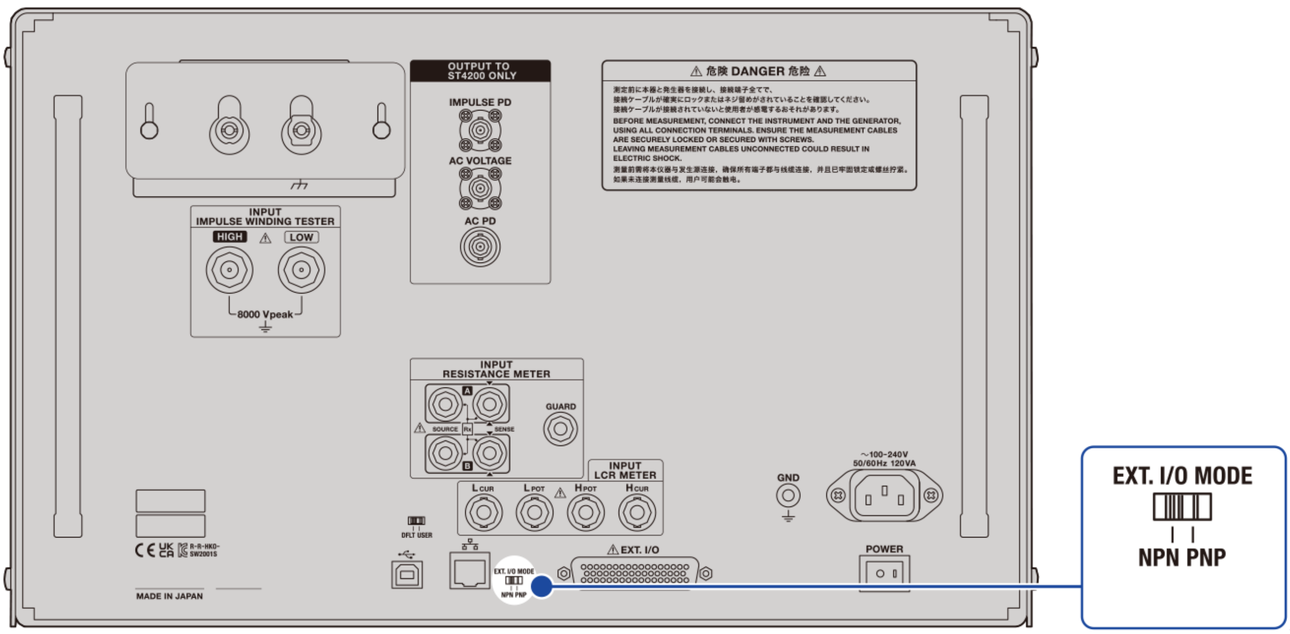
Carefully read "Overview of External Control" **alerts** in advance.

Supported PLC types can be changed using the **EXT. I/O MODE** switch.
This is set to the NPN side when shipped.

EXT. I/O MODE switch and status of EXT. I/O terminals

Location	NPN	PNP
Instrument input circuit	Support for sync output	Support for source output
Instrument output circuit	Non-polarized	Non-polarized
ISO_5V output	+5 V output	–5 V output

EXT. I/O MODE switch appearance



6.4 Connection

⚠ WARNING

Observe the following when wiring to the **EXT. I/O** connector. Failure to do so could result in the risk of electric shock or damage to instruments.

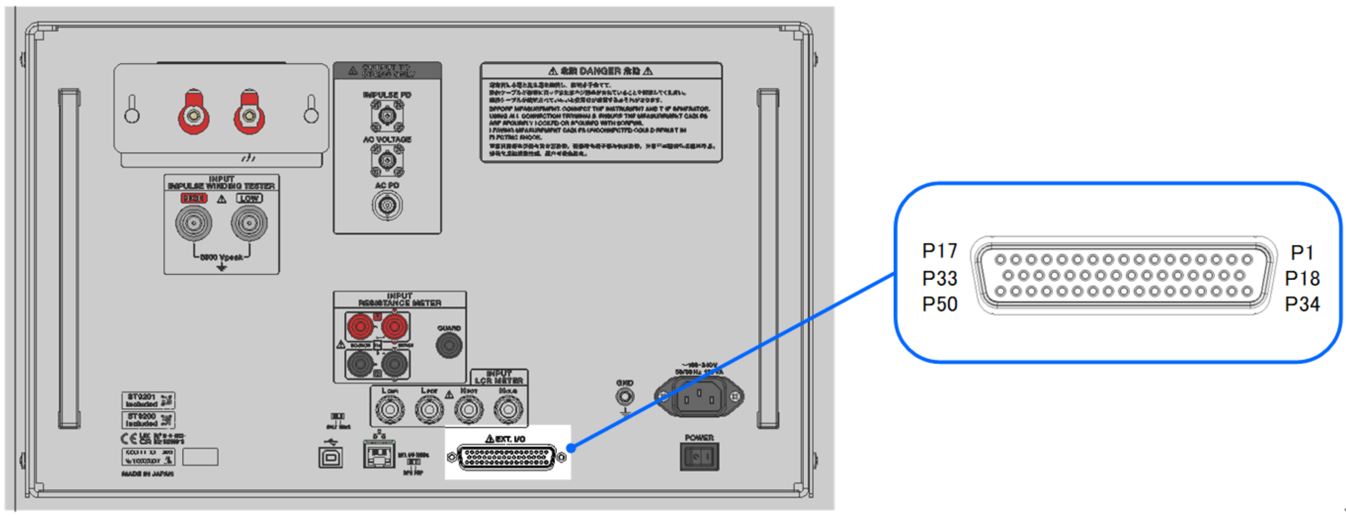
- Always turn off the instrument and any equipment to be connected before making connections.
- Connections becoming detached and touching other conductive parts during operation is dangerous. Firmly affix the connection to the **EXT. I/O** connector with a screw.
- Appropriately isolate the instruments and systems to be connected to the **EXT. I/O** connector from one another.

⚠ CAUTION

Take care of the following to avoid damage to the instrument.

- Do not input voltage or current more than rated to the **EXT. I/O** connector.
- When using relays, be sure to attach a diode for absorbing back electromotive force.
- Do not short-circuit ISO_5V and ISO_COM.

Instrument connectors and compatible connector



Connectors used (instrument side)

D-SUB 50 pin, female
#4-40 inch screw

Compatible connector

The connector accompanying the instrument is as follows.
D-SUB 50 pin, male
If you require additional connectors, inquire with your authorized Hioki distributor or reseller.

The connector frame is connected to the metal part of the instrument and also connected to (conducting) the protective ground terminal of the power supply inlet.
Be careful because it is not insulated from the ground.

Pin No.	Signal name	IN / OUT	Function	Operating conditions
1	OUTPUT_01(13)	IN	Output side relay CLOSE/OPEN CH1 (CH13)*1	Level
2	OUTPUT_02(14)	IN	Output side relay CLOSE/OPEN CH2 (CH14)*1	Level
3	OUTPUT_03(15)	IN	Output side relay CLOSE/OPEN CH3 (CH15)*1	Level
4	OUTPUT_04(16)	IN	Output side relay CLOSE/OPEN CH4 (CH16)*1	Level
5	OUTPUT_05(17)	IN	Output side relay CLOSE/OPEN CH5 (CH17)*1	Level
6	OUTPUT_06(18)	IN	Output side relay CLOSE/OPEN CH6 (CH18)*1	Level
7	OUTPUT_07(19)	IN	Output side relay CLOSE/OPEN CH7 (CH19)*1	Level
8	OUTPUT_08(20)	IN	Output side relay CLOSE/OPEN CH8 (CH20)*1	Level
9	OUTPUT_09(21)	IN	Output side relay CLOSE/OPEN CH9 (CH21)*1	Level
10	OUTPUT_10(22)	IN	Output side relay CLOSE/OPEN CH10 (CH22)*1	Level

Pin No.	Signal name	IN / OUT	Function	Operating conditions
11	OUTPUT_11(23)	IN	Output side relay CLOSE/OPEN CH11 (CH23)*1	Level
12	OUTPUT_12(24)	IN	Output side relay CLOSE/OPEN CH12 (CH24)*1	Level
13	ISO_5V	—	DC ±5 V output	—
14	ERR	OUT	Error	—
15	NC	—	Not assigned	—
16	NC	—	Not assigned	—
17	NC	—	Not assigned	—
18	POLE_01(13)	IN	Output polarity HIGH/LOW CH1 (CH13)*1	Level
19	POLE_02(14)	IN	Output polarity HIGH/LOW CH2 (CH14)*1	Level
20	POLE_03(15)	IN	Output polarity HIGH/LOW CH3 (CH15)*1	Level
21	POLE_04(16)	IN	Output polarity HIGH/LOW CH4 (CH16)*1	Level
22	POLE_05(17)	IN	Output polarity HIGH/LOW CH5 (CH17)*1	Level
23	POLE_06(18)	IN	Output polarity HIGH/LOW CH6 (CH18)*1	Level
24	POLE_07(19)	IN	Output polarity HIGH/LOW CH7 (CH19)*1	Level
25	POLE_08(20)	IN	Output polarity HIGH/LOW CH8 (CH20)*1	Level
26	POLE_09(21)	IN	Output polarity HIGH/LOW CH9 (CH21)*1	Level
27	POLE_10(22)	IN	Output polarity HIGH/LOW CH10 (CH22)*1	Level
28	POLE_11(23)	IN	Output polarity HIGH/LOW CH11 (CH23)*1	Level

Pin No.	Signal name	IN / OUT	Function	Operating conditions
29	POLE_12(24)	IN	Output polarity HIGH/LOW CH12 (CH24)*1	Level
30	ISO_COM	—	Common	—
31	SWITCHED	OUT	Pulse output when switching relay. Others are FALSE	—
32	NC	—	Not assigned	—
33	NC	—	Not assigned	—
34	INPUT_HIPOT	IN	Input side relay CLOSE/OPEN HIPOT	Level
35	INPUT_IMPULSE	IN	Input side relay CLOSE/OPEN IMPULSE	Level
36	INPUT_LCR	IN	Input side relay CLOSE/OPEN LCR	Level
37	INPUT_RES	IN	Input side relay CLOSE/OPEN RESISTANCE	Level
38	ACPD	IN	AC PD measurement relay USE/NOTUSE	Level
39	CLS	IN	Error reset	Edge
40	TRIG	IN	Trigger for executing closing of relay switches	Edge
41	LATCH_13TO24	IN	Retains settings for CH13 to 24 output channels	Edge
42	DISCHARGE_TRIG	IN	Trigger for executing speed discharge	Edge
43	DISCHARGE_13TO24	IN	Retains settings for CH13 to 24 speed discharge channels	Edge
44	INTER_LOCK	IN	Interlock	Level
45	CLOSE_LOCK	IN	Close lock	Level
46	ISO_COM	—	Common	—
47	NC	—	Not assigned	—
48	NC	—	Not assigned	—

Pin No.	Signal name	IN / OUT	Function	Operating conditions
49	NC	—	Not assigned	—
50	NC	—	Not assigned	—

*1. These terminals are used as CH1 to CH12 settings for TRIG and DISCHARGE_TRIG, and used as CH13 to CH24 settings for LATCH_13TO_24 and DISCHARGE_13TO24.

Functions of signals

OUTPUT

This is an input pin for selecting the output channel.
When connecting to common, this is the target channel when the relay switches are closed next.
One channel can be selected for H and L respectively (total of two channels) when performing four-terminal measurement (input channel is **RESISTANCE** or **LCR**). Multiple channels can be set when performing high-voltage measurement (input channel is **HIPOT** or **IMPULSE**).
Two-terminal output (only **SOURCE** closed) when performing high-voltage measurement and four-terminal output when performing four-terminal measurement (both **SOURCE** and **SENSE** closed).

ERR

This is an output terminal notifying the occurrence of an error.
The common potential is maintained when an error occurs.

POLE

This is an input pin for specifying the polarity of the output channel.
The output polarity of channels connected to common is set to H, and the output polarity not connected to common is set to L.

SWITCHED

This is an output pin notifying completion of switching of relays.
After relay switching is completed, and the time set in the channel delay command `:IO:DELay <t>` has elapsed, the common potential is output for the time set with the command to set the pulse width `:IO:PULSe:TIME <t>`.
The default value for the channel delay is 0 ms and the default value for the pulse width is 5 ms.

INPUT

This is an input pin for selecting the input channel to be used.
The input channel to be connected to common is set to the input when executing closing of relay switching.
Multiple channels cannot be selected. If multiple channels are selected, the pin with the highest priority is given priority. The priority of the INPUT pins is as follows.
INPUT_HIPOT>INPUT_IMPULSE>INPUT_RES>INPUT_LCR

ACPD

This is an input pin for selecting the AC PD circuit. (When equipped with ST9200)
The AC PD measurement circuit connection can be enabled when connected to common.

CLS

This is an input pin for clearing errors.
It clears errors when this input pin turns on. (It is the same function as the `*CLS` command)

TRIG

This is an input pin for executing the closing of relay switches.
It performs relay switching operation to make connections as set with INPUT, OUTPUT, AC PD signals, etc. when this input pin turns on.
When switching, all relays are opened before performing the switching for each relay.

LATCH_13TO24

This is an input pin for performing settings for output channels from CH13 for SW2001-16 and SW2001-24.
It sets relays to close the state of CH13 through CH24 indicated in the parentheses of the POLE and OUTPUT pins when this input pin turns on.
When this signal is input, the actual close operation is performed when the TRIG signal is input simply by retaining the settings.

DISCHARGE_TRIG

This is an input pin for executing speed discharge.
This additionally closes the channels set in OUTPUT and POLE when this input pin turns on.

If the channel selected with OUTPUT matches an output channel that is already closed when DISCHARGE_TRIG is executed, that channel is set to the OPEN state after speed discharge finishes.

DISCHARGE_13TO24

This is an input pin for performing settings for speed discharge channels from CH13 for SW2001-16 and SW2001-24.
It sets the scope of switching when performing speed discharge on CH13 through CH24 indicated in parentheses for the POLE and OUTPUT pins when this input pin turns on.
When this signal is input, actual closing operations are performed when the DISCHARGE_TRIG signal is input simply by retaining the settings.

INTER_LOCK

This is an input pin for the interlock.
Relays can only be closed when this pin is connected to common.
When not connected to common, all relays are opened unconditionally with the highest priority.

