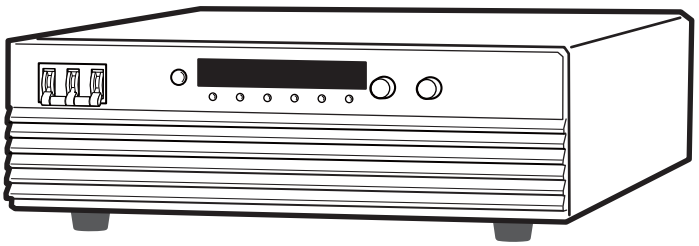
Part No. Z1-004-072, IB012554
Jul. 2008

OPERATION MANUAL

Regulated DC Power Supply

PAT20-400T
PAT40-200T
PAT60-133T
PAT160-50T



KIKUSUI

Use of Operation Manual

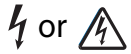
Please read through and understand this Operation Manual before operating the product. After reading, always keep the manual nearby so that you may refer to it as needed. When moving the product to another location, be sure to bring the manual as well.

If you find any incorrectly arranged or missing pages in this manual, they will be replaced. If the manual gets lost or soiled, a new copy can be provided for a fee. In either case, please contact Kikusui distributor/agent, and provide the "Kikusui Part No." given on the cover.

This manual has been prepared with the utmost care; however, if you have any questions, or note any errors or omissions, please contact Kikusui distributor/agent.

⚠ Safety Symbols

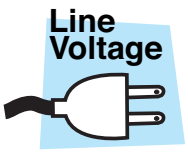
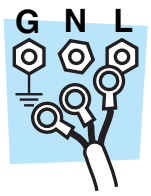
For the safe use and safe maintenance of this product, the following symbols are used throughout this manual and on the product. Note the meaning of each of the symbols to ensure safe use of the product. (Not all symbols may be used.)

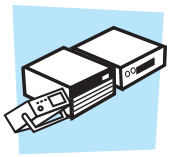
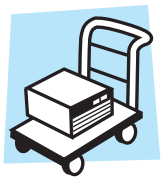
	Indicates that a high voltage (over 1 000 V) is used here. Touching the part causes a possibly fatal electric shock. If physical contact is required by your work, start work only after you make sure that no voltage is output here.
DANGER	Indicates an imminently hazardous situation which, if ignored, will result in death or serious injury.
 WARNING	Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.
 CAUTION	Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.
	Shows that the act indicated is prohibited.
	Indicates a general danger, warning, or caution. When this symbol is marked on the product, see the relevant sections in this manual.
	Protective conductor terminal.
	Chassis (frame) terminal.
	On (supply)
	Off (supply)
	In position of a bi-stable push control
	Out position of a bi-stable push control

⚠ Safety Precautions

The following safety precautions must be observed to avoid fire hazards, electric shock, accidents, and other failures. Keep them in mind and make sure to observe them.

Using the product in a manner that is not specified in this manual may impair the protection functions provided by the product.

Users 	• This product must be used only by qualified personnel who understand the contents of this operation manual and confirm safety of the product. • If unqualified personnel is to use the product, be sure the product is handled under the supervision of qualified personnel (those who have electrical knowledge). This is to prevent the possibility of personal injury.
Purpose of use 	• Never use the product for purposes other than the product's intended use. • This product is not designed or manufactured for general home or consumer use.
Input power 	• Use the product within the rated input power voltage range. • For applying power, use the power cable provided. For details, see the respective page in the operation manual. • This product is designed as an equipment of IEC Overvoltage Category II (energy-consuming equipment supplied from the fixed installation).
Cover 	• Some parts inside the product may cause physical hazards. Do not remove the external cover.
Grounding 	• This product is an IEC Safety Class I equipment (equipment with a protective conductor terminal). To prevent the possibility of electric shock, be sure to connect the protective conductor terminal of the product to electrical ground (safety ground).

Installation 	• This product is designed for safe indoor use. Be sure to use it indoors. • When installing this product, be sure to observe the description referred to the applicable section in this operation manual.
Relocation 	• Turn off the POWER switch, and disconnect all cables before relocating the product. • The product weighs over 20 kg. When moving the product, have more than one person carry it. The weight of the product is indicated on the rear panel of the product and in the specification table in this manual. • When relocating the product, be sure to include the manual.
Operation 	• Before using the product, be sure to check the input power voltage and that there is no abnormality in the appearance of the power cable. Be sure to turn off the switchboard breaker before checking. • If a malfunction or abnormality is detected on the product, stop using it immediately, and remove the power plug from the outlet. Make sure the product is not used until it is completely repaired. • Use cables or wires with sufficiently large current capacity for output wires and load cables. • Do not disassemble or modify the product. If you need to modify the product, contact your Kikusui distributor/agent.
Maintenance and inspection 	• To prevent electric shock, be sure to turn off the switchboard breaker before carrying out maintenance or inspection. Do not remove the external cover. • Conduct periodic inspection for checking the tears or breaks of the power cable. • If the panel needs cleaning, gently wipe using a soft cloth with water-diluted neutral detergent. Do not use volatile chemicals such as benzene or thinner. • To maintain the performance and safe operation of the product, it is recommended that periodic maintenance, inspection, cleaning, and calibration be performed.
Service 	• Kikusui service engineers will perform internal service on the product. If the product needs adjustment or repairs, contact your Kikusui distributor/agent.

Warning label

- There is a warning label affixed to the product. If this label tears or falls off, replace with a new label. If you need a new label, contact your Kikusui agent or distributor.

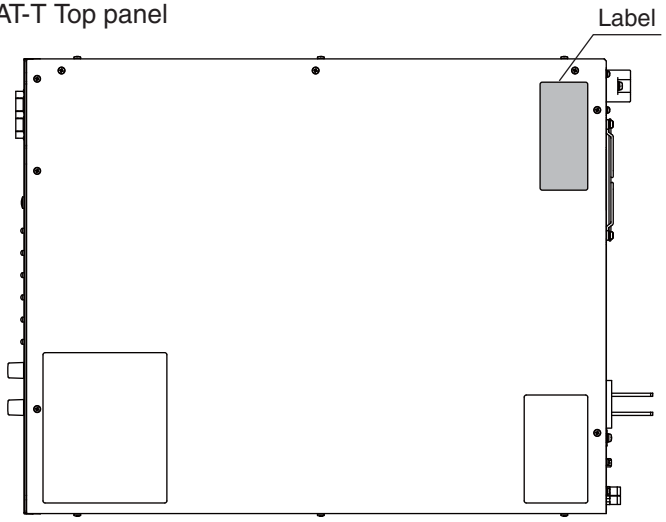
⚠ WARNING

・DO NOT REMOVE COVERS, REFER SERVICING TO QUALIFIED PERSONNEL.
・SECURELY SWITCH BOARD BEFORE HANDLING INPUT POWER CORD.
・TO AVOID AN ELECTRIC SHOCK, THE POWER CORD PROTECTIVE CONDUCTOR TERMINAL OR THE PROTECTIVE CONDUCTOR TERMINAL ⏚ MUST BE CONNECTED TO AN ELECTRICAL GROUND.

⚠ 警　告

・本製品のカバーは、絶対に取り外してはいけません。
・電源コードの取り扱いは、必ず配電盤からの給電を遮断してから行ってください。
・感電事故防止のため、電源コードの保護導体端子、又は本製品の保護導体端子⏚を確実に接地してご使用ください。

PAT-T Top panel



How to Read This Manual

Introduction

Thank you for purchasing the PAT-T Series regulated DC power supply.

This manual is intended for first-time users of the PAT. It gives an overview of the PAT and describes various settings, operation, SCPI commands, maintenance, safety precautions, etc.

Read this manual thoroughly to use the functions of the PAT effectively. You can also review this manual when you are confused about an operation or when a problem occurs.

How to read this manual

This manual is designed to be read from the beginning to the end. We recommend that you read the manual thoroughly from the beginning before using the PAT for the first time.

Intended readers of this manual

This manual is intended for those using the PAT or teaching your operators how to use the PAT.

The manual assumes that the reader has knowledge about electrical aspects of power supplies.

Information on SCPI commands is provided with the premise that the reader has sufficient knowledge about controlling regulated DC power supplies using a personal computer.

Structure of this manual

This Operation Manual is consisting of the following sections. The following outlines each chapter.

Chapter 1 General Description

This chapter describes an overview and describes the features.

Chapter 2 Installation and Preparation

This chapter describes the procedures of unpacking and preparation of the PAT before use.

Chapter 3 Connecting the Load

This chapter describes the consideration to be given to the load, explains how to connect the load wires, and explains how to connect to the output terminals.

Chapter 4 Basic Operation

This chapter describes how to turn on/off the output and the basic operations that you can carry out from the front panel.

Chapter 5 External Control

This chapter describes external analog control and remote monitoring using the J1 connector.

Chapter 6 Parallel/Series Operation

This chapter describes the functions of the master-slave series and parallel operations as well as the connection, setup, and operation procedures.

Chapter 7 Remote Control

This chapter describes an overview of the remote control function and explains the SCPI command structure, syntax, details of each command, registers, and so on used in the remote control.

Chapter 8 Maintenance

This chapter describes maintenance such as cleaning, inspecting, and calibrating.

Chapter 9 Specifications

This chapter describes the specifications and gives the dimensions of the PAT.

Appendix

The appendix contains lists of messages, lists of command errors, Access and operation for the built-in Web site, tutorials, sample programs, and troubleshooting.

Notations used in the manual

- In this manual, the PAT-T Series regulated DC power supply is often simply referred to as “the PAT.”
- “PC” in this manual is a generic term for personal computers and workstations.
- The following marks are used with the explanations in this manual.

⚠ WARNING

Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.

NOTE

Indicates information that you should know.

DESCRIPTION

Explanation of terminology or operation principle.

See

Indicates reference to detailed information.

SHIFT+switch name (marked in blue)

Indicates an operation in which a switch marked in blue is pressed while holding down the SHIFT switch.

CFxx : x

The first two characters “CF” indicates a configuration setting, and the next two-digit number indicates the CONFIG parameter number. The character after the colon indicates the selected setting.

Contents

Chapter 9 Specifications

Appendix

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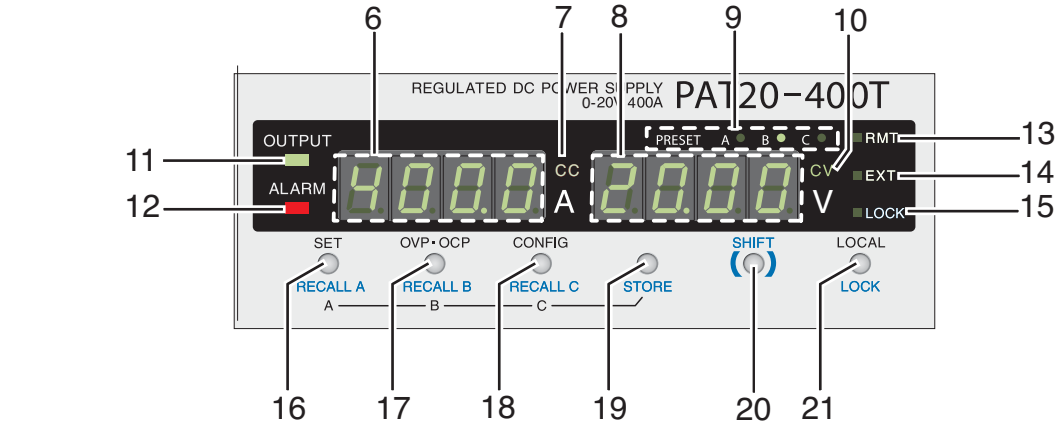
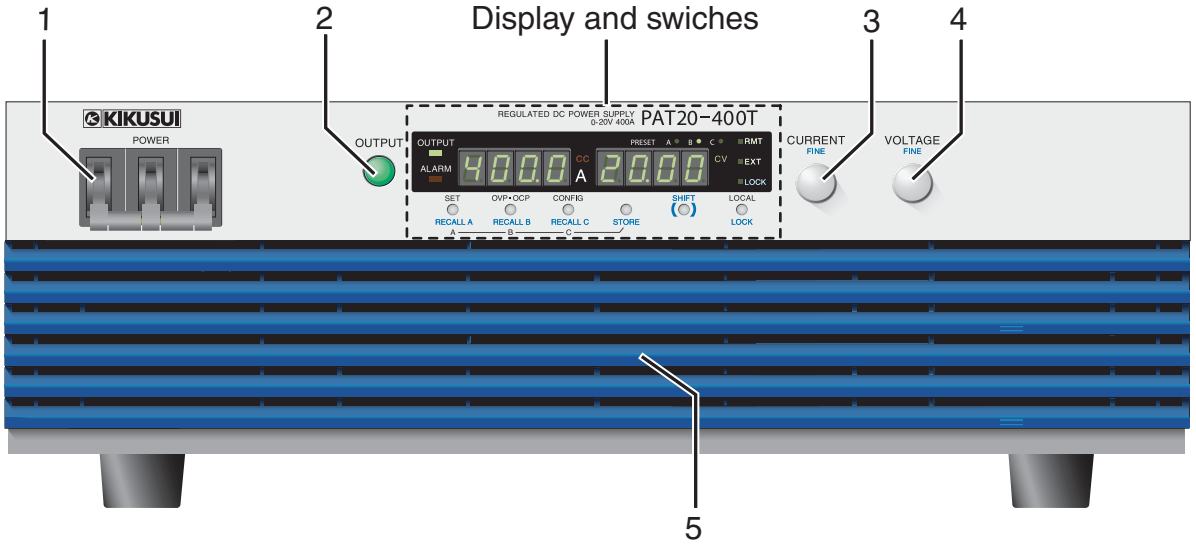
Contents by Function

Preparation

Operation

Front panel

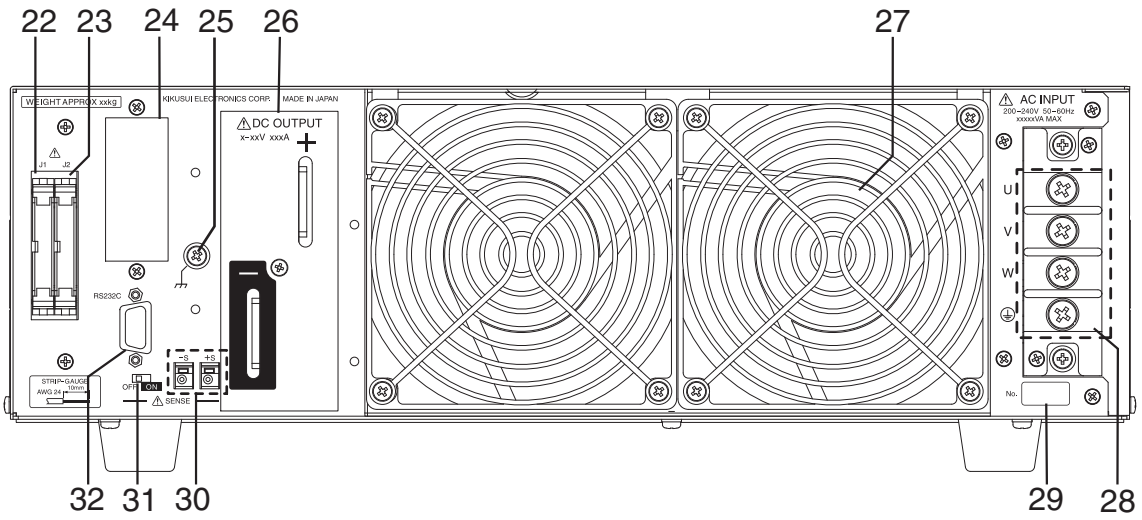




Examples of PAT20-400T

No.	Name	+SHIFT	Function	See Page
1	POWER		Power on/off lever Raise the lever to turn the power on (|). Lower to turn the power off (○).	2-8
2	OUTPUT		Output on/off switch.	4-3
3	CURRENT knob		Used to set the current value or select the CONFIG parameter number.	–
		FINE	Current adjustment knob when the fine adjustment function is enabled.	4-7
4	VOLTAGE knob		Used set the voltage value or change the CONFIG parameter setting.	–
		FINE	Voltage adjustment knob when the fine adjustment function is enabled.	4-7
5	Air inlet (louver)		Inlet for taking in air from the outside. A dust filter is built in.	8-2
6	Ammeter		Displays the current value or the CONFIG parameter number.	–
7	CC		Illuminates in constant current mode.	4-7
8	Voltmeter		Displays the voltage value or the CONFIG parameter setting.	–
9	PRESET		The LED of the preset memory in use illuminates.	4-22
10	CV		Illuminates during constant voltage mode.	4-7
11	OUTPUT LED		Illuminates when output is on and turns off when output is off.	4-2
12	ALARM LED		Illuminates when a protection circuit is activated.	4-8
13	RMT LED		Illuminates when operating in remote control.	4-24
14	EXT LED		Illuminates when operating in external analog remote control.	5-2
15	LOCK LED		Illuminates when panel operations except turning the output on/off and viewing settings.	4-24
16	SET		Switch with an LED for setting and checking the output voltage or output current.	4-7
	–	RECALL A	Switch for recalling the value of preset memory A	4-23
	A		Switch for saving the value to preset memory A. Press STORE and then A.	4-23
17	OVP•OCP		Switch with an LED for setting and checking the trip points of the overvoltage protection (OVP) and overcurrent protection (OCP).	4-9
	–	RECALL B	Switch for recalling the value of preset memory B	4-23
	B		Switch for saving the value to preset memory B. Press STORE and then B.	4-23
18	CONFIG		Switch with an LED for setting various conditions concerning the operation.	4-14
	–	RECALL C	Switch for recalling the value of preset memory C	4-23
	C		Switch for saving the value to preset memory C. Press STORE and then C.	4-23
19	–		–	–
		STORE	Switch for storing the preset memory	4-23
20	SHIFT		Switch for calling up the functions marked in blue characters.	vii
21	LOCAL		Switch for changing between remote and local modes.	4-24
		LOCK	Switch for disabling only the operations that change the settings (keeping the display and recall operations enabled).	4-24

Rear panel



No.	Name	Function	See Page
22	J1	Connector for external analog control.	5-2
23	J2	Connector for parallel operation.	6-4
24	Option slot	Slot for installing the optional interface board (GPIB, USB or LAN). A factory option.	7-6 7-7
25	Chassis terminal	Terminal used to ground the output.	3-6
26	DC OUTPUT	Output terminal.	3-4 3-6
27	Air outlet	Exhaust port for cooling.	2-3
28	AC INPUT	Input terminal.	2-6
29	Serial number	The serial number of the PAT.	–
30	Sensing terminal	A terminal used to connect the sensing wires.	4-25
31	Sensing switch	Switch for enabling/disabling remote sensing.	
32	RS232C	Connector for the RS-232C cable.	7-4

General Description

This chapter describes an overview and describes the features.

1.1 About This Manual

This manual describes the PAT-T Series regulated DC power supply.

Applicable firmware version of the PAT

See p. 2-8

This manual applies to PATs with firmware version 3.0x.

When making an inquiry about the product, please provide us with the following information.

- Model (indicated at the top section on the front panel)
- Firmware version
- Serial number (indicated at the bottom section on the rear panel)

See p. 7-17

This product information can also be obtained using the *IDN? remote control command.

1.2 Product Overview

The PAT is a low-noise, highly efficient Constant Voltage (CV)/Constant Current (CC) automatic crossover power supply that employs a software switching system.

Capable to expand the system up to a maximum output of 40 kW by the master-slave parallel operation.

Communication functions for remote control also come standard with the product.

Features

- **Reduction of harmonic current and power transmission loss**

  The power-factor improvement circuit reduces the effects of harmonic currents on the input power line. It also suppresses the peak current and reduces the power transmission loss.

- **Master-Slave parallel operation**

  Up to five power supplies can be connected in parallel to expand the output power to 40 kW.

- **Output limit function**

  You can set the upper limit of current and voltage that is applied when setting the output.
  This function is used to prevent setting inappropriate value by mistake.

- **Remote interface**

  Equipped with RS232C as standard. You can select the GPIB, USB or LAN interface as a factory option.

  The remote interface complies with IEEE 488.2 std 1992 and SCPI Specification 1999.0.

- **High efficiency and low noise**

  The PAT is a highly efficient, low-noise power supply that employs a software switching system.
  High power conversion efficiency has reduced the rise in the internal temperature and has contributed to the product's compact and light design.

- **Downsized input distribution device**

  The input distribution device (breaker) can be downsized, because the built-in power-factor improvement circuit reduces the required input current.

- **Preset memory function of settings**

  Up to three output setting presets (combination of current and voltage) can be saved.
  You can simply select a preset to set the output without having to set the voltage and current every time you use the PAT.

- **Output on/off delay function**

  You can set a delay until the output is actually turned on or off after turning the OUTPUT switch on or off.

  For example, this feature is useful if you want to turn the output on/off by setting a time offset according to the load characteristics.

Options

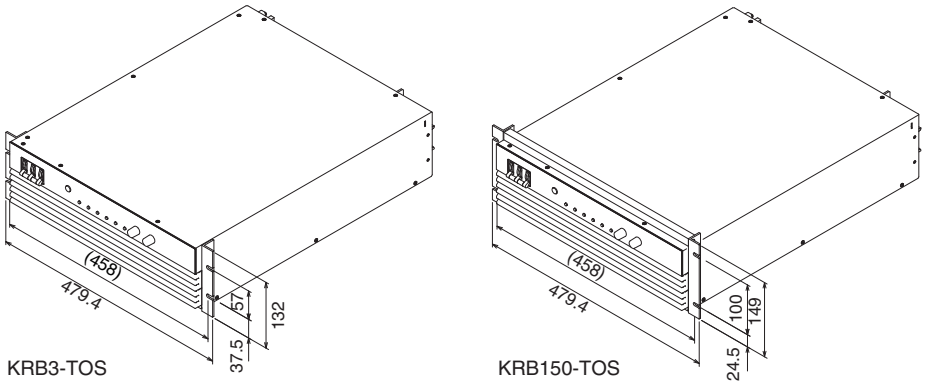
The options listed below are available for the PAT-T Series.

For details on the options, contact your Kikusui agent or distributor.

See p. 2-5

■ Rack mounting option

Product	Model	Note
Rack mount bracket	KRB3-TOS	Inch rack EIA standard
	KRB150-TOS	Milli rack JIS standard

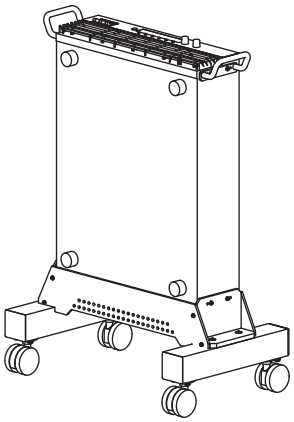


Unit: mm

■ Vertical stand

A vertical stand is used as a stand to hold the equiment in a vertical position.

Product	Model	Note
Vertical stand	VS01	580 W x 245 H x 350 Dmm(MAX) (Excluding the size of the equipment)

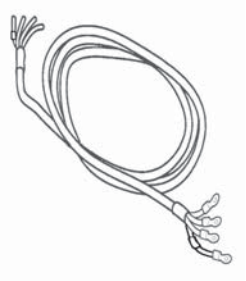


See p. 2-6

■ Power cable

A power cable to connect to the input terminal block on the rear panel.

Product	Model	Note
Power cable	AC8-4P4M-M6C	4 m 4 cores

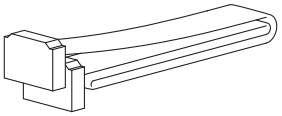


See p. 6-4

■ Cable for parallel operation

A cable used when performing parallel operation.

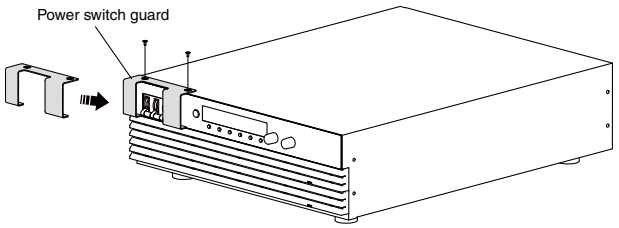
Product	Model	Note
Cable for parallel operation	PC01-PAT	250 mm 26 pins



■ Power switch guard

A power switch guard is to prevent accidental operation of the POWER switch.

Product	Model	Note
Power switch guard	OP01-PAT	–



Installation and Preparation

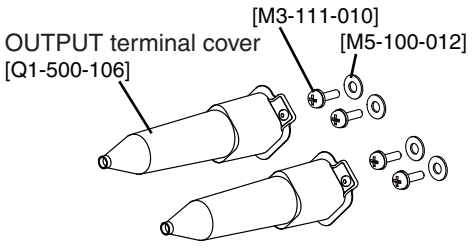
This chapter describes the procedures of unpacking and preparation of the PAT before use.

2.1 Checking the Package Contents

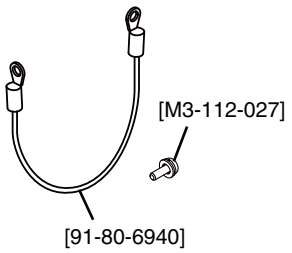
When you receive the product, check that all accessories are included and that the accessories have not been damaged during transportation.

If any of the accessories are damaged or missing, contact your Kikusui agent or distributor.

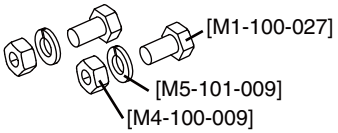
We recommend that all packing materials be saved, in case the product needs to be transported at a later date.



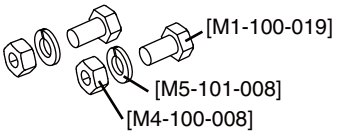
☐ OUTPUT terminal cover set (2 sets)



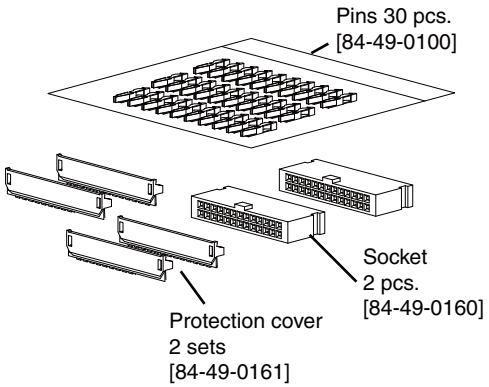
☐ Chassis connection wire set (1 set)



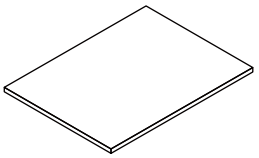
☐ Output terminal bolt (M12) (2 sets)
(PAT20-400T)



☐ Output terminal bolt (M10) (2 sets)
(PAT40-200T/60-133T/160-50T)



☐ J1/J2 connector kit



☐ Operation manual (1 pc)
[Z1-004-072]

Fig.2-1 Accessories

2.2 Precautions Concerning Installation

Be sure to observe the following precautions when installing the product.

- **Do not use the product in a flammable atmosphere.**

  To prevent the possibility of explosion or fire, do not use the product near alcohol, thinner or other combustible materials, or in an atmosphere containing such vapors.

- **Avoid locations where the product is exposed to high temperature or direct sunlight.**

  Do not install the product near a heater or in areas subject to drastic temperature changes.

  Operating temperature range: 0 ° C to +50 ° C
  Storage temperature range: -25 ° C to +70 ° C

- **Avoid humid environments.**

  Do not install the product in high-humidity locations–near a boiler, humidifier, or water supply.

  Operating humidity range: 20 %rh to 85 %rh (no condensation)
  Storage humidity range: 90 %rh or less (no condensation)

  Condensation may occur even within the operating relative humidity range. If this happens, do not use the product until the condensation dries up completely.

- **Be sure to use the product indoors.**

  This product is designed for safe indoor use.

- **Do not install the product in a corrosive atmosphere.**

  Do not install the product in a corrosive atmosphere or in environments containing sulfuric acid mist, etc. This may cause corrosion of various conductors and bad contacts of connectors leading to malfunction and failure, or in the worst case, a fire.
  However, operation in such environments may be possible through alteration. If you want to use the PAT in such environments, consult your Kikusui agent or distributor.

- **Do not install the product in a dusty location.**

  Accumulation of dust can lead to electric shock or fire.

- **Do not use the product where ventilation is poor.**

  The product employs a forced air cooling system. Air is taken in from the air inlet on the front panel and exhausted from the air outlet on the rear panel. Secure adequate space around the product to prevent the possibility of fire caused by accumulation of heat.
  Allow at least 20 cm of space between the air inlet/outlet and the wall (or obstacles). Hot air (approximately 20 ° C higher than the ambient temperature) is exhausted from the air outlet. Do not place objects that are affected by heat near the air outlet.

- **Do not place objects on the product.**

  Placing heavy objects on top of the product may cause failures.

- Do not install the product on an inclined surface or location subject to vibrations.

  The product may fall or tip over causing damages and injuries.

- Do not use the product in a location where strong magnetic or electric fields are nearby or a location where large amount of distortion and noise is present on the input power supply waveform.

  The product may malfunction.

- Do not use the product near highly sensitive measuring instruments or transceivers.

  The noise generated by the product may affect them.

2.3 Precautions to Be Taken When Moving the Product

Note the following points when moving the product or transporting the product to the installation location.

- Lower the POWER switch lever to turn it off.

  Moving the product while the POWER switch is turned on may cause electric shock or damage.

- Remove all wiring.

  Moving the product with the cables connected may cause wires to break or injuries due to the product falling over.

- When transporting the product, be sure to use the original packing materials.

  Otherwise, damage may result from vibrations or from the product falling during transportation.

- When moving the product, have more than one person carry it.

- Be sure to include this manual.

2.4 Rack Mounting the Product

See p. 1-4

Remove the rubber feet before rack mounting the product to a frame. Fig.2-2 shows how to remove the rubber feet.

For details on rack mounting, see the KRB3-TOS or KRB150-TOS Operation Manual.

Install the suitable support angles applying to the used rack system to support the instrument.

We recommend that you keep all the parts so that you can use them again when you detach the product from the frame.

To reattach the rubber feet, use the screws that you removed.

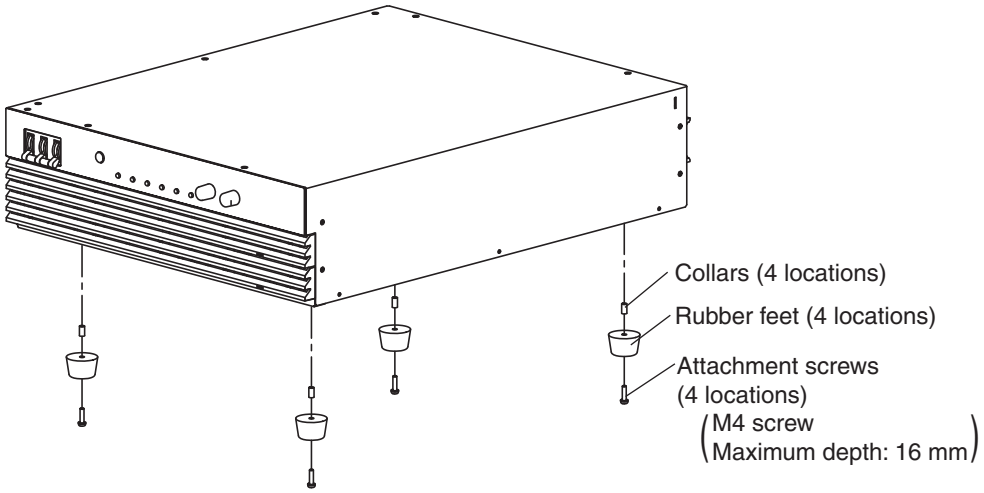


Fig.2-2 Removing the rubber feet

Removing the rubber feet

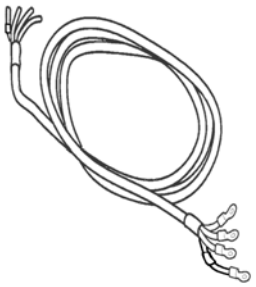
Unfasten the screws and remove the four rubber feet.

2.5 Connecting the Power Cable

This product is designed as an equipment of IEC Overvoltage Category II (energy-consuming equipment supplied from the fixed installation).

See p. 1-5

This product does not come with a power cable. In case the optional power cable (AC8-4P4M-M6C) is used, you can use it immediately as it is already assembled.



Three-phase power cable
(AC8-4P4M-M6C)

Fig.2-3 Optional power cable

Exercise the following precautions when preparing the power cable.

⚠WARNING

Possible electric shock.

- **Turn off the switchboard breaker (switch that cuts off the power supply from the switchboard) before making the connection.**
- **This product is an IEC Safety Class I equipment (equipment with a protective conductor terminal). Be sure to ground the product to prevent electric shock.**
- **Connect the ground terminal to earth ground.**
- **Be sure to have a qualified engineer connect the power cable to the switchboard.**

⚠CAUTION

- Inside the power supply, an appropriate protective circuit is connected to the input terminal. Be sure to connect the wires correctly by matching the U, V, W, and ⏚(GND) between the switchboard and the product.

NOTE

- The POWER switch of the product can be used to disconnect the product from the AC line in an emergency. Provide adequate space around the POWER switch so that the POWER switch can be turned off at any time.

Use a four-core PVC insulated cable with a nominal cross-sectional area of at least 8 mm^2 for 600 Vac.

Attach crimping terminals that comply with the terminal screws on the switchboard and connect the power cable firmly so that it does not come loose.

Connection procedure (when using the optional power cable)

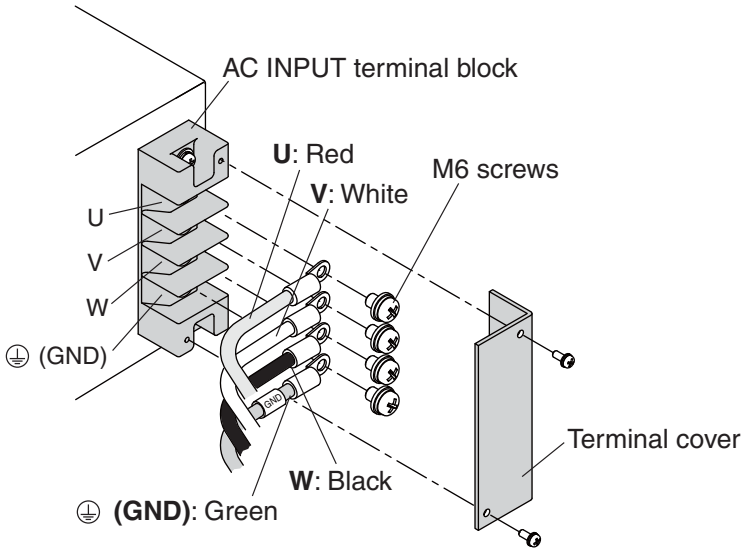


Fig.2-4 Connecting the power cable (example in which the optional power cable is used)

1. Check that the AC power supply meets the nominal input rating of the product.
   The voltage that can be applied is any of the nominal power supply voltages in the range of 200 Vac to 240 Vac. The frequency is 50 Hz or 60 Hz.
2. Check that the POWER switch is turned off.
3. Connect the power cable to the AC INPUT terminal block as shown in Fig.2-4
4. Attach crimping terminals to the switchboard end of the power cable.
5. Turn off the switchboard breaker.
6. Connect the power cable by matching the U, V, W, and ⏚(GND) of the switchboard.

Precautions Concerning Grounding (Earth)

Be sure to ground the product for your safety.

Make sure to connect the GND terminal of the AC INPUT terminal block to the GND terminal of the switchboard.

2.6 Turning On

⚠CAUTION

- The CONFIG parameters can be configured so that the output is automatically turned on when the POWER switch is turned on. When this function is enabled, the PAT powers up with the output turned on even if the output was off when the PAT was turned off the last time. However, there is a possibility that a load may break, if you connect a different load and turn the POWER and output on simultaneously without changing the OVP and OCP settings to appropriate values.

Turning the POWER switch on

1. Check that the power cable is correctly connected.
2. Raise the lever and turn the POWER switch on.

   If an odd sound, odd odor, fire, or smoke occurs around or in the PAT, lower the POWER lever to turn it off.
3. Check the firmware version on the front panel display.

   The voltmeter and ammeter show the PAT firmware version for approximately 1 second. The measuring value will be shown after the firmware version is displayed.

See p. 4-2

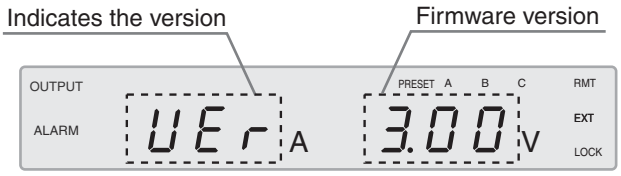


Fig.2-5 Firmware version display at power-on (example for Ver.3.00)

See p. 4-28

If the POWER switch is turned on for the first time after purchasing the PAT, the PAT starts up in a factory default condition.

Precautions Concerning Measurements

An inrush current (100 Amax.) flows when the POWER switch is turned on. In particular, check that sufficient current capacity is available in the AC power line and the switchboard if you are using multiple PATs and turning on the POWER switches simultaneously.

If front panel display shows indicated in Table 2-1 after power-on, follow the corresponding remedy. If the remedy does not correct the problem, contact your Kikusui agent or distributor.

Table 2-1 Panel display during and after power-on

Panel Display		Cause and Remedy
SYS1 ERR	SYS1 Err	The PAT may have malfunctioned. Contact your Kikusui agent.
SYS2 ERR	SYS2 Err	The calibration has not been completed normally. Recalibrate. If “SYS2 ERR” appears even after recalibration, the PAT may have malfunctioned. Contact your Kikusui agent.
CLR ABC	CLr ABC	Preset memories A, B, and C have been reset to factory default settings because the values were abnormal. To continue the operation, press any panel switch.
CLR SET	CLr SEt	The voltage and current calibration values have been reset to factory default settings, because the values were abnormal. To continue the operation, press any panel switch.
CLR CONF	CLr COnF	The CONFIG settings have been reset to factory default values, because the values were abnormal.To continue the operation, press any panel switch.

Turning the POWER switch off

Lower the POWER switch lever to turn it off.

When the POWER switch is turned off, the front panel display shows the characters indicated in the following figure for about 10 to 15 seconds.

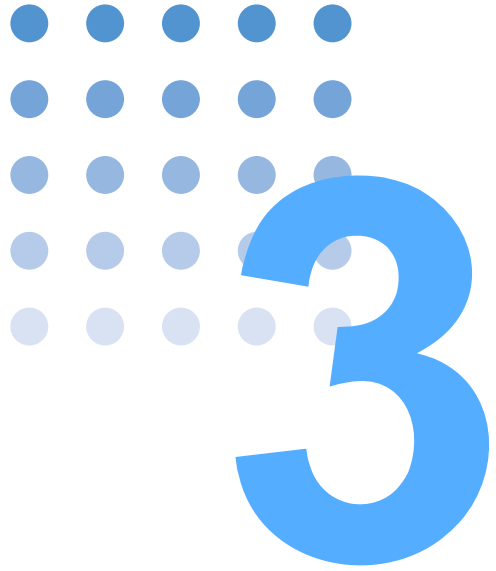
Fig.2-6 Display at power-off

The PAT stores the panel settings (excluding output on/off condition) immediately before the POWER switch is turned off. For these items, the PAT starts up using the settings that existed when the POWER switch was turned off the last time.

If the POWER switch is turned off immediately after changing the settings, the last settings may not be stored.

⚠CAUTION

- When turning the POWER switch off and then back on, allow at least 10 seconds after the fan stops. Repeated ON/OFF of the POWER switch at short intervals can cause damage to the inrush current limiter or shorten the service life of the POWER switch and the internal input fuse.



Connecting the Load

This chapter describes the consideration to be given to the load, explains how to connect the load wires, and explains how to connect to the output terminals.

3.1 Load Considerations

Note that the output will become unstable if the following types of loads are connected.

Load with peaks and pulse-shaped current

The PAT indicates only mean values. Even when the indicated value is less than the preset current value, the peak values may actually exceed the preset current value. If this happens, the PAT is instantaneously put into constant-current operation mode, and the output voltage drops accordingly.
For these types of loads, you must increase the preset current value or increase the current capacity.

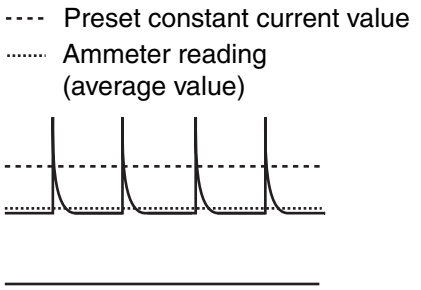


Fig.3-1 Load current with peaks

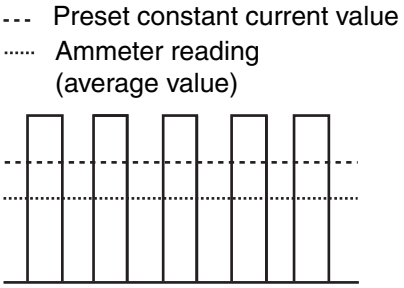


Fig.3-2 Pulse-shaped load current

Load that generates reverse current to the power supply

The PAT cannot absorb reverse current from the load. Therefore, if a regenerative load (such as an inverter, converter, or transformer) is connected, the output voltage increases and becomes unstable.
For these types of loads, connect a resistor R_D as shown in Fig.3-3 to bypass the reverse current. However, the amount of current to the load decreases by max. reverse current I_{rp}.

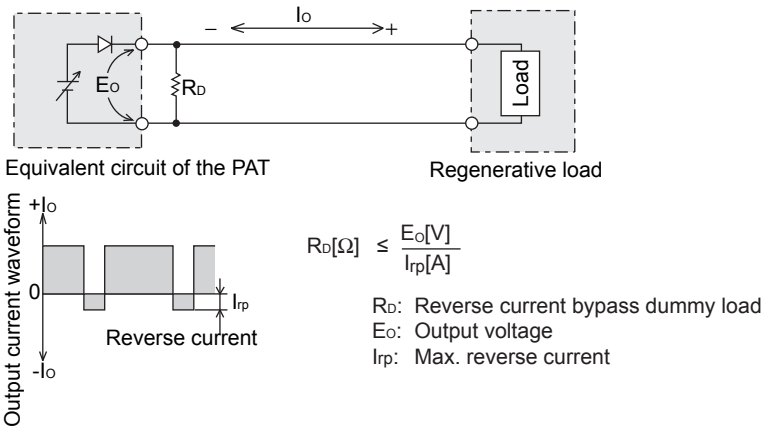


Fig.3-3 Remedy for regenerative load

⚠CAUTION

- Use a resistor with sufficient rated power for resistor R_D.
- If a resistor with insufficient rated power for the circuit is used, resistor R_D may burn out.

Load with accumulated energy

Connecting a load with accumulated energy, such as a battery, to the PAT may cause current to flow from the load to the internal circuit of the PAT. This current may damage the PAT or reduce the life of the battery.
For this type of loads, connect a reverse-current-prevention diode (D_{RP}) between the PAT and the load in series as shown in Fig.3-4.

This cannot be used in conjunction with remote sensing.

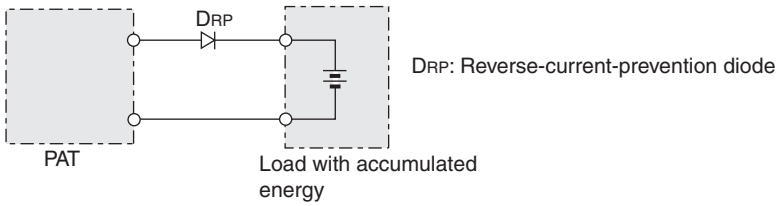


Fig.3-4 Remedy against load with accumulated energy

⚠CAUTION

- Use a reverse-current-prevention diode (D_{RP}) complied to the following references.
  Reverse voltage withstand capacity :
  At least twice the rated output voltage of the PAT.
  Forward current capacity :
  Three to ten times the rated output current of the PAT.
  A diode with small loss.
- Be sure to take into account the heat generated by reverse-current-prevention diode D_{RP}. Reverse-current-prevention diode D_{RP} may burn out with inadequate heat dissipation.

3.2 Load Cable

⚠WARNING To prevent the possibility of fire.

- **Use a load cable with sufficient current capacity with respect to the rated output current of the PAT.**
- **The output terminal and its area nearby gets very high temperature, use the cable with sufficient heat resistance higher than 85° C of the covering materials.**

Possible electric shock.

- **Use a load cable with a higher voltage rating than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 9, "Specifications."**

■ Current capacity of the load cable

If their current rating exceeds the maximum rated output current, the cable will remain intact even if the load is short-circuited. Load cables must be rated to carry the maximum rated output current of the PAT.

■ Allowable current of the cable dependent on the maximum allowable temperature of the cable insulation

The cable temperature is determined by a current-caused resistance loss, ambient temperature, and thermal resistance to the outside. Table 3-1 shows the allowable capacity of current that can flow through a heat-resistant PVC wire (single wire) having a maximum allowable temperature of 60 ° C when the wire is stretched horizontally in the air at an ambient temperature of 30 ° C. If the condition is such that PVC wires with lower heat-resistant temperature are used, the ambient temperature exceeds 30 ° C, or the wires are bundled resulting in low heat radiation, the current capacity needs to be reduced.

Table 3-1 Nominal cross-sectional area of cables and allowable currents

Nominal cross-sectional area [mm^2]	AWG	(Reference cross-sectional area) [mm^2]	Allowable current*1 [A] (Ta = 30 ° C)	Current recommended by Kikusui [A]
2	14	(2.08)	27	10
3.5	12	(3.31)	37	-
5.5	10	(5.26)	49	20
8	8	(8.37)	61	30
14	5	(13.3)	88	50
22	3	(21.15)	115	80
30	2	(33.62)	139	-
38	1	(42.41)	162	100
50	1/0	(53.49)	190	-
60	2/0	(67.43)	217	-
80	3/0	(85.01)	257	200
100	4/0	(107.2)	298	-
125	-	-	344	-
150	-	-	395	300
200	-	-	469	400

*1. Excerpts from Japanese laws related to electrical equipment.

■ Taking measures against noise

When connecting wires that have the same heat-resistant temperature, more current can flow by separating the wires to make heat radiation as great as possible. However, installing the + (pos.) and - (neg.) output wires of the load cable side by side or bundling them together is more effective against unwanted noise. The Kikusui-recommended currents shown in Table 3-1 are allowable current values that have been reduced in consideration of the potential bundling of load cables. Use these values as a guideline when connecting load cables.

■ Limitations of the sensing function

All wires have resistance. The voltage drop in wires becomes greater as the wire becomes longer or the current becomes larger. This results in the voltage applied at the load end to be smaller. The PAT has a sensing function that compensates for this voltage drop up to approximately 0.6 V for a single line. If the voltage drop exceeds this level, wires having a greater sectional area should be used.

3.3 Connecting to the Output terminal

⚠WARNING **Possible electric shock.**

- **Be sure to turn the POWER switch off before touching the output terminal.**
- **Be sure to attach the OUTPUT terminal cover after wiring the load.**

Connection procedure

After the installation of the OUTPUT terminal cover for the output terminal, the portion of the terminal cover is on top of the sensing terminal. In case the remote sensing is used, install the OUTPUT terminal cover after wiring of the sensing cable.

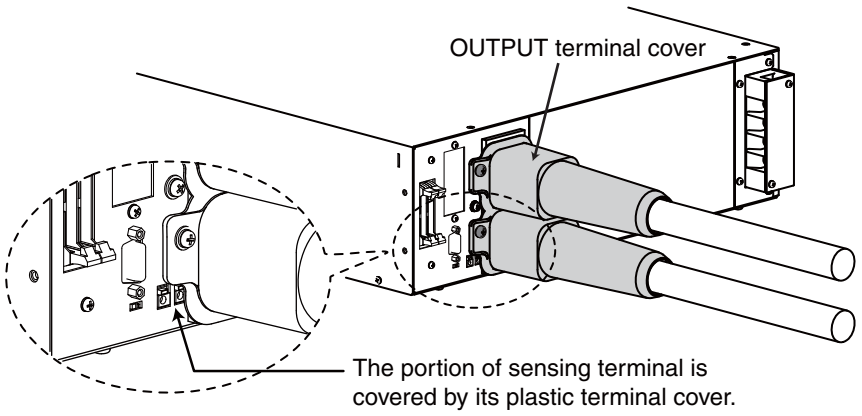


Fig.3-5 Attachment completion of the OUTPUT terminal cover

■ How to use the OUTPUT terminal cover for the output terminal

Cut the sleeve of the OUTPUT terminal cover for the appropriate size of the load cable which goes through its OUTPUT terminal cover.

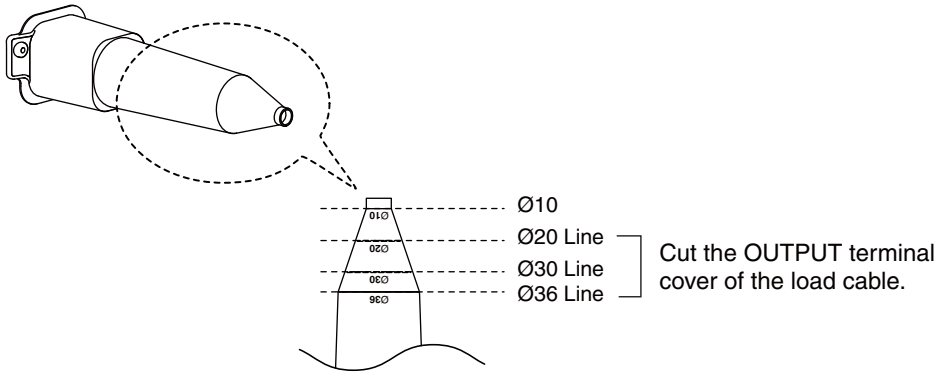


Fig.3-6 OUTPUT terminal cover

Connection preparation

1. Turn the POWER switch off.

2. Using the chassis connection wire set that comes with the package, connect the chassis terminal to either the negative or positive DC output terminal.

   The output terminal has a hole used to connect the chassis connection cable that comes with the package.

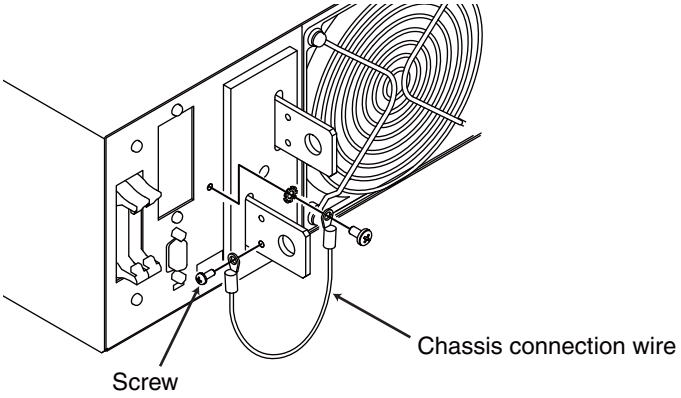


Fig.3-7 Connecting the chassis connection wire

3. Attach crimping terminals to the load cable.

   The output terminal has a hole for connecting the load cable. Attach the crimping terminal that matches the bolt used.

4. Insert the load cable through the OUTPUT terminal cover.

5. Connect the load cable on the rear panel.

   Insert the bolt for the positive (+) terminal from right side, and the negative (-) terminal from left side as you face, then fix it using the nut and spring washers. Connect the load cable straight forward (vertical angle against the surface of the output terminal).

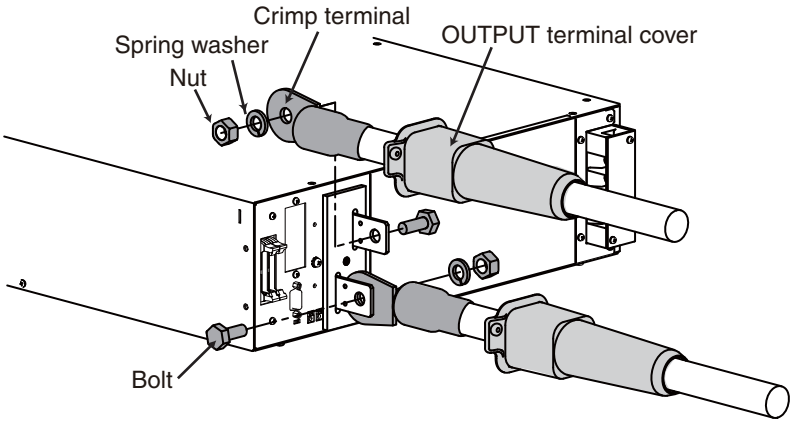


Fig.3-8 Connection of the load cable

6 Install the OUTPUT terminal cover on the rear panel.

Uses the attached screws to install the OUTPUT terminal cover firmly and make sure they are not loosen.

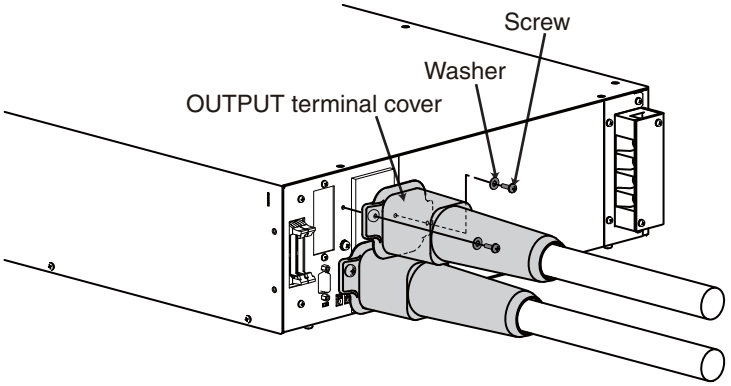


Fig.3-9 Attachment of the OUTPUT terminal cover

Basic Operation

This chapter describes how to turn on/off the output and the basic operations that you can carry out from the front panel.

4.1 Measured Value Display and Setting Display (Setting the Output Voltage and Output Current)

The panel display has two modes. One mode displays the measured values of the output voltage and output current, and the other mode displays the settings. These two modes can be distinguished by the on/off state of the SET, OVP•OCP, and CONFIG switches.

■ Measured value display

The measured value display shows the present output terminal voltage and load current. In this mode, the LEDs of the SET, OVP•OCP, and CONFIG switches are all off.

See p. 4-7

You can change the output voltage and current settings in the measured value display mode.

Fig.4-1 Measured value display example

■ Setting display

The following three states are available.

- Setting display of the output voltage and output current

  Press the SET switch. The switch LED illuminates. The present output voltage and current are displayed.

Fig.4-2 Setting display example of the output voltage and output current

See p. 4-22

If you save or recall a preset memory, the panel display shows the preset memory values.

- Setting display of the overvoltage and overcurrent protection

  Press the OVP•OCP switch. The switch LED illuminates. The present overvoltage and overcurrent settings are displayed.

Fig.4-3 Setting display example of the overvoltage and overcurrent protection

- Setting display of the system configuration

  Press the CONFIG switch. The switch LED illuminates.The system configuration settings are displayed.

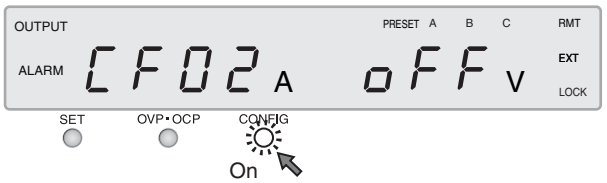


Fig.4-4 Setting display example of the system configuration

4.2 Output Operation

The OUTPUT switch is a toggle switch.

When you press the OUTPUT switch and the output turns on, the OUTPUT LED illuminates. When you press the OUTPUT switch and the output turns off, the OUTPUT LED turns off.

If the output is turned on, the present setting is output. If you change the setting while the output is on, the change is applied to the output.

See p. 5-17

It is possible to control on/off of the output by external control.

Fig.4-5 Output on display example

Output on/off when power is turned on

By factory default, the output is off when the power is turned on. You can set the output state at power-on to on (CF25: ON) in the CONFIG settings.

If you set the output state at power-on to on, check the OVP trip point setting before you turn off the POWER switch.

If you set the breaker trip setting that is applied when an OVP or OCP activates is set to “trip” (CF28: ON) and the OVP trip point is set lower than the output voltage setting, the OVP will activate every time you turn the POWER switch on and the POWER switch will turn off.

See p. 4-28

If the condition above occurs and you are unable to change any of the settings, turn the POWER switch on while holding down the SHIFT switch to reset the PAT to factory default settings.

⚠CAUTION

- If the OVP/OCP settings are not appropriate when you change the load, the load may break.

Output on/off delay functions

See p. 4-16
p. A-20

You can set a delay (0.1 s to 10.0 s) until the output is actually turned on or off after you turn the OUTPUT switch on or off. This function is useful if you want to turn the output on/off by setting a time offset according to the load characteristics.

To enable this function, set the output on delay (CF10: 0.1 to 10.0) and output off delay (CF11: 0.1 to 10.0) of the CONFIG parameter. You can set separate delays for on and off.

The OUTPUT LED blinks while the output on/off delay function is in operation.

Press the OUTPUT switch while the OUTPUT LED is blinking to cancel the output on/off delay.

Press the OUTPUT switch while holding down the SHIFT switch while the OUTPUT LED is blinking to cancel the output on/off delay and forcibly switch the output.