CLOSE_LOCK

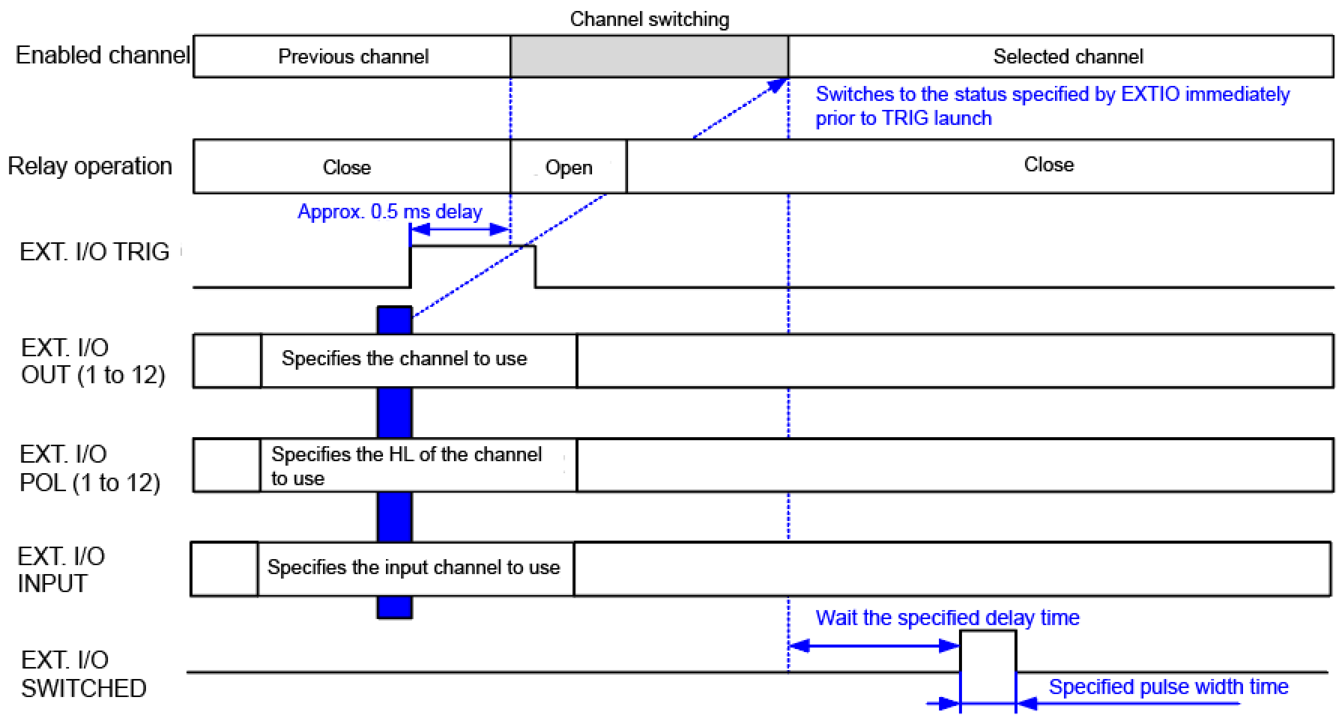
This is a pin for preventing relay welds.
Connecting this pin to common prevents being able to close relays.
Be sure to connect to common when performing high-voltage measurement.

6.5 Timing Charts

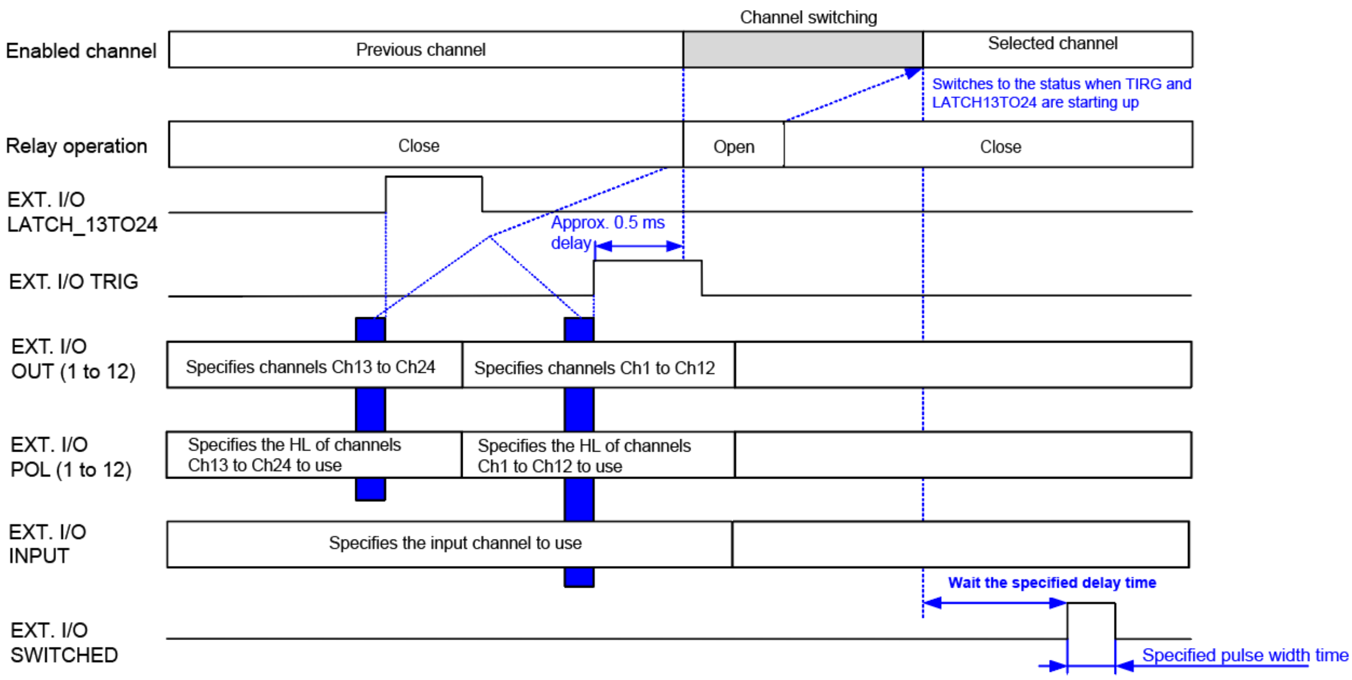
The levels for each signal indicate the ON/OFF state of contacts.
With the current source (PNP) setting, the HIGH and LOW in the timing chart are the same as the voltage levels of the **EXT. I/O** terminals.
The voltage levels in the current sync (NPN) setting are reversed for HIGH and LOW.

Channel switching operations

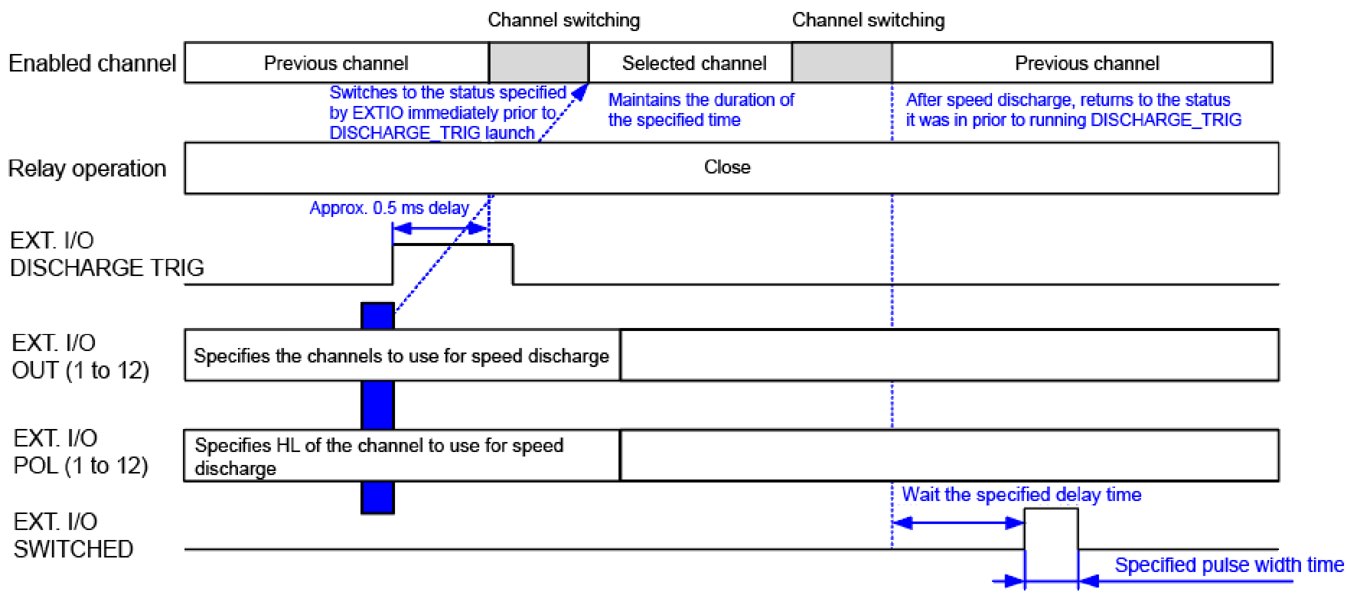
Timing chart for switching CH1 through CH12 (PNP)



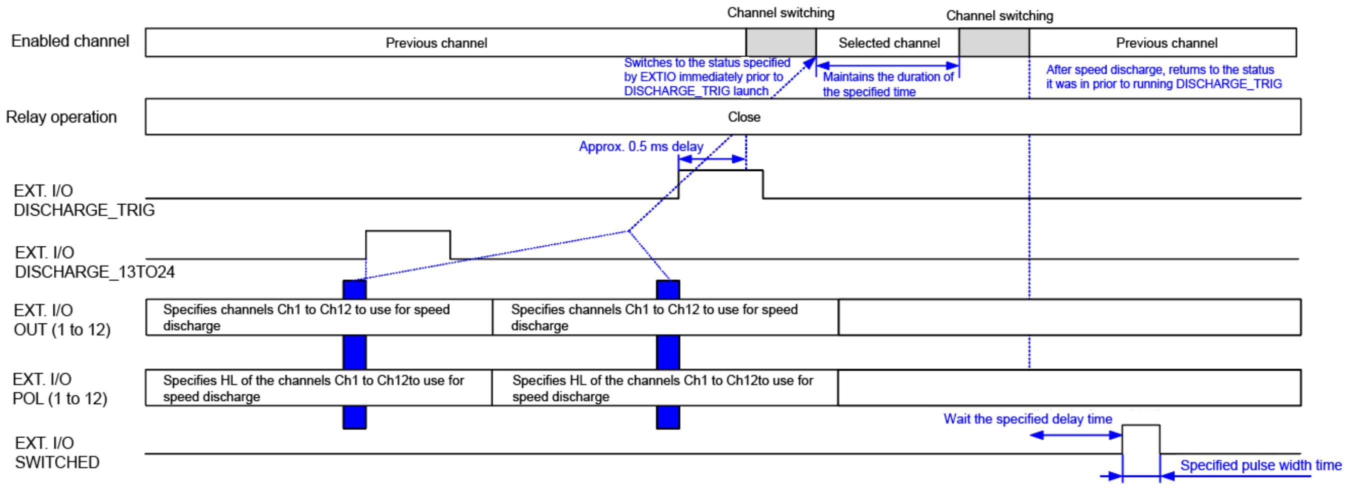
Timing chart for switching CH1 through CH24 (only SW2001-16 and SW2001-24) (PNP)



Timing chart for performing speed discharge on CH1 through CH12 (PNP)



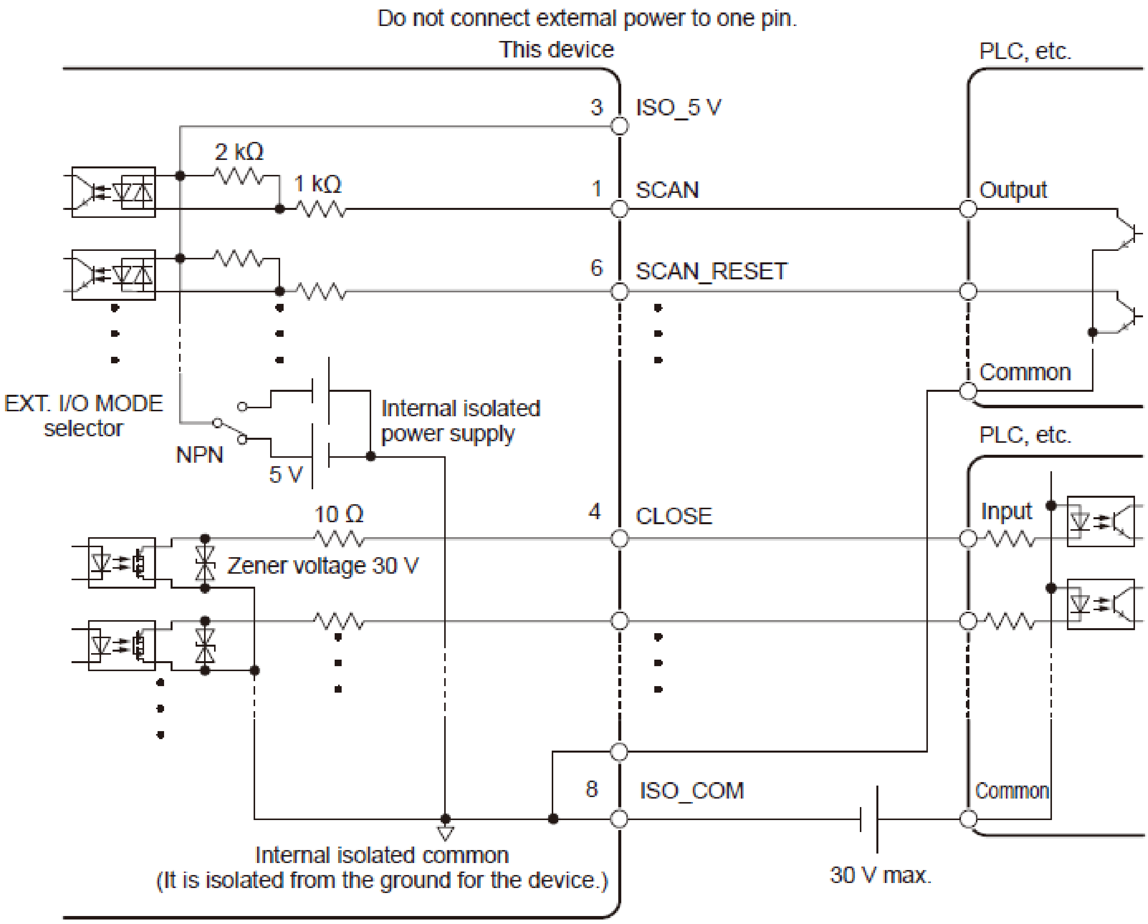
Timing charts for performing speed discharge on CH1 through CH24 (only SW2001-16 and SW2001-24) (PNP)