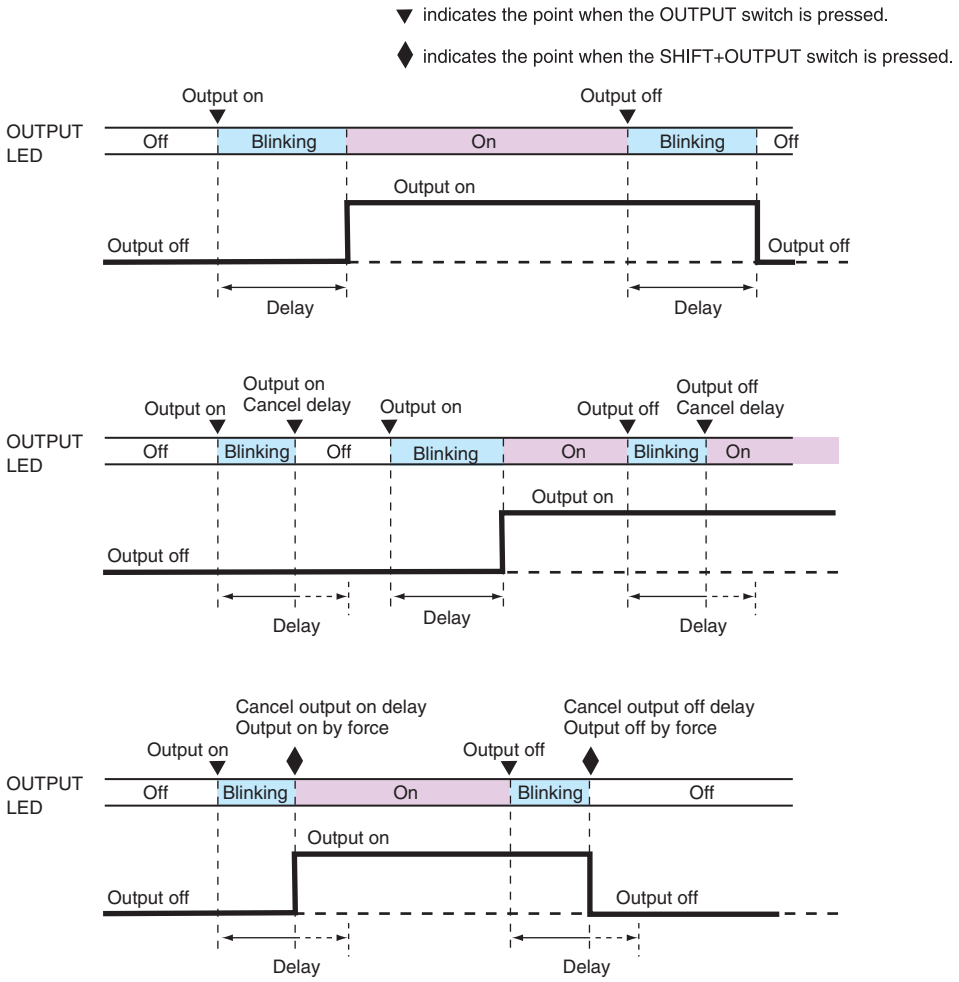


Fig.4-6 Output on/off delay action

4.3 Constant Voltage (CV) and Constant Current (CC) Power Supplies

The PAT has a constant voltage power supply function that maintains the output voltage at a constant level and a constant current power supply function that maintains the output current at a constant level even when the load changes. The condition in which the PAT is operating as a constant voltage power supply is called the constant voltage (CV) mode. The condition in which the PAT is operating as a constant current power supply is called the constant current (CC) mode. The operation mode is determined by the following three values.

- Preset output voltage (Vs)
- Preset output current (Is)
- Load resistance (R_L)

The operation modes are described below.

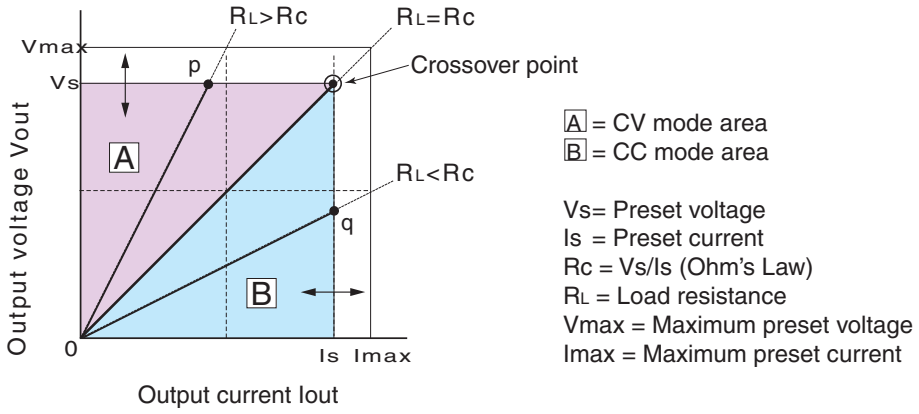


Fig.4-7 Constant voltage operation and constant current operation

Fig.4-7 shows the operation modes of the PAT. We denote the load resistance as R_L and the resistance calculated from the preset current and voltage as Rc (Rc = Vs/Is). The power supply is designed so that it operates in CV mode in area A and CC mode in area B. The boundary is the line defined by R_L = Rc. This line represents the load at which the output voltage and the preset voltage are equal and the output current and preset current are equal. If load resistance R_L is greater than resistance Rc, the operating point is in area A, and the PAT operates in CV mode (point p). In this case, preset current Is is the current limit.

When operating in CV mode, the output voltage is maintained at the preset voltage. Output current I is determined by the relationship defined by the equation I = Vs/R_L. It is a current less than current limit Is. In this mode, the actual current that flows is not necessarily equal to the specified value.

For loads in which transient peak current flows, preset current Is must be set so that the peak value does not reach the current limit.

Conversely, if load resistance R_L is less than resistance Rc, the operating point is in area B, and the PAT operates in CC mode (point q). In this case, preset voltage Vs is the voltage limit.

When operating in CC mode, the output current is maintained at the preset current. Output voltage V is determined by the relationship defined by the equation V = Is × RL. It is a voltage less than voltage limit Vs. In this mode, the actual voltage that is applied is not necessarily equal to the specified value.

For loads that generate transient surge voltage, preset voltage Vs must be set so that the surge voltage does not reach the voltage limit.

■ Crossover point

CV mode and CC mode switch automatically according to the changes in the load. The point at which the mode switches is called the crossover point.

For example, if the load changes and the output current reaches the current limit when operating in CV mode, the operation mode automatically switches to CC to protect the load. Likewise, if the output voltage reaches the voltage limit when operating in CC mode, the operation mode automatically switches to CV.

CV and CC mode operation example

This section uses a power supply with a rated output voltage of 100 V and a rated output current of 10 A as an example.

A load resistance (RL) of 8 Ω is connected to the output terminals of the power supply. The output voltage and output current are set to 30 V and 5 A, respectively. In this case, Rc = 30 V/5 A = 6 Ω. Since, 8 Ω is greater than 6 Ω (RL > Rc), the operation mode is CV. If you want to increase the voltage in CV mode, the voltage can be increased up to the voltage defined by the following equation: Vs = Is × RL. Substituting the values, we obtain Vs = 5A × 8 Ω = 40 V. If you try to increase the voltage above this point, the crossover point is reached, and the operation mode automatically switches to CC mode. To maintain CV mode, increase the current limit.

Next a load resistance (RL) of 5 Ω is connected to the output terminals of the power supply. The output voltage and output current are set to 30 V and 5 A, respectively. In this case, Rc = 30 V/5 A = 6 Ω. Since, 5 Ω is less than 6 Ω (RL < Rc), the operation mode is CC. If you want to increase the current in CC mode, the current can be increased up to the current defined by the following equation: Is = Vs/RL. Substituting the values, we obtain Is = 30 V/5 Ω = 6 A. If you try to increase the current above this point, the crossover point is reached, and the operation mode automatically switches to CV mode. To maintain CC mode, increase the voltage limit.

4.4 Using the PAT as a CV or CC Power Supply (Setting the Output Voltage and Output Current)

When using the PAT as a constant voltage power supply, the preset current is the limit that can flow through the load.

When using the PAT as a constant current power supply, the preset voltage is the limit that can be applied to the load.

If the specified limit is reached, the operation mode automatically switches. If the operation mode switches, the CV LED or CC LED changes to indicate the switch.

1. Turn the POWER switch off.
2. Connect the load to the output terminal.
3. Turn the POWER switch on.

   If the OUTPUT LED on the display is illuminated, press the OUTPUT switch to turn the output off.
4. Check that the SET switch is illuminated.

   If it is not, press the SET switch so that you can set the voltage and current.
5. Turn the VOLTAGE knob to set the voltage.
6. Turn the CURRENT knob to set the current.
7. Press the OUTPUT switch.

   The OUTPUT LED on the display illuminates, and the voltage and current are delivered to the output terminal.

   The CV LED illuminates when the PAT is operating as a constant voltage power supply.

   The CC LED illuminates when the PAT is operating as a constant current power supply.

You can set the voltage and current by carrying out step 5 and step 6 while checking the actual output voltage or current with the output turned on.

Fine adjustment function

This function increases the resolution of the VOLTAGE and CURRENT knobs. By turning the VOLTAGE or CURRENT knob while holding down the SHIFT key, you can set the value using finer resolution.

The display resolution of the preset voltage and preset current does not change even if you use the fine adjustment function. Therefore, the displayed value may not change even if you turn the knob. The display changes when the amount of change reaches the minimum displayed digit of the preset voltage or current.

4.5 Protection Functions and Alarms

The PAT is equipped with the following protection function.

- Overvoltage protection (OVP)
- Overcurrent protection (OCP)
- Overheat protection (OHP)
- Overheat protection of the bleeder circuit (BOHP)
- Fan failure protection (FAN)
- Incorrect sensing connection protection (SENSE)
- Input open-phase protection (PHASE)
- Shut down (SD)

Alarm occurrence and release

Alarm occurrence

When a protection function activates, the PAT behaves as follows:

- The output turns off.

  For the overvoltage protection (OVP), overcurrent protection (OCP), and shutdown (SD), you can select breaker trip in the CONFIG settings.

See p. 4-19

- The ALARM LED on the front panel display illuminates, then the cause of alarm occurrence and the current measuring value displays alternately.

  When the breaker trip is selected in overvoltage protection (OVP) or overcurrent protection (OCP) or shutdown (SD), the front panel display shows the characters indicated as power off respectively for about 10 to 15 seconds.

See p. 4-10 to p. 4-13

- The ALARM signal is output from pin 5 of the J1 connector.

  The ALARM signal is delivered 10 to 15 seconds even if the breaker is tripped.

■ Verifying the cause of alarm occurrence

When the “cause of alarm occurrence” and the “present measuring value” displays alternately, you can change the status of display by pressing the switch specified as follows. It is helpful to verify the cause of alarm occurrence. Note that the displayed setting value can not be changed.

See p. 4-16

CONFIG switch	Displays “the cause of alarm occurrence” and “the parameter number of alarm cause display (CF01).”
SET switch	Displays “the cause of alarm occurrence” and “the present setting value.”
OVP•OCP switch	Displays “the cause of alarm occurrence” and “the setting value of OVP/OCP trip point.”

Releasing the alarm

■ When the breaker trips (when the POWER switch turns off)

After eliminating the cause of the alarm occurrence, turn on the POWER switch.

■ When the output turns off

Turn off the POWER switch, eliminate the cause the alarm occurrence, and then turn the POWER switch back on.

If you cannot clear the alarm even when all of the causes of the alarm occurrence are eliminated, the PAT may have malfunctioned. If this happens, stop using the PAT and contact your Kikusui agent or distributor.

See p. 4-9, p. 4-12

The cause of the alarm occurrences are described in the protection functions.

4.5.1 Overvoltage protection (OVP) and overcurrent protection (OCP)

The overvoltage protection (OVP) and overcurrent protection (OCP) functions activate under the following conditions.

■ Conditions in which the OVP is activated

- When the output terminal voltage exceeds the specified voltage (OVP trip point).
- When the sensing wire comes loose.
- When there is a problem with the PAT.

■ Conditions in which the OCP is activated

- When the output current exceeds the specified current (OCP trip point).
- When there is a problem with the PAT.

The user must set appropriate values for the OVP and OCP trip points. Be sure to first set the OVP and OCP trip points to comply with the load immediately after installing the PAT or changing the load.

Breaker trip function when the OVP or OCP is activated

See p. 4-19

You can select whether to trip the breaker (CF28: ON/OFF) when the OVP or OCP function activates.

OVP and OCP trip point settings

The OVP operates on the output terminal voltage. If you want to activate the function on the voltage across the load, set the OVP trip point by considering the voltage drop in the load cable.

1 Press the OVP•OCP switch.

The OVP•OCP switch LED illuminates, and the specified OVP/OCP trip point is shown on the display.

See p. 9-4

2 While viewing the panel display, turn the VOLTAGE knob to set the OVP trip point or the CURRENT knob to set the OCP trip point.

If the voltage setting is limited in the CONFIG settings (CF29: ON), the OVP trip point cannot be set lower than the present preset output voltage.

If the current setting is limited in the CONFIG settings (CF30: ON), the OCP trip point cannot be set lower than the present preset output current.

Setting limit function

The PAT allows limits to be placed on the voltage and current settings through CONFIG settings so that the overvoltage protection (OVP trip point) and the overcurrent protection (OCP trip point) settings are not exceeded.

This function prevents the output from being turned off when you accidentally set the voltage or current to a value exceeding the OVP or OCP when the output is on.

If you select to limit the voltage setting (CF29: ON), the output voltage can no longer be set to a value to approximately 95% of the OVP trip point. In addition, the OVP trip point can no longer be set to a value less than the preset output voltage.

If you select to limit the current setting (CF30: ON), the output current can no longer be set to a value to approximately 95% of the OCP trip point. In addition, the OCP trip point can no longer be set to a value less than the preset output current.

Checking the OVP or OCP operation

The OVP or OCP is a function for protecting the load. Once you set the OVP or OCP trip point, check that the OVP or OCP works before you connect the load by carrying out the procedure below.

If the voltage limit setting is enabled in the CONFIG settings (CF29: ON), the output voltage cannot be set higher than the OVP trip point. Thus, you will not be able to check the OVP operation.

If the current setting limit is enabled in the CONFIG settings (CF30: ON), the output current cannot be set higher than the OCP trip point. Thus, you will not be able to check the OCP operation.

1 Check that the OUTPUT LED on the display is not illuminated.

2 Set the output voltage to a value less than the OVP trip point.

3 Press the OUTPUT switch to turn the output on.

The OUTPUT LED illuminates.

4 Turn the VOLTAGE knob slowly clockwise.

When the setting value of output voltage exceeds OVP trip point, the ALARM LED on the front panel display illuminates and either of the POWER switch or the output will be turned off (Depending on the CONFIG settings).

When the POWER switch is turned off, the ALARM LED illuminates even the power turns off, and the Power-off display of the over voltage protection (OVP) will be displayed for about 10 to 15 seconds. When the output is turned off, OVP function display and the measuring value are displayed alternately and the ALARM LED continues to be illuminated.

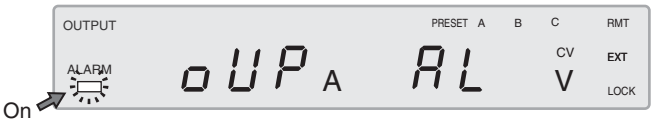


Fig.4-8 Alarm display of the overvoltage protection (OVP)

Fig.4-9 Power-off display of the overvoltage protection (OVP)

5 Check that the POWER switch is turned off.

Make sure that the POWER switch is in "off" position.

6 Short the output terminal.

7 Turn the POWER switch on again.

8 Check that the OUTPUT LED on the display is not illuminated.

9 Set the output current to a value less than the OCP trip point.

10 Press the OUTPUT switch to turn the output on.

The OUTPUT LED illuminates.

11 Turn the CURRENT knob slowly clockwise.

When the setting value of output current exceeds OCP trip point, the ALARM LED on the front panel display illuminates and either of the POWER switch or the output will be turned off (Depending on the CONFIG settings).

When the POWER switch is turned off, the ALARM LED illuminates even the power turns off, and the Power off display of the over current protection (OCP) will be displayed for about 10 to 15 seconds. When the output is turned off, OCP function display and the measuring value are displayed alternately and the ALARM LED continues to be illuminated.

Fig.4-10 Alarm display of the overcurrent protection (OCP)

Fig.4-11 Power-off display of the overcurrent protection (OCP)

If you do not change the preset output, the OVP or OCP will activate again.

4.5.2 Other Protection Functions

Overheat protection (OHP)
Overheat protection of the bleeder circuit (BOHP)

This function is activated when the internal temperature of the PAT rises abnormally, and the output turns off.
It protects the PAT from the following conditions.

- When the PAT is used in an environment exceeding the operation temperature range
- When the PAT is used with the intake or exhaust port blocked

If you turn the POWER switch back on without correcting the condition that caused the OHP or BOHP, the OHP or BOHP will be activated again.

Fig.4-12 Alarm display of the overheat protection (OHP)

Fig.4-13 Alarm display of the overheat protection of the bleeder circuit (BOHP)

Fan failure protection (FAN)

This function is activated when the fan rotation drops to an abnormal level, and the output turns off.

Fig.4-14 Alarm display of fan failure protection (FAN)

Incorrect sensing connection protection (SENSE)

This function is activated when the remote sensing wires are connected with the polarity reversed of + (pos.) and - (neg.), and the output turns off.

Fig.4-15 Alarm display of incorrect sensing connection protection (SENSE)

Input open-phase protection (PHASE)

Three-phase input power supply may operate normally even when one of the phase is open. However, operating the PAT in an open-phase condition puts stress on the PAT and may cause a malfunction.

To prevent a malfunction from abnormal input, this function is activated when one or more phase is open among the three-phase input, and the turns off.

Fig.4-16 Alarm display of input open-phase protection (PHASE)

Shutdown (SD)

See p. 5-19

Shutdown is not activated as a result of the PAT detecting an error. It is a function used to turn off the output by applying an external signal to the J1 connector on the rear panel when an abnormal condition occurs.

See p. 4-19

You can select whether to trip the breaker (CF27: ON/OFF) when the shutdown signal is applied.

Fig.4-17 Power-off display of the shutdown (SD)

4.6 CONFIG Settings

CONFIG settings are used to set the system configuration of the PAT. You can set or display the parameters in Table 4-1 in the CONFIG settings. On the top panel of the PAT is a label that indicates a list of CONFIG parameters and settings.

Table 4-1 CONFIG parameters

Parameter number	Indication on the top panel label	Description of the setting or display
CF01	ALARM	Alarm cause display
CF02	REMOTE SENSING	Remote sensing status display
CF10	ON DELAY	Output on delay setting
CF11	OFF DELAY	Output off delay setting
CF12	PRESET KEYLOCK	Preset recall setting while locked
CF13	ERR TRACE	Communication error display setting*1
CF20	CV CONTROL	CV control source setting*2
CF21	CC CONTROL	CC control source setting*2
CF22	EXT OUT CTRL	External control logic setting of the output on/off*2
CF23	PWR ON/OFF STATUS	Status signal setting of the power on/off*1
CF24	PARALLEL	Setting the number of units in Master-Slave Parallel Operation*2
CF25	POWER ON OUTPUT	Output status setting at power-on
CF26	MASTER/SLAVE	Master-slave parallel operation setting*1, *2
CF27	BREAKER TRIP (SD)	Breaker trip setting when the shutdown signal is applied*1
CF28	BREAKER TRIP	Breaker trip setting when the OVP or OCP is activated*1
CF29	V SETTING LIMIT	Voltage limit setting*2
CF30	I SETTING LIMIT	Current limit setting*2
CF40	BAUDRATE	RS232C data rate setting*1
CF41	DATABITS	RS232C data length setting*1
CF42	STOPBITS	RS232C stop bit setting*1
CF43	FLOW	RS232C flow control setting*1
CF50	VERSIOIN	Interface version display*3
CF51	GPIB ADDRESS	GPIB address setting*4
CF52	VENDOR ID	Vendor ID display*5
CF53	PRODUCT ID	Product ID display*5
CF54	ADDON I/F	Remote interface setting*1, *3
CF55	DHCP CLIENT	DHCP setting*6
CF56	AUTO IP ADDRESS	AUTO IP address setting*6
CF57	IP ADDRESS (1)	IP address display (1)*6
CF58	IP ADDRESS (2)	IP address display (2)*6
CF59	IP ADDRESS (3)	IP address display (3)*6
CF60	IP ADDRESS (4)	IP address display (4)*6
CF61	LAN STATUS	LAN status display*6

*1. The setting is possible even when the product is used as a slave unit.
*2. Cannot be set when the output is on.
*3. Only when the factory option GPIB, USB or LAN interface is installed.
*4. Only when the factory option GPIB interface is installed.
*5. Only when the factory option USB interface is installed.
*6. Only when the factory option LAN interface is installed.

Setup and view procedure of CONFIG parameters

CF01, CF02, CF50, CF52, CF53 and CF57 to CF61 are parameters only for viewing the status. You cannot set them.

CF50 to CF61 appear only when the option board is installed. The display of the setting varies depending on the interface option.

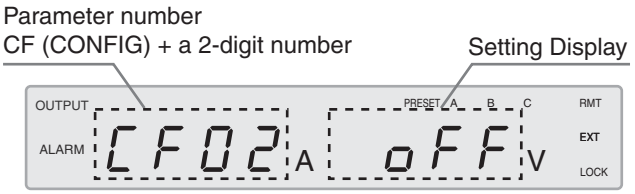


Fig.4-18 CONFIG parameter display example

1 Press the CONFIG switch.

The switch LED illuminates. The ammeter displays the parameter number, and the voltmeter displays the present setting.

2 Turn the CURRENT knob to select the parameter number.

3 Turn the VOLTAGE knob to change the setting.

If you select a new setting, it blinks.

When the setting is blinking, the new setting is not entered until you press a switch. If you do not want to change the setting, turn the VOLTAGE knob and select the setting that illuminates (not blinking) to return to the original setting.

You cannot set CF20, CF21, CF22, CF24, CF26, CF29, and CF30 when the output is on. The present setting is displayed, but it cannot be changed even if you turn the VOLTAGE knob.

4 To set or display other parameters, repeat step 2 and step 3 .
To exit from the CONFIG settings, proceed to step 5 .

5 Press any of the switch from SET, OVP•OCP, CONFIG or OUTPUT switch. If it is set to the slave unit, press CONFIG switch.

It will exit from the CONFIG setting to reflect the setting conditions.

Even when the POWER switch is turned off, the setting description will be reflected.

CONFIG parameter details

CF01 Alarm cause display

Displays the cause of the alarm occurrence (while the ALARM LED is illuminated). If there are multiple causes, the sum of each cause is displayed.

Display	Description
0	Not an alarm condition (ALARM LED is off)
1	Overvoltage protection (OVP)
2	Overcurrent protection (OCP)
4	overheat protection (OHP)
8	Input open-phase protection (PHASE)
16	Incorrect sensing connection protection (SENSE)
32	Fan failure protection (FAN)
64	Shut down (SD)
128	Overheat protection of the bleeder circuit (BOHP)

CF02 Remote sensing status display

See p. 4-25

Displays the state of the sensing switch on the rear panel.

Display	Description
oFF	Remote sensing is off
on	Remote sensing is on

CF10 Output on delay setting

See p. 4-4

Set the delay from the time the OUTPUT switch is pressed until the output turns on.

When exiting from the CONFIG settings by the OUTPUT switch, the output on delay function is activated at the some time for which setting conditions were set by the output on delay settings.

Settings	Description
oFF	No delay (factory default)
0.1 to 10.0	Output on delay. Unit: s, resolution: 0.1

CF11 Output off delay setting

See p. 4-4

Set the delay from the time the OUTPUT switch is pressed until the output turns off.

When exiting from the CONFIG settings by the OUTPUT switch, the output off delay function is activated at the some time for which setting conditions were set by the output off delay settings.

Settings	Description
oFF	No delay (factory default)
0.1 to 10.0	Output off delay. Unit: s, resolution: 0.1

CF12 Preset recall setting while locked

See p. 4-24

Sets whether preset memory values can be recalled even when the lock function is enabled.

Settings	Description
0	Able to recall preset memory values in the locked condition
1	Unable to recall preset memory values in the locked condition (factory default)

CF13 Communication error display setting

See p. A-26

Sets whether to display communication errors by performing a device trace. Displays the error number when the PAT is in remote mode, and there is at least one error in the SCPI error queue. The setting is possible even when the product is used as a slave unit.

Fig.4-19 Error display example (Err-100 example)

Settings	Description
oFF	Not display communication errors (factory default)
on	Display communication errors

CF20 CV control source setting

See p. 5-9, p. 5-11

Selects the constant voltage control mode. Cannot be set when the output is on.

Settings	Description
0	Panel control (factory default)
1	External voltage control
2	External resistance control 10 kΩ → MAX OUT
3	External resistance control 10 kΩ → 0 OUT (FAIL SAFE)

CF21 CC control source setting

See p. 5-13, p. 5-15

Select the constant current control mode. Cannot be set when the output is on.

Settings	Description
0	Panel control (factory default)
1	External voltage control
2	External resistance control 10 kΩ → MAX OUT
3	External resistance control 10 kΩ → 0 OUT (FAIL SAFE)

CF22 External control logic setting of the output on/off

See p. 5-17

Sets the logic used to control the output on/off using an external contact (J1 connector). Cannot be set when the output is on.

Select “H” when not controlling the output on/off with an external contact.

Settings	Description
H	Turn the output on with a high signal (factory default)
L	Turn the output on with a low signal

CF23 Status signal setting of the power on/off

See p. 5-22

Sets whether to output a low level signal while the power is on or off when monitoring the power on/off status externally (through the J1 connector). The setting is possible even when the product is used as a slave unit.

Settings	Description
0	Output a low level signal while the power is on (factory default)
1	Output a low level signal for 10 to 15 s when the power is off

CF24 Setting the number of units in Master-Slave Parallel Operation

See p. 6-2

Sets the total number of units which consists of the master unit and the slave units under the Master-Slave Parallel Operation. However, it can not be set when the output is turned on.

Settings	Description
1 to 5	Setting the total number of units 1 (factory default) to 5

CF25 Output status setting at power-on

See p. 4-3

Sets the output state when the POWER switch is turned on. This setting is invalid when the output is turned off using an external contact.

Settings	Description
oFF	Output is off at power-on (factory default)
on	Output is on at power-on

CF26 Master-Slave parallel operation setting

See p. 6-6

Sets the PAT condition during master-slave parallel operation. Cannot be set when the output is on. The setting is possible even when the product is used as a slave unit.

Settings	Description
0	Master unit or independent operation (factory default)
1	Slave unit

CF27 Breaker trip setting when the shutdown signal is applied

See p. 4-13

Sets whether to trip the breaker (turn the POWER switch off) when an external shutdown (SD) signal is applied. The setting is possible even when the product is used as a slave unit.

Settings	Description
oFF	Not trip (turn the output off) (factory default)
on	Trip (turn the POWER switch off)

CF28 Breaker trip setting when the OVP or OCP is activated

See p. 4-9

Sets whether to trip the breaker (turn the POWER switch off) when the overvoltage protection (OVP) or overcurrent protection (OCP) is activated. The setting is possible even when the product is used as a slave unit.

Settings	Description
oFF	Not trip (turn the output off) (factory default)
on	Trip (turn the POWER switch off)

CF29 Voltage limit setting

See p. 4-10

Sets whether to limit the output voltage setting so that it does not exceed the overvoltage protection setting (to approximately 95% of the OVP trip point) Cannot be set when the output is on.

Settings	Description
oFF	Not limit (factory default)
on	Limit

CF30 Current limit setting

See p. 4-10

Sets whether to limit the output current setting so that it does not exceed the overcurrent protection setting (to approximately 95% of the OCP trip point) Cannot be set when the output is on.

Settings	Description
oFF	Not limit (factory default)
on	Limit

CF40 RS232C data rate setting

See p. 7-4

Sets the baud rate of RS232C. The setting is possible even when the product is used as a slave unit.

Settings	Description
1.2	1200 bps
2.4	2400 bps
4.8	4800 bps
9.6	9600 bps
19.2	19200 bps (factory default)
38.4	38400 bps

CF41 RS232C data length setting

See p. 7-4

Sets the RS232C data length. The setting is possible even when the product is used as a slave unit.

Settings	Description
7bIt	7 bits
8bIt	8 bits (factory default)

CF42 RS232C stop bit setting

See p. 7-4

Sets the RS232C stop bit. The setting is possible even when the product is used as a slave unit.

Settings	Description
1bIt	1 bit (factory default)
2bIt	2 bits

CF43 RS232C flow control setting

See p. 7-4

Sets whether to perform flow control of RS232C. The setting is possible even when the product is used as a slave unit.

Settings	Description
oFF	Disable flow control
on	Enable flow control (factory default)

CF50 Interface version display

Displays the version of the factory option interface. Displayed only when the interface is installed.

Display	Description
1.00	Interface version

CF51 GPIB address setting

See p. 7-6

Sets the GPIB address. The settings are displayed only when the factory option GPIB interface is installed.

Settings	Description
1 to 30	Specify the address between 1 (factory default) and 30

CF52 Vendor ID display

Displays the vendor ID. Displayed only when the factory option USB interface is installed.

Display	Description
0b3E	0x0B3E

CF53 Product ID display

Displays the product ID. Displayed only when the factory option USB interface is installed.

Display	Description
100E	0x100E

CF54 Remote interface setting

Sets the remote interface that is to be used. Displayed only when the factory option interface is installed. The displayed settings vary depending on the installed interface option. The setting is possible even when the product is used as a slave unit.

The installed interface becomes the default.

When the GPIB interface is installed

Settings	Description
232C	Use RS232C for the remote interface
GPib	Use GPIB for the remote interface (factory default)

When the USB interface is installed

Settings	Description
232C	Use RS232C for the remote interface
uSb	Use USB for the remote interface (factory default)

When the LAN interface is installed

Settings	Description
232C	Use RS232C for the remote interface
uSb	Use LAN for the remote interface (factory default)

See p. 7-8

CF55 DHCP setting

Set whether to fix the IP address by using the DHCP server. Displayed only when the factory option LAN interface is installed.

Settings	Description
oFF	Not to use the DHCP server
on	Use the DHCP server (factory default)

See p. 7-8

CF56 AUTO IP address setting

When the DHCP is not used or not enable to be used, set whether to fix the IP address automatically. The IP address assigned by the AUTO IP is 169.254.x.x (x is 0 to 254). Displayed only when the factory option LAN interface is installed.

Settings	Description
oFF	Not to use the AUTO IP function
on	Use the AUTO IP function (factory default)

See p. A-11

When the fixed IP address is used, set CF55 and CF56 to turning off. The value of the filed IP address cannot be set from the panel. It is only to confirm the status. For setting, specify the fixed IP address on the condition that the DHCP server or AUTO IP can be used.

CF57 to CF60 IP address display

Confirm the setting IP address. Displayed only when the factory option LAN interface is installed.

Parameter number	Display	Description
CF57	0 to 255	Display the 1st number of the IP address
CF58	0 to 255	Display the 2nd number of the IP address
CF59	0 to 255	Display the 3rd number of the IP address
CF60	0 to 255	Display the 4th number of the IP address

CF61 LAN status display

Display the status of the LAN interface. Displayed only when the factory option LAN interface is installed.

Display	Description
Stby	Stand by state (the LAN can not be used)
nFLt	No fault state (the LAN is functioned properly)
FLt	Fault state (the LAN is not functioned properly)
LAn	Display identifying the LAN

4.7 Preset Memory Function

The PAT has a function that stores up to three combinations of voltage setting and current setting. You can store a combination by selecting PRESET A, PRESET B, or PRESET C.
RECALL switches allow you to recall any of the three preset memory values.

Storing the preset memory values

1. Press the SET switch.

   The SET switch LED illuminates, and the specified voltage and current are shown on the panel.

2. While viewing the panel display, turn the VOLTAGE knob to set the voltage preset memory value, the CURRENT knob to set the current preset memory value.

3. Press the STORE switch while holding down the SHIFT switch.

   PRESET A, B, and C LEDs blink in the display.

4. Press any memory switch (A, B or C) to be stored, and save the value of preset memory.

   The selected preset memory (A, B or C) illuminates on the display.

You can save preset memory values by carrying out step 3 and step 4 with the output turned on while displaying the measured values (SET switch turned off). After saving the preset memory values, press the SET switch to check them.

Recalling the preset memory values

1. Press the SET switch.

   The SET switch LED illuminates, and the specified voltage and current are shown on the panel.

2. While holding down the SHIFT switch, press the RECALL switch in which the preset memory values you want to recall is stored.

   The LED of the recalled preset memory values (PRESET A, B, or C) illuminates.

   If no load is connected, it takes a long time for the output voltage to rise.

You can recall preset memory values by carrying out step 2 above with the output turned on while displaying the measured values (SET switch turned off). If the recalled memory value exceeds the OVP or OCP trip point, the OVP or OCP function trips.

If the voltage or current setting is limited in the CONFIG settings (CF29 or CF30: ON) and the recalled preset memory values exceed the OVP or OCP trip point, the output setting is limited to approximately 95 % of the OVP or OCP trip point. Then, PRESET A, B, or C LED corresponding to the preset memory that was recalled illuminates for approximately 1 second and turns off.

See p. 4-17

You can set CF12 to 0 CONFIG parameter to enable preset memory values to be recalled even in the locked condition.

4.8 Lock Function

The PAT has a lock function that prevents the settings from being changed inadvertently.

The following operations are disabled in the locked condition (the LOCK LED on the display is illuminated).

- Setting of the current and voltage.
- Setting of the OVP and OCP.
- Setting of the CONFIG parameters.
- Saving and recalling of preset memories.

See p. 4-17

You can set CONFIG parameter CF12 to 0 to enable preset memory values to be recalled even in the locked condition.

Fig.4-20 Panel display example in the locked condition

■ Setting

1. Set all the required parameters such as the output voltage and output current.
2. Press the LOCK (SHIFT+LOCAL) switch.

   The LOCK LED on the display illuminates, and the lock is enabled.

■ Release

To release the lock function, hold down LOCK (SHIFT+LOCAL) switch until the LOCK LED on the display turns off.

4.9 Switching from Remote to Local Mode

When the PAT is operating under remote control, the RMT LED on the display illuminates.

Fig.4-21 Panel display example in remote mode

To switch from the remote mode to the local mode (panel operation) from the panel, press the LOCAL switch.

See p. 7-42

If SYST:RWL or IEEE488.0 llo is specified in remote mode, the PAT does not switch to local mode (panel operation) even when the LOCAL switch is pressed.

4.10 Remote Sensing Function

The remote sensing function is used to reduce the influence of voltage drops due to the load cable resistance and stabilize the output voltage across the load.

See p. 3-5

The remote sensing function of the PAT can compensate up to approximately 0.6 V for a single line. Select a load cable with sufficient current capacity so that the voltage drop in the load cable does not exceed the compensation voltage. When the remote sensing is performed, apply the voltage of sensing point (at the load terminal) which does not exceed the rated output voltage. When the remote sensing is performed at near to the maximum output voltage, the output is limited at the maximum voltage (105 % of the rated output voltage).

To perform remote sensing, an electrolytic capacitor may be required at the sensing point (load terminal).

Connection of the sensing cable

⚠WARNING Possible electric shock or damage to the internal circuitry.

- **Never wire the cable to the sensing terminals while the POWER switch is turned on.**
- **For sensing cables, use cables with a higher voltage rating than the isolation voltage of the PAT. Protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 9, "Specifications."**
- **The sensing terminals are at approximately the same potential as the - (neg.) output terminal of the PAT. Insert the wire so that the wire scraps protruding from the sensing terminals do not come in contact with the chassis. Also, insert wires to the terminals so that the stripped sections do not protrude from the terminals.**

If the sensing wires come loose, the output voltage across the load cannot be stabilized and may cause excessive voltage to be applied to the load. If an appropriate OVP trip point is set, the OVP trips and prevents excessive voltage output.

After you are done using the remote sensing function, remove the sensing wires, and be sure to turn off remote sensing using the sensing switch.

See p. 4-16

You can check the sensing switch status using the CONFIG settings (CF02).

■ Notes when connecting the sensing cable

Use AWG24 wires to connect to the sensing terminals. Remove 10 mm of the wire covering.

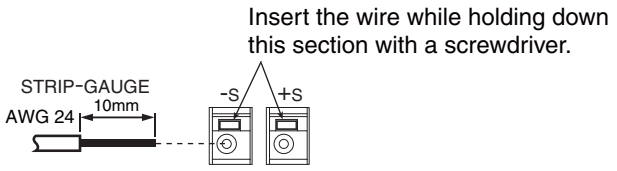


Fig.4-22 Connection to the sensing terminal

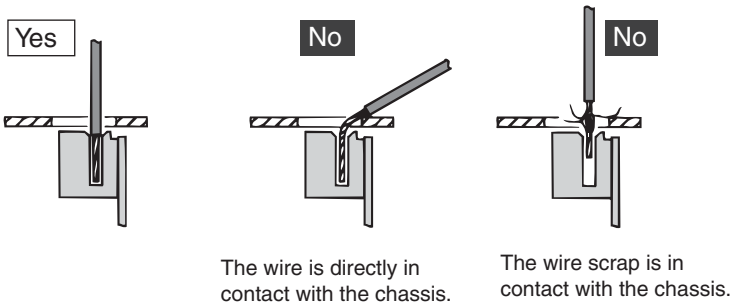


Fig.4-23 Appropriate and inappropriate connections

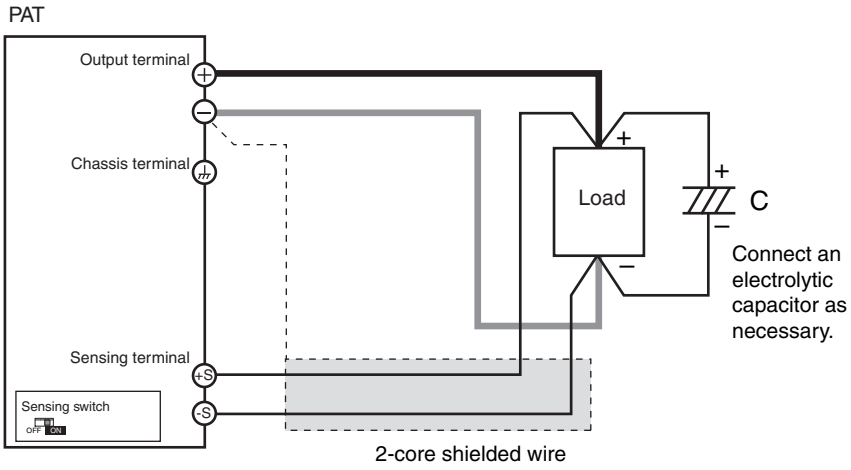


Fig.4-24 Remote sensing connection

1. Turn the POWER switch off.
2. Turn on the sensing switch on the rear panel.
3. As shown in Fig.4-24, connect the sensing cable between the sensing terminal and the load terminal.

   To decrease output ripple voltages resulting from inductive effects, use a two-core shielded wire for the sensing wires. Connect the shield to the − (neg.) terminal.
   If you cannot use shielded wires, twist the + (pos.) and − (neg.) wires thoroughly.
   Remove the covering from the sensing wires appropriately before connecting them.

See Fig.4-22

■ Electrolytic capacitor connected at the load end

If the inductance in the wire is large, the following symptoms may appear. Twisting the load wires reduces the inductance, thereby stabilizing the output. However, if this does not solve the problem, connect an electrolytic capacitor at the load end.

- Oscillation

  If the wiring to a load is long, the phase shift caused by the inductance and capacitance of the wiring becomes non-negligible, thereby causing oscillation.

- Fluctuating output

  If the load current changes suddenly to pulse form, the output voltage may increase due to the effects from the inductance component of the wiring.

Electrolytic capacitor required

Capacitance: 0.1 µF to several-hundred µF

Withstand voltage: Greater than or equal to 120 % of the rated output voltage of the PAT

■ When inserting a mechanical switch between the PAT and the load

If you are using a mechanical switch that is inserted between the PAT and the load to turn on/off the connection between them, insert a switch also in the sensing wire as shown in Fig.4-25 and turn on/off the load wire and the sensing wire simultaneously. Be sure to turn off the OUTPUT switch or POWER switch before turning on/off the mechanical switch.

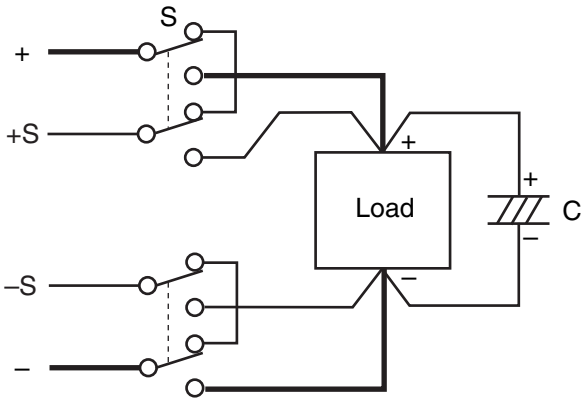


Fig.4-25 On/Off using the mechanical switch

4.11 Factory Default Settings

Turning ON the POWER switch while holding down the SHIFT switch initializes the settings to factory default. Carry out this operation when you want to reset all settings to factory default values. The factory default settings are given in the tables below.

Table 4-2 Factory dfault settings of basic parameters

Basic Item	Setting
Output voltage	0 V
Output current	105 % of the rated output current
Overvoltage protection (OVP)	111.5 % of the rated output voltage
Overcurrent protection (OCP)	111.5 % of the rated output current
Preset memory values A/B/C	Voltage: 0 V, Current: 105 % of the rated output current

Table 4-3 Factory default settings of the CONFIG parameters

Parameter number	Operating condition (CONFIG parameter)	Setting
CF10	Output on delay setting	OFF
CF11	Output off delay setting	OFF
CF12	Preset recall setting while locked	1 (unable to recall)
CF13	Communication error display setting	OFF (not displayed)
CF20	CV control source setting	0 (panel control)
CF21	CC control source setting	0 (panel control)
CF22	External control logic setting of the output on/off	H
CF23	Status signal setting of the power on/off	0 (POWER ON STATUS)
CF24	Setting the number of units in Master-Slave Parallel Operation	1 (1 unit)
CF25	Output status setting at power-on	OFF (output off at power-on)
CF26	Master-slave parallel setting	0 (master unit)
CF27	Breaker trip setting when the shutdown signal is applied	OFF (not trip)
CF28	Breaker trip setting when the OVP or OCP is activated	OFF (not trip)
CF29	Voltage limit setting	OFF (not limit)
CF30	Current limit setting	OFF (not limit)
CF40	RS232C data rate setting	19.2 (kbit/s)
CF41	RS232C data length setting	8 bit
CF42	RS232C stop bit setting	1 bit
CF43	RS232C flow control setting	ON (Xon/off flow control)
CF51*1	GPIB address setting	1
CF52*1	Remote interface setting	GPIB, USB or LAN*2
CF55*1	DHCP setting	ON (Use the DHCP server)
CF56*1	AUTO IP address setting	ON (Use the AUTO IP function)

*1. Only when the factory option GPIB, USB or LAN interface is installed.
*2. Interface installed by factory option.

External Control

This chapter describes external analog control and remote monitoring using the J1 connector.

5.1 Overview of External Control

The J1 connector on the rear panel of the PAT can be used to perform external control listed below.

- Output voltage control

  Control using external voltage or external resistance
- Output current control

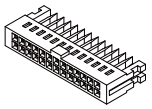
  Control using external voltage or external resistance
- Output on/off using external contact
- Shutdown using external contact (turn off the output or POWER switch)

When the PAT is operating under external control, the EXT LED on the front panel display illuminates.

Fig.5-1 Display example during external control operation

5.2 J1 Connector

At the factory shipment, the protection socket is attached to the J1 connector. Keep this protection socket and be sure to attach when the J1 connector is not used. If the protection socket is damaged or lost, contact Kikusui distributor/agent.



[84-49-0110]

Fig.5-2 Protection socket

⚠WARNING Possible electric shock.

- **The J1 connector contains pins that are at the same electric potential as the output terminal. If you are not using the J1 connector, be sure to insert the protective socket provided.**
- **Be sure to use the protective cover on the sockets.**

A connector kit is provided for connecting the J1 connector. The connector kit consists of connector parts conforming to the MIL standard made by Omron.

The single contact connection tool and contact removal tool are not provided. Please obtain your own tools.

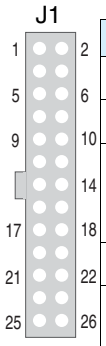
For information on how to obtain the tools and consumable parts, contact your Kikusui agent or distributor.

Table 5-1 Connector parts by Omron needed to connect the J1 connectorJ1

Product	Model	Kikusui parts no.	Notes
Single contact connection tool	XY2B-7006	Y2-070-001	Not included.
Contact removal tool	XY2E-0001	Y2-070-002	Not included.
Pin (contact)	XG5W-0031	84-49-0100	Recommended wire size AWG24 (UL-1061).
Socket	XG5M-2632-N	84-49-0160	MIL standard type socket.
Protection cover (semi cover)	XG5S-1301	84-49-0161	–

For details about how to use the products, refer Omron's catalog.

Table 5-2 connector pin arrangement



Pin No.	Signal Name	Description
1	STATUS COM	Common for status signals from pin 3 through 7.*1
2	STATUS COM	Common for status signals from pin 3 through 7.*1
3	PWR ON/OFF STATUS*2	PWR ON STATUS (CF23: 0): Output a low level signal while the power is on. PWR OFF STATUS (CF23: 1): Output a low level signal when the power is off. (open collector output by a photocoupler*3)
4	OUT ON STATUS	On when the output is on (open collector output by a photocoupler*3).
5	ALM STATUS	Turns on when the OVP, OCP, OHP, PHASE, SENSE, FAN, or BOHP is activated or when a shutdown signal is applied (open collector output by a photocoupler).*3
6	CC STATUS	On during CC operation (open collector output by a photocoupler*3).
7	CV STATUS	On during CV operation (open collector output by a photocoupler*3).
8	AUX	Reserved.
9	AUX	Reserved.
10	I SUM IN	Current signal input terminal in Master-Slave Parallel Operation
11	D COM	Digital signal common for pins 12 and 14*1 When the remote sensing is used, connect the cable to the negative electrode (-S) of the sensing input, and when the remote sensing is not used, connect the cable to the negative (-) output (same as pin 13).
12	SHUT DOWN	Shutdown (trips the POWER switch or turns the output off when a low TTL level signal is applied. The internal circuit is pulled up to +5 V through 10 kΩ).
13	D COM	Same as pin 11.
14	OUT ON/OFF CONT	Output on/off terminal Turn off when a low (or high) TTL level signal is applied. The internal circuit is pulled up to +5 V through 10 kΩ.
15	A COM	Analog signal common for pins 16, 18, 20, and 22.*1 Connected to the negative electrode (-S) of the sensing input when remote sensing is used; connected to - (neg.) output when remote sensing is not used. (Same as pins 17, 19, 21, and 23.)
16	I MON	Output current monitor (Outputs 0 % to 100 % of the rated current using 0 V to 10 V).
17	A COM	Same as pin 15.
18	V MON	Output voltage monitor (Outputs 0 % to 100 % of the rated voltage using 0 V to 10 V).
19	A COM	Same as pin 15.
20	EXT CC CONT	External voltage control of output current (0 % to 100 % of the rated output voltage using 0 V to 10 V) or external resistance control of output current. • 0 % to 100 % of the rated output current in the range of 0 kΩ to 10 kΩ (CF21: 2) • 100 % to 0 % of the rated output current in the range of 0 kΩ to 10 kΩ (CF21: 3)
21	A COM	Same as pin 15.
22	EXT CV CONT	External voltage control of output voltage (0 % to 100 % of the rated output voltage using 0 V to 10 V) or external resistance control of output voltage. • 0 % to 100 % of the rated output voltage in the range of 0 kΩ to 10 kΩ (CF20: 2) • 100 % to 0 % of the rated output voltage in the range of 0 kΩ to 10 kΩ (CF20: 3)
23	A COM	Same as pin 15.
24	PRL IN COMP	Correction signal input terminal during master-slave parallel operation.
25	PRL IN-	Negative electrode input terminal during master-slave parallel operation.
26	PRL IN+	Positive electrode input terminal during master-slave parallel operation.

*1. Use the shortest possible wires for the common wires.
*2. Status signal setting of the power on/off (CF23): Either one specified in the CONFIG settings is activated.
*3. Open collector output: Maximum voltage of 30 V and maximum current of 8 mA. It is insulated from the control circuit.

5.3 Output terminal Insulation

Note the following points and insulate the output terminals.

⚠WARNING

- **Possible electric shock. For safety reasons, even if the output terminal is grounded, make sure the insulation capacity of the output terminal (including the sensing terminal) is greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 9, "Specifications."**
  If you cannot obtain a cable with sufficient rated voltage, secure adequate withstand voltage by passing the cable through an insulation tube with a withstand voltage greater than the isolation voltage of the PAT.

⚠CAUTION

- The signal wire may burn out. If the PAT is to be controlled through an external voltage (Vext), do not ground it (leave it floating).

The cable and load that are connected to the output terminal (including the sensor terminal) must have an insulation capacity that is greater than the isolation voltage of the PAT with respect to the chassis.
Isolation voltage indicates the maximum allowed voltage that appears across the output terminal of the power supply unit and the protective conductor terminal (chassis terminal).

5.3.1 When the Output terminal Is Not Grounded (Floating)

The output terminal of the PAT is isolated from the protective conductor terminal. By connecting the GND wire of the power cable to the ground terminal of the switchboard, the chassis of the PAT is set to ground potential as shown in Fig.5-3.

Pins 10 through 26 of the J1 connector on the rear panel (for external control and output monitoring) are at approximately the same potential as the - (neg.) output terminal of the PAT. Cables and devices that are connected to these pins must also have an insulation capacity that is greater than or equal the isolation voltage of the PAT.

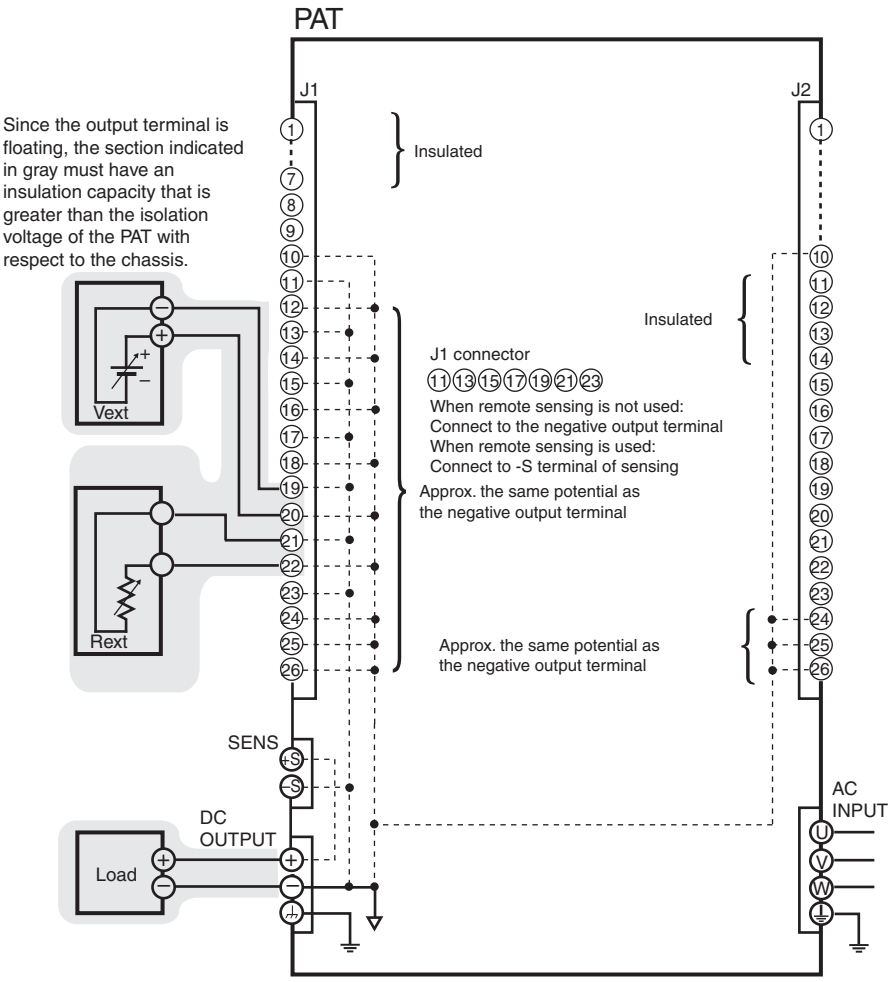


Fig.5-3 When the output terminal is not grounded

5.3.2 When the Output terminal Is Grounded

If the positive output terminal is connected to the chassis terminal, the terminal is at ground potential as shown in Fig.5-4. The cable and load that are connected to the output terminal (including the sensing terminal) will only require an insulation capacity that is greater than the maximum output voltage of the PAT with respect to the chassis. There is no need to provide insulation greater than the isolation voltage of the PAT.

The same holds true when the negative terminal is connected to the chassis terminal. The cable and load require an insulation capacity that is greater than the maximum output voltage of the PAT.

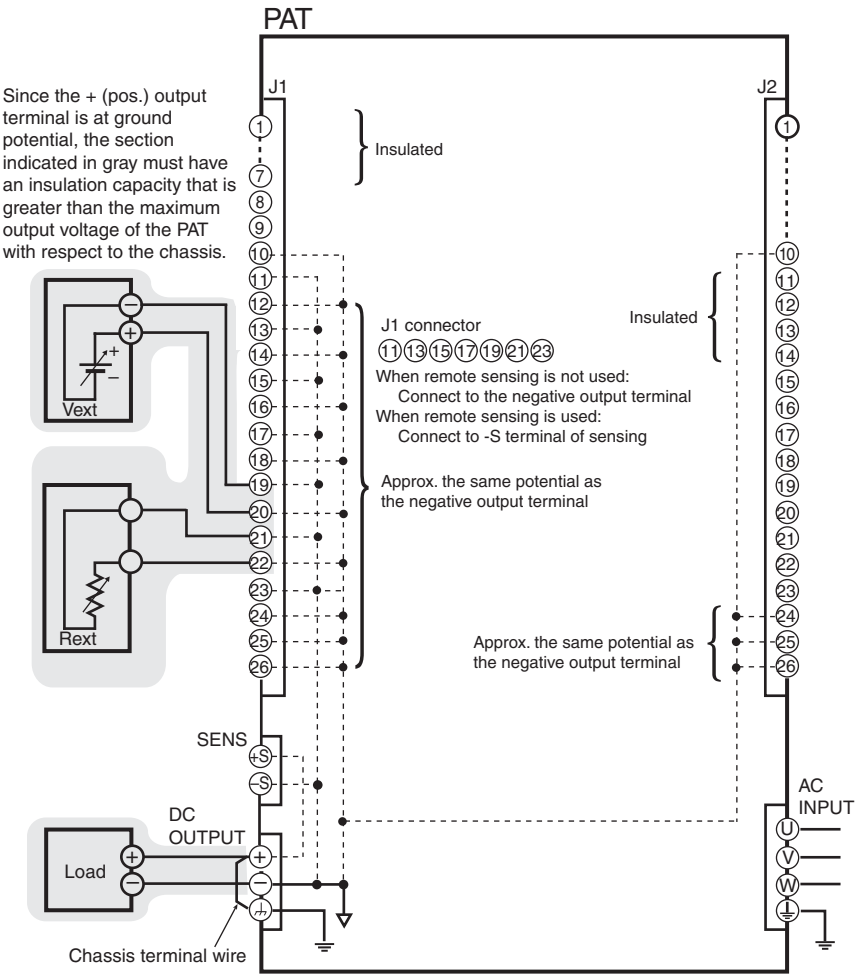


Fig.5-4 When the output terminal is grounded

If the external voltage (Vext) output is grounded for the case shown in Fig.5-4, the output is short-circuited (which can cause accidents).

For safety reasons, connect either output terminal to the chassis terminal unless your application requires the output terminal to be floating.

When using the external voltage (Vext)

Connect the wires so that the output is not shorted as shown in Fig.5-5 and Fig.5-6.

⚠CAUTION The signal wire may burn out.

- The signal wire may burn out. Leave the Vext output floating.
- If you are connecting the shield to the Vext side, do not connect the shield to the output terminal of the PAT.

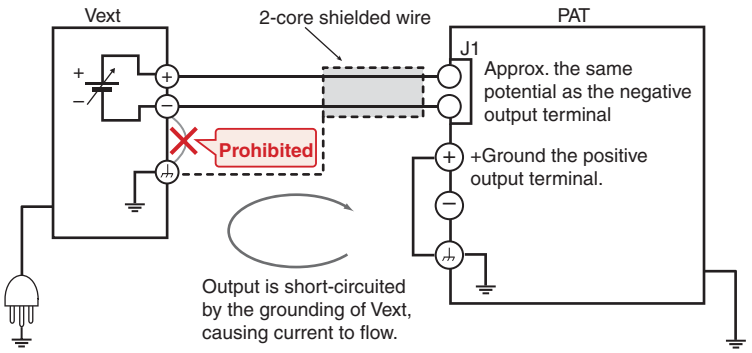


Fig.5-5 A connection in which the output is short-circuited by the grounding of Vext (example of a prohibited connection)

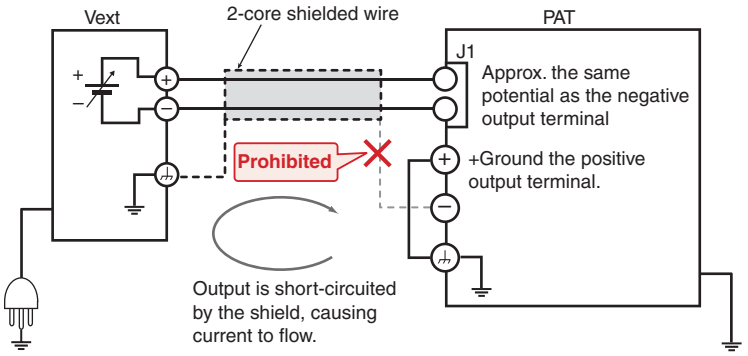


Fig.5-6 A connection in which the output is short-circuited by the shield (example of a prohibited connection)

5.4 Controlling the Output Voltage

This section explains the method used to control the output voltage using an external voltage (Vext) in the range 0 V to approx. 10 V or an external resistor (Rext) in the range 0 kΩ to approx. 10 kΩ.

If no load is connected, it takes a long time for the output voltage to fall.

⚠WARNING **Possible electric shock.**

- **The insulation of the Vext or Rext and the connected cable should be greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 9, "Specifications."**
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PAT.**

5.4.1 External Voltage (Vext) Control

See p. 4-17

To control the output voltage using Vext, set the CV control source in the CONFIG settings to external voltage control (CF20: 1).

The output voltage (Eo) varies in the range of 0 to the rated output voltage (Ertg) by setting the external voltage (Vext) in the range of 0 V to 10 V.

$$Eo = Ertg \times Vext / 10 \ [V] \qquad Vext = 10 \times Eo / Ertg \ [V]$$

⚠CAUTION

- The signal wire may burn out. Leave the Vext output floating.
- Make sure the polarity of Vext is correct. If the polarity is reversed, the PAT may break.
- Do not apply voltage or reverse voltage exceeding 10.5 V across the external voltage control pins. Doing so may break the PAT.

External voltage (Vext) connection

Use a low-noise and stable voltage source for Vext. The noise in Vext is multiplied by the amplification factor of the PAT and appears at the output. Thus, the output ripple noise may not meet the PAT's specifications.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and Vext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal. If the shield needs to be connected to the Vext side, See "When using the external voltage (Vext)" on page 5-8.

Pins 21 and 22 of the J1 connector are used.