6.6 Internal Circuit Configuration

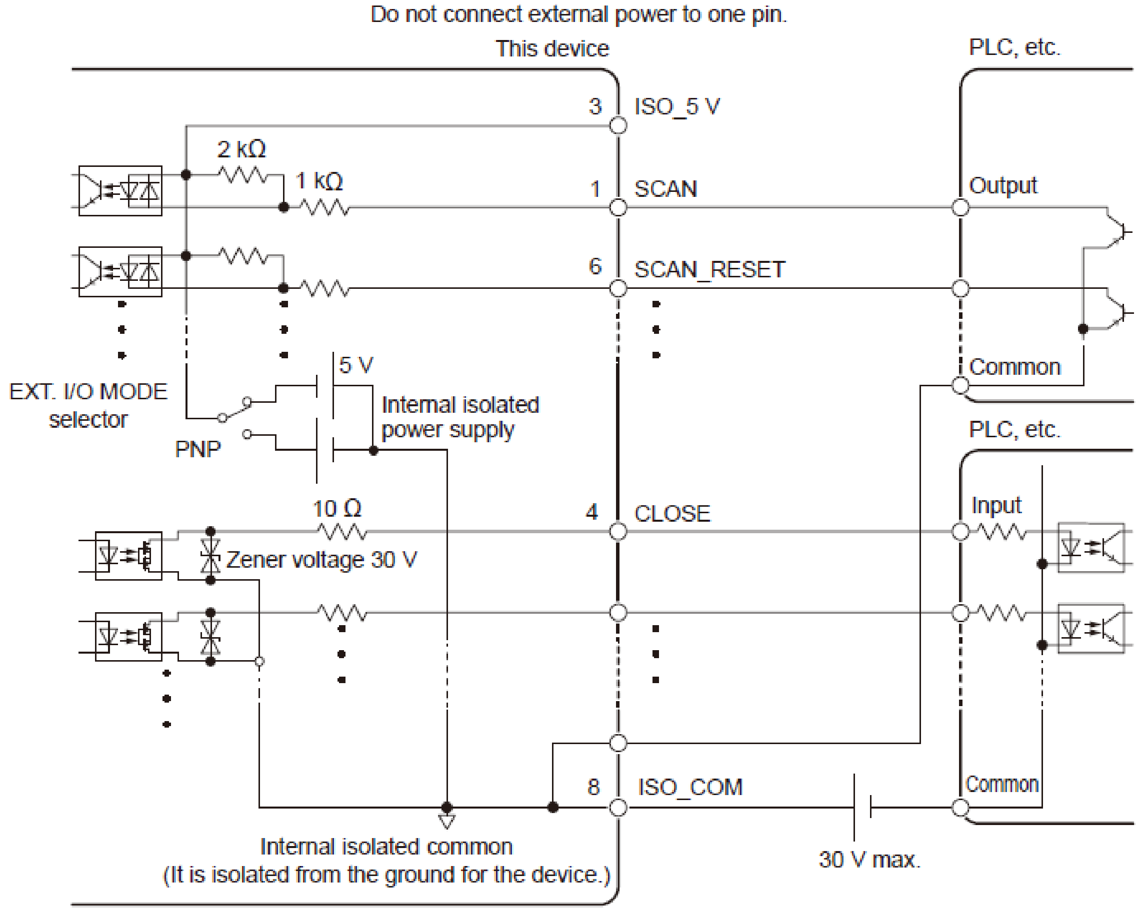
Circuit diagram

When the EXT. I/O MODE switch is set to NPN



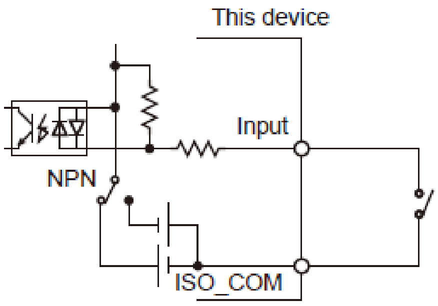
When the EXT. I/O MODE switch is set to PNP

Use ISO_COM for the common terminals of both the input signal and output signal.

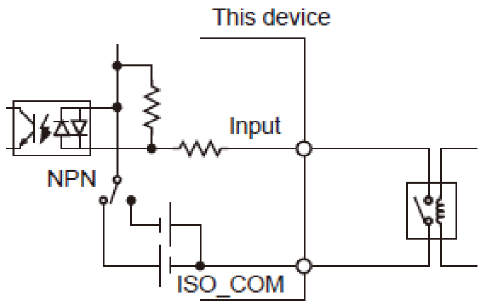


Connection Examples

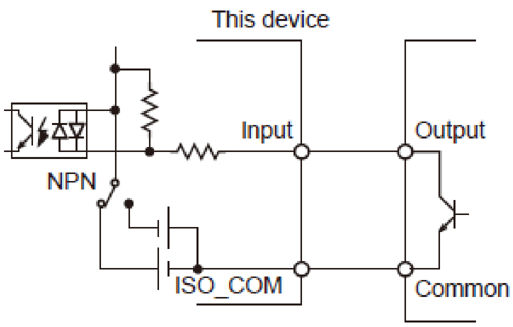
Example of connecting input circuit



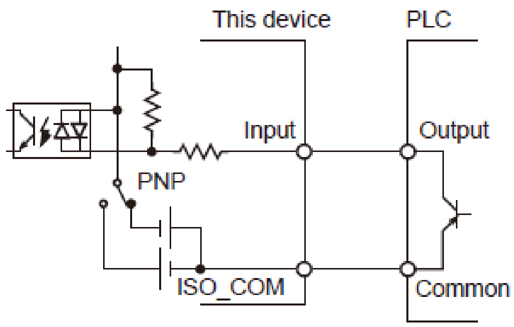
Connection to the switch



Connection to the relay

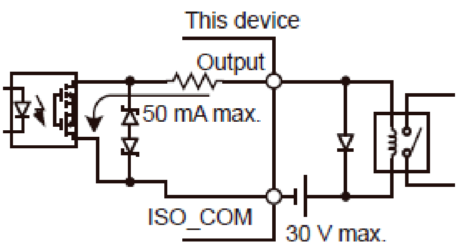


Connection to the PLC output (NPN output)

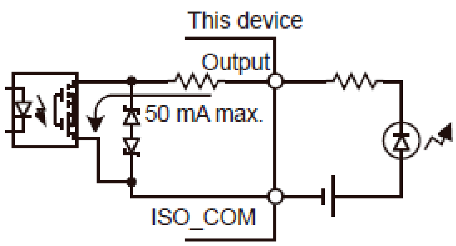


Connection to the PLC output (PNP output)

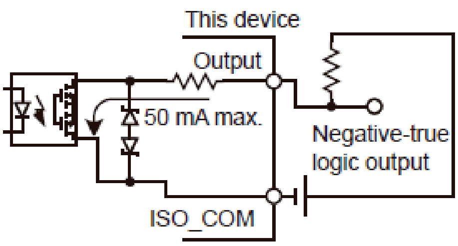
Example of connecting output circuit



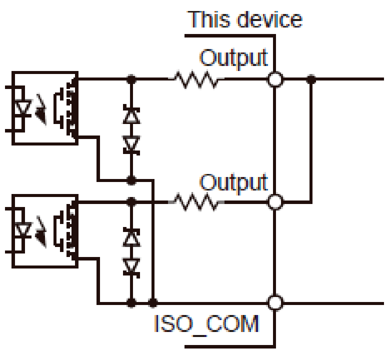
Connection to the relay



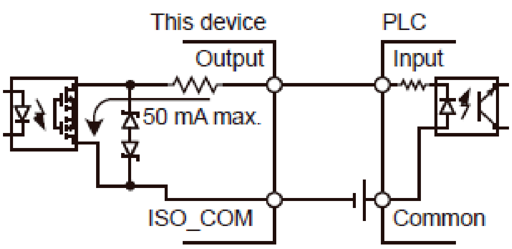
Connection to the LED



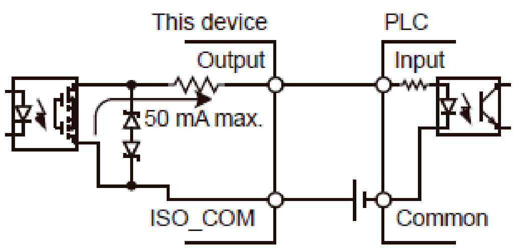
Negative-true logic output



Wired-OR



Connection to the PLC input
(plus common input)



Connection to the PLC input
(minus common input)

7 Communications Function

7.1 Overview and Features of Interfaces

The instrument can be controlled using a LAN interface or USB interface.
It is not necessary to set which interface to use, and all interfaces can be used.
However, to avoid malfunction, perform control using a single interface.

See "Interface Specifications" for specifications.

⚠ CAUTION

To avoid damage to the instrument, do not unplug the communication cable during communication.

- Ground the ground terminal of the instrument and the ground terminal of the computer to a single location. Using different ground circuits will result in a ground potential difference between the instrument and the computer. If a cable is connected while such a potential difference between grounds exists, it may result in equipment malfunction or failure.
- Before connecting or disconnecting a communication cable, always turn off the instrument and the computer. Failure to do so could result in an equipment malfunction or damage to the equipment.
- After connecting the communication cable, tighten the screws on the connector securely. Failure to securely connect the connector could result in a malfunction or damage.

7.2 Configuring Communication Setting Modes

Control the instrument using a LAN or USB communication interface.
When performing communication by LAN, the mode can be selected using the switch located on the rear of the instrument.
Configure the communication setting mode before turning on the instrument.

Communication setting mode	Description
Default setting mode (**DFLT**)	Communicates with default communication settings. ・ IP address: 192.168.0.254 ・ Subnet mask: 255.255.255.0 ・ Default gateway: 0.0.0.0 (none) ・ Communications command port number: 23
User setting mode (**USER**)	Communicates with communication settings set by the user. See "Setting communication conditions" to perform communication settings.

Communication via USB is possible regardless of the position of the switch on the rear.

7.3 LAN Interface

The instrument is equipped with Ethernet 100BASE-TX as an interface by default.
The instrument can be controlled from a computer by connecting to a network with a LAN cable supporting 100BASE-TX.
A program can be created to control the instrument with communications commands when connected to the communications command port by TCP/IP.

Preparation flow

1 **Setting the instrument's communication conditions**

2 **Connecting the LAN cable**

Setting communication conditions

Confirm before configuring settings

Instrument and external equipment settings will differ when connecting to an existing network and when forming a new network with the instrument and a single computer.

When connecting the instrument to an existing network

It is necessary to have the network system administrator (department) assign the following items in advance. Ensure the IP address does not duplicate that of another device.

- Address settings for the instrument
  IP address: _ _ _._ _ _._ _ _._ _ _
  Subnet mask: _ _ _._ _ _._ _ _._ _ _
- Gateway
  Whether or not a gateway is used: Use / Do not use
  IP address (if using): _ _ _._ _ _._ _ _._ _ _
  (Set to 0.0.0.0 if not using)
- Port number
  Port number used for communications commands: _ _ _ (Default setting: 23)

When forming a new network with the instrument and a single computer

(When using a local network not connected externally)
The following settings are recommended in cases where there is no administrator or cases where discretion is given for settings.

Example setting

Set IP addresses with sequential numbers as follows.
Computer: 192.168.0.1
First instrument: 192.168.0.2
Second instrument: 192.168.0.3
Third instrument: 192.168.0.4
↓
Subnet mask: 255.255.255.0
Gateway: OFF (0.0.0.0)
Communications command port number: 23

LAN communication configuration method

LAN communication settings and commands are as follows.

Item	Description	Command
IP address	This is the address for identifying individual devices connected to a network. Configure so that it does not duplicate that of another device.	`:SYSTem:COMMunicate:LAN:IPADdress <n1>,<n2>,<n3>,<n4>`
Subnet mask	This is a setting for separating the IP address into the address part indicating the network and the address part indicating the device. Configure so that it is the same subnet mask as other devices on the same network.	`:SYSTem:COMMunicate:LAN:SMASk <n1>,<n2>,<n3>,<n4>`
Gateway IP address	**When connecting to an existing network** When the computer (device for communication) being used is connected to a separate network from the network connecting the instrument, this IP address is set to designate the gateway device. If the computer is on the same network, this is generally set to the same default gateway as in the computer settings. **When connecting the instrument and computer 1-to-1, or when not using a gateway** Set the IP address to 0.0.0.0.	`:SYSTem:COMMunicate:LAN:GATeway <n1>,<n2>,<n3>,<n4>`
Communications command port number	This designates the TCP/IP port number used for connecting.	`:SYSTem:COMMunicate:LAN:CONTrol <1~9999>`
	This updates and reflects LAN settings.	`:SYSTem:COMMunicate:LAN:UPDate`

If the communication setting mode switch is set to **DFLT**, default settings are used without using these settings.
See: "Configuring Communication Setting Modes"

Connecting the LAN cable

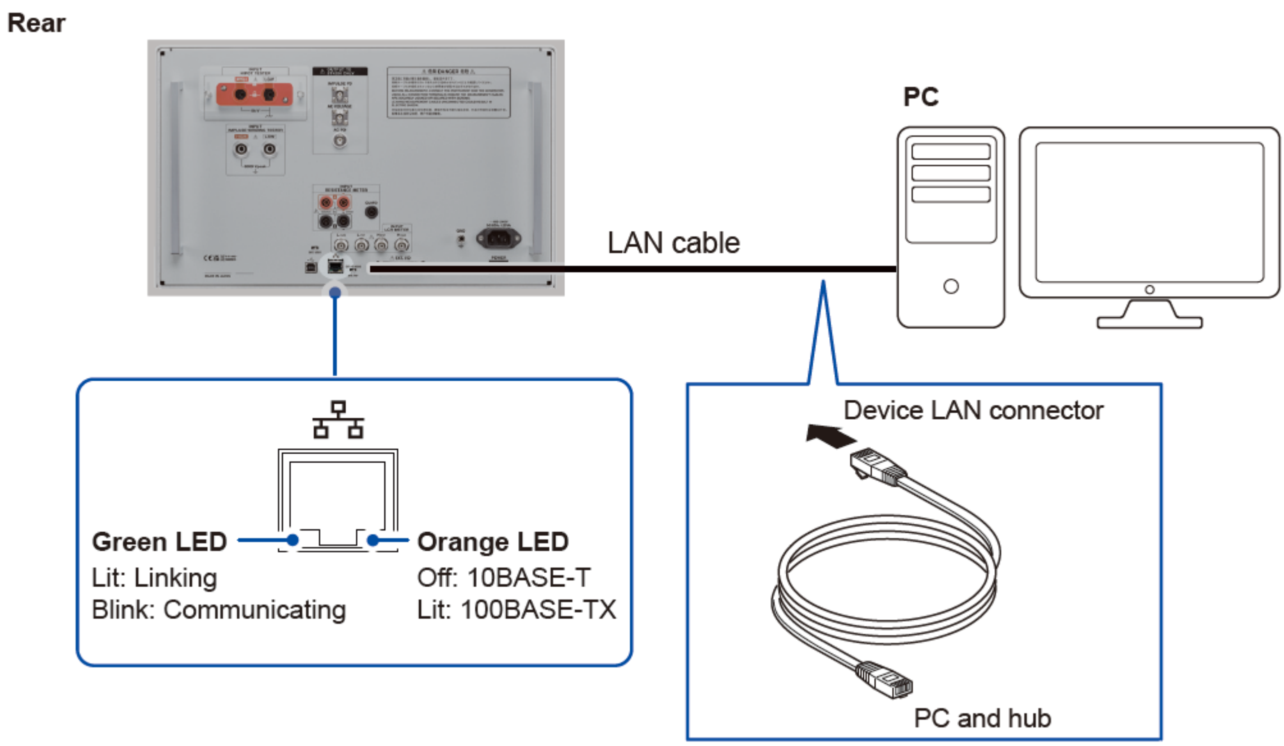
Connect a LAN cable to the LAN connector of the instrument.