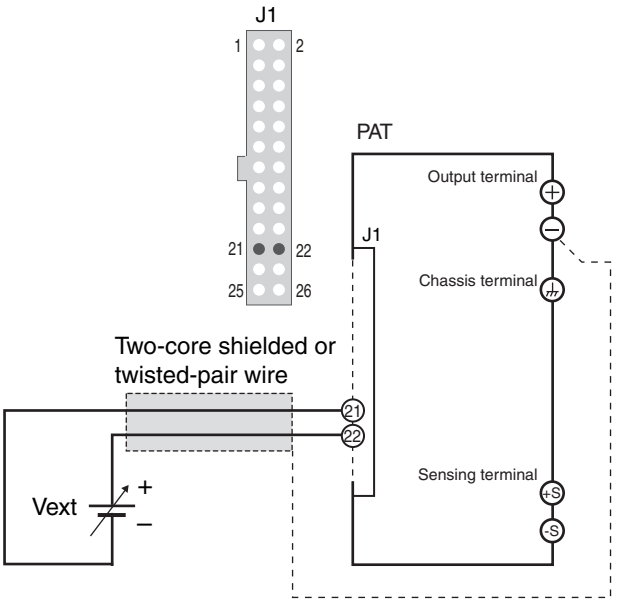


Fig.5-7 Connection of the output voltage control using external voltage

5.4.2 External resistance (Rext) control

See p. 4-17

To control the output voltage using Rext, select the CV control source in the CONFIG settings from the following two modes.

- External resistance control 10 kΩ → MAX OUT (CF20: 2)

  The output voltage (Eo) varies in the range of 0 to the rated output voltage (Ertg) by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ.

  Eo = Ertg×Rext /10 [V] Rext = 10×Eo /Ertg [V]

- External resistance control 10 kΩ → 0 OUT (FAIL SAFE) (CF20: 3)

  The output voltage (Eo) varies in the range of the rated output voltage (Ertg) to 0 by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ.

  Eo = Ertg×(10-Rext)/10 [V] Rext = 10×(Ertg-Eo)/Ertg [V]

NOTE

- If Rext comes loose when using the 10 kW → MAX OUT CV mode, excessive voltage may be applied to the load. For safety reasons, it is recommended that fail-safe 10 kW → 0 OUT CV mode be used.
- If you are using fixed resistors for Rext and controlling the output voltage by switching through them, use a short-circuit or continuous type switch.

External resistance (Rext) connection

For Rext, use a 1/2 W or larger metal film or wire-wound type resistor with good temperature coefficient and small aging effect.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and Rext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal.

Pins 21 and 22 of the J1 connector are used.

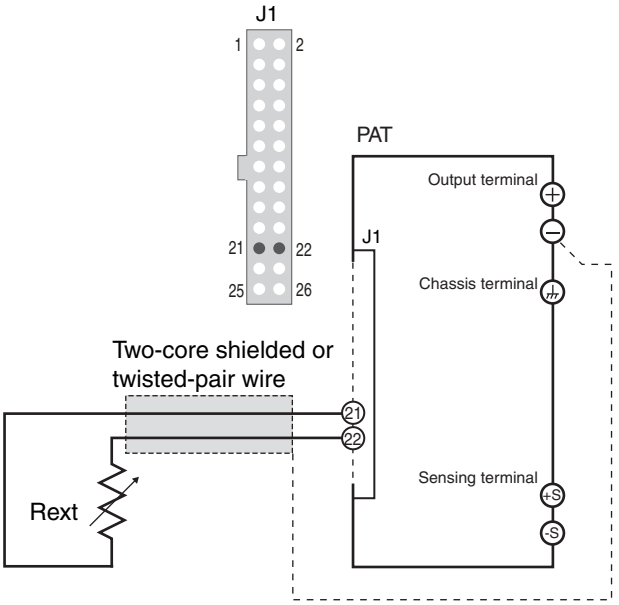


Fig.5-8 Connection of the output voltage control using Rext

5.5 Controlling the Output Current

This section explains the method used to control the output current using an external voltage (Vext) in the range 0 V to approx. 10 V or an external resistor (Rext) in the range 0 kΩ to approx. 10 kΩ.

⚠WARNING **Possible electric shock.**

- **The insulation of the Vext or Rext and the connected cable should be greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 9, "Specifications."**
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PAT.**

5.5.1 External Voltage (Vext) Control

See p. 4-17

To control the output current using Vext, set the CC control source in the CONFIG settings to external voltage control (CF21: 1).

The output current (Io) varies in the range of 0 to the rated output current (Irtg) by setting the external voltage (Vext) in the range of 0 V to 10 V.

$$Io = Irtg \times Vext / 10 \ [A] \qquad Vext = 10 \times Io / Irtg \ [A]$$

⚠CAUTION

- The signal wire may burn out. Leave the Vext output floating.
- Make sure the polarity of Vext is correct. If the polarity is reversed, the PAT may break.
- Do not apply voltage or reverse voltage exceeding 10.5 V across the external voltage control pins. Doing so may break the PAT.

External voltage (Vext) connection

Use a low-noise and stable voltage source for Vext. The noise in Vext is multiplied by the amplification factor of the PAT and appears at the PAT output. Thus, the output ripple noise may not meet the PAT's specifications.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and Vext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal. If the shield needs to be connected to the Vext side, See "When using the external voltage (Vext)" on page 5-8.

Pins 19 and 20 of the J1 connector are used.

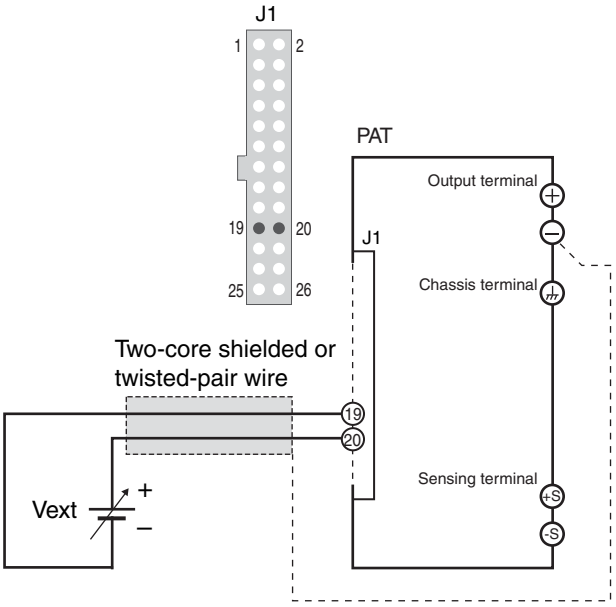


Fig.5-9 Connection of the output current control using Vext

5.5.2 External Resistance (Rext) Control

See p. 4-17

To control the output current using Rext, select the CC control source in the CONFIG settings from the following two modes.

- External resistance control 10 kΩ → MAX OUT (CF21: 2)

  The output current (Io) varies in the range of 0 to the rated output current (Irtg) by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ.

  Io = Irtg × Rext /10 [A] Rext = 10 × Io /Irtg [A]

- External resistance control 10 kΩ → 0 OUT (FAIL SAFE) (CF21: 3)

  The output current (Io) varies in the range of the rated output current (Irtg) to 0 by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ.

  Io = Irtg × (10-Rext)/10 [A] Rext = 10 × (Irtg-Io)/Irtg [A]

NOTE

- If Rext comes loose when using the 10 kW → MAX OUT CC mode, excessive current may flow through the load. For your safety, it is recommended that fail-safe 10 kW → 0 OUT CC mode be used.
- If you are using fixed resistors for Rext and controlling the output voltage by switching through them, use a short-circuit or continuous type switch.

External resistance (Rext) connection

For Rext, use a 1/2 W or larger metal film or wire-wound type resistor with good temperature coefficient and small aging effect.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and Rext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal.

Pins 19 and 20 of the J1 connector are used.

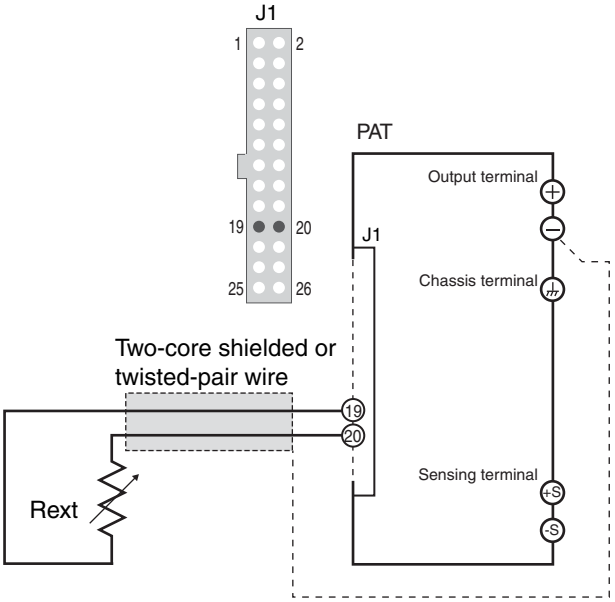


Fig.5-10 Connection of the output current control using Rext

5.6 Controlling the Output On/Off

This section explains the method used to control the on/off of the output by connecting an external contact.

⚠WARNING **Possible electric shock.**

- **The insulation of the external contact (S) and the connected cable should be greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 9, "Specifications."**
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PAT.**

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and the external contact. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal.

See p. 4-18

To control the output on/off using external contact, select the external control logic setting of output on/off in the CONFIG settings from the following two modes.

- Turn the output on with a high signal (default) (CF22: H)

  The output turns on when pin 14 of the J1 connector is set high (TTL level) or opened.

- Turn the output on with a low signal (CF22: L)

  The output turns on when pin 14 of the J1 connector is set low (TTL level).

If the output is set to off using an external contact, the OUTPUT switch on the front panel is invalid. If you are not controlling the output using an external contact, turn the output on by setting the external control logic setting of output on/off in the CONFIG settings to high (CF22: H).

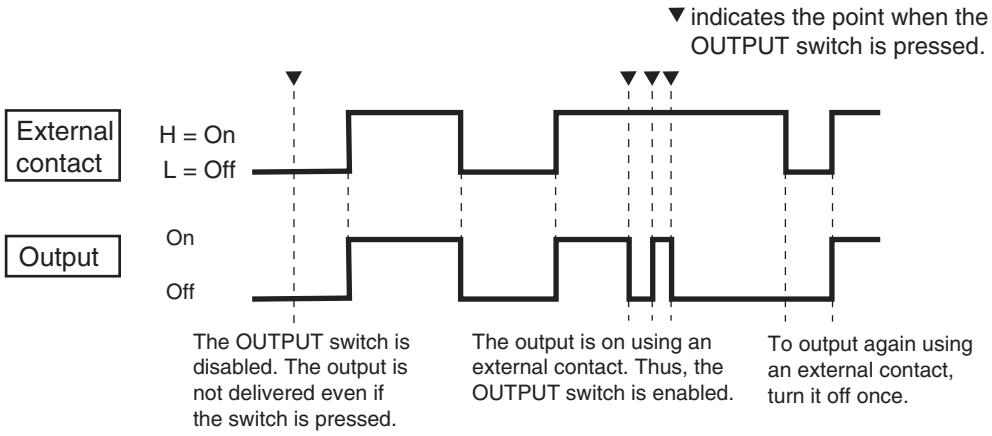


Table 5-3 Output on/off control (example in which the output is on at high)

External contact connection.

Pins 13 and 14 of the J1 connector are used.

The release voltage across pins 13 and 14 is approx. 5 V maximum, and the short circuit current is approx. 500 µA maximum. (The internal circuit is pulled up to 5 V through 10 kΩ.)

Use parts with a contact rating of 5 Vdc and 0.5 mA for the external contact.

If multiple units are used under floating conditions and a single external contact is used to turn on/off the output, isolate the signal to each unit such as by using a relay on the external contact signal.

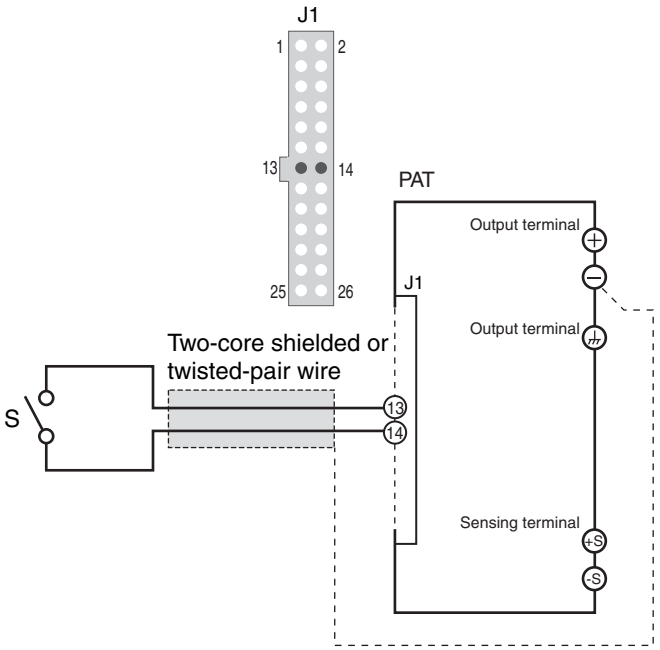


Fig.5-11 On/Off control connection using an external contact

■ For long-distance wiring

When wiring over a great distance, use a small relay and extend the coil side of the relay.

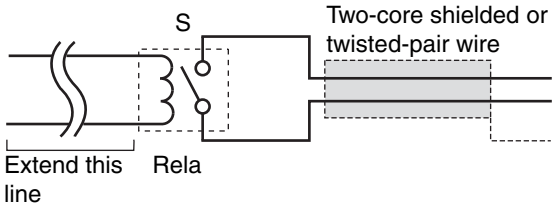


Fig.5-12 On/Off control using an external contact (for long-distance wiring)

5.7 Shutdown Control Using External Contact

This section explains the method used to trip the breaker (turn the POWER switch off) or turn the output off using external contact.

⚠WARNING

Possible electric shock.

- **The insulation of the external contact (S) and the connected cable should be greater than the isolation voltage of the PAT. For the isolation voltage of each model, see Chapter 9, "Specifications."**
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PAT.**

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and the external contact. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used.

When using a shielded cable, connect the shield to the - (neg.) output terminal.

See p. 4-19

To control the shutdown using an external contact, select the breaker trip setting when the shutdown signal is applied in the CONFIG settings from the following two modes.

- Not trip (default) (CF27: OFF)

  The output turns off when pin 12 of the J1 connector is set low (TTL level). The breaker is not tripped.

  To recover, set pin 12 high (TTL) or open the pin and turn the POWER switch off and then back on.

- Trip (CF27: ON)

  The breaker trips when pin 12 of the J1 connector is set low (TTL level). To recover, set pin 12 high (TTL) or open the pin and turn on the POWER switch.

Shutdown control connection

Pins 11 and 12 of the J1 connector are used.

The release voltage across pins 11 and 12 is approx. 5 V maximum, and the short circuit current is approx. 500 µA maximum. (The internal circuit is pulled up to 5 V through 10 kΩ.)

Use parts with a contact rating of 5 Vdc and 0.5 mA for the external contact.

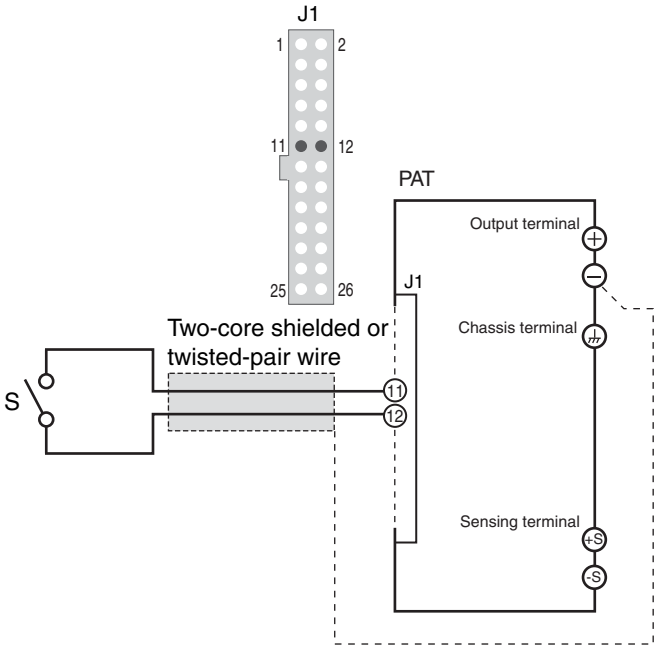


Fig.5-13 Shutdown control connection using an external contact

■ For long-distance wiring

When wiring over a great distance, use a small relay and extend the coil side of the relay.

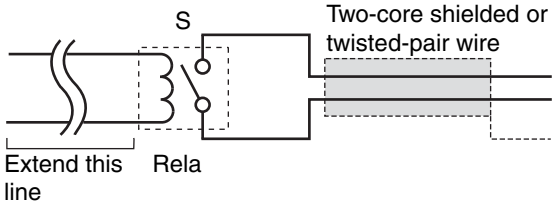


Fig.5-14 Shutdown control connection using an external contact (for long-distance wiring)

5.8 External Monitoring

External monitoring of the output voltage and output current

The J1 connector consists of monitor outputs for output voltage and output current.

Table 5-4 Monitor output of output voltage and output current

Pin No.	Signal name	Description
15 and 17	A COM	Common for remote control input Common terminal of the output monitor
18	V MON	Monitor output of output voltage 0 V to approx. 10 V for 0 to the rated output voltage
16	I MON	Monitor output of output current 0 V to approx. 10 V for 0 to the rated output current

⚠CAUTION

- Shorting V MON and I MON to A COM can cause damage to the PAT.

- Monitor output rating

  Output impedance: 1 kΩ or less
  Maximum output current: Approx. 10 mA

The monitor outputs are used to monitor the DC voltage (mean value).

They cannot be used to accurately monitor the AC components (ripple, transient response, etc.) of the actual output voltage or current.

External monitoring of the operation mode

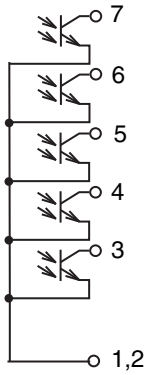
The J1 connector consists of status outputs that can be used to externally monitor the operating condition of the PAT. The status outputs consist of the following five items.

The outputs are open collector outputs of photocouplers; they are insulated from the internal circuits of the PAT.

The maximum rating of each signal terminal is as follows:

- Maximum voltage: 30 V
- Maximum current (Sink): 8 mA

Table 5-5 Status output

Pin No.	Signal name	Description	Circuit
7	CV STATUS	Set to low level when in constant voltage mode. Photocoupler collector output	
6	CC STATUS	Set to low level when in constant current mode. Photocoupler collector output	
5	ALM STATUS	Set to low level when a protection function is activated. Photocoupler collector output	
4	OUT ON STATUS	Set to low level when output is turned off. Photocoupler collector output	
3	PWR ON/OFF STATUS*1	Set to low level when the POWER switch is on (PWR ON STATUS) or when the POWER switch is turned off (POWER OFF STATUS: approx. 10 to 15 seconds). Photocoupler collector output	
1 and 2	STATUS COM	Common for status output Photocoupler emitter output	

See p. 4-18

*1 Status signal setting of the power on/off in the CONFIG settings is used to select whether to output a low level signal when the power is ON (CF23: 0) or when the power is off (CF23: 1).

Parallel/Series Operation

This chapter describes the functions of the master-slave series and parallel operations as well as the connection, setup, and operation procedures.

6.1 Master-Slave Parallel Operation

In master-slave parallel operation, one of the PATs is made a master and connected to all other PATs as slaves. The master is used to control the entire system.

The output current can be expanded using master-slave parallel operation (maximum output current: the rated output current of a unit × number of units connected in parallel).

Maximum number of units that can be connected is five including the master.

6.1.1 Functions during Master-Slave Parallel Operation

The functions of the PAT during master-slave parallel operation are as follows:

Voltage display and current display

The voltage is displayed only on the master unit. It is not appeared on the display of the slave unit.

The total value of current in which the number of unit connected in the parallel operation is displayed in the current display part of the master unit. As for the voltage display part, the voltage value which was set at as the last setting on the master unit will be displayed.

See p. 4-18

If the actual number of connected units in Master-Slave Parallel Operation was different from the setting condition which were set by CONFIG setting in the “setting the number of units in Master-Slave Parallel Operation” (CF24), the current value on the display will not be shown properly.

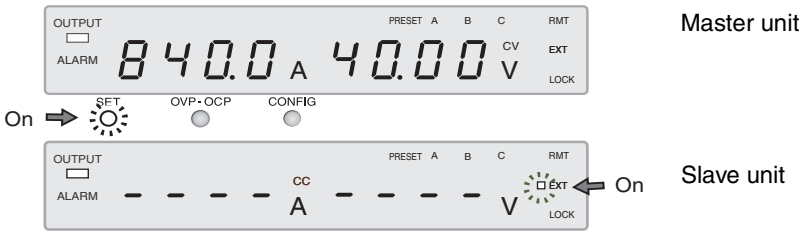


Fig.6-1 Panel display example during parallel operation (examples of output current 400 A)

⚠ CAUTION

- If the firmware version of the PAT40-200T is prior to 3.00, the total current is not displayed on the master unit when connected in the parallel operation. The current value is displayed on each unit. It is necessary to update the firmware version to 3.00 to display the total value on the master unit. When connecting the unit in the parallel operation, do not combine the unit with the firmware version prior to 3.00 of the PAT40-200T, it may causes the mis-operation.
  Contact your Kikusui distributor/agent when the firmware version prior to 3.00 of the PAT40-200T is combined in the system of master slave parallel operation. Refer to the page 2-8 , “2.6 Turning On" for confirmation of the firmware version.

See p. 4-25

Remote sensing

Available only on the master unit.

See Chapter 5

External control

Available only on the master unit.

See p. 5-21

External monitoring

- External monitoring of output voltage (V MON)

  Can be monitored on the master unit.

- External monitoring of output current (I MON)

  Can be monitored on the master unit.

- Status monitors

  The status of the constant voltage operation (CV STATUS), constant current operation (CC STATUS), output on, and POWER switch on can be monitored on each master and slave unit. However, slave units always output the status of the constant current operation.

  For details on ALM STATUS, see the “Alarms” below.

⚠CAUTION

- Do not connect the common wires of the master and slave monitors outside the PAT. If the wire connecting the load comes loose, the common wire will break.

Alarm

If an alarm is detected, the units behave as follows:

- Master unit

  If an alarm is detected on the master unit, alarms on the slave units are also activated, and the output of the entire system is turned off or the breaker trips.

- Slave unit

  If an alarm signal is applied from the master unit, the output is turned off or the breaker trips on the slave unit independently.

See p. 4-19

In determining whether to function the breaker trip when the alarm is detected, it can be set by the config setting (CF27). To do the breaker trip as to when the OVP/OCP trips, it is set by the config setting (CF28) on the master unit and (CF27) on the slave unit.

See p. 4-9, p. 6-8

■ Releasing the alarm

If the breaker trips, turn the power switch on after eliminating the cause of the alarm. If the output is turned off, turn the power switch off from the slave unit and the master unit in this order, after eliminating the cause of the alarm, turn the power switch on from the slave unit and the master unit in this order.

6.1.2 Connection (Parallel Operation)

Up to five units including the master unit (up to four slave units) can be connected.

Connecting the signal wires (parallel operation)

Fig.6-4 and Fig.6-5 shows an example when connecting two slave units.

If you are using the optional parallel operation power cable (PC01-PAT), you can use it immediately as it is already assembled.

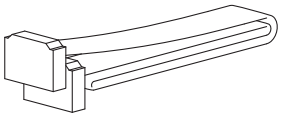
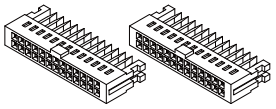


Fig.6-2 Optional parallel operation power cable (PC01-PAT)

See p. 5-3

If you are using the J1/J2 connector kit that comes with the package, refer to Fig.6-4 to make the connection. For tools needed for the connection, see Table 5-1.

At the factory shipment, the protection socket is attached to the J1/J2 connector. Keep this protection socket and be sure to attach when the J1/J2 connector is not used. If the protection socket is damaged or lost, contact Kikusui distributor/agent.



[84-49-0110]

Fig.6-3 Protection socket

⚠WARNING Possible electric shock.

- **The J1/J2 connector contains pins that are at the same electric potential as the output terminal. If you are not using the J1/J2 connector, be sure to insert the protective socket provided.**
- **Be sure to use the protective cover on the sockets.**

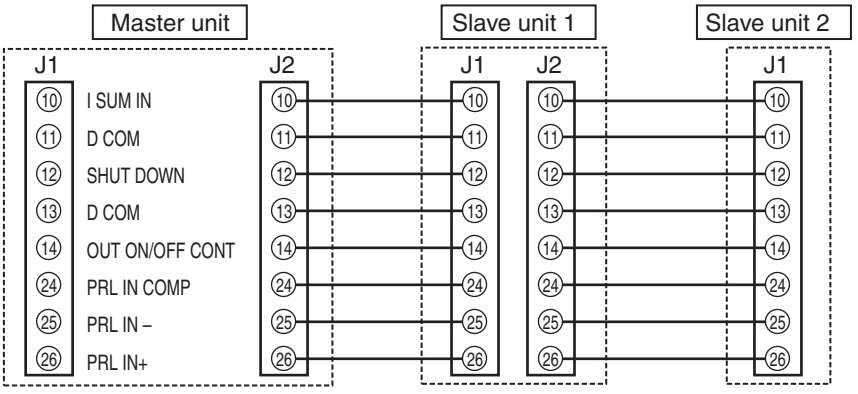


Fig.6-4 Connection for parallel operation (two slave units)

1. Choose the power supply that is to be the master unit.
2. Connect the J2 connector on the rear panel of the master unit to the J1 connector on the rear panel of slave unit 1 using the parallel operation power cable (PC01-PAT).
   If you are not using the PC01-PAT, connect pins 10 to 14 and 24 to 26.
3. Connect the J2 connector on the rear panel of slave unit 1 to the J1 connector on the rear panel of slave unit 2 using the parallel operation power cable (PC01-PAT).
   If you are not using the PC01-PAT, connect pins 10 to 14 and 24 to 26.

If slave units 3 and 4 are available, connect them in a similar manner.

Connecting the load (parallel operation)

⚠ WARNING

- **Possible electric shock. Be sure to turn the POWER switch off before touching the output terminal. Be sure to attach the OUTPUT terminal cover after wiring the load.**

⚠ CAUTION

- When connecting the output terminal to the chassis terminal, be sure that the output terminal of the same polarity (positive or negative) for both the master and slave units is connected to the chassis terminal. If you connect the output terminal of different polarities for the master and slave units, the output is short-circuited through the GND cable of the power cable. This not only impedes the retrieval of correct voltage but also may burn out the chassis terminal cable.
- If necessary, connect the electrolytic capacitor with the range in value from several hundreds to several ten thousands of µF to the end of load terminal. The inductance of wiring and the phase transition by capacity cannot be disregarded, and the oscillation might be occurred. The electrolytic capacitor prevents the oscillation. The withstanding voltage of the electrolytic capacitor must be used for the range of 120 % or more of the ratings output voltage.

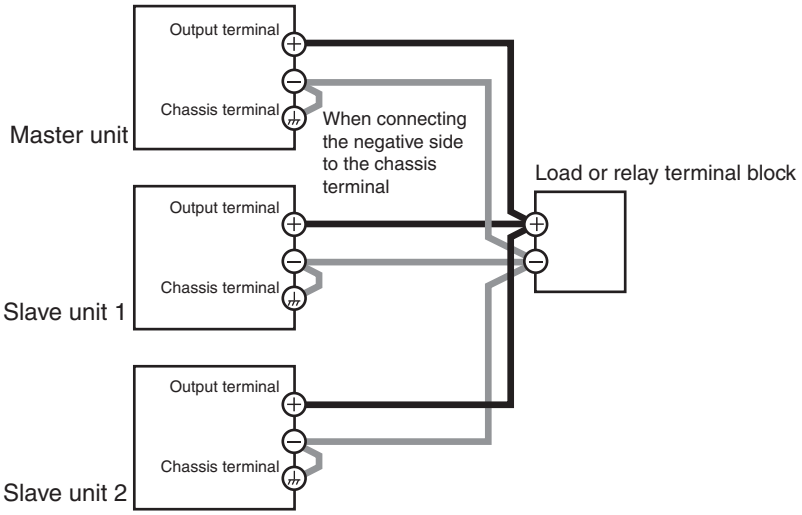


Fig.6-5 Load connection for parallel operation (two slave units)

1. Turn off the POWER switches on all power supply units to be connected in parallel.

See p. 3-6

2. Remove the OUTPUT terminal cover.

See p. 3-4

3. Connect the load wires to the output terminals of the master and slave units.

4. As shown in Fig.6-5, connect the load wires of the master and slave units to the load or the relay terminal block.

   Use load cables with sufficient current capacity. In addition, use the shortest load cables of the same length and cross-sectional area from each power supply to the load.

   Wire the signal cable of the J1 and J2 connectors and load cables as far apart as possible.

5. Connect the output terminals (+ or) of the master and slave units to the chassis terminal.

   Use the same polarities for the output terminals of the master and slave units.

   If you are using the master and slave units under floating conditions, do not connect the output terminals to the chassis terminal.

6. Attach the OUTPUT terminal cover.

If slave units 3 and 4 are available, connect them in a similar manner.