⚠ CAUTION

Use a LAN cable with a length of 3 m or less. Using a cable longer than 3 m may cause malfunctions due to the effects of noise.

Recommended cable

100BASE-TX or 10BASE-T LAN cable (both straight cables and crossover cables can be used)



If the green LED does not light up even when connected to the LAN, this could be a malfunction of the instrument or connected device, or a break in the LAN cable.

7.4 USB Interface

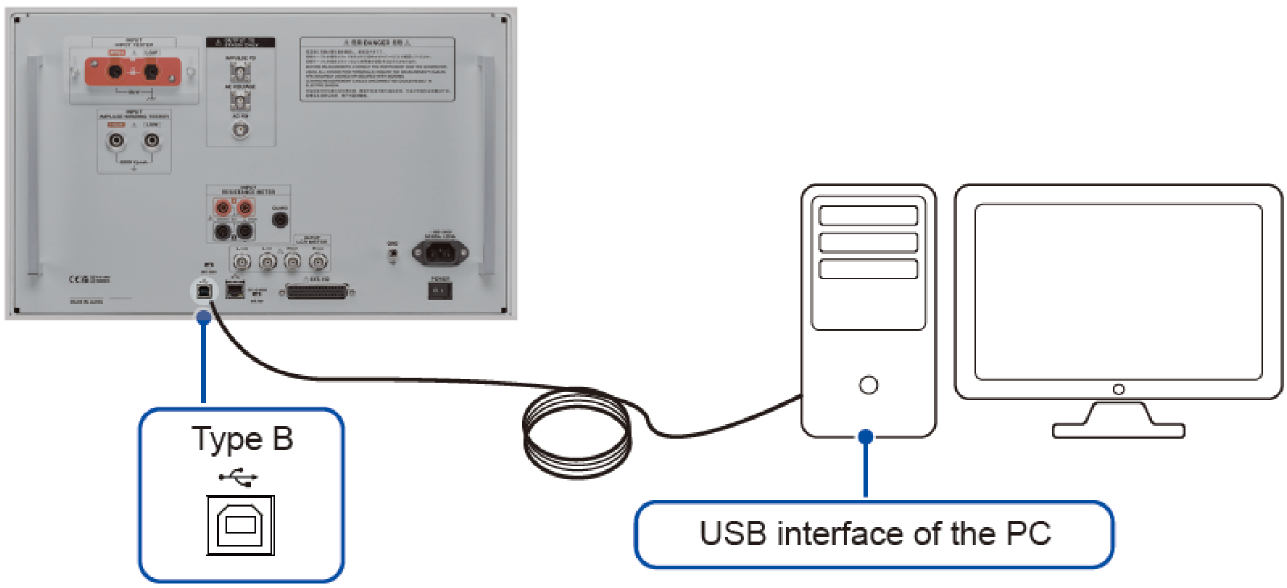
USB driver

A device driver is not required when connecting the instrument's USB interface to a computer.
The instrument will be automatically recognized when connected to a computer via USB cable.

Connecting the USB cable

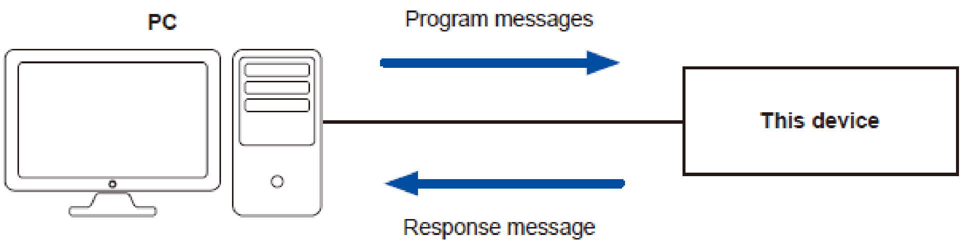
Carefully read the **warnings** in "Overview of External Control" in advance.
Recommended cable: L1002 USB cable (A-B)

Rear



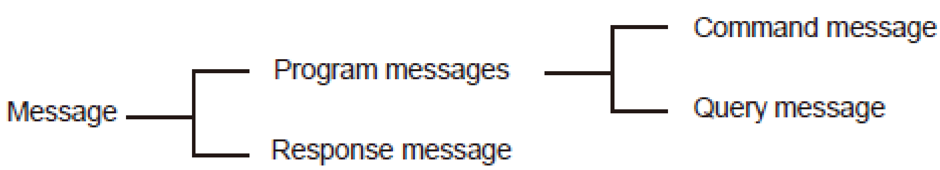
7.5 Communication Method

Various messages are provided for controlling the instrument via LAN interface.
Messages include program messages sent from the computer to the instrument, and response messages sent from the instrument to the computer.



Message format

Messages are categorized as follows.



Program messages

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

Command messages
Commands for controlling instruments such as for configuring and resetting instruments

Format
[Header part] [Data part]
Insert a space between the header part and the data part.

Example: Command for setting LCR to the input channel
`:RELay:INPut LCR`

Query messages

Commands for querying operation results, measurement results or the status of instrument settings

Format

[Header part] ?

Example: Command querying the input channel

`:RELay:INPut?`

Response messages

These are created when a query message is received and the syntax has been checked.
If an error occurs when receiving a query message, no response message will be created for that query message.

Command syntax

Commands are written in the two following forms.

- Long form that can be associated with the function
- Abbreviated short form

In this document, the short form portion is written in upper case and the remainder in lower case. Both upper case and lower case are accepted.

Command text sent to the instrument	Content/description
`:RELay:INPut HIPot`	Expression in this document
`:RELAY:INPUT HIPOT`	OK (long form)
`:REL:INP HIP`	OK (short form)
`:REL:INP HIPO`	Causes a command error.
`:REL:INP HI`	Causes a command error.

Response messages from the instrument are returned in the long form in upper case.

Header part

Program messages require a header.

Command program headers
There are three types as follows.

Command type	Example	Description
Simple command type header	`:ABORt`	Header made up of one word starting with an alphabetical character
Compound command header	`:RELay:INPut`	A header made up of multiple simple headers separated by a colon (`:`)
Simple command header	`*RST`	A header starting with an (`*`) indicating that it is a common command (specified by IEEE 488.2)

Query program header
This is used to query the status of settings of the instrument or to query the operation status of relays. As shown below, a query is recognized when a question mark (`?`) is placed after the program header.

Example:
```
:RELay:INPut?
*IDN?
```

Message terminators (delimiters)

The instrument accepts the following as message terminators.
CR, LF, CR+LF
The terminator for response messages is fixed as **CR+LF**.

Separators

Command program header

Multiple messages can be written on a single line by connecting them with a semicolon (;).

Example:
```
:RELay:CH 1,HIGH;:RELay:CH 2,LOW
```

When messages are written in succession, if an error occurs midway, the message from there until the terminator is not executed.

Header separator

For messages with a header and data, the header part and the data part are separated using a space.

Example:
```
:RELay:INPut IMPulse
```

Data separator

In messages containing multiple data items, a comma(,) is required between data items.

Example:
```
:RELay:CH 1,HIGH
```

Data part

The instrument uses "text data" and "base 10 numerical data" in the data part and differentiates these by command.

Text data

Data that must start with an alphabetical character and is made up of alphabetical and numerical characters. Text data is accepted in both upper case and lower case, but responses from the instrument are always returned in upper case. There is a long form and a short form in the same way as command syntax, and both are accepted.

Example:
```
:RELay:INPut IMPulse
```

Base 10 numerical data

Formats of numerical data include NR1 format, NR2 format and NR3 format. Both signed numerical values and unsigned numerical values are accepted for each of these. Unsigned numerical values are treated as positive numerical values.

- NR1 Integer data (Examples: +12, −23, 34)
- NR2 Decimal data (Examples: +1.23, −23.45, 3.456)
- NR3 Floating point index representation data (Examples +1.0E-2, −2.3E+4)

Numerical data used by the instrument is only NR1 format. Using NR2 format or NR3 format for numerical data in command values with cause an execution error.

Example:

```
:IO:PULse 100
```

Abbreviation of compound command headers

When there are multiple commands with a common start part, the common part of the command can be abbreviated only when written in succession. This common part is called the "current path" and subsequent commands are interpreted as having the "current path abbreviated" until it is cleared.

How to use the current path is shown in the example below.

Normal notation:

```
:RELay:INPut HIPot;:RELay:CH 1,HIGH;:RELay:CH 2,LOW
```

Abbreviated notation:

```
:REL:INP HIP;CH 1,HIGH;CH 2,LOW
```

The current path is cleared in the following cases.

- When the power is turned on
- When a command starting with a colon (`:`) is sent
- When a message terminator is detected

Common command type messages are executed regardless of the current path. Also, they do not affect the current path.

It is not necessary to place a colon (`:`) at the start of simple command type headers and compound command type headers. However, we recommend placing a colon (`:`) at the start of the command to prevent confusion with abbreviated form and malfunctions.

Output queue and input buffer

Output queue

Response messages are stored in the output queue. The output queue is cleared in the following cases.

- When data is read with a controller
- When the power is turned on
- When a query error occurs

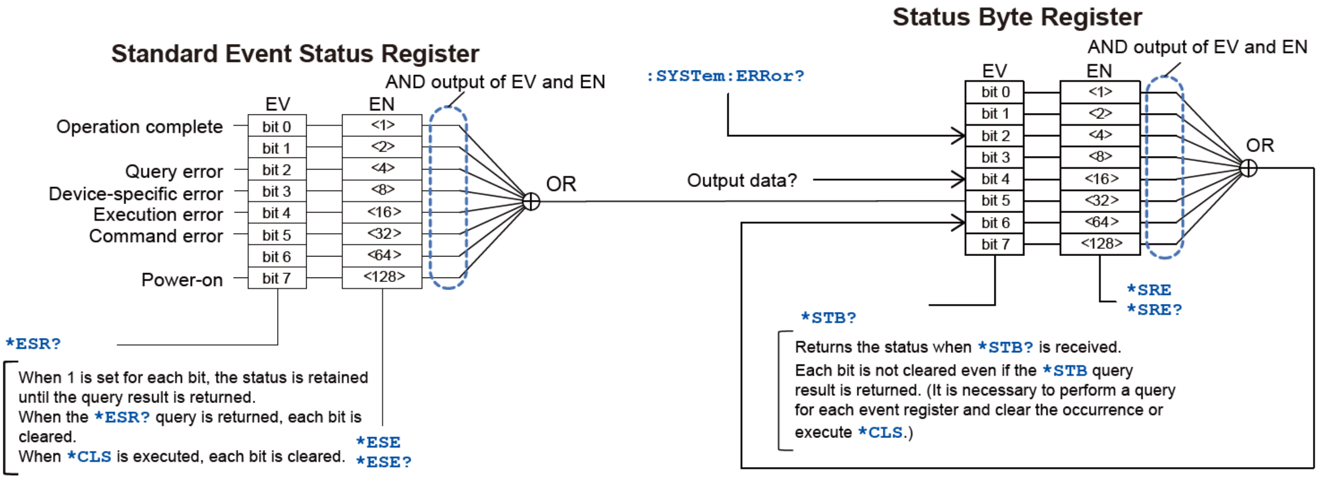
The buffer size of the instrument's output queue is 65536 bytes. When there is no remaining buffer space, query operations are suspended until a response message is received.

Input buffer

The instrument's buffer size is 4096 bytes. Messages received are input to this buffer and executed in sequence. When there is no free buffer space, operations are suspended until the space can be used. However, they are executed when an **:ABORT** command is received.

Status system

The instrument's status system uses the status model specified by IEEE 488.2 as a reference.



Status Byte Register (STB)

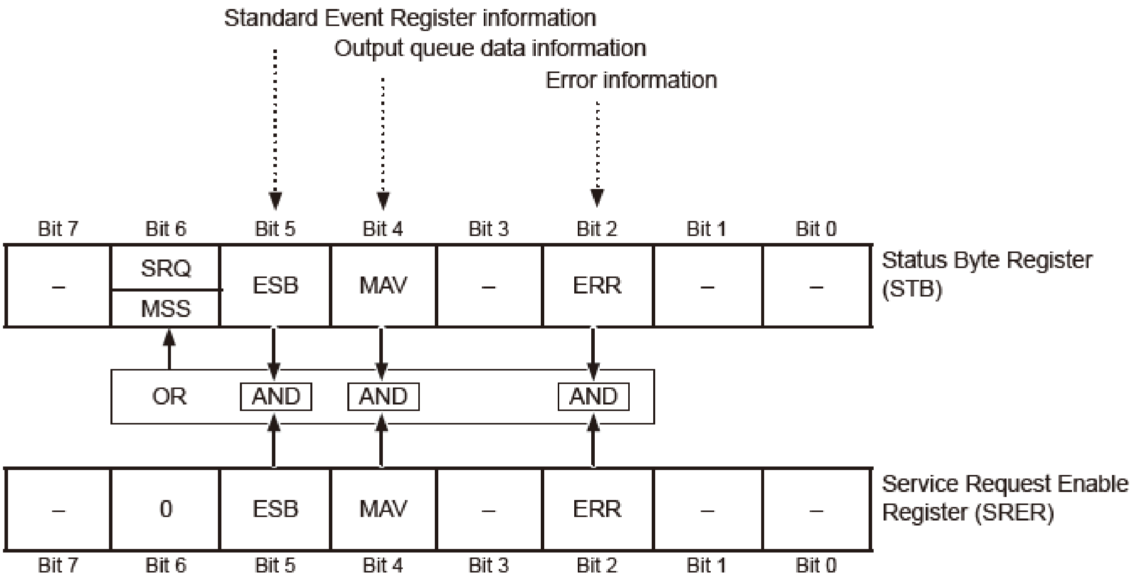
The Status Byte Register (STB) is an 8-bit register that holds information from the event register and output queue. The Status Byte Register (STB) is not cleared even when the `*STB?` query is executed. It is cleared when the `*CLS` command is executed, but the ERR bit is not cleared when a instrument anomaly error occurs.

Each bit of the status byte is a summary (logical sum) of the event registry corresponding to that bit.

Bit No.	Bit name	Description of function
Bit 7	—	Not used
Bit 6	RQS MSS	RQS: Not used MSS: Represents the logical sum of other bits in the Status Byte Register (STB).
Bit 5	ESB	Standard event summary bit Represents the logical sum of the standard event status register. Cleared by `*ESR?`
Bit 4	MAV	Message available Set to "1" when there is a message in the output queue.
Bit 3	—	Not used
Bit 2	—	Error bit Set to "1" when there is error information. It is cleared when error information is output by `:SYSTem:ERRor?` However, it is not cleared when there is an instrument anomaly error.
Bit 1	—	Not used
Bit 0	—	Not used

Service Request Enable Register (SRER)

The Service Request Enable Register (SRER) is a register where setting each bit to "1" will enable the corresponding bit in the Status Byte Register (STB) to be set to "1" when any of them change from "0" to "1". When all bits are set to "0", the MSS bit will be set to "0". Unused bits of the Status Byte Register (STB) and Bit 6 are set to "0".



Standard Event Status Register

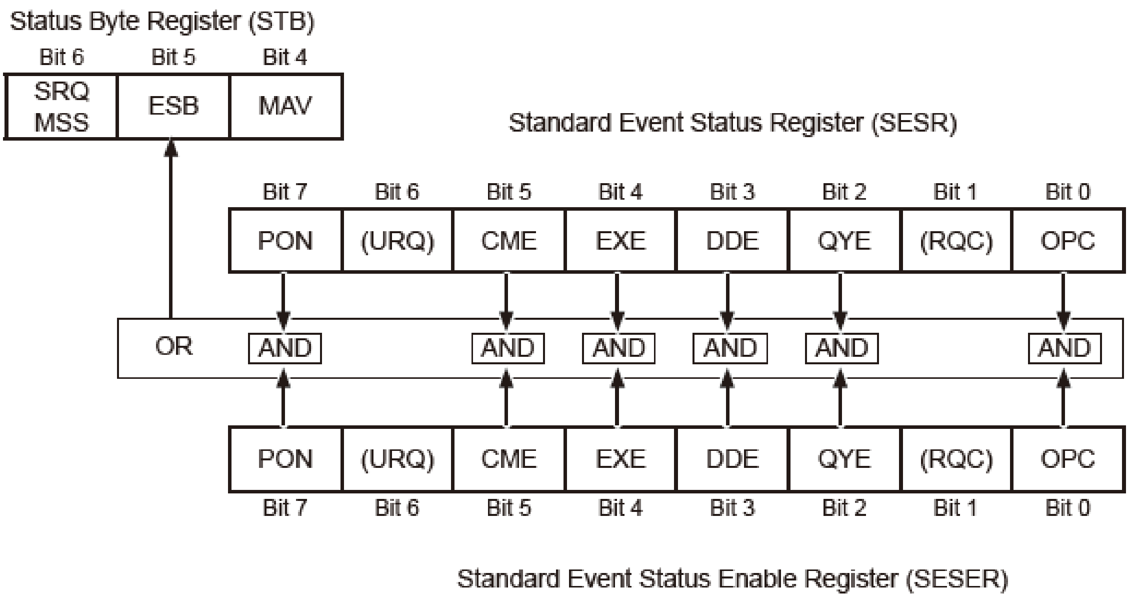
The Standard Event Status Register (SESR) is an 8-bit register.
The content of the Standard Event Status Register (SESR) is cleared in the following cases.

- When the `*CLS` command is executed
- When an event registry query is executed (`*ESR?`)
- When turning on the instrument again.

Bit No.	Bit name	Description of function
Bit 7	PON	Power on flag Set to "1" when the power is turned on and when recovering from a power outage.
Bit 6	(URQ)	Not used
Bit 5	CME	Command error (commands until the message terminator are ignored) Set to "1" when a message received has an error in syntax or meaning. When there is an error in the program header When the data quantity is different from that specified When the data format is different from that specified When a command not in the instrument is received
Bit 4	EXE	Execution error Set to "1" when a command cannot be executed for some reason. When the specified data is outside the range set When the specified data cannot be set When the command cannot be executed because another function is operating
Bit 3	DDE	Instrument dependent error Set to "1" when a instrument dependent error occurs. See "Before Requesting Repairs" for details.
Bit 2	QYE	Query error (clears the output queue) Set to "1" when an error occurs in processing related to the output queue. When data overflows from the output queue When data is lost within the output queue
Bit 1	(RQC)	Not used
Bit 0	OPC	Operation complete Set to "1" when an operation is completed. When the `*OPC` command is executed When operations of all messages before the `*OPC` command are ended.

Standard Event Status Enable Register (SESER)

The Standard Event Status Enable Register (SESER) is a register where setting each bit to "1" will enable the corresponding bit in the Standard Event Status Register (SESR) to trigger the ESB bit in the Status Byte Register (STB) to be set to "1" when any of them change from "0" to "1". When all bits are set to "0", the ESB bit will be set to "0".



Query and set registers

Register	Query	Setting
Status Byte Register	*STB?	—
Service Request Enable Register	*SRE?	*SRE
Standard Event Status Register	*ESR?	—
Standard Event Status Enable Register	*ESE?	*ESE

Items returned to default state

Items that return to the default state when the instrument is initialized are as follows.
See "Default Settings" for initialization of device-specific functions.

Register	When the power is turned on	*RST command	*CLS command
Device-specific functions (measurement conditions, compensation values, etc.)	—	√	—
Output queue	√	—	—
Input buffer	√	—	—
Status Byte Register	√	—	√*1
Event register	√*2	—	√
Enable register	√	—	—
Current path	√	—	—

√: Returns to default state, —: Does not return to default state
*1: Bits other than MAV are cleared.
*2: Excludes the PON bit (Bit 7).

7.6 Message Reference

Common commands

System data commands

Query instrument ID (identification code)

`*IDN?`

Syntax

Query

`*IDN?`

Response

<Manufacturer name>, <Model name>, <Serial number>, <Version>

Details

Queries the text string identifying the instrument.

- Manufacturer name: HIOKI
- Model name: SW2001-24 (the last two digits return the number of channels)
- Serial number: Returns the serial number.
- Version: Returns the firmware version number.

Example

```
*IDN?
HIOKI,SW2001-24,230612345,V1.00
```

Initialize instrument

`*RST`

Syntax

Command

`*RST`

Details

Sets the instrument to defaults. However, communication settings and contents saved in panels are not changed.

The initialization content is the same as for the `:PRESet command.`

See: "Default Settings" »

Example

`*RST`

Query self-test execution and results

```
*TST?
```

Syntax

Query

```
*TST?
```

Response

Result {PASS|FAIL}

Details

Performs a self-test of the instrument and returns the result.
Returns **PASS** if the test is passed.
Repairs are required if **FAIL** is returned. Contact your authorized Hioki distributor or reseller.

Example

```
*TST?
PASS
```

No problems found as a result of executing the test.

Trigger

`*TRG`

Syntax

Command

`*TRG`

Details

Executes closing of relay switches.
Can also be closed with the `:RELay CLOSe command.`

Example

`*TRG`
Executes closing of relays

Note

Configure the input channels and output channels before executing this command.

Usage Conditions

Must not be in interlock state.
Must not be in close lock state.

Wait for completion of current operation and set OPC bit of SESR

`*OPC`

Syntax

Command

`*OPC`

Query

`*OPC?`

Response

1

Details

In the case of a command, the OPC bit of the Standard Event Status Register (SESR) is set to "1" when the current operation is completed.
In the case of a query, "1" is returned when the current operation is completed.
Subsequent commands are not executed until completed, but the `:ABORt` command is accepted.

Example

```
*OPC
*ESR?
1
```

```
*OPC?
1
```

The immediately preceding operation must be completed.

Wait for completion of current operation

`*WAI`

Syntax

Command

`*WAI`

Details

Waits for completion of current operation.
Subsequent commands are not executed until completed, but the `:ABORt` command is accepted.
In contrast to `*OPC`, the OPC bit of the Standard Event Status Register (SESR) is not set to "1". The rest is the same as `*OPC`.

Example

`*WAI`

Clear event register and Status Byte Register

`*CLS`

Syntax

Command

`*CLS`

Details

Clears the event status register.
It also clears the bit of the Status Byte Register corresponding to the event register.
Errors are also cleared.

Example

`*CLS`
Clears each register.

Set and query Standard Event Status Enable Register (SESER)

`*ESE <Mask>`

Syntax

Command

`*ESE <Mask>`

Query

`*ESE?`

Response

<Mask>

Details

Mask {0~255}: SESER value

Sets the Standard Event Status Enable Register (SESER) mask with a numerical value of 0 to 255. The default value when the power is turned on is 0.
Sets the ESB bit of the Status Byte Register (STB) to "1" when an event corresponding to the specified bit occurs.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PON	(URQ)	CME	EXE	DDE	QYE	(RQC)	OPC

Example

`*ESE 1`

If the OPC bit of the Standard Event Status Enable Register (SESER) is set to "1", the ESB bit of the Status Byte Register (STB) is set to "1".

`*ESE?`

`1`

The OPC bit of the Standard Event Status Enable Register (SESER) is set to "1".

Query Standard Event Status Register (SESR)

`*ESR?`

Syntax

Query

`*ESR?`

Response

<Register value>

Details

Register value {0~255}
Current SESR value

Queries the Standard Event Status Register (SESR) value.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PON	0	CME	EXE	DDE	QYE	0	OPC

Example

```
*OPC
*ESR?
1
```

The OPC bit of the Standard Event Status Register (SESR) is set to "1" by `*OPC`.

Set and query Service Request Enable Register (SRER)

`*SRE <Mask>`

Syntax

Command

`*SRE <Mask>`

Query

`*SRE?`

Response

<Mask>

Details

Mask {0~255}: SRER value

Sets the Service Request Enable Register (SRER) mask with a numerical value of 0 to 255. The default value when the power is turned on is 0. Sets the MSS bit of the Status Byte Register (STB) to "1" when the bit corresponding to the specified bit is set to "1".

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	ESB	MAV	0	ERR	0	0

Example

- Command
  `*SRE 4`
  The MSS bit of the Status Byte Register (STB) is set to "1" when a system error occurs.
- Query
  `*SRE?`
  `4`
  The ERR bit of the Service Request Enable Register (SRER) is set to "1".

Query Status Byte Register

`*STB?`

Syntax

Query

`*STB?`

Response

<Register value>

Details

Register value {0~255}: STB value

Queries the Status Byte Register (STB) value.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-	MSS	ESB	MAV	-	ERR	-	-

Example

`*STB?`

`4`

The ERR bit of the Status Byte Register (STB) is set to "1".

Panel operation

Panel save

`*SAV {<panel number>|"panel name"}`
`[:SYSTem]:PANel:SAVE {<panel number>|"panel name"}`

Syntax

Command

```
*SAV {<panel number>|"panel name"}
[:SYSTem]:PANel:SAVE {<panel number>|"panel name"}
```

Details

- Panel number {1~1000}
  Specifies the panel number for saving relay switching conditions.
- Panel name {Up to 8 ASCII characters including any other than " (double quotation mark)}
  Specifies the panel name for saving relay switching conditions.
- If a panel number that is already saved or a panel name with the same name is specified, it is overwritten with the current conditions.

Example

```
*SAV 1
```

Saves the current relay switching conditions to panel number 1.

```
:SYSTem:PANel:SAVE "TEST-A"
```

Saves the current relay switching conditions to the panel named "TEST-A".

Panel load

```
*RCL {<panel number>|"panel name"}
[:SYSTem]:PANel:LOAD {<panel number>|"panel name"}
```

Syntax

Command

```
*RCL {<panel number>|"panel name"}
[:SYSTem]:PANel:LOAD {<panel number>|"panel name"}
```

Details

- Panel number {1~1000}
  Specifies the panel number for loading relay switching conditions.
- Panel name {Up to 8 ASCII characters including any other than " (double quotation mark)}
  Specifies the panel name for loading relay switching conditions.
- An execution error occurs if a number or panel name without saved relay switching conditions is specified.

Example

```
*RCL 1
```

Loads the relay switching conditions saved in panel number 1.

```
:SYSTem:PANel:LOAD "TEST-A"
```

Loads the relay switching conditions saved in panel name "TEST- A".

Panel clear

`[:SYSTem]:PANel:CLEar {<panel number>|"panel name"}`

Syntax

Command

`[:SYSTem]:PANel:CLEar {<panel number>|"panel name"}`

Details

- Panel number {1~1000}
  Specifies the number of the panel to clear.
- Panel name {Up to 8 ASCII characters including any other than " (double quotation mark)}
  Specifies the name of the panel to clear.

Clears the relay switching conditions saved in the specified panel number or panel name.
An execution error does not occur even if a number or panel name without saved relay switching conditions is specified.

Example

`:SYSTem:PANel:CLEar 1`

Clears the relay switching conditions saved in panel number 1.

`:SYSTem:PANel:CLEar "TEST-A"`

Clears the relay switching conditions saved in panel name "TEST- A".

Set panel name

`[:SYSTem]:PANel:NAME <panel number>|"panel name"`

Syntax

Command

`[:SYSTem]:PANel:NAME <panel number>|"panel name"`

Details

- Panel number {1~1000}
  Specifies the number of the panel to give a panel name.
- Panel name {Up to 8 ASCII characters including any other than " (double quotation mark)}
  Specifies the name to give the panel.

Gives a panel name to the panel with the specified panel number.

Example

`:SYSTem:PANel:NAME 1,"TEST-A"`

Gives the panel name "TEST-A" to the panel with panel number 1.

Usage Conditions

An execution error occurs if a panel number without saved relay switching conditions is specified.

Query panel name

`[:SYSTem]:PANel:NAME? <panel number>`

Syntax

Query

`[:SYSTem]:PANel:NAME? <panel number>`

Response

{"Panel name"|NONE}

Details

Panel name: Up to 8 ASCII characters including any other than " (double quotation mark)

Queries the panel name of the panel with the specified panel number.
NONE is returned if the panel with the specified panel number does not exist.

Example

`:SYSTem:PANel:NAME? 1`
`"TEST-A"`
The panel name of panel number 1 is "TEST-A".

`:SYSTem:PANel:NAME? 1000`
`NONE`
The panel for panel number 1000 does not exist.

Query panel number

`[:SYSTem]:PANel:NO? "panel name"`

Syntax

Query

`[:SYSTem]:PANel:NO? "panel name"`

Response

<panel number>

Details

Panel number {0~1000}

Queries the panel number of the panel with the specified panel name.
0 is returned if the panel with the specified panel name does not exist.

Example

```
:SYSTem:PANel:NO? "TEST-A"
1
```

The panel number of the panel with the panel name "TEST-A" is 1.

Abort

`:ABORt`

Syntax

Command

`:ABORt`

Details

Aborts all operations and processes being executed.
Also opens all relays.

Example

```
:ABORt
```

Reset

`:PRESet`

Syntax

Command

`:PRESet`

Details

Sets the instrument to defaults. However, communication settings and contents saved in panels are not changed.
The initialization content is the same as for the `*RST` command.