6.1.3 Master-Slave Parallel Operation Setup

Designating the master and slave units

See p. 4-18

Turn the output off and designate the master and slave units of the master-slave parallel operation. Set CF26 to 0 for the master unit and 1 for the slave units.

The settings take effect when you exit from the CONFIG settings.

Setting the number of units in Master-Slave Parallel Operation (Including the Master unit)

See p. 4-18

Turn the output off and set the number of units (CF24) in Master-Slave Parallel Operation.

The setting conditions become effective when you exit from CONFIG settings.

Setting the voltage and current

See p. 6-2

The voltage and current are set on the master unit. The total value of the master and slave units are delivered for the current.

When the setting number of units is set by the config setting (CF24) under the master-slave parallel operation, the maximum output current value (105 % of the rated output current of the product times number of units connected in parallel operation) is set, and it's value will be displayed when it is set to the setting value display (lights up the SET switch). The voltage value is set with the last setting of the master unit. When the OUTPUT switch is pressed with keeping this condition, its setting value will be output. Set the value as desired.

Setting the overvoltage protection (OVP) and overcurrent protection (OCP) of the master unit

See p. 4-10

Use the master-slave parallel operation, set the overvoltage protection (OVP) and overcurrent protection (OCP) of the master unit.

When the setting number of units is set by the config setting (CF24) under the master-slave parallel operation, the maximum over current protection value (111.5 % of the rated output current of the product times number of units connected in parallel operation) is set, and it's value will be displayed when it is set to the OPV/OCP setting value display (lights up the OVP/OCP switch). The value of over voltage protection is set with the last setting of the master unit.

CONFIG parameters that can be set on the slave unit

See p. 4-14

- CF13 Error message display setting
- CF23 Status signal setting of the power on/off
- CF26 Master-slave parallel setting
- CF27 Breaker trip setting when the shutdown signal is applied
- CF28 Breaker trip setting when the OVP or OCP is activated
- CF40 to CF43 RS232C settings
- CF51 GPIB address setting

NOTE

- Make sure to match the number of units in Master-Slave Parallel Operation for the setting number (CF24) and the actual number of connected units. If the setting number of units are different from the actual number of units, it is unable to set properly for such a current value setting (including EXT CC CONT), overcurrent protection (OCP) setting, and also the measured current value will not be appeared properly on the display.

6.1.4 Starting the Master-Slave Parallel Operation

Turning the power on

1. Turn on the POWER switch of the slave units.
2. Turn on the POWER switch of the master unit.

Turning the power off

1. Turn off the POWER switch of the slave units.
2. Turn off the POWER switch of the master unit.

⚠CAUTION

- When turning the POWER switch off and then back on, allow at least 10 seconds after the fan stops. Repeated on/off of the POWER switch at short intervals can cause damage to the inrush current limiter and shorten the service life of the POWER switch and internal input fuse.

Turning the output on/off

Turn the output on/off using the OUTPUT switch on the master unit.

6.2 Series Operation

Up to two PAT-T Series can be connected in series. Master-slave operation is not possible. The total of the output voltages of the two units is supplied to the load. The voltage setting accuracy is the same as that of each unit.

6.2.1 Functions during series operation

The functions of the PAT during series operation are as follows:

Voltage display and current display

Add the voltages of unit 1 and unit 2 to obtain the total output voltage.

Fig.6-6 Panel display example during series operation

Remote sensing

Cannot be used.

See Chapter 5

External control

Can be used.

See p. 5-21

External monitoring

WARNING

- **When monitoring the output voltage or current during series operation, the common electric potential of the monitor signal of unit 1 and unit 2 is different.**

- External monitoring of output voltage (V MON)

  The output voltage of each unit can be monitored.

- External monitoring of output current (I MON)

  The output current of each unit can be monitored.

- Status monitors

  Constant voltage operation (CV STATUS), constant current operation (CC STATUS), output on status, POWER switch on status, and so on can be monitored on each unit.

Alarm

All of the alarms that are detected on a single unit are also detected during series operation.

See p. 4-9, p. 6-11

■ Releasing the alarm

If the breaker trips, turn the power switch on after eliminating the cause of the alarm. If the output is turned off, turn the power switch off of the unit 1 and the unit 2 in this order, after eliminating the cause of the alarm, turn the power switch on of the unit 1 and the unit 2 in this order.

6.2.2 Load Connection (Series Operation)

⚠WARNING

- **Possible electric shock. Be sure to turn the POWER switch off before touching the output terminal. Be sure to attach the OUTPUT terminal cover after wiring the load.**

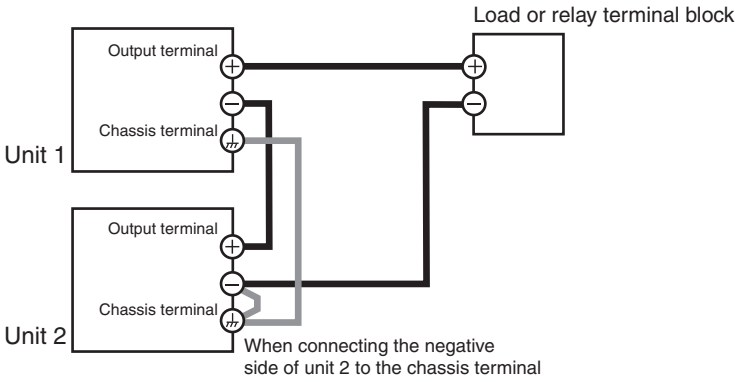


Fig.6-7 Load connection for series operation (Example in which the negative terminal of unit 2 is connected to the chassis terminal)

1. Turn off the POWER switches on all power supply units to be connected in series.
2. Remove the OUTPUT terminal cover.

See p. 3-6

3. As shown in Fig.6-7, connect the load and the PAT using the load wires.

See p. 3-4

Use load cables with sufficient current capacity. Connect the load wires at the shortest length possible. If the voltage drop in the output cable is large, the difference in the potential between power supply units and the load effect become large.

4. Connect the output terminals of unit 1 and unit 2.
5. Connect one of the negative terminal or the positive terminal of unit 1 or unit 2 to the chassis terminal.
6. Attach the OUTPUT terminal cover.

6.2.3 Series Operation Setup

Setting the voltage and current

See Fig.6-6

The voltage and current are set on each unit. The voltage that is delivered is the sum of the voltages of the two units. Set the same value for the current on each unit.

Setting the overvoltage protection (OVP) and overcurrent protection (OCP)

See p. 4-10

Overvoltage protection (OVP) and overcurrent protection (OCP) must be configured on each unit when carrying out series operation. Set the same values on each unit.

6.2.4 Starting the Series Operation

Turning the power on/off

Turn on/off the POWER switches on unit 1 and unit 2.

⚠CAUTION

- When turning the POWER switch off and then back on, allow at least 10 seconds after the fan stops. Repeated on/off of the POWER switch at short intervals can cause damage to the inrush current limiter and shorten the service life of the POWER switch and internal input fuse.

Turning the output on/off

Turn on/off the OUTPUT switches on unit 1 and unit 2.

Remote Control

This chapter describes an overview of the remote control function and explains the SCPI command structure, syntax, details of each command, registers, and so on used in the remote control.

7.1 Remote Control Overview

In addition to using the front panel, the PAT can be controlled remotely using the following interfaces.

- RS232C interface
- GPIB interface (factory option)
- USB interface (factory option)
- LAN interface (factory option)

The PAT is equipped with RS232C as standard.

If the factory option interface board is installed, you can use GPIB, USB or LAN. The GPIB, RS232C, USB and LAN interfaces cannot be used simultaneously.

The remote interface complies with IEEE Std 488.2-1992 and SCPI Specification 1999.0.

See p. 7-11

Use the SCPI commands only after you have understood the SCPI command syntax for the PAT.

When the PAT is operating under remote control, the RMT LED on the display on the front panel illuminates. To switch from the remote mode to the local mode (panel operation) from the panel, press the LOCAL switch.

7.2 Instrument Interface Standards

The PAT conforms to the following standards.

- IEEE Std 488.2-1992 IEEE Standard Codes, Formats, Protocols, and Common Commands For Use With IEEE Std 488.1-1987
- IEEE Std 488.1-1987 IEEE Standard Digital Interface for Programmable Instrumentation
- Standard Commands for Programmable Instruments (SCPI) version 1999.0
- Universal Serial Bus Specification Rev 2.0
- Universal Serial Bus Test and Measurement Class Specification (USBTMC) Rev 1.0
- Universal Serial Bus Test and Measurement Class, Subclass USB488 Specification (USBTMC-USB488) Rev 1.0
- TCP/IP instrument Protocol Specification VXI-11 Rev 1.0

7.3 VISA Library

If you are using a VISA library (VISA COM) for the I/O library, the VISA library must be installed on the controller (here in after called “the computer”).

A device driver supporting USB T&M Class (USBTMC) is required to control the PAT through the optional USB interface. The USBTMC driver is automatically installed by the VISA library.

When the product is controlled by the LAN interface, middleware which applies to the VXI-11 protocol is required. Middleware is automatically installed by VISA library.

VISA (Virtual Instrument Software Architecture) is a specification for standard software for connecting instruments that was defined by the VXIplug&play Systems Alliance.

One of the VISA libraries below is required.

Do not install the plural number of VISA library to the PC. It may cause possible malfunction.

USB functions for those cannot be used on Windows 95 or Windows NT 3.5x or 4.0.

- NI-VISA by National Instruments (Ver. 4.0 or later)
- Agilent VISA by Agilent Technologies (Agilent IO Libraries Suite14.2 or later)
- KI-VISA Ver. 3.1.3 or later

Installing KI-VISA

KI-VISA is not required if NI-VISA or Agilent VISA is already installed. It may cause possible malfunction.

KI-VISA is Kikusui’s original VISA library that supports VXIplug&play VISA Specifications 3.0. The newest version can be downloaded from Download service of Kikusui website (http://www.kikusui.co.jp/en/download/).

Double-click on Kivisa_3_0_x.exe, then proceed with the installation according to the instructions on the screen. The value for x varies depending on the revision of the VISA library stored on the CD-ROM.

7.4 Interface Setup

7.4.1 RS232C Control (Standard Equipped)

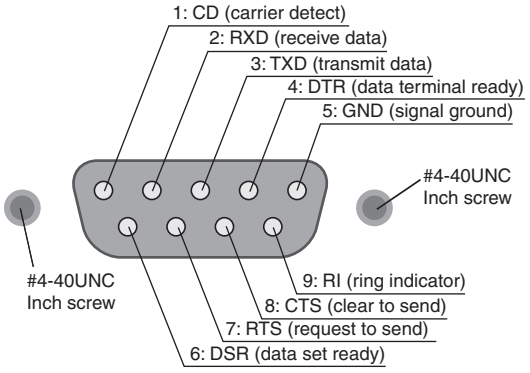
RS232C connection

The RS232C port on the PAT is a standard D-sub 9-pin male connector.

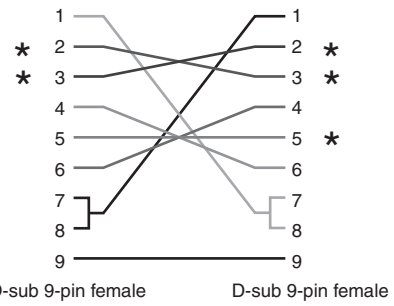
Check that the POWER switches of the PAT and computer are off, and connect the PAT to the computer using a standard cross cable (null modem cable).

Use a D-sub 9-pin female-to-female AT type for the cross cable. Fig.7-1 shows the connector pin arrangement.

The PAT does not use hardware handshaking (as shown in the cross cable example 2).



Facing the PAT rear panel



Wiring configuration of the cross cable

* : Communication Iline used of this producct

Fig.7-1 9-pin AT type connector

RS232C configuration

See p. 4-15, p. 4-21

1. If an option board is installed, select RS232C in the CONFIG settings (CF54: 232C).
2. In the CONFIG settings, set the RS232C data rate (CF40), RS232C data length (CF41), RS232C stop bit (CF42), and RS232C flow control (CF43).
   For the settings, see Table 7-1.

Protocol

Table 7-1 shows the RS232C protocol. Underline indicates factory default condition. The value inside the parentheses is the CONFIG setting value.

Table 7-1 RS232C protocol

Item	Setting
Connector	9-pin D-sub terminal on the rear panel
Baudrate	1200 bps/ 2400 bps/ 4800 bps/ 9600 bps/ 19200 bps/ 38400 bps (1.2/2.4/4.8/9.6/19.2/38.4)
Data length	(8 bits or 7 bits)
Stop bit	(1 bit or 2 bits)
Parity	Fixed to none
Flow (X-flow control)	XFLOW / None (on/off)

Break signal

The break signal functions as a substitute for the IEEE488.1 dcl/sdc (Device Clear, Selected Device Clear) message.

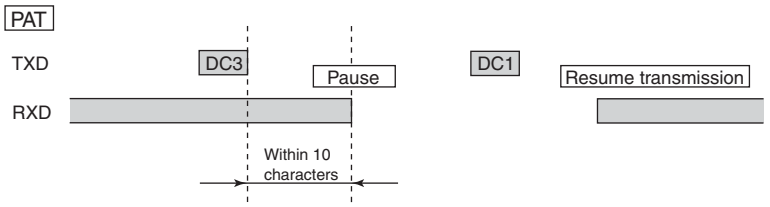
RS232C communication

Use flow control for RS232C communication. DC (device control) codes are used as control codes.

Transmission/reception may not work correctly through unilateral transmission.

Table 7-2 DC codes

Code	Function	ASCII code
DC1 (Xon)	Request to send	11H
DC3 (Xoff)	Transmission stop request	13H



The RS232C terminal must pause transmission within 10 characters after receiving DC3.

Fig.7-2 RS232C terminal and transmission control of the PAT

7.4.2 GPIB Interface (Option)

This interface valid only when the factory option GPIB interface board is installed.

GPIB connection

Use a standard IEEE488 cable to connect the PAT to the computer.

GPIB configuration

See p. 4-15, p. 4-21

1. Select GPIB (CF54: GPIb) in the CONFIG settings.
2. Set the address (CF51: 1 to 30) in the CONFIG settings.
   The address is set to 1 as factory default setting.

GPIB function

Table 7-3 GPIB function

Function	Subset	Description
Source handshaking	SH1	Full capability
Acceptor handshaking	AH1	Full capability
Talker	T6	Function available
Listener	L4	Function available
Service request	SR1	Full capability
Remote local	RL1	Full capability
Parallel polling	PP0	No capability
Device clear	DC1	Full capability
Device trigger	DT1	Full capability
Controller	C0	No capability
Electrical interface	E1	Open collector driver

Service request

Service request and serial polling functions are implemented.

7.4.3 USB Interface (Option)

See p. 7-3

This interface valid only when the factory option USB interface board is installed.

A device driver supporting USB T&M Class (USBTMC) is required to control the PAT through the USB interface. The USBTMC driver is automatically installed by the VISA library.

USB configuration

See p. 4-15, p. 4-21

Select USB (CF54: uSb) in the CONFIG settings.

Service request

Service request and serial polling functions are implemented.

USB function

Complies with USB Specification 2.0.

Complies with USBTMC Specification 1.0 and USBTMC-USB488 Specification 1.0.

Data rate: 12 Mbps maximum (full speed)

VID (vendor ID): 0x0B3E

PID (product ID): 0x100E

You can check the VID (CF52) and PID (CF53) in the CONFIG settings.

7.4.4 LAN interface (Option)

This interface valid only when the factory option LAN interface board is installed.

See p. 7-3

When the product is controlled by the LAN interface, middleware which applies to the VXI-11 protocol is required. Middleware is automatically installed by VISA library.

See p. A-11

The built-in Web site is equipped with the LAN interface board. The LAN interface can be set in detail from the browser on the PC.

Contact the network administrator for details concerning LAN connection in in-house, Internet Protocol address, the host name, and security, etc.

LAN connection

Connect this product with the network hub or the router by using a standard LAN cable (category 5, straight type).

LAN setting

See p. A-11

In normal operation, the DHCP server is used. When the fixed IP address is used, it can not be set from the panel. Use the built-in Web site for setting.

1. Select LAN (CF54 : LAn) by the CONFIG setting.
2. Select DHCP (CF55 : On) by the CONFIG setting.
3. Select AUTO IP (CF56 : On) by the CONFIG setting.

Service request

The features of service request and serial polling are equipped.

LAN function

The connection to the Internet line may be required by the function according to the operation of the built-in Web site.

Comply with VXI-11 protocol

Communication speed: Maximum 100 Mbps (Auto negotiation)

DHCP client function

AUTO IP function

Operation of the Web site

- LAN setting, Security setting
- Use of temporary control application
- Firmware update (Internet Explore 5.5/6.0/7.0), Mozilla Fire fox 2.0 or later, Opera 9.0 or later, Netscape 7.1 or later, Safari 3.0 or later)

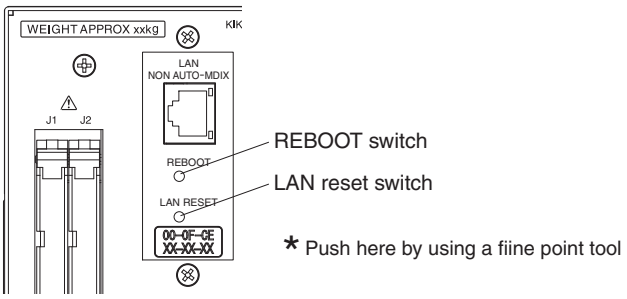


Fig.7-3 REBOOT switch and LAN reset switch

■ REBOOT switch

When you keep pressing the "REBOOT" switch for more than 2 seconds, the LAN will reboot. However, the setting condition of LAN interface will not be changed.

■ LAN reset switch

When you keep pressing the "LAN RESET" switch for more than 2 seconds, all of the setting of LAN interface returns to the factory default setting. It can be used when neither the security password nor IP address are forgotten.

Either switch doesn't reflect to the panel setting of the product. In case the product is in the state of remote mode, it can be switched (from the panel operation) to the local mode.

⚠WARNING

- **There are possible damage on the equipment or an electric shock. The LAN interface can be accessed from any place on the network. Set the security when it is necessary.**
  Security can be set by the password protection and the host limitation by IP address. Refer to Appendix "A.5 Access and Operation for the Built-in Web site (LAN interface)" for setting procedure.

NOTE

- Do not touch neither REBOOT switch nor LAN reset switch inadvertently while the automatic measurement system is in operation. It may cause to mis-operation.
- The LAN interface should be shifted remotely by the command unlike other interfaces. Set it by the SCPI command "SYSTem:REMote" to the remote state. When you do a remote programming, transmit this command to the front of the program.

7.5 Overview of Messages

The information that is exchanged between the computer and the PAT is called a message.

The PAT uses the SCPI language for the messages.

There are two types of messages, commands that are sent from the computer to the PAT and responses that are sent from the PAT to the computer.

Commands are used to execute functions of the PAT, change settings, and query settings and status. Responses return the settings and status of the PAT.

Command hierarchy

SCPI is an ASCII-based command language designed for test and measurement devices. The command hierarchy is structured around the common root or node, which is the construction block of the SCPI sub system. A command consists of a program header, parameters, and punctuations.

The hierarchy is explained using the SOURce subsystem as an example.

Program header	Parameter	Node hierarchy
SOURce:		Root node
CURRent		2nd level
[:PROTection]		3rd level
[:LEVel]	<numeric>	4th level
:STATe	<bool>	4th level
VOLTage		2nd level
[:PROTection]		3rd level
[:LEVel]	<numeric>	4th level
:STATe	<bool>	4th level

A higher node is separated from a lower node using a colon (:).

7.5.1 SCPI Command Syntax

Command syntax

This manual denotes SCPI commands using the following format.

(Example)

```
[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]
  {<current>|MINimum|MAXimum}
```

- There are two forms of SCPI commands, the long form in which the command is written out in its entirety and the short form in which the letters written in lowercase are omitted.

  SCPI commands can be sent in the long form or short form.

- SCPI commands are not case sensitive. CURR, Curr, and curr are all accepted as short forms of CURRent.

  CURRENT, Current, current are all accepted as long forms.

- A space is required between the program header section and the parameter section.

- Multiple parameters, when available, are concatenated using commas.

- Compound commands can be created by concatenating two commands with a semicolon.

  (Example)

  ```
  SOURce:CURRent MINimum;VOLTage MINimum
  ```

  This compound command is the same as entering the following two commands.

  ```
  SOURce:CURRent MINimum
  SOURce:VOLTage MINimum
  ```

  The first command, SOURce:CURRent MINimum, sets the path to SOURce. Therefore, the root node, SOURce, can be omitted in the second command.

  An error occurs if a node that is not defined in the current path (except CURRent and VOLTage) is designated.

- A colon is required between program headers.

- Commands of different subsystems can be concatenated using colons and semicolons.

  (Example)

  ```
  SOURce:CURRent MINimum;:MEASure:CURRent?
  ```

  This compound command contains two root nodes, SOURce and MEASure.

  When the second or subsequent command starts with a colon, the path specified by the previous command is cleared.

- The maximum number of characters that can be transmitted in a single line is 128.

Special symbols and characters

Special symbols and characters used in this manual to describe SCPI commands are defined as indicated in Table 7-4.

Table 7-4 Definitions of special symbols and characters

Symbols or characters	Description
< >	Characters strings inside the < and > symbols indicate program data. Do not include these symbols in the actual program.
{ }	Characters and numbers delimited by "|" in braces indicate that one of the items is to be selected. Do not include the braces in the actual program.
[ ]	Characters strings inside brackets indicate option data. When option data is not sent with the program, the default value is sent. Do not include the brackets in the actual program.

Query

The device settings or status can be queried.

To make a query, add a question mark at the end of the program header section. If a query has parameters, enter a space after the question mark followed by the parameters.

(Example) CURRent? MIN

NOTE

- When transmitting two queries in separate lines, read the response to the first query before transmitting the second line. If you send two lines of query commands at once, an incomplete response may be received.

String termination

All commands must be terminated using a valid terminator.

The available terminators are <line feed> (ASCII 0x0A) and EOI (end-or-identify). Either one can be used as a terminator.

Because EOI is not available on the RS232C, be sure to use <line feed>.

When a command string is terminated, the path is reset to the root level.

NOTE

- CR (ASCII 0x0D) is not a terminator.

Common commands

See p. 7-16

The IEEE-488.2 and SCPI standards contain a set of common commands for reset, self-test, and other functions. These common commands always start with an asterisk. The commands may have one or multiple parameters.

7.5.2 Parameters

The parameter format of SCPI is derived from the program parameter format defined in IEEE 488.2.

The representation system of the program data that is used on the PAT is indicated below.

Non-numeric parameters

The PAT uses the following three types of non-numeric parameters.

Table 7-5 Non-numeric parameters

Symbols or characters	Description
Character string data (String)	Used when a series of ASCII characters are requested. Be sure to enclose a string in single quotations or double quotations. The start and end quotation marks must match. (Example) `FUNCtion "IMP"` If you wish to use a quotation mark as a part of the string, enter two quotation marks consecutively (with no characters in between). ASCII codes 20H to 7EH can be used.
Character data (Character)	Used when only a limited number of values is available for the program setting. Responses are returned in the short form. (Example) `TRIGger:SOURce {BUS|IMMediate|TIMer}`
Boolean data	Expresses a 1 or 0 condition or an ON or OFF condition. Responses are returned as 1 or 0. (Example) `OUTPut {ON|OFF|1|0}`

Numeric parameters

The PAT uses the following five types of numeric parameters.

Table 7-6 Numeric parameters

Symbols or characters	Description
NR1	Represents an integer.*1
NR2	Represents a real number (floating point).*1
NR3	Represents a real number (exponential).*1 The value +3.80000+E02 is returned for the response data 380. The number of digits of the decimal place is 5.
NRf	NRf is a generic term that includes NR1, NR2, and NR3.
Numeric	Represents a decimal point, optional sign, and measurement unit. The numeric representation syntax is the same as NRf. MINimum and MAXimum are available as substitutes for declaring certain values. Units such as V, A, and W can also be used in a numeric parameter. If a value that cannot be assigned is entered, the device rounds the value to the closest possible value. (Example) `SOURce:CURRent 500` for PAT20-400T The range of values for SOUR:CURR is 0 % to 105 % of the rated output current. Thus, 500 is set even if 420 is specified.

*1: Details are given in the "IEEE 488.2 Standard Digital Interface for Programmable Instrumentation."

Special form numeric parameter

The special form numeric parameters MINimum and MAXimum can be used as substitutes for limit values when the parameter is numeric.

In the example below, the overcurrent protection is set to the minimum value.

```
CURRent:PROTection MINimum
```

The minimum and maximum values can be inquired for most parameters using queries.

```
CURRent:PROTection? MIN
CURRent:PROTection? MAX
```

Measurement unit

Below are the default measurement units. Commands are accepted even if measurement units are not specified.

- V (voltage)
- A (current)
- S (second)

The following optional prefixes are supported. To enter “μ” in the parameter, use “U” instead.

- M (milli)
- U (micro)

NOTE

- The unit symbols in the International System of Units contain lowercase characters. The IEEE standard uses uppercase characters. SCPI commands are not case sensitive.

7.6 Command Description in This Manual

This manual describes the commands in the following manner.

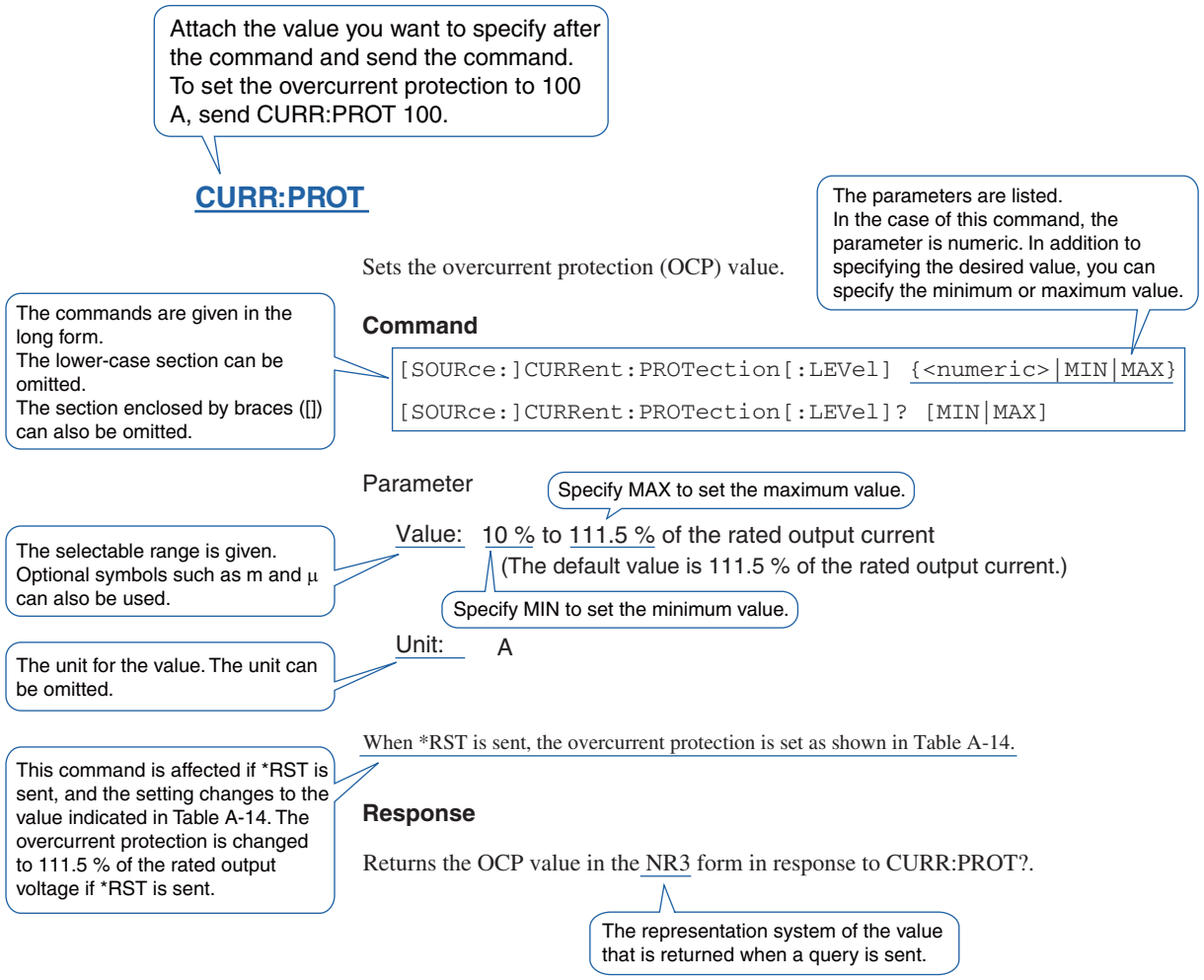


Table 7-7 Command items and reference pages

Item	See Page
Command syntax	7-11
Parameters	7-13
Unit	7-14
Table A-16	A-10
Query	7-12
Representation system	7-13
List of messages	A-2
List of errors	A-7
Tutorial	A-16
Sample program	A-27

7.7 IEEE488.2 Common Commands

*CLS

Clears all event registers including the status byte, event status, and error queue.

See p. 7-42

Command

```
*CLS
```

*ESE

See p. 7-45

Sets the event status enable register that is counted by the event summary bit (ESB) of the status byte.

Command

```
*ESE <NR1>
*ESE?
```

Parameter

Value: 0 to 255

An SCPI error (-222, “Data out of range”) occurs if outside the range.

(Example) When *ESE 16 is transmitted, bit 4 of the event status enable register is set. Each time the execution error bit (bit 4) of the event status register is set, the summary bit (ESB) of the status byte is set.

Response

Returns the value of the event status enable register in the NR1 form in response to *ESE?.

*ESR

See p. 7-45

Queries the event status register. Registers that are read are cleared.

Command

```
*ESR?
```

Response

Returns the value of the event status register in the NR1 form in response to *ESR? and clears the register.

*IDN

Queries the model name, serial number, and firmware version of the PAT.

Command

```
*IDN?
```

Response

The response to *IDN? is indicated below.

(Example) For PAT20-400T with a serial number AB123456 and firmware version 1.00 Returns

```
KIKUSUI,PAT20-400T,AB123456,1.00.
```

*OPC

See IEEE 488.2-1992 Section 12.5.3

Sets the OPC bit (bit 0) of the event status register when all of the command processings in stand by have been completed.

Command

```
*OPC
*OPC?
```

Response

Returns 1 when all the commands processing in stand by are standing by is completed in response to *OPC?.

*OPT

Queries the option interface board that is installed in the PAT.

Command

```
*OPT?
```

Response

Returns 0 if there is no option installed in response to *OPT?.

If the factory option GPIB, USB or LAN interface board is installed, "GPIB", "USB" or "LAN" is returned in response to *OPT?.

*PSC

See IEEE 488.2-1992 Section 10.25

Sets whether to clear the event status enable register and the service request enable register when the POWER switch is turned on (power-on status).

Command

```
*PSC <NR1>
*PSC?
```

Parameter

Value:	0	Does not clear the *ESE and *SRE settings when the POWER switch is turned on.
	1	Clears the *ESE and *SRE settings when the POWER switch is turned on.

An SCPI error (-222, “Data out of range”) occurs if outside the range.

(Example) To enable the power-on SRQ function

```
*PSC 0;*SRE 32;*ESE 128
```

Response

Returns the power-on status setting in response to *PSC?

*RST

See p. A-10

Aborts the measurement operation and initializes the PAT to factory default condition.

For the commands that are affected by *RST, see Table A-16.

Command

```
*RST
```

*SRE

Sets the service request enable register.

The service request enable register is used to select the summary messages in the status byte register that will be able to perform service requests.

To clear the service request enable register, send *SRE 0. If the register is cleared, service requests cannot be generated by status information.

Command

```
*SRE <NR1>
*SRE?
```

Parameter

Value: 0 to 255

An SCPI error (-222, “Data out of range”) occurs if outside the range.

(Example) Sending *SRE 8 sets bit 3 of the service request enable register. Each time the summary bit (bit 3) of the QUEStionable status register in the status byte is set, a service request message is generated.

Response

Returns the value of the service request enable register in the NR1 form in response to *SRE?.

*STB

See p. 7-44

Queries the contents of the status byte register and the MSS (master summary status) message.

The response is the same as serial polling only with the exception that the MSS message appears in place of the RQS message in bit 6.

Command

```
*STB?
```

Response

Returns the value of the status byte register and the MSS message (bit 6) in NR1 form in response to *STB?.

*TRG

See IEEE 488.2-1992 Section 10.37

Trigger command.

This is a substitute command for the IEEE488.1 get message (Group Execute Trigger).

If the PAT is not in a condition to accept triggers, an SCPI error (-211, “Trigger ignored”) occurs.

Command

```
*TRG
```

*TST

See IEEE 488.2-1992 Section 10.38

This command is to perform the self-test, however, the PAT does not equip this feature.

Command

```
*TST?
```

Response

Returns 0 in response to *TST?.

*WAI

Prevents the PAT from executing subsequent commands until all operations in standby are complete.

Command

```
*WAI
```

7.8 Output Setting

Output on / off

OUTP

Turn the output on/off. The condition set by the Output on/off Delay function is disabled.

Command

```
OUTPut[:STATe][:IMMediate] {ON|OFF|1|0}
OUTPut[:STATe][:IMMediate]?
```

Parameter

Value:	ON(1)	Output on
	OFF(0)	Output off (default)

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the output status in the NR1 form in response to OUTP?.

OUTP:PON:STAT

Sets the output state at power-on.

Command

```
OUTPut:PON:STATe {RST|AUTO}
OUTPut:PON:STATe?
```

Parameter

Value:	RST	Output off at power-on (default)
	AUTO	Output on at power-on

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the output state at power-on as character data in response to OUTP:PON:STAT?.

Voltage Settings

VOLT

Sets the voltage.

Command

```
[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude]
  {<numeric>|MIN|MAX}
[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude]?
  {MIN|MAX}
```

Parameter

Value: 0 % to 105 % of the rated output voltage
(The default value is 0 % of the rated output voltage.)

An SCPI error (-221, "Settings conflict") occurs if VOLT:EXT:SOUR is not set to NONE.

Unit V

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the voltage setting in the NR3 form in response to VOLT?. If the voltage value is set using external input, the specified voltage is returned.

Current Settings

CURR

Sets the current.

Command

```
[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]
  {<numeric>|MIN|MAX}
[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]?
  [MIN|MAX]
```

Parameter

Value: 0 % to 105 % of the rated output current
(The default value is 105 % of the rated output current.)

An SCPI error (-221, "Settings conflict") occurs if CURR:EXT:SOUR is not set to NONE.

Unit A

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the current setting in the NR3 form in response to CURR?. If the current value is set using external input, the specified current is returned.

7.9 Measurement Operation Settings

For the procedure to set the measurement operation, See “Measurement Operation” on page 7-39.

7.10 Protection Function Settings

Overvoltage protection settings

VOLT:PROT

Sets the overvoltage protection (OVP).

Command

```
[SOURce:]VOLTage:PROTection[:LEVel]
  {<numeric>|MIN|MAX}
[SOURce:]VOLTage:PROTection[:LEVel]? [MIN|MAX]
```

Parameter

Value: 10 % to 111.5 % of the rated output voltage
(The default value is 111.5 % of the rated output voltage.)

Unit V

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the OVP value in the NR3 form in response to VOLT:PROT?.

Voltage limit setting

VOLT:LIM

Queries the voltage limit setting. The voltage limit setting is approximately 95 % of the OVP trip point.

This command is valid when VOLT:LIM:AUTO ON is specified.

Command

```
[SOURce:]VOLTage[:AMPLitude]?
```

Response

Returns the voltage limit setting value in the NR3 form in response to VOLT:LIM?.

Unit V

VOLT:LIM:AUTO

Sets whether to enable the voltage limit setting. If enabled, the voltage limit setting is automatically set to approximately 95 % of the OVP trip point. This cannot be set when the output is on.

Command

```
[SOURce:]VOLTage:LIMit:AUTO {ON|OFF|1|0}
[SOURce:]VOLTage:LIMit:AUTO?
```

Parameter

Value:	ON (1)	Limit the voltage setting
	OFF (0)	Not limit the voltage setting (default)

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns whether to enable the voltage limit setting in the NR1 form in response to VOLT:LIM:AUTO?.

Overcurrent protection settings

CURR:PROT

Sets the overcurrent protection (OCP) value.

Command

```
[SOURce:]CURRent:PROTection[:LEVel]
  {<numeric>|MIN|MAX}
[SOURce:]CURRent:PROTection[:LEVel]? [MIN|MAX]
```

Parameter

Value:	10 % to 111.5 % of the rated output current (The default value is 111.5 % of the rated output current.)
Unit	A

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the OCP value in the NR3 form in response to CURR:PROT?.

Current setting limit

CURR:LIM

Queries the current setting limit. The current setting limit is approximately 95 % of the OCP trip point.

This command is valid when CURR:LIM:AUTO ON is specified.

Command

```
[SOURce:]CURRent:LIMit[:AMPlitude]?
```

Response

Returns the current limit value in the NR3 form in response to CURR:LIM?.

Unit A

CURR:LIM:AUTO

Sets whether to enable the current setting limit. If enabled, the current setting limit is automatically set to approximately 95 % of the OCP trip point. This cannot be set when the output is on.

Command

```
[SOURce:]CURRent:LIMit:AUTO {ON|OFF|1|0}
[SOURce:]CURRent:LIMit:AUTO?
```

Parameter

Value:	ON (1)	Limit the current setting
	OFF (0)	Not limit the current setting (default)

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns whether to enable the current setting limit in the NR1 form in response to CURR:LIM:AUTO?.

Operation when a protection function is activated

SYST:CONF:BTR:PROT

Sets whether to trip the breaker (turn the POWER switch off) when the overvoltage protection (OVP) or overcurrent protection (OCP) is activated.

Command

```
SYSTem:CONFigure:BTRip:PROTection {ON|OFF|1|0}
SYSTem:CONFigure:BTRip:PROTection?
```

Parameter

Value:	ON(1)	Trip (turn the POWER switch off)
	OFF(0)	Not trip (turn the output off) (default)

Response

Returns whether to trip the breaker when the OVP or OCP is activated in the NR1 form in response to SYST:CONF:BTR:PROT?.

SYST:CONF:BTR:SHUT

Sets whether to trip the breaker (turn the POWER switch off) when an external shutdown (SD) signal is applied.

Command

```
SYSTem:CONFigure:BTRip:SHUTdown {ON|OFF|1|0}
SYSTem:CONFigure:BTRip:SHUTdown?
```

Parameter

Value:	ON(1)	Trip (turn the POWER switch off)
	OFF(0)	Not trip (turn the output off) (default)

Response

Returns whether to trip the breaker when the SD signal is applied in the NR1 form in response to SYST:CONF:BTR:SHUT?.

7.11 Releasing the Alarm

OUTP:PROT:CLE

Clears the alarm, except for the “Fan failure protection (FAN)”.

Command

```
OUTPut:PROTection:CLEar
```

7.12 Other System Configuration

OUTP:EXT

Sets the logic used to control the output on/off using an external contact (J1 connector). This cannot be set when the output is on.

Command

```
OUTPut:EXTernal {NORMal|INVerted}
OUTPut:EXTernal?
```

Parameter

Value:	NORMal	Turn the output on with a high signal (default)
	INVerted	Turn the output on with a low signal

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the external control logic setting of the output on/off as character data in response to OUTP:EXT?.

VOLT:EXT:SOUR

Sets the constant voltage control mode. This cannot be set when the output is on.

Command

```
[SOURce:]VOLTage:EXTernal:SOURce
  {NONE|VOLTage|RESistance|IRESistance}
[SOURce:]VOLTage:EXTernal:SOURce?
```

Parameter

Value:	NONE	Panel control (default)
	VOLTage	External voltage control
	RESistance	External resistance control 10 kΩ → MAX OUT
	IRESistance	External resistance control 10 kΩ → 0 OUT (FAIL SAFE)

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the constant voltage control mode as character data in response to VOLT:EXT:SOUR?.

CURR:EXT:SOUR

Sets the constant current control mode. This cannot be set when the output is on.

Command

```
[SOURce:]CURRent:EXTernal:SOURce
  {NONE|VOLTage|RESistance|IRESistance}
[SOURce:]CURRent:EXTernal:SOURce?
```

Parameter

Value:	NONE	Panel control (default)
	VOLTage	External voltage control
	RESistance	External resistance control 10 kΩ → MAX OUT
	IRESistance	External resistance control 10 kΩ → 0 OUT (FAIL SAFE)

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the constant current control mode as character data in response to CURR:EXT:SOUR?.

SYST:CONF:BTR

Sets the breaker trip (turn the POWER switch off).

Command

```
SYSTem:CONFigure:BTRip[:IMMediate]
```

SYST:CONF:PAR

Sets the number of units in Master-Slave Parallel Operation. It enables to set only for the Master unit. It can not be set when the output is turned on.

Command

```
SYSTem:CONFigure:PARallel {1|2|3|4|5}
SYSTem:CONFigure:PARallel?
```

Parameter

Value:	1 to 5 (The default value is 1.)

Response

Returns the setting numbers of Master-Slave Parallel Operation in the NR1 form in response to SYST:CONF:PAR?.

SYST:CONF:PST

Sets whether to output a low level signal at power on status or power off status when monitoring the power on/off status externally (through the J1 connector).

Command

```
SYSTem:CONFigure:PSTatus {NORMal|INVerted}
SYSTem:CONFigure:PSTatus?
```

Parameter

Value:	NORMal	Output a low level signal while the power is on (default)
	INVerted	Output a low level signal for 10 s to 15 s when the power is off.

Response

Returns the power on/off status as character data in response to SYST:CONF:PST?.

SYST:CONF:RSEN

Queries the state of the sensing switch on the rear panel.

Command

```
SYSTem:CONFigure:RSENsing?
```

Response

Returns 0 if the sensing switch on the rear panel is set to off (remote sensing disabled) or 1 if set to on (remote sensing enabled) in response to SYST:CONF:RSEN?.

SYST:CONF:MSL

Sets the PAT condition during master-slave parallel operation.

Command

```
SYSTem:CONFigure:MSLave {MASTer|PARallel}
SYSTem:CONFigure:MSLave?
```

Parameter

Value:	PARallel	Slave unit
	MASTer	Master unit or independent operation (default)

Response

Returns the PAT status under master-slave parallel control as character data in response to SYST:CONF:MSL?.

SYST:CONF:TRAC

Sets whether to display communication errors by performing a debug trace. If the debug trace function is turned on, error codes (example: Err-100) are shown on the PAT display.

Command

```
SYSTem:CONFigure:TRACe {ON|OFF|1|0}
SYSTem:CONFigure:TRACe?
```

Parameter

Value:	ON(1)	Display communication errors
	OFF(0)	Not display communication errors (default)

Response

Returns whether to display communication errors in the NR1 form in response to SYST:CONF:TRAC?.

7.13 Preset Memory Function

This section explains the commands related to the memory functions of the PAT.

MEM:SAV

Saves the present voltage and current settings of the PAT to the preset memory.

Command

```
MEMory:SAV {1|2|3}
```

Parameter

Value:	1	Preset memory A
	2	Preset memory B
	3	Preset memory C

MEM:RCL

Recalls a preset memory.

Command

```
MEMory:RCL {1|2|3}
```

Parameter

Value:	1	Preset memory A
	2	Preset memory B
	3	Preset memory C

MEM:KLOC

Sets whether preset memory values can be recalled from the panel even when the lock function is enabled. MEM:RCL allows preset memory values to be recalled regardless of this setting.

Command

```
MEMory:KLOCk  {ON|OFF|1|0}
MEMory:KLOCk?
```

Parameter

Value:	ON (1)	Unable to recall preset memory values in the locked condition (Default)
	OFF (0)	Able to recall preset memory values in the locked condition

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns whether recalling of the preset memory is allowed when the keys are locked in the NR1 form in response to MEM:KLOC?.

7.14 Trigger Function

Specifies settings related to the trigger function.

Setting the trigger

The trigger is classified into three sequence groups, TRIGger[:SEQuence[1]], TRIGger:SEQuence2, and TRIGger:SEQuence3.

There are two second level nodes for each sequence in the TRIGger subsystem. The same operation is carried out regardless of the node that is used.

■ Sequence 1

Trigger subsystem that changes the settings

Second level node: SEQuence[1] or TRANsient

■ Sequence 2

Trigger subsystem for the output on/off delay

Second level node: SEQuence2 or OUTPut

■ Sequence 3

Trigger subsystem for measurements

Second level node: SEQuence3 or ACQuire

7.14.1 Setting Changes (Sequence 1: TRANsient Settings)

See p. A-19

The sequence 1 group can synchronize the output changes using triggers.

When ABOR is sent, INIT:SEQ1 is cancelled. The VOLT:TRIG setting does not change.

If the voltage (VOLT) is changed, the voltage setting that is applied with a trigger is cancelled and overwritten to the VOLT setting. Table 7-8 shows the responses when the voltage is set to 20 V (VOLT 20) and when the voltage setting that is applied with a trigger is set to 10 V (VOLT 10).

Table 7-8 Responses after sending VOLT 20;:VOLT:TRIG 10

	Response	
	VOLT?	VOLT:TRIG?
Immediately after the setting	20	10
After a trigger is sent	10	10
After *RST is sent	0	0
ABOR is sent before sending a trigger	20	20 (cancel)
Voltage change VOLT 30 is sent before sending a trigger	30	30 (cancel)

VOLT:TRIG

Sets the voltage that is applied when INIT:SEQ1 / INIT:NAME TRAN and a software trigger are sent.

Command

```
[SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPLitude]
  {<numeric>|MIN|MAX}
[SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPLitude]?
  [MIN|MAX]
```

Parameter

Value: 0 % to 105 % of the rated output voltage
(The default value is 0 % of the rated output voltage.)

Unit V

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the voltage value that is applied when a trigger is received in the NR3 form in response to VOLT:TRIG?.

CURR:TRIG

Sets the current value that is applied when INIT:SEQ1 / INIT:NAME TRAN and a software trigger are sent.

Command

```
[SOURce:]CURRent[:LEVel]:TRIGgered[:AMPLitude]
  {<numeric>|MIN|MAX}
[SOURce:]CURRent[:LEVel]:TRIGgered[:AMPLitude]?
  [MIN|MAX]
```

Parameter

Value: 0 % to 105 % of the rated output current
(The default value is 105 % of the rated output current.)

Unit A

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the current value that is applied when a trigger is received in the NR3 form in response to CURR:TRIG?.

TRIG:SOUR

Sets the condition (trigger source) for actually changing the setting after the sequence 1 group receives INIT:SEQ1 / INIT:NAME TRAN.

Command

```
TRIGger[:SEQuence[1]]:SOURce {IMMediate|BUS}
TRIGger[:SEQuence[1]]:SOURce?
TRIGger[:TRANsient]:SOURce {IMMediate|BUS}
TRIGger[:TRANsient]:SOURce?
```

Parameter

Value:	IMM	Starts the setting immediately
	BUS	Wait for a software trigger (*TRG, TRIG, or IEEE488.1 get (Group Execute Trigger)) to change the setting (Default)

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the trigger source of the sequence 1 group as character data in response to TRIG:SOUR?.

TRIG

Executes a software trigger to the sequence 1 group.

Command

```
TRIGger[:SEQuence1:IMMediate]
TRIGger[:TRANsient:IMMediate]
```

INIT / INIT:NAME TRAN

Starts the trigger function of the sequence 1 group.

If TRIG:SOUR is set to IMM, the change starts immediately. If set to BUS, the change starts after waiting for a software trigger.

Command

```
INITiate[:IMMediate][:SEQuence[1]]
INITiate[:IMMediate]:NAME TRANsition
```

7.14.2 Output On/Off Delay Function (Sequence 2: OUTPUT Settings)

See p. A-20

The sequence 2 group enables the OUTPut on/off delay to be controlled with triggers.

OUTP:TRIG

Sets whether to turn the output on or off when a trigger is applied.

Command

```
OUTPut[:STATe]:TRIGgered {ON|OFF|1|0}
OUTPut[:STATe]:TRIGgered?
```

Value:	ON(1)	Turn the output no when a trigger is applied
	OFF(0)	Turn the output off when a trigger is applied (default)

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns whether the output is turned on or off when a trigger is applied in the NR1 form in response to OUTP:TRIG?.

TRIG:SEQ2:DEL:ON / TRIG:OUTP:DEL:ON

Sets the delay for turning on the output.

Command

```
TRIGger:EQuence2:DELay:ON {<numeric>|MIN|MAX}
TRIGger:SEQuence2:DELay:ON?
TRIGger:OUTPut:DELay:ON {<numeric>|MIN|MAX}
TRIGger:OUTPut:DELay:ON?
```

Parameter

Value: 0.0 to 10.0 0 is no delay (The default value is 0.0)

Unit S

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the delay until the output is turned on in the NR3 form in response to TRIG:SEQ2:DEL:ON? / TRIG:OUTP:DEL:ON?.

TRIG:SEQ2:DEL:OFF / TRIG:OUTP:DEL:OFF

Sets the delay for turning off the output.

Command

```
TRIGger:SEQuence2:DELay:OFF {<numeric>|MIN|MAX}
TRIGger:SEQuence2:DELay:OFF?
TRIGger:OUTPut:DELay:OFF {<numeric>|MIN|MAX}
TRIGger:OUTPut:DELay:OFF?
```

Parameter

Value: 0.0 to 10.0 0 is no delay (The default value is 0.0)

Unit S

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the delay time until the output is turned off in the NR3 form in response to TRIG:SEQ2:DEL:OFF? / TRIG:OUTP:DEL:OFF?.

TRIG:SEQ2:SOUR / TRIG:OUTP:SOUR

Sets the condition (trigger source) for actually starting the delay action after the sequence 2 group receives INIT:SEQ2 / INIT:NAME OUTP.

The output turns on or off after the delay elapses.

Command

```
TRIGger:SEQuence2:SOURce {IMMediate|BUS}
TRIGger:OUTPut:SOURce {IMMediate|BUS}
TRIGger:SEQuence2:SOURce?
TRIGger:OUTPut:SOURce?
```

Parameter

Value:	IMM	Start the delay action immediately
	BUS	Wait for a software trigger (*TRG, TRIG, or IEEE488.1 get (Group Execute Trigger)) to start the delay action

For the setting that is applied when *RST is sent, see Table A-16.

Response

Queries the trigger source setting for the sequence 2 group as character data in response to TRIG:SEQ2:SOUR? / TRIG:OUTP:SOUR?.

INIT:SEQ2 / INIT:NAME OUTP

Starts the trigger function of the sequence 2 group.

If TRIG:SEQ2:SOUR or TRIG:OUTP:SOUR is set to IMM, the delay action starts immediately. If set to BUS, the delay action starts after waiting for a software trigger.

Command

```
INITiate[:IMMediate]:SEQuence2
INITiate[:IMMediate]:NAME OUTPut
```

TRIG:SEQ2 / TRIG:OUTP

Executes a software trigger to the sequence 2 group.

Command

```
TRIGger:SEQuence2[:IMMediate]
TRIGger:OUTPut[:IMMediate]
```

7.14.3 Measurement (Sequence 3: ACQuire Settings)

See p. A-21

The sequence 3 group can control the measurement conditions using triggers.

TRIG:SEQ3:SOUR / TRIG:ACQ:SOUR

Sets the condition (trigger source) for actually starting the measurement after the sequence 3 group receives INIT:SEQ3 / INIT:NAME ACQ.

Command

```
TRIGger:SEQuence3:SOURce {IMMediate|BUS}
TRIGger:SEQuence3:SOURce?
TRIGger:ACQuire:SOURce {IMMediate|BUS}
TRIGger:ACQuire:SOURce?
```

Parameter

Value:	IMM	Start the measurement immediately (default)
	BUS	Wait for a software trigger (*TRG, TRIG:SEQ3, TRIG:ACQ, or IEEE488.1 get (Group Execute Trigger)) to start the measurement

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the trigger source of the sequence 3 group as character data in response to TRIG:SEQ3:SOUR? / TRIG:ACQ:SOUR?.

INIT:SEQ3 / INIT:NAME ACQ

Clears the present valid measurement data and starts a new measurement.

If the trigger source parameter of the sequence 3 group is IMM, the measurement starts immediately. If set to BUS, the measurement starts after waiting for a software trigger.

New measurement data will be established after 4 ms from the measurement begins. The measured data is stored in the measurement data cache, and it can be queried by "FETC:xxx?"command. The measurement data returns the mean value data (the moving average deviations of 64 times measured in every 4 ms).

Command

```
INITiate[:IMMediate]:SEQuence3
INITiate[:IMMediate]:NAME ACQuire
```

TRIG:SEQ3 / TRIG:ACQ

Executes a software trigger to the sequence 3 group.

Command

```
TRIGger:SEQuence3[:IMMediate]
TRIGger:ACQuire[:IMMediate]
```

Sequence operation auto continue mode

When the sequence operation auto continue mode is turned on

If the trigger source parameter is set to IMM, the measurement starts immediately. When the operation is complete, a new measurement automatically starts.

If the parameter is set to BUS, the measurement starts after receiving a software trigger. When the operation is complete, the PAT waits for the next trigger.

When the sequence operation auto continue mode is turned off

The measurement currently in progress continues unless ABOR is sent. New measurements are not automatically continued.

INIT:CONT:SEQ3 / INIT:CONT:NAME ACQ

Sets the measurement conditions of the sequence 3 group in sequence operation auto continue mode.

Command

```
INITiate:CONTinuous:SEQuence3 {ON|OFF|1|0}
INITiate:CONTinuous:SEQuence3?
INITiate:CONTinuous:NAME ACQuire,{ON|OFF|1|0}
INITiate:CONTinuous:NAME? ACQuire
```

Parameter

Value:	ON(1)	Auto continue mode on
	OFF(0)	Auto continue mode off (default)

For the setting that is applied when *RST is sent, see Table A-16.

Response

Returns the sequence operation auto continue mode setting in the NR1 form in response to INIT:CONT:SEQ3? / INIT:CONT:NAME ACQ.

Clearing the measurement data

SENS:AVER:CLE

See p. A-22

It clears all the measurement data (The mean value data: the moving average deviations of 64 times measured in every 4 ms) stored in the measurement data cache, and the measurement data after 256 ms (New moving average created by another 64 times) becomes valid.

When the data is acquired while varying the setting of the voltage or the current, transmit the "SENS:AVER:CLE" command after setting the voltage or the current. The measurement data becomes valid after 256 ms upon receipt of the command.

Command

```
SENSe:AVERage:CLEar
```

Measurement Operation

If the measurement is not complete immediately after sending the INIT:SEQ3 / INIT:NAME ACQ command or immediately after a MEAS query, the response data is generated after the measurement for the FETC or MEAS query is complete.

■ FETCh query

FETC? queries the measured data without starting the measurement operation. If FETC? is sent without making a single measurement after resetting the PAT (using *RST) or after switching from local mode (panel operation) to remote mode, an SCPI error (-230,“Data corrupt or stale”) occurs. This is because there is no valid measured data that is held. Be sure to use this command after the INIT or MEAS command.

■ MEASure query

Queries the measured data after starting a new measurement operation.

MEAS? is equivalent to combining the INIT command and FETC? query.

FETC:VOLT / MEAS:VOLT

Queries the measured value of the voltage output.

Command

```
FETCh[:SCALar]:VOLTage[:DC]?
MEASure[:SCALar]:VOLTage[:DC]?
```

Response

Returns the measured value of the voltage output in the NR3 form in response to FETC:VOLT? / MEAS:VOLT?.

FETC:CURR / MEAS:CURR

Queries the measured value of the current output.

Command

```
FETCh[:SCALar]:CURRent[:DC]?
MEASure[:SCALar]:CURRent[:DC]?
```

Response

Returns the measured value of the current output in the NR3 form in response to FETC:CURR? / MEAS:CURR?.

7.14.4 Aborting the Operation

Aborts the operation in all sequence groups.

ABOR

Aborts operations such as setting, change, and measurement in all sequence groups.

The trigger status immediately after the power is turned on is the same as the condition when the ABOR command is sent. If the ABOR command is sent when the change or measurement is already started, the measured data of the sequence 3 group remains invalid.

If the ABOR command is sent when the sequence 3 group is not initiated and the measured data that is held is valid, the measured data is not discarded.

A specific sequence group cannot be specified with the ABOR command. It is always interpreted as ALL.

Command

```
ABORt
```

7.15 System Settings

SYST:ERR

Reads the oldest error information or event information from the error queue. The error queue can store up to 255 errors.

The error queue is cleared using the *CLS command.

Command

```
SYSTem:ERRor[:NEXT]?
```

Response

Returns the oldest error or event information in the error/event queue in response to SYST:ERR? as follows:

(Example) When there is no error or event

```
Returns 0, "No error".
```

(Example) When a command that cannot be executed in the current operating condition is received

```
Returns -221, "Settings conflict".
```

SYST:KLOC

Sets/Releases the panel operation lock.

Command

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

Parameter

Value:	ON (1)	Lock the panel operation
	OFF (0)	Release the panel operation lock

Response

Returns the panel operation lock setting in the NR1 form in response to SYST:KLOCk?.

SYST:LOC (RS232C, USB and LAN only)

Sets the PAT operation to local mode (panel operation). This is a substitute command for the IEEE488.1 REN message (Remote Disable).

Command

```
SYSTem:LOCal
```

SYST:OPT

Queries the hardware interface board that is installed in the PAT.

This command is the same as *OPT?.

Command

```
SYSTem:OPTion?
```

Response

Returns 0 if there is no option installed in response to SYST:OPT?.

If the factory option GPIB, USB or LAN interface board is installed, “GPIB”, “USB” or “LAN” is returned in response to SYST:OPT?.

SYST:REM (RS232C, USB and LAN only)

Sets the PAT operation to remote mode. All panel keys except the LOCAL key are locked. This is a substitute command for the IEEE488.1 REN message (Remote Enable) and address designation.

SYST:LOC is used to return to local mode.

Command

```
SYSTem:REMote
```

SYST:RWL (RS232C, USB and LAN only)

Sets the PAT operation to remote mode. All panel keys are locked (LOCAL key is also locked). This is a substitute command for the IEEE488.1 llo message (Local Lock Out).

SYST:LOC is used to return to local mode.

Command

```
SYSTem:RWLock
```

SYST:VERS

Queries the version of the SCPI specifications to which the PAT conforms.

Command

```
SYSTem:VERSion?
```

Response

Returns SCPI 1999.0 in response to SYST:VERS?.

7.16 Status Register and Status Report Function

IEEE488.2 and SCPI registers are used for the status reports.

In each SCPI status register, there are sub registers, CONDition register, EVENt register, ENABle register, PTRansition filter, and NTRansition filter.