See: "Default Settings"

Example

`:PRESet`

Reset (full reset)

`:SYSTem:RESet`

Syntax

Command

`:SYSTem:RESet`

Details

Sets the instrument to defaults. However, communication settings are not changed.
Unlike with `:PRESet`, the content saved in panels is initialized.

See: "Default Settings" »

Example

```
:SYSTem:RESet
```

Query and clear error information

`:SYSTem:ERRor?`

Syntax

Query

`:SYSTem:ERRor?`

Response

Error number, "error content"

Details

If there is an error, an error is returned and the error is cleared. When an error occurs, the ERR bit of the Status Byte Register (STB) is set to "1" until it is read with this command or `*CLS` is executed. However, it is not cleared when there is an instrument anomaly error. Also, when a device anomaly error occurs, the **ERROR** LED on the front of the instrument lights up, and the **ERROR** terminal of **EXT. I/O** outputs ON.

Example

```
:SYSTem:ERRor?
370,"Self-test failed"
```

The self-test resulted in an error.

Settings backup

`:SYSTem:BACKup {OFF|ON}`

Syntax

Command

`:SYSTem:BACKup {OFF|ON}`

Query

`:SYSTem:BACKup?`

Response

{OFF|ON}

Details

Sets the backup of settings to enabled (ON) or disabled (OFF).
When in the default state (ON), changes to settings are recorded even if the power is turned off and on again, but settings cease to be recorded after backup is set to OFF.
When set to ON, the current settings are backed up, and subsequent settings are recorded.

Example

`:SYSTem:BACKup OFF`

Backup of settings turned OFF.

`:SYSTem:BACKup?`

`OFF`

Backup of settings is OFF.

Remote disengagement

`:LOCal`

Syntax

Command

`:LOCal`

Details

Disengages the remote state of communication.
When this command is received, the **REMOTE** LED on the instrument turns off.

Example

`:LOCal`

Disengaged the remote state.

Set and query IP address

`:SYSTem:COMMunicate:LAN:IPADdress <n1>,<n2>,<n3>,<n4>`

Syntax

Command

`:SYSTem:COMMunicate:LAN:IPADdress <n1>,<n2>,<n3>,<n4>`

Query

`:SYSTem:COMMunicate:LAN:IPADdress?`

Response

<n1>,<n2>,<n3>,<n4>

Details

n1,n2,n3,n4 {0~255}

Sets the LAN IP address.
The setting is enabled after executing `:SYSTem:COMMunicate:LAN:UPDate`.
The LAN stops when the IP address is set to 0.0.0.0.
When connecting to an existing network, set in advance using USB. Using an incorrect IP address or a duplicate IP address may cause trouble on an existing network.

Example

`:SYSTem:COMMunicate:LAN:IPADdress 192,168,1,100`

Sets the IP address to 192.168.1.100.

`:SYSTem:COMMunicate:LAN:IPADdress?`
`192,168,1,100`

The IP address is set to 192.168.1.100.

Note

Although a periods are normally used as separators in IP addresses, commas are used in this command.

Set and query subnet mask

`:SYSTem:COMMunicate:LAN:SMASk <n1>,<n2>,<n3>,<n4>`

Syntax

Command

`:SYSTem:COMMunicate:LAN:SMASk <n1>,<n2>,<n3>,<n4>`

Query

`:SYSTem:COMMunicate:LAN:SMASk?`

Response

<n1>,<n2>,<n3>,<n4>

Details

n1,n2,n3,n4 {0~255}

Sets the LAN subnet mask.
The setting is enabled after executing `:SYSTem:COMMunicate:LAN:UPDate`.
When to an existing network, set in advance using USB communication.
Using an incorrect subnet mask may cause trouble on an existing network.

Example

`:SYSTem:COMMunicate:LAN:SMASk 255,255,255,0`
Sets the subnet mask to 255.255.255.0.

`:SYSTem:COMMunicate:LAN:SMASk?`
`255,255,255,0`
The subnet mask is set to 255.255.255.0.

Note

Although a periods are normally used as separators in the subnet mask, commas are used in this command.

Set and query default gateway

`:SYSTem:COMMunicate:LAN:GATeway <n1>,<n2>,<n3>,<n4>`

Syntax

Command

`:SYSTem:COMMunicate:LAN:GATeway <n1>,<n2>,<n3>,<n4>`

Query

`:SYSTem:COMMunicate:LAN:GATeway?`

Response

<n1>,<n2>,<n3>,<n4>

Details

n1,n2,n3,n4 {0~255}

Sets the default gateway of the LAN.
The setting is enabled after executing `:SYSTem:COMMunicate:LAN:UPDate`.
The default gateway is disabled when set to 0,0,0,0.
When to an existing network, set in advance using USB communication.
Using an incorrect default gateway may cause trouble on an existing network.

Example

`:SYSTem:COMMunicate:LAN:GATeway 192,168,1,1`
Sets the default gateway to 192.168.1.1.

`:SYSTem:COMMunicate:LAN:GATeway?`
`192,168,1.1`
The default gateway is set to 192.168.1.1.

Note

Although a periods are normally used as separators in the default gateway, commas are used in this command.

Set and query port number

`:SYSTem:COMMunicate:LAN:CONTrol <Port number>`

Syntax

Command

`:SYSTem:COMMunicate:LAN:CONTrol <Port number>`

Query

`:SYSTem:COMMunicate:LAN:CONTrol?`

Response

<Port number>

Details

Port number {1~65535}

Specifies the TCP/IP port number for accepting commands via LAN communication.
The setting is enabled after executing `:SYSTem:COMMunicate:LAN:UPDate`.

Example

`:SYSTem:COMMunicate:LAN:CONTrol 23`

Specifies the port number as 23.

`:SYSTem:COMMunicate:LAN:CONTrol?`

`23`

The port number is set to 23.

Finalize LAN settings

`:SYSTem:COMMunicate:LAN:UPDate`

Syntax

Command

`:SYSTem:COMMunicate:LAN:UPDate`

Details

This updates and reflects LAN settings. LAN communication connections are disconnected.

Example

```
:SYSTem:COMMunicate:LAN:IPADdress 192,168,1,100
:SYSTem:COMMunicate:LAN:SMASk 255,255,255,0
:SYSTem:COMMunicate:LAN:GATeway 0,0,0,0
:SYSTem:COMMunicate:LAN:CONTrol 23
:SYSTem:COMMunicate:LAN:UPDate
```

Sets the LAN IP address to 192.168.1.100, the subnet mask to 255.255.255.0, the default gateway to OFF, and the port number to 23.

Query MAC address

`:SYSTem:COMMunicate:LAN:MAC?`

Syntax

Query

`:SYSTem:COMMunicate:LAN:MAC?`

Response

<MAC address>

Details

Queries the MAC address of the instrument's LAN port.
The MAC address is returned as a string in a format such as "00-01-67-00-00-00".

Example

```
:SYSTem:COMMunicate:LAN:MAC?
"00-01-67-00-00-00"
```

The MAC address is 00-01-67-00-00-00.

Execute closing/opening

`:RELay {CLOSE|OPEN}`

Syntax

Command

`:RELay {CLOSE|OPEN}`

Details

Executes the closing or opening of relays.
Settings for each relay are retained after executing opening, and are enabled until next closed.
`*TRG` They can also be opened using the `:ABORt` command.

Example

```
:RELay:INPut HIPot
:RELay:CH 1,HIGH
:RELay:CH 2.LOW
:RELay:ACPD ON
:RELay CLOSE
```

Sets the input channel to HIPOT, output channel CH1 to HIGH, output channel CH2 to LOW, AC PD relay to ON, and executes closing of relays.

```
:RELay OPEN
```

Executes opening of relays.

Usage Conditions

When closing:
- Must not be in interlock state.
- Must not be in close lock state.

When opening, must be in SWITCHED state.
To open in any state, use the `:ABORt`

Query operating status

`:RELay:STATus?`

Syntax

Query

`:RELay:STATus?`

Response

{INTERLOCKED|ALL_OPEN|CLOSE_START|CH_DELAY|SWITCHED|DISCHARGE|OPEN_START}

Details

Returns the operating status of relays.
The operating states represented by each response are as follows.

Response	Instrument status
INTERLOCKED	Interlock state
ALL_OPEN	Open state
CLOSE_START	Starting to close
CH_DELAY	During channel delay
SWITCHED	Closed state
DISCHARGE	During speed discharge
OPEN_START	Starting to open

The operating states of relays go through the following processes.

- When closing: ALL_OPEN > CLOSE_START > CH_DELAY > SWITCHED
- When performing speed discharge: SWITCHED > DISCHARGE > SWITCHED
- When opening: SWITCHED > OPEN_START > ALL_OPEN

Example

```
:RELay:STATus?
INTERLOCKED
```

The instrument is currently in an interlock state.

Set and query input channel

`:RELay:INPut {OFF|HIPot|IMPulse|RESistance|LCR|CH1_2|CH3_4|CH5_6|CH7_8}`

Syntax

Command

`:RELay:INPut {OFF|HIPot|IMPulse|RESistance|LCR|CH1_2|CH3_4|CH5_6|CH7_8}`

Query

`:RELay:INPut?`

Response

{OFF|HIPOT|IMPULSE|RESISTANCE|LCR|CH1_2|CH3_4|CH5_6|CH7_8}

Details

Sets the input channel.
Relays are not operated by this command.
Sending the `:RELay CLOSE` or `*TRG` command closes the selected relay.

Example

```
:RELay:INPut HIPot
:RELay:CH 1,HIGH
:RELay:CH 2.LOW
:RELay:ACPD ON
:RELay CLOSE
```

Sets the input channel to HIPOT, output channel CH1 to HIGH, output channel CH2 to LOW, AC PD relay to ON, and executes closing of relays.

```
:RELay:INPut?
HIPOT
```

The input channel is set to the HIPOT channel.

Set and query AC PD relays

`:RELay:ACPD {OFF|ON}`

Syntax

Command

`:RELay:ACPD {OFF|ON}`

Query

`:RELay:ACPD?`

Response

{OFF|ON}

Details

Sets AC PD relays to ON or OFF.
Relays are not operated by this command.
Sending the `:RELay CLOSE` or `*TRG` command closes the selected relay.

Example

```
:RELay:INPut HIPot
:RELay:CH 1,HIGH
:RELay:CH 2.LOW
:RELay:ACPD ON
:RELay CLOSE
```

Sets the input channel to HIPOT, output channel CH1 to HIGH, output channel CH2 to LOW, AC PD relay to ON, and executes closing of relays.

```
:RELay:ACPD?
ON
```

AC PD relays are set to ON.

Individually set and query output channels

`:RELay:CH <ch>,{OFF|HIGH|LOW}`

Syntax

Command

`:RELay:CH <ch>,{OFF|HIGH|LOW}`

Query

`RELay:CH? <ch>`

Response

{OFF|HIGH|LOW}

Details

Sets the connection for the output channel specified with the <ch> parameter.
Connects to the H terminal of the input channel if set to **HIGH**, and the L terminal of the input channel if set to **LOW**.
Does not connect to either input channel if set to **OFF**.
Relays are not operated by this command.
Sending the `:RELay CLOSE` or `*TRG` command closes the selected relay.

Example

```
:RELay:INPut HIPot
:RELay:CH 1,HIGH
:RELay:CH 2.LOW
:RELay:ACPD ON
:RELay CLOSE
```

Sets the input channel to HIPOT, output channel CH1 to HIGH, output channel CH2 to LOW, AC PD relay to ON, and executes closing of relays.

```
:RELay:CH? 1
HIGH
```

The connection setting for output channel 1 is HIGH.

Batch set and query output channels

`:RELay:CHALL {OFF|HIGH|LOW},{OFF|HIGH|LOW},....`

Syntax

Command

`:RELay:CHALL {OFF|HIGH|LOW},{OFF|HIGH|LOW},....`

Query

`:RELay:CHALL?`

Response

{OFF|HIGH|LOW},{OFF|HIGH|LOW},....

Details

Sets the connections for output channels. Parameters are separated by commas in sequence from CH1 to CH24 for the settings of each output channel.
If the number of parameters is less than the number of output channels, all channels after the channel set by the parameters are set to **OFF**.
Connects to the H terminal of the input channel if set to **HIGH**, and the L terminal of the input channel if set to **LOW**.
Does not connect to either input channel if set to **OFF**.
Relays are not operated by this command.
Sending the `:RELay CLOSE` or `*TRG` command closes the selected relay.

Example

```
:RELay:INPut HIPot
:RELay:CHALL
HIGH,HIGH,HIGH,LOW,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF
,OFF,OFF,OFF,OFF,OFF
:RELay:ACPD OFF
:RELay CLOSE
```

Sets the input channel to HIPOT, output channels CH1, CH2, CH3 to HIGH, output channel CH4 to LOW, output channels CH5 to Ch24 to OFF, AC PD relay to OFF, and executes closing of relays.

```
:RELay:CHALL?
HIGH,HIGH,HIGH,LOW,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF,OFF
,OFF,OFF,OFF,OFF,OFF
```

Output channel connection settings are set to HIGH for output channels CH1, CH2, CH3, LOW for output channel CH4, and OFF for output channels CH5 to CH24.

Set and query protective discharge time

`:DISCharge:PROTect <Discharge time>`

Syntax

Command

```
:DISCharge:PROTect <Discharge time>
```

Query

```
:DISCharge:PROTect?
```

Response

<Discharge time>

Details

Discharge time <0~1000>
Unit: [ms] (milliseconds)

Sets or queries the protective discharge time.
The protective discharge function is OFF when set to 0.

Example

```
:DISCharge:PROTect 500
```

Sets the protective discharge time to 500 ms.

```
:DISCharge:PROTect?
500
```

The protective discharge time setting value is 500 ms.

Set and query speed discharge time

`:DISCharge:SPEed <Discharge time>`

Syntax

Command

`:DISCharge:SPEed <Discharge time>`

Query

`:DISCharge:SPEed?`

Response

<Discharge time>

Details

Discharge time <100~9999>
Unit: [ms] (milliseconds)

Sets or queries the speed discharge time.

Example

`:DISCharge:SPEed 2000`
Sets the speed discharge time to 2000 ms.

`:DISCharge:SPEed?`
`2000`
The speed discharge time setting value is 2000 ms.

Set and query speed discharge channels

`:DISCharge:CH <1~24>,{OFF|HIGH|LOW}`

Syntax

Command

`:DISCharge:CH <1~24>,{OFF|HIGH|LOW}`

Query

`:DISCharge:CH? <1~24>`

Response

{OFF|HIGH|LOW}

Details

Sets or queries the output channels used for speed discharge.
Output channels set to **OFF** are not connected to either bus during speed discharge.
Output channels set to **HIGH** are connected to the HIGH bus during speed discharge.
Output channels set to **LOW** are connected to the LOW bus during speed discharge.
Relays are not operated by this command.
Selected relays are closed and speed discharge is carried out when the `:DISCharge:STARt` command is sent.