Fig.7-4 shows the SCPI status register structure. The character "+" represents the logic sum of the register bits. Table 7-9 to Table 7-12 describe the bit number, bit weight, and the meaning of each bit.

CONDition register

The CONDition register transits automatically and reflects the condition of the PAT in real-time. Reading this register does not affect the contents.

EVENt register

The EVENt register bits are automatically set according to the changes in the CONDition register. The rule varies depending on the positive and negative transition filters (PTRansition and NTRansition). The EVENt register is reset when it is read.

ENABle register

The ENABle register enables the reports to the summary bit or status bit of the event bit.

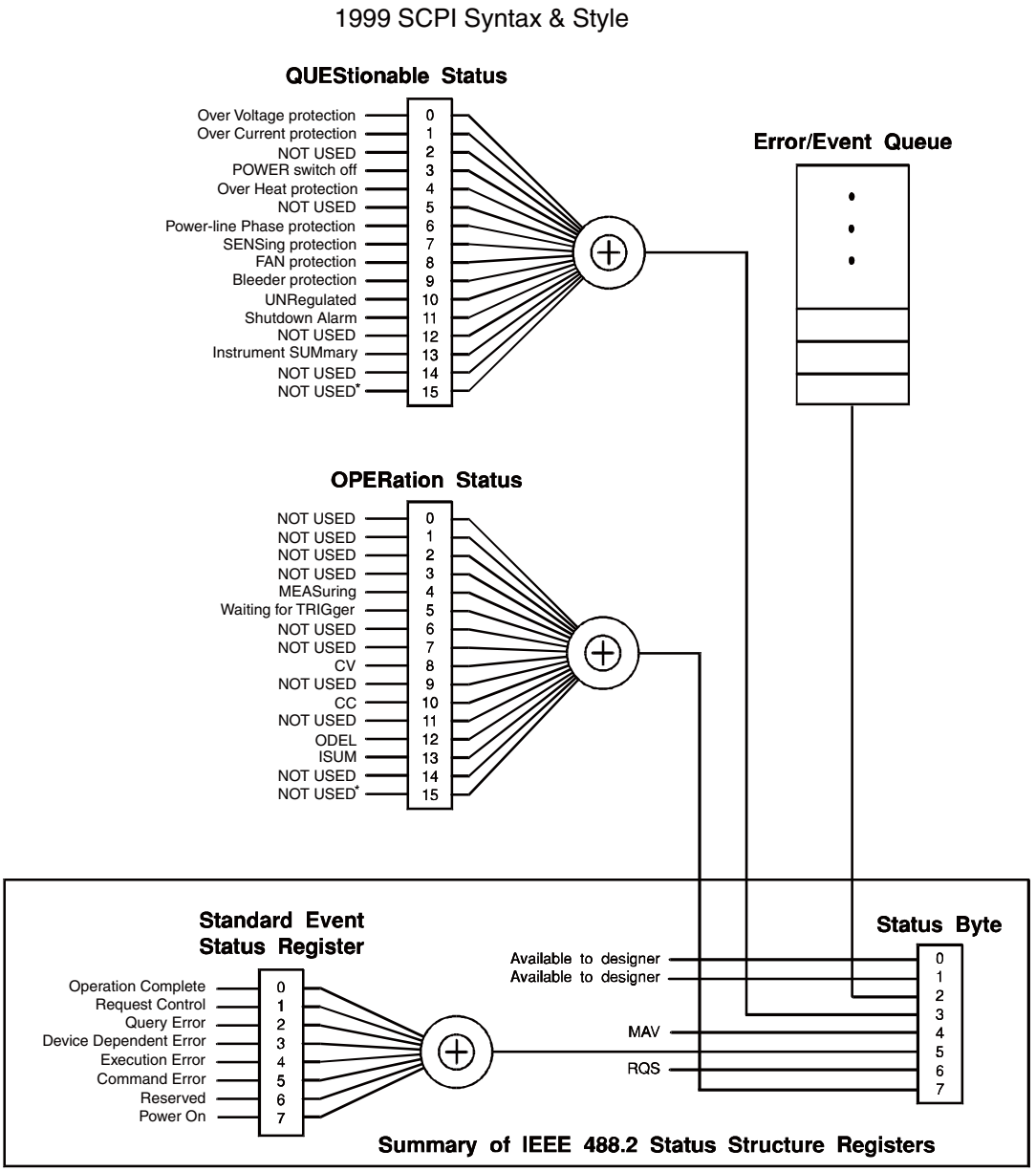
Transition filter

Use the PTRansition (positive transition) filter to report events when the condition changes from false to true.

Use the NTRansition (negative transition) filter to report events when the condition changes from true to false.

If both the positive filter and the negative filter are set to true, events can be reported each time the status changes.

If both filters are cleared, event reporting is disabled.



Partially changed SCPI Standard 1999.0 Volume1 fig.9-1.

Fig.7-4 Status registers

7.16.1 IEEE488.2 Register Model

Status byte register

The status byte register stores STB and RQS (MSS) messages as defined by the IEEE488.1 standard. The status byte register can be read using IEEE488.1 serial polling or IEEE488.2 common command *STB?.

When serial polling is carried out, bit 6 responds with the request service (RQS). The status byte value is not changed by serial polling.

*STB? makes the device transmit the contents of the status byte register and the master status summary (MSS) message.

*STB? does not change the status byte, MSS, and RQS.

Table 7-9 Status byte register

Bit	Bit Weight	Bit Name	Description
0	1	Reserved	Reserved for future use by the IEEE488. The bit value is notified as zero.
1	2	Reserved	
2	4	Error/Event Queue	If data exists in the error or event queue, this bit is set to true.
3	8	Questionable Status Register (QUES)	This bit is set to true when a bit is set in the QUEStionable event status register and the corresponding bit in the QUEStionable status enable register is true.
4	16	Message Available (MAV)	This bit is set to true when a request is received from the digital programming interface and the PAT is ready to output the data byte.
5	32	Standard Event Status Bit Summary (ESB)	This bit is set to true when a bit is set in the event status register.
6	64	Request Service (RQS)	This bit is set to true when a bit is set in the service request enable register, and the corresponding bit exists in the status byte. The SRQ line of the GPIB is set.
		Master Status Summary (MSS)	This bit is set to true when any of the bits in the status byte register is set to 1 and the corresponding bit in the service request enable register is set to 1.
7	128	Operation Status Register (OPER)	This bit is set to true when a bit is set in the OPERation event status register and the corresponding bit in the OPERation status enable register is set.
8-15	–	Not Used	–

Event status register

The event status register bits are set when certain events occur during PAT operation. All bits of the event status register are set by the error event queue.

The register is defined by the IEEE488.2 standard and is controlled by the IEEE488.2 common commands *ESE, *ESE?, and *ESR?.

See p. A-7

Check to the SYST:ERR? for the description of the error.

Table 7-10 Event status register (Standard Event Status Register)

Bit	Bit Weight	Bit Name	Description	Error Code
0	1	Operation Complete (OPC)	Set when an *OPC command is received and all operations in standby are complete.	-800 to -899
1	2	Request Control (RQC)	Not used	–
2	4	Query Error (QYE)	Set when an attempt is made to read data from the output queue when there is no output or the error queue is in wait status. Indicates that there is no data in the error queue.	-400 to -499
3	8	Device Dependent Error (DDE)	Set when there is a device-specific error.	-300 to -399 100 to 199
4	16	Execution Error (EXE)	Set when the PAT evaluates the program data following the header is outside the formal input range or does not match the performance of the PAT. This indicates that a valid SCPI command may not be executed correctly depending on the conditions of the PAT.	-200 to -299
5	32	Command Error (CME)	Set when an IEEE 488.2 syntax error is detected, when an unidentifiable header is received, or when a group execution trigger enters the internal IEEE 488.2 SCPI command input buffer.	-100 to -199
6	64	Reserved	Not used	–
7	128	Power ON (PON)	Set when the power is turned on.	–
8-15	–	Reserved	Not used	–

7.16.2 SCPI Register Model

OPERation status register

The OPERation status register is a 16-bit register which contains information about conditions which are part of the PAT normal operation.

Table 7-11 OPERation status register (STATus:OPERation)

Bit	Bit Weight	Bit Name	Description
0	1	NOT USED	–
1	2	NOT USED	–
2	4	NOT USED	–
3	8	NOT USED	–
4	16	MEASuring	Indicates whether measurement is in progress on the PAT.
5	32	Waiting for TRIGger	Indicates whether the PAT is waiting for a trigger (TRIG).
6	64	NOT USED	–
7	128	NOT USED	–
8	256	CV	CV output
9	512	NOT USED	–
10	1024	CC	CC output
11	2048	NOT USED	–
12	4096	ODEL (ON/OFF DELAY)	Indicates whether the output delay operation is in progress.
13	8192	ISUM	Not used
14	16384	NOT USED	–
15	32768	NOT USED	–

STAT:OPER

Queries the event of the OPERation status register.

A query clears the contents of the register.

Command

```
STATus:OPERation[:EVENt]?
```

Response

Returns the event of the OPERation status register in the NR1 form.

STAT:OPER:COND

Queries the condition of the OPERation status register.

A query does not clear the contents of the register.

Command

```
STATus:OPERation:CONDition?
```

Response

Returns the condition of the OPERation status register in the NR1 form.

STAT:OPER:ENAB

Sets the enable register of the OPERation status register.

Command

```
STATus:OPERation:ENABle <NRF>
STATus:OPERation:ENABle?
```

Parameter

Value: 0 to 32767

Response

Returns the enable register of the OPERation status register in the NR1 form.

STAT:OPER:PTR

Sets the positive transition of the OPERation status register.

Command

```
STATus:OPERation:PTRansition <NRF>
STATus:OPERation:PTRansition?
```

Parameter

Value: 0 to 32767

Response

Returns the positive transition of the OPERation status register in the NR1 form.

STAT:OPER:NTR

Sets the negative transition of the OPERation status register.

Command

```
STATus:OPERation:NTRansition <NRF>
STATus:OPERation:NTRansition?
```

Parameter

Value: 0 to 32767

Response

Returns the negative transition of the OPERation status register in the NR1 form.

QUEStionable status register

The QUEStionable status register is a 16-bit register that stores information related to the questionable events and status during PAT operation.

These register bits may indicate problems with the measured data of the PAT.

Table 7-12 QUEStionable status register (STATus:QUEStionable)

Bit	Bit Weight	Bit Name	Description
0	1	OV (Over Voltage protection)	Overvoltage protection activated
1	2	OC (Over Current protection)	Overcurrent protection activated
2	4	Not Used	–
3	8	POW	POWER switch off
4	16	OHP (Over Heat protection)	Over heat protection activated
5	32	Not Used	–
6	64	PHASE (Power-line Phase protection)	Power-line phase protection activated
7	128	SENS (SENSing protection)	Incorrect sensing connection protection activated
8	256	FAN (FAN failure protection)	Fan failure protection occurred
9	512	BLD (Bleeder protection)	Bleeder protection
10	1024	UNR (UNRegulated)	Not operating in CV/CC mode
11	2048	SD (Shutdown Alarm)	Shutdown
12	4096	Not Used	–
13	8192	ISUM (Instrument Summary)	–
14	16384	Not Used	–
15	32768	Not Used	–

STAT:QUES

Queries the event of the QUEStionable status register.

A query clears the contents of the register.

Command

```
STATus:QUEStionable[:EVENt]?
```

Response

Returns the event of the QUEStionable status register in the NR1 form.

STAT:QUES:COND

Queries the condition of the QUEStionable status register.

A query does not clear the contents of the register.

Command

```
STATus:QUEStionable:CONDition?
```

Response

Returns the status of the QUEStionable status register in the NR1 form.

STAT:QUES:ENAB

Sets the enable of the QUEStionable status register.

Command

```
STATus:QUEStionable:ENABle <NRF>
STATus:QUEStionable:ENABle?
```

Parameter

Value: 0 to 32767

Response

Returns the enable register of the QUEStionable status register in the NR1 form.

STAT:QUES:PTR

Sets the positive transition of the QUEStionable status register.

Command

```
STATus:QUEStionable:PTRansition <NRF>
STATus:QUEStionable:PTRansition?
```

Parameter

Value: 0 to 32767

Response

Returns the positive transition of the QUEStionable status register in the NR1 form.

STAT:QUES:NTR

Sets the negative transition of the QUEStionable status register.

Command

```
STATus:QUEStionable:NTRansition <NRF>
STATus:QUEStionable:NTRansition?
```

Parameter

Value: 0 to 32767

Response

Returns the negative transition of the QUEStionable status register in the NR1 form.

Preset status

STAT:PRES

Resets the ENABle, PTRansition, NTRansition filter registers of all status registers (including sub registers) to their default values.

Default values:

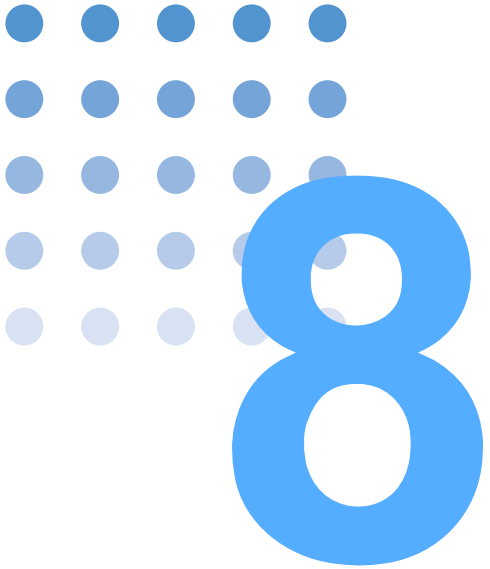
STATus:ENABle = 0x0000

STATus:PTRansition = 0x7FFF

STATus:NTRansition = 0x0000

Command

```
STATus:PRESet
```



Maintenance

This chapter describes maintenance such as cleaning, inspecting, and calibrating.

8.1 Inspection

Periodic inspection is essential to maintain the initial performance of the PAT over an extended period.

Check for tears in the power cable insulation and breaks in the terminal block.

⚠WARNING

- **Tears in the insulation coating may cause electric shock or fire. If a tear is found, stop using it immediately.**

To purchase accessories or options, contact your Kikusui agent or distributor.

8.2 Cleaning

Cleaning the Dust Filter

Two dust filter sheets are installed on the inside of the louver on the front panel. Periodically clean the filter to prevent clogging.

⚠CAUTION

- Clogged filters hinder the cooling of the inside of the PAT and can cause a malfunction and shortening of the service life.
- When the PAT is in operation, air is sucked through the dust filter to cool the inside.
  If moisture is present in the dust filter, the temperature or humidity inside the PAT increases and may cause a malfunction.

Removing the dust filter

1. Remove the lower louver from the panel.

   While lifting the bottom of the removal mark with your finger tips, slide the entire louver to the right. Then, pull it toward you.

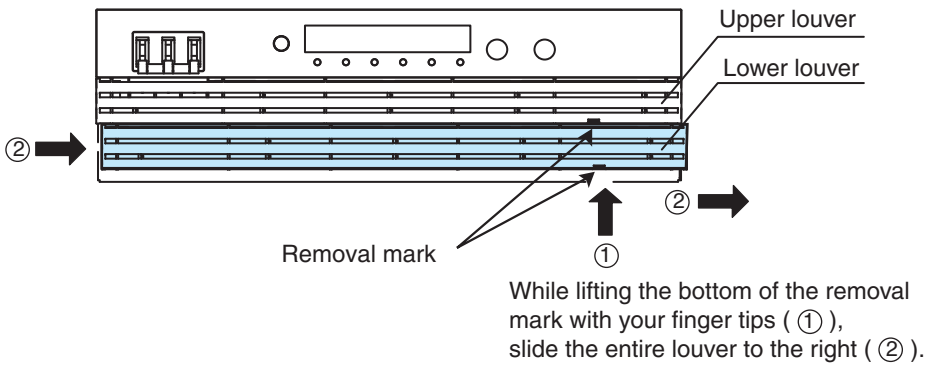


Fig.8-1 Louver removal

2 Remove the upper louver in the same manner as step 1 .

3 Remove the dust filter from the inside of the louver and clean it.

There is a hook on the louver tab. Be sure not to get the dust filter caught in the hook when removing the dust filter from the louver.

Dispose of foreign particles and dust from the dust filter using a vacuum cleaner. If the filter is extremely dirty, clean it using a water-diluted neutral detergent and dry it completely.

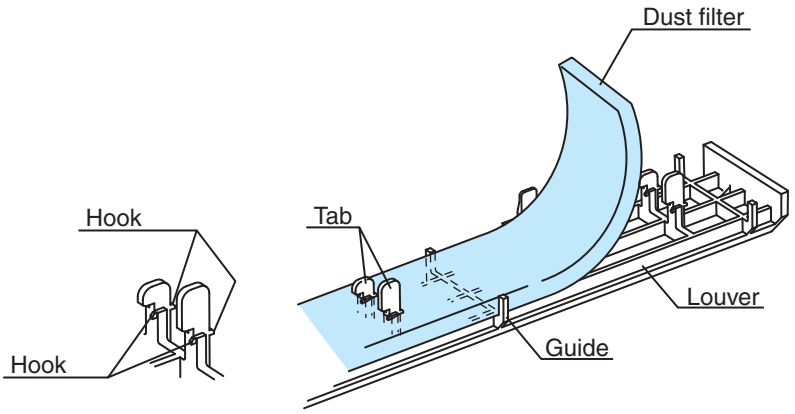


Fig.8-2 Dust filter removal

Attaching the dust filter

1 Align the dust filter along the guide and attach it to the louver.

Be sure to attach it firmly until the tab hooks of the louver completely passes through the cut in the dust filter.

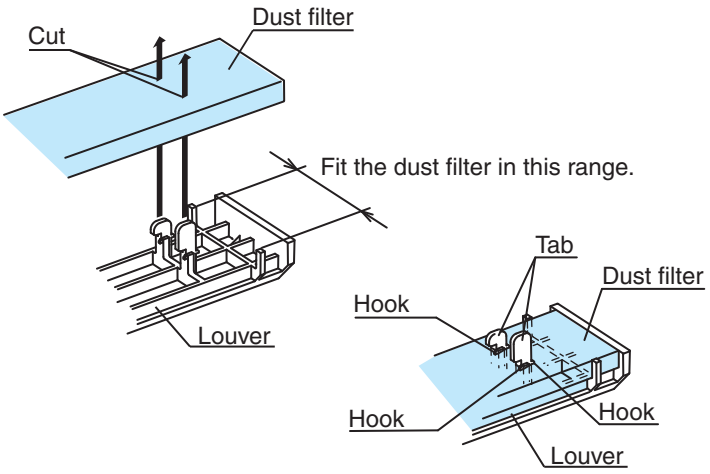


Fig.8-3 Dust filter attachment

2 Attach the upper louver first.

The shapes of the upper and lower dust filters are different. The upper dust filter has a cutout.

Align the tab on the inner side of the louver to the panel groove and slide the louver to the left to attach it.

You can easily attach the louver by aligning the long tabs (five locations) with the grooves.

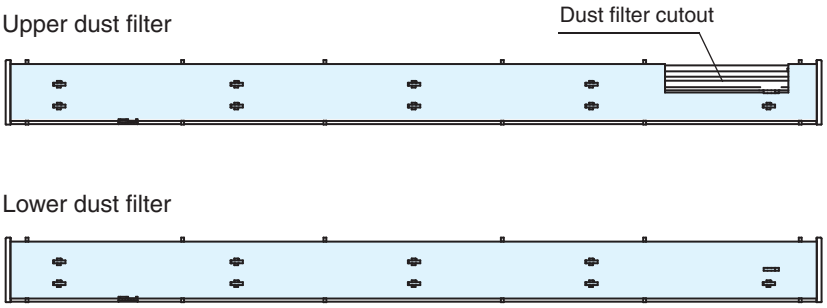


Fig.8-4 Dust filter as seen from the rear

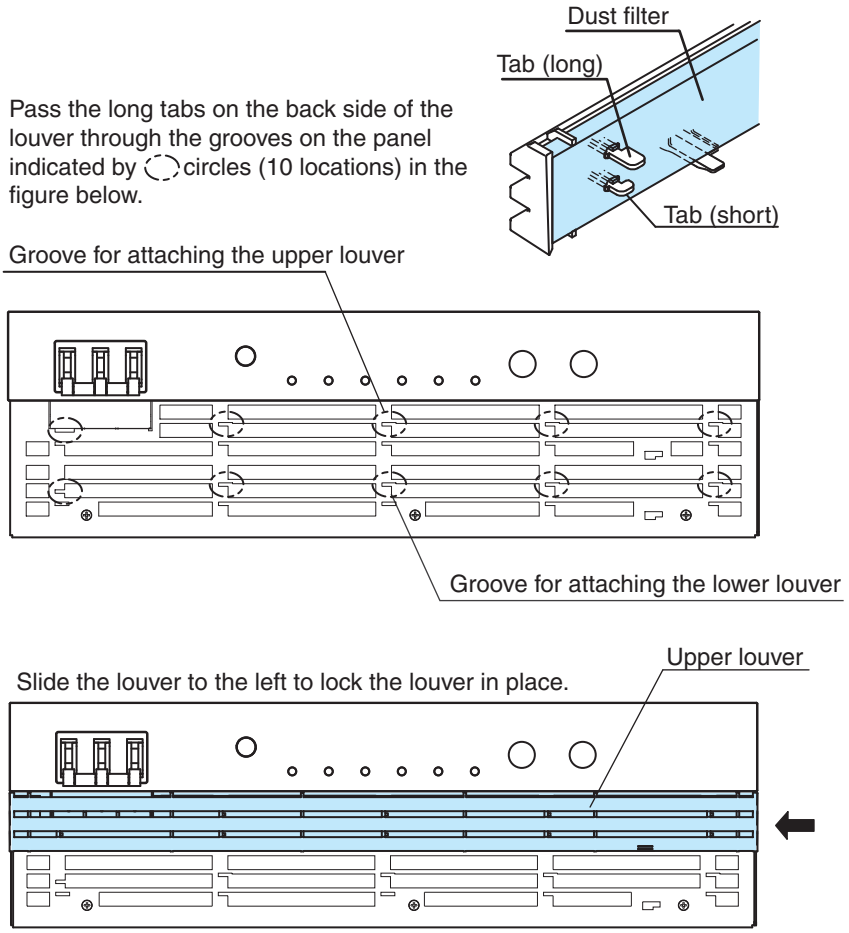


Fig.8-5 Louver attachment

3 Attach the lower louver in the same manner as step 2 .

⚠CAUTION

- Pay attention to the shape of the dust filter when attaching the louver to the panel. If you attempt to attach the wrong louver by force, the louver may break.

8.3 Calibration

The PAT is shipped after carrying out appropriate calibrations. We recommend periodic calibration to maintain the performance over an extended period.

For calibration, contact your Kikusui agent or distributor.

If you are going to calibrate the PAT yourself, follow the procedures below.

The calibration procedures given in this section includes all calibration items of the PAT.

8.3.1 Calibration Overview

The following six calibration items are available.

- Output voltage and voltmeter
- Output current and ammeter
- Overvoltage protection
- Overcurrent protection
- Output voltage control
- Output current control

Test Equipment Required

For calibration, the following equipment is necessary.

- DC voltmeter (DVM) with measuring accuracy of 0.02 % or better.
- Shunt (See Table 8-1)

Table 8-1 Recommended shunt resistors

Model	Shunt resistors	
	Rating	Tolerance
PAT20-400T	500 A/50 mV (0.1 mΩ)	± 0.1 % or less
PAT40-200T	200 A/50 mV (0.25 mΩ)	
PAT60-133T	150 A/50 mV (0.3 mΩ)	
PAT160-50T	50 A/50 mV (1 mΩ)	

- 10-kΩ resistor with accuracy of 1 % or better
- DC power supply (variable power supply that can output +10 V, used as a voltage source)

Environment

Perform calibration under the following environment.

- Temperature: 23 ° C ± 5 ° C
- Relative humidity: 80 % or less

To minimize the calibration error due to initial drift, warm up the PAT for at least 30 minutes before calibration. In addition, warm up the DVM and shunt resistor adequately.

8.3.2 Calibration Procedure

Be sure to carry out the calibration items to the last step. If you move to a different type of calibration in the middle of another calibration or if you turn the POWER switch off, the calibration is invalid.

⚠WARNING Possible electric shock.

- **Be sure to turn the POWER switch off before touching the output terminal.**
- **Be sure to connect the output terminal and the chassis terminal.**

Calibration mode indication

The ammeter display switches between CAL. 1 to CAL. 8 depending on the calibration mode type. CAL. 1 and CAL. 2 as well as CAL. 3 and CAL. 4 are calibrated subsequently.

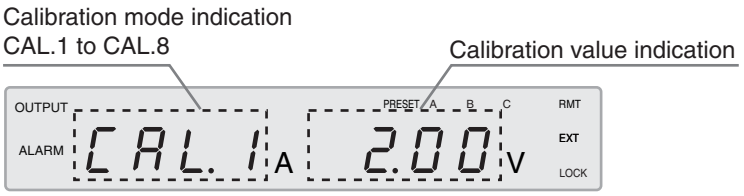


Fig.8-6 Panel display example of calibration mode

CAL.1: Calibration of the output voltage and voltmeter

CAL.2: Calibration of the overvoltage protection (OVP)

CAL.3: Calibration of the output current and ammeter

CAL.4: Calibration of the overcurrent protection setting (OCP)

CAL.5: Calibration of the output voltage control using external voltage (EXT-V CV CONT)

CAL.6: Calibration of the output voltage control using external resistance (EXT-R CV CONT)

CAL.7: Calibration of the output current control using external voltage (EXT-V CC CONT)

CAL.8: Calibration of the output current control using external resistance (EXT-R CC CONT)

Calibration procedure of the output voltage, voltmeter, and the overvoltage protection setting (CAL.1 and CAL.2)

Calibrate CAL.1 and CAL.2 consecutively.

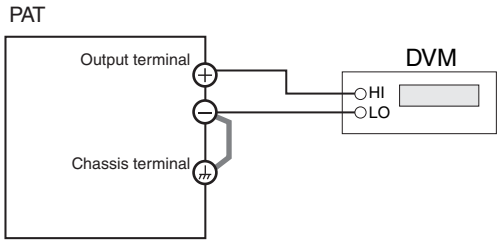


Fig.8-7 Connection for CAL.1 and CAL.2

1. Turn the POWER switch off.
2. Connect a DVM to the output terminal.
3. While holding down the SET switch, turn on the POWER switch.

   Keep holding the SET switch until the ammeter is showing “CAL.1,” and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.
4. Press the OUTPUT switch to turn the output on.

   The OUTPUT LED illuminates.
5. Turn the VOLTAGE knob to set the DVM reading to 5 % of the rated voltage.
6. Press the RECALL A (SHIFT+SET) switch.

   The calibration of this item is set, and the LOCK LED illuminates.
7. Press the SET switch.

   The voltmeter shows the rated voltage value.
8. Turn the VOLTAGE knob to set the DVM reading of the rated voltage.
9. Press the RECALL A (SHIFT+SET) switch.

   The calibration of this item is set, and the EXT LED illuminates.

   Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.
10. Press the LOCK (SHIFT+LOCAL) switch to execute the calibration of the overvoltage protection (OVP).

    The ammeter displays “CAL.2,” and the voltmeter displays 5 % of the rated voltage value. The calibration is automatically executed. In the middle of the calibration, the voltmeter display changes to the rated voltage value.

    When the calibration completes, the PRESET B LED illuminates.
11. Turn the POWER switch off to finish the calibration of the output voltage, voltmeter, and the overvoltage protection.

Calibration procedure of the output current, ammeter, and the overcurrent protection setting (CAL.3 and CAL.4)

Calibrate CAL.3 and CAL.4 consecutively.

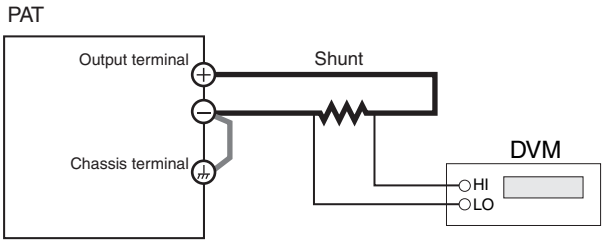


Fig.8-8 Connection for CAL.3 and CAL.4

1. Turn the POWER switch off.
2. Connect a shunt resistor to the output terminal, and connect the DVM to across the shunt resistor.
3. While holding down the SET switch, turn on the POWER switch.

   Keep holding the SET switch until the ammeter is showing "CAL.1," and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.
4. Press the OVP•OCP switch.

   The voltmeter shows "CAL.3," and the ammeter shows 5 % of the rated current value.
5. Press the OUTPUT switch to turn it on.

   The OUTPUT LED illuminates.
6. Turn the CURRENT knob to set the DVM reading to 5 % of the rated current.
7. Press the RECALL A (SHIFT+SET) switch.

   The calibration of this item is set, and the LOCK LED illuminates.
8. Press the OVP•OCP switch.

   The ammeter shows the rated current value.
9. Turn the CURRENT knob to set the DVM reading to the rated current.
10. Press the RECALL A (SHIFT+SET) switch.

    The calibration of this item is set, and the EXT LED illuminates.
    Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.
11. Press the LOCK (SHIFT+LOCAL) switch to execute the calibration of the overcurrent protection (OCP).

    The voltmeter displays "CAL.4," and the ammeter displays 5 % of the rated current value. The calibration is automatically executed. In the middle of the calibration, the ammeter display changes to the rated current value.
    When the calibration completes