Example

`:DISCharge:CH 7,HIGH`
Sets the HIGH speed discharge channel to CH7.
`:DISCharge:CH 8,LOW`
Sets the LOW speed discharge channel to CH8.

Note

When the `:RELay:INPut` input channel setting is used to specify CH1 to CH8, those channels cannot be set to HIGH or LOW for speed discharge.
Also, channels set to HIGH or LOW with the `:RELay:CH` output channel setting cannot be set to HIGH or LOW for speed discharge.

Start speed discharge

`:DISCharge:STARt`

Syntax

Command

`:DISCharge:STARt`

Details

Starts speed discharge.
Closes the relays for the speed discharge channel when starting, and opens the speed discharge channel relays after maintaining a speed discharge state for the duration set with the `:DISCharge:SPEed` command.
Relays other than those for the speed discharge channel are kept in the same state from before starting.

Example

`:DISCharge:STARt`
Executes speed discharge.

Usage Conditions

Must be in a SWITCHED state.
Must not be in close lock state.

Query switching count (output channel relays)

`:COUNt:CH? {HSRC|HSEN|LSRC|LSEN}`

Syntax

Query

`:COUNt:CH? {HSRC|HSEN|LSRC|LSEN}`

Response

n1,n2,......n24

Details

n1,n2,......n24: Relay switching count for each channel from output channel 1 to output channel 24

Returns the relay switching count for output channel relays.
Each output channel has four output channel relays: SOURCE HIGH, SOURCE LOW, SENSE HIGH and SENSE LOW. The parameter specifies which relay to obtain the switch count for.
HSRC: SOURCE HIGH
HSEN: SENSE HIGH
LSRC: SOURCE LOW
LSEN: SENSE LOW

Example

```
:COUNt:CH? HSRC
15443,15443,15443,10,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
```

Switch counts for the SOURCE HIGH output channel relays are CH1: 15443 times, CH2: 15443 times, CH3: 15443 times, CH4: 10 times, and CH5 to 24: 0 times.

Query switch count (high-voltage input relays)

`:COUNt:HINPut?`

Syntax

Query

`:COUNt:HINPut?`

Response

n1,n2,n3,n4,n5,n6

Details

Queries the relay switching counts for the high-voltage instrument input channel.
The switching counts for six relays are returned separated by commas.
The breakdown is as follows.
n1: HIPOT HIGH relay
n2: HIPOT LOW relay
n3: IMPULSE HIGH relay
n4: IMPULSE LOW relay
n5: AC PD relay A
n6: AC PD relay B

Example

```
:COUNt:HINPut?
15443,15443,2149,2149,6016,6016
```

Returns the relay switching count for the high-voltage instrument input channel.

Query switch count (low-voltage input relays)

`:COUNt:LINPut?`

Syntax

Query

`:COUNt:LINPut?`

Response

n1,n2,n3,n4,n5,n6

Details

Queries the relay switching counts for the low-voltage instrument input channel.
The switching counts for six relays are returned separated by commas.
The breakdown is as follows.
n1: RESISTANCE METER HIGH relay
n2: RESISTANCE METER LOW relay
n3: LCR HIGH relay
n4: LCR LOW relay
n5: Protective relay A
n5: Protective relay B

Example

```
:COUNt:LINPut?
15443,15443,2149,2149,6016,6016
```

Returns the relay switching count for the low-voltage instrument input channel.

Query switch count (relays between low voltage and high voltage)

`:COUNt:BETWeen?`

Syntax

Query

`:COUNt:BETWeen?`

Response

n1,n2,n3,n4,n5,n6,n7,n8

Details

Queries the switching counts for the relays separating high-voltage parts and low-voltage parts.
The switching counts for eight relays are returned separated by commas.
The breakdown is as follows.
n1: Relay A
n2: Relay B
n3: Relay C
n4: Relay D
n5: Relay E
n6: Relay F
n7: Relay G
n8: Relay H

Example

```
:COUNt:BETWeen?
2149,2149,2149,2149,2149,2149,2149,2149
```

Returns the switching counts for the relays separating high-voltage parts and low-voltage parts.

Set and query channel delay time

`:IO:DELay <Delay time>`

Syntax

Command

`:IO:DELay <Delay time>`

Query

`:IO:DELay?`

Response

<Delay time>

Details

Delay time <0~9999>
Unit: [ms] (milliseconds)

Sets or queries the channel delay time.

Example

`:IO:DELay 2000`
Sets the channel delay time to 2000 ms.

`:IO:DELay?`
`2000`
The channel delay time setting value is 2000 ms.

Set and query SWITCHED signal pulse width

`:IO:PULSe:TIME <pulse width>`

Syntax

Command

`:IO:PULSe:TIME <pulse width>`

Query

`:IO:PULSe:TIME?`

Response

<Pulse width>

Details

Pulse width <1~100>
Unit: [ms] (milliseconds)

Sets or queries the SWITCHED signal pulse width.

Example

`:IO:PULSe:TIME 100`
Sets the SWITCHED signal pulse width to 100 ms.

`:IO:PULSe:TIME?`
`100`
The SWITCHED signal pulse width is 100 ms.

8 Maintenance and Service

8.1 Default Settings

Each item is set as follows when shipped from the factory.
The content of settings with a check mark (✓) in the "Backup" column is retained when the power is turned off. However, settings are not retained after turning the backup of settings OFF (`:SYSTem:BACKup OFF`).
If the instrument is initialized using the reset command (`*RST`, `:SYSTem:RESet`), settings with a check mark (✓) return to the default settings.
The panel save command (`*SAV`) saves settings with a check mark (✓) to a panel.

Item	Default Settings	Backup	*RST	:SYSTem :RESet	Panel save
Input channel	OFF	✓	✓	✓	✓
Output channels (CH1 to CH24)	OFF	✓	✓	✓	✓
AC PD relay	OFF	✓	✓	✓	✓
Protective discharge time	0 ms	✓	✓	✓	✓
Channel delay	0 ms	✓	✓	✓	✓
Speed discharge time	1000 ms	✓	✓	✓	✓
Speed discharge channels (CH1to CH24)	OFF	✓	✓	✓	✓
SWITCHED signal pulse width	5 ms	✓	✓	✓	✓
Panels	Clear	✓	—	✓	—

Default settings of LAN user setting mode

Item	Default setting	Backup	*RST	:SYSTem :RESet	panel save
IP address	192.168.1.1	✓	—	✓	—
Subnet mask	255.255.0.0	✓	—	✓	—
Default gateway	0.0.0.0 (None)	✓	—	✓	—
Communications command port number	23	✓	—	✓	—

8.2 Maintenance and Service

⚠ WARNING

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

Precautions During Shipment

⚠ CAUTION

Be sure to observe the following precautions:

- The instrument contains high-voltage lead relays, and any damage from vibration or shock may reduce insulation performance. To avoid damage to the instrument, remove any accessories and optional equipment from the instrument. Use the original packing materials the instrument was shipped in and be sure to use double packaging. Damage during transportation is not covered by warranty.
- When requesting repairs, be sure to include a memo that describes the problem in detail.

Replaceable parts and operating lifetimes

The characteristics of some of the parts used in the instrument may deteriorate with extended use.
To ensure the instrument can be used over the long term, it is recommended to replace these parts on a periodic basis.
When replacing batteries, please contact your authorized Hioki distributor or reseller.
The service life of parts varies with the operating environment and frequency of use. These parts are not guaranteed to operate throughout the recommended replacement cycle.

Part name	Recommended replacement cycle	Remarks/conditions
Electrolytic capacitors	Approx. 10 years	Printed circuit boards that include this component must be replaced. Deteriorates in approx. 10 years when the instrument is used in a severe environment (at an ambient temperature of 40°C (104°F)).
Switching power supply	Approx. 10 years	The switching power supply must be replaced. Deteriorates in approx. 10 years when the instrument is used in a severe environment (at an ambient temperature of 40°C (104°F)).
High-voltage relays	Approx. 5 million times	Parts are not guaranteed to operate for the minimum operation count. The operation count of relays varies significantly depending on frequency, such as the number of measurement items of the object under measurement and the number of units measured. The daily operation count can be calculated by first determining the number of channels actually operated and the number of times those channels are operated. Anticipate the replacement cycle based on this operation count. The actual operation count of each relay is stored internally*1 and a readout thereof confirmed. If the actual operation count is concentrated on a specific relay, the operation count can be leveled by taking steps such as changing the channel used or the polarity. (The operating program must be changed.)

*1. Self-tests

8.3 Self-tests

Executing a self-test checks the instrument for malfunctions. A self-test consists of the following items.

Checking output channel relay welds

When an output channel relay undergoes a weld failure, this may result in a short-circuit of the object under measurement or in being unable to perform correct measurements due to channels connecting in parallel.
A measuring instrument (resistance meter, etc.) connected to the instrument can be used to check conductivity to check for relay weld failures in the output channel.
The method of checking is as follows.

1 Input channel selection

Use the input channel selection command `:RELay:INPut` to select the input channel for the measuring instrument (resistance meter, etc.) to be used to check conductivity.
Example: When using a resistance meter to check output channel relay welds.

```
:RELay:INPut RESistance
```

2 Output channel selection

Use the output channel setting command `:RELay:CH` to select the relay opposite the side where the weld is being checked. (Select LOW if checking the relay weld on the HIGH side, and HIGH if checking the relay weld on the LOW side)
Example: When checking the relay weld on the HIGH side of channel 1.

```
:RELay:CH 1,LOW
```

3 Closing relays

Send the relay switching command.

```
:RELay CLOSe
```

4 Checking conductivity

Use the measuring instrument connected to the channel selected in step 1 to check conductivity.
If the result of checking conductivity is Open: The relay is not welded.
If the result of checking conductivity is Short: The relay is welded.

5 Opening relays

Send the relay switching command.

`:RELay OPEN`

Checking for output channel relay OPEN failures

Measurements cannot be performed correctly if there is an output channel relay OPEN failure.
A measuring instrument (resistance meter, etc.) connected to the instrument can be used to check conductivity to check for relay OPEN failures in the output channel.
The method of checking is as follows.

1 Input channel selection

Use the input channel selection command `:RELay:INPut` to select the input channel for the measuring instrument (resistance meter, etc.) to be used to check conductivity.
Example: When using a resistance meter to check output channel OPEN failures.

`:RELay:INPut RESistance`

2 Selecting and closing output channels

Use the `:TEST:RELAYSHORT` command for testing the output channel relays, and select the output channel to check for failures. Close the relays for both HIGH and LOW for the output channel specified with this command.
Example: When checking output channel 1 for OPEN failures.

`:TEST:RELAYSHORT 1`

3 Checking conductivity

Use the measuring instrument connected to the channel selected in step 1 to check conductivity.
If the result of checking conductivity is Open: There is an Open failure.
If the result of checking conductivity is Short: There is not an Open failure.

4 Opening relays

Send the open all relays for testing command, and release all relays switched to test mode.

`:TEST:RELAYSHORT END`

Checking the relay operation count

The operation count of high-voltage relays in the instrument can be confirmed to check whether operations are concentrated on specific relays. If there are relays with a high operation count, the operation count can be dispersed with the following method. This will enable stable use of the instrument for a prolonged period. However, the measurement program must be changed.

- Change polarity of the channels used (program change only)
- Change the channels used (reinsertion of L2265 and program change)
- Perform measurements by switching between multiple types of objects under measurement (machine setup required)
  The operation count of channels other than output channels cannot be leveled out.

The four following commands can be used to check the relay operation count.

1 **Output channel** `:COUNT:CH? type`

The operation count for each output channel relay (for 24 channels) is returned.
`:COUNT:CH? HSRC` : Source HIGH relay
`:COUNT:CH? HSEN` : Sense HIGH relay
`:COUNT:CH? LSRC` : Source LOW relay
`:COUNT:CH? LSEN` : Sense LOW relay

2 **Input channel (high-voltage)** `:COUNt:HINPut?`

Numerical values are returned in the order of IMPULSE × 2, HIPOT × 2, AC PD × 2. (The two numerical values for each measurement system are the same values.)

3 **Input channel (low-voltage)** `:COUNt:LINPut?`

Numerical values are returned in the order of RESISTANCE × 2, LCR × 2, Protective Discharge × 2. (The two numerical values for each measurement system are the same values.)

4 **Switching between high-voltage and low-voltage measurement systems** `:COUNt:BETWeen?`

Eight numerical values are returned. (All are the same value.)

8.4 Cleaning the Instrument

⚠ CAUTION

To clean the instrument, wipe it gently with a soft cloth moistened with water or mild detergent.
Do not use solvents such as benzene, alcohol, acetone, ether, ketone, thinners or gasoline.
Doing so could deform and discolor the instrument.

8.5 Troubleshooting

See "Before Requesting Repairs" if you think there is a problem. If this does not help you resolve your problem, contact your authorized Hioki distributor or reseller.

Before Requesting Repairs

If the power does not operate properly

Condition	Check item or cause	Solution	Reference
If the **POWER** LED does not light up even though the power is turned on.	・ The power cord is disconnected. ・ The power cord is not connected properly.	Connect the power cord properly.	Connecting the Power Cord

When the ERROR LED lights up or flashes

Condition	Check item or cause	Solution
The **ERROR** LED blinks when the power is turned on.	An error is occurring in the self-check during startup.	Request repairs.
The **ERROR** LED lights up when the power is turned on.	Settings were initialized because there was a problem with the setting conditions in the self-check during startup.	The instrument can be used without problems if it does not light up when the power is turned on again. There may be a malfunction if it lights up every time during startup. Request repairs.

If the cause cannot be revealed

Initialize the instrument. Settings will be restored to the factory default.
See: "Initialize instrument"

8.6 Rack Mounting

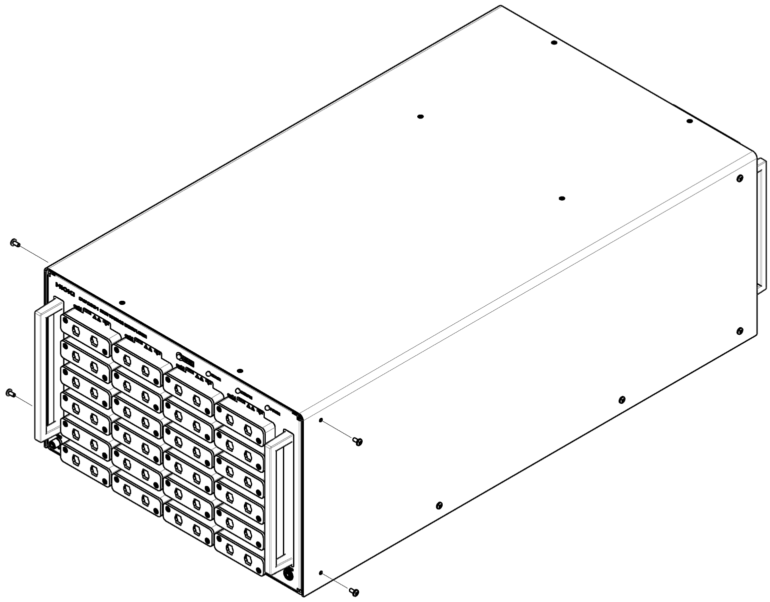
⚠ WARNING

Use screws with the specified lengths to prevent damage to the instrument and electric shock.
When you remove the rack mount and restore the instrument to its original condition, use the screws (M4 × 8 mm) that were installed at the factory.
If you have lost a screw or find that the screw is damaged, contact your authorized Hioki distributor or reseller.

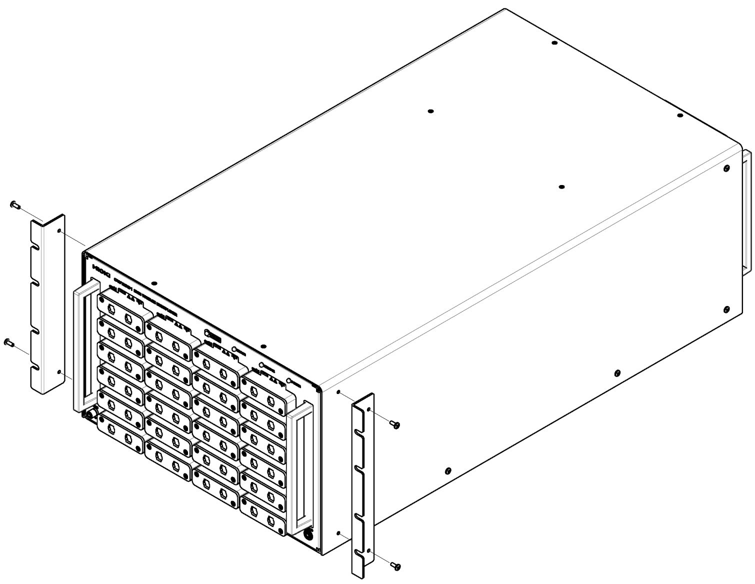
⚠ CAUTION

When mounting the instrument in a rack, place it on the shelf plate and support brackets specified by the manufacturer of the rack.
The rack mount may be damaged if mounted to the rack with only the rack mounting brackets.

1 **Unscrew the screws (M4 × 8 mm) in four locations on the sides of the instrument.**



2 **Fix the rack mounting brackets to the instrument with the included screws (M4 × 10 mm) in four locations.**



9 Specifications

9.1 General Specifications

Item	Description
Operating environment	Indoor use, pollution degree 2, altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Conforming standards	• Safety EN 61010 • EMC EN 61326 Class A
Power supply	• Commercial power supply Rated supply voltage: 100 to 240 V AC (Assuming voltage fluctuation of ±10%.) Rated supply frequency: 50 Hz/60 Hz Anticipated transient overvoltage: 2500 V Maximum rated power 120 VA Normal power consumption (reference value): 17W (during low-voltage system measurement)
Displays	Power LED, remote LED, high voltage output LED, error LED
Interface	USB, LAN, EXT. I/O
Dimensions	Approx. 439.2W × 265.9H × 770D mm (17.3W × 10.5H × 30.3D in.) (excluding protrusions)
Weight	SW2001-04: Approx. 20.5 kg (45.2 lbs) SW2001-08: Approx. 22.5 kg (49.6 lbs) SW2001-16: Approx. 27.0 kg (59.5 lbs) SW2001-24: Approx. 31.5 kg (69.4 lbs) (None including the ST9200 or ST9201 options available only at the time of purchase order issuance for the instrument) If including ST9200: Add 1.2 kg (2.6 lbs) If including ST9201: Add 0.139 kg (0.3 lbs)
Product warranty period	3 years
Included accessories	See: "Included accessories"

Item	Description
Options	See: "Options"

9.2 Basic Specifications

Item	Description
Input channels	• Two channels for high-voltage two-terminal input **HIPOT**: Withstanding Tester input (banana jacks (special shape)) **IMPULSE**: Impulse Winding Tester input (LEMO 10 kV terminal) • Two channels for low-voltage four-terminal input **LCR**: LCR meter input (BNC terminal) **RESISTANCE**: Resistance meter input (banana jacks) Only one channel can be closed at a time. All open can be selected
Output channels	• CH1 through CH4 (SW2001-04), CH1 through CH8 (SW2001-08), CH1 through CH16 (SW2001-16), CH1 through CH24 (SW2001-24) • Each channel has a SOURCE terminal (or an output terminal for 2-terminal output) and a SENSE terminal Up to 24 channels can be closed at once (only one HIGH and LOW channel respectively when low-voltage four-terminal input channel is selected as the input channel)
Partial discharge sensor output (only when equipped with ST9200 or ST9201)	AC voltage monitor (BNC terminal) AC partial discharge current sensor output (BNC terminal) Impulse partial discharge current sensor output (BNC terminal)
Maximum input voltage	No measurement categories • High-voltage two-terminal input **HIPOT** (withstand voltage tester input terminals) 5 kV AC rms, 5 kV DC, 7.07 kV peak • High-voltage two-terminal input **IMPULSE** (impulse input terminals) 8 kV peak (impulse) • Low-voltage four-terminal input **LCR** and **RESISTANCE** 30 V AC rms, 60 V DC, 42.4 V peak
Rated output voltage	5 kV AC rms, 5 kV DC, 8 kV peak (impulse)

Item	Description
Maximum rated line-to-ground voltage	No measurement categories Anticipated transient overvoltage: 0 V • High-voltage two-terminal input **HIPOT** (withstand voltage tester input terminals) 5 kV AC rms, 5 kV DC, 7.07 kV peak • High-voltage two-terminal input **IMPULSE** (impulse input terminals) 8 kV peak (impulse) • Low-voltage four-terminal input **LCR** and **RESISTANCE** 30 V AC rms, 60 V DC, 42.4 V peak • Output terminal 5 kV AC rms, 5 kV DC, 8 kV peak (impulse)
Maximum allowable impulse current	100 A peak
Service life of main circuit relays	Switching count: 5 million times or more (reference value)
Impact of measurement accuracy (added to measurement instrument accuracy)	• LCR measurement: measurement frequency DC less than 10 kHz (±3%), 10 kHz to 100 kHz (±5%), measurement impedance 1 MΩ or more is ±5% • DC resistance measurement ±5% (less than 1 Ω), ±2% (1 Ω or more) • Insulation resistance measurement 1 MΩ or more to less than 1 GΩ (±2%) 1 GΩ or more to less than 10 GΩ (±5%) • Impulse voltage No provisions on effect (internal wiring impedance up to 150 μH) Considering parasitic capacitance of 500 pF • No-load leakage current At 1.5 mA or less and 5 kV AC (23°C, 50%RH)
Effect on AC PD measurement (reference value)	Ambient temperature 23°C, 50%RH Measurement probe in released state (no capacitive load) 40 pC or less when applied voltage is 3kV 100 pC or less when applied voltage is 4kV

9.3 Specifications of Functions

Item	Description
Channel switching	Connects the specified input and output channels to the bus using **EXT. I/O** or a communications command
Interlock	Opens all relays with the highest priority and unconditionally using **EXT. I/O**
Channel delay	The delay time from the completion of all relay switching operations until the output of the SWITCHED signal can be set Delay time setting value: 0.000 s to 9.999 s (default value: 0.000 s)
Settings backup	Backs up communications settings to non-volatile memory
Panel functions	Saves the content of settings for switching channels to non-volatile memory (up to 1000 patterns)
Communication setting mode switching	Select the LAN communication settings with a slide switch Fixed setting mode (**DFLT**) or user setting mode (**USER**) See: "Communication Setting Mode"
Protective discharge function	Grounds and discharges the main circuit on the output side in advance when the main circuit of the input and output relay is closed Discharge time (grounding main circuit on the output side → standby time for closing the main circuit on the input side) can be set Discharge time setting value: 0.000 s to 1.000 s (Default value: 0.000 s)
Speed discharge function	Shortens the discharge time by discharging the residual charge of the object under measurement through an external discharge resistor after insulation withstanding measurement Two output channels are used for the discharge resistance connection
LED display	**POWER** (green): Lights up when power is on, turns off when power is off **DANGER** (red): Lights up when HIPOT or IMPULSE relay is ON, turns off when OFF **ERROR** (orange): **REMOTE** (green): Lights up when LAN communication is established or a command is received by USB communication Turns off when a remote disengagement command is received

9.4 Specifications of Interfaces

Item	Description
LAN	• Standard IEEE 802.3 • Transfer format 100BASE-TX Full duplex • Protocol TCP/IP • Connector RJ-45 • Communication content Settings and queries using communications commands • Settings IP address, subnet mask, default gateway Communications command port number: 1 to 65535 • Delimiter Sending: CR+LF, Receiving: CR, LF or CR+LF (automatic detection) • Default setting mode IP address: 192.168.0.254 Subnet mask: 255.255.255.0 Default gateway: 0.0.0.0 (none) Communications command port number: 23 • User setting mode default settings IP address: 192.168.1.1 Subnet mask: 255.255.0.0 Default gateway: 0.0.0.0 (none) Communications command port number: 23 • Maximum cable length 3 m
USB	• Electrical specifications USB 2.0 (Full-speed) • Connector Series B receptacle • Class CDC class (USB COM) • Communication content Settings and queries using communications commands • Delimiter Sending: CR+LF, Receiving: CR, LF or CR+LF (automatic detection) • Maximum cable length 3 m

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>EXT.
I/O</td><td>

Connector
D-SUB 50 pin, female, fitting and securing block, #4-40 inch screw
Polarity
Method of switching between PNP (source of current)/NPN (current sink)
Input

Electrical specifications

Isolation
Photo coupler isolated no-voltage contact input(Current sink/source output compatible)
Input ON
Residual voltage of 1 V or less
Input ON: Current of 4 mA (reference value)
Input OFF
Open (Breaking current of 100 μA or less)
Response time
ON edge: Max. 5 ms, OFF edge: Max. 5 ms

Output

Electrical specifications

Isolation
Photo coupler isolated open-drain output(Non-polar)
Maximum load voltage
DC 30 V
Residual voltage
1 V or less (load current of 50 mA), 0.5 V or less (load current of 10 mA)
Maximum output current
50 mA/channel

Power supply output

Output voltage
For sink output: +4.5 V to +5.5 V
Source output compatible: -4.5 V to -5.5 V
Maximum output current
100 mA
External power supply input
None
Isolation
Floating from protective grounding potential and the measurement circuit
Line-to-earth voltage of 33 V rms, 46.7 V AC peak or less

</td></tr>
</table>

9.5 Other Specifications

Item	Description
Partial discharge sensor (for AC PD detection) settings	The ST9200 PD Sensor (for AC partial discharge) (option available only at the time of purchase order issuance for the instrument) can be turned ON and OFF by communications command.
Relay switching count	The total relay switching count can be obtained using a communications command. See: "Checking the relay operation count"

9.6 Options

L2005 Connection Cable

Item	Description
Operating environment	Indoor use, pollution degree 2, altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Dimensions	Total length: Approx. 1500 mm (59.1 in.)
Weight	Approx. 220 g (7.8 oz.)
Maximum rated voltage	30 V peak
Maximum rated line-to-ground voltage	30 V DC or less, no measurement categories
Maximum rated current	2.5 A peak
Characteristic impedance	50 Ω
Cable used	Coaxial cable Characteristic impedance 50 Ω
Connector used	BNC

L2111 Connection Cable

Item	Description
Operating environment	Indoor use, pollution degree 2, altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Dimensions	Total length: Approx. 1500 mm (59.1 in.)
Weight	Approx. 189 g (6.7 oz.)
Maximum rated current	3 A AC/DC continuous
Maximum rated voltage	60 V DC or less, 30 V AC rms or less, 42.4 V AC peak or less
Maximum rated line-to-ground voltage	60 V DC or less, 30 V AC rms or less, 42.4 V AC peak or less

L2255 Connection Cable

Item	Description
Operating environment	Indoor use, pollution degree 2, altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Dimensions	Total length: Approx. 1500 mm (59.1 in.)
Weight	Approx. 254 g (9.0 oz.)
Maximum rated line-to-ground voltage	4200 V peak, no measurement category Anticipated transient overvoltage: 0 V

L2265 Unterminated Lead Cable

Item	Description
Operating environment	Indoor use, pollution degree 2, altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Dimensions	Total length: Approx. 3000 mm (118.1 in.)
Weight	Approx. 73 g (2.6 oz.)
Maximum rated current	150 mA AC/DC rms
Maximum rated line-to-ground voltage	5000 V AC/DC rms, 8 kV peak, no measurement category Anticipated transient overvoltage: 0 V

L2270 Connection Cable

Item	Description
Operating environment	Indoor use, pollution degree 2, altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Dimensions	Total length: Approx. 1500 mm (59.1 in.)
Weight	Approx. 49 g (1.7 oz.)
Maximum rated current	150 mA AC/DC
Maximum rated line-to-ground voltage	5000 V AC/DC rms, no measurement category Anticipated transient overvoltage: 0 V

L2271 Connection Cable

Item	Description
Operating environment	Indoor use, pollution degree 2, altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Dimensions	Total length: Approx. 1500 mm (59.1 in.)
Weight	Approx. 43 g (1.5 oz.)
Maximum rated current	150 mA AC/DC

L9218 Connection Cable

Item	Description
Operating environment	Indoor use, pollution degree 2, altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Dimensions	Total length: Approx. 1500 mm (59.1 in.)
Weight	Approx. 78 g (2.8 oz.)
Maximum rated current	0.2 A
Maximum rated voltage between lines	30 V AC rms
Maximum rated line-to-ground voltage	30 V AC rms

ST9200 PD Sensor (for AC Partial Discharge)

Item	Description
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Dimensions	Approx. 100W × 82H × 180D mm (3.9W × 3.2H × 7.1D in.) (excluding protrusions)
Weight	Approx. 1.2 kg (2.6 lbs)
Product warranty duration	1 year
Number of measurement channels	1 channel
Maximum input voltage	5 kV AC rms
Maximum rated line-to-ground voltage	No measurement category HIGH side: 5 kV AC rms
Output terminal	BNC terminal
Blocking coil inductance	14 mH ±20%
Coupling capacitor capacitance	1.33 nF ±10%
Tested object measurable capacitance range	10 nF or less

ST9201 PD Sensor (for Impulse Partial Discharge)

Item	Description
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Dimensions	Approx. 77.2W × 53.6H × 54.2D mm (3.0W × 2.1H × 2.1D in.) (excluding protrusions)
Weight	Approx. 139 g (4.9 oz.)
Product warranty duration	Not covered
Input rated current	AC 2 A rms
Maximum input current	100 A peak
Output terminal	BNC terminal

10 Lecense Infomation

10.1 About Open-source Software

The instrument uses the following open-source software.

Amazon FreeRTOS

lwIP

HIOKI

www.hioki.com/

All regional contact information

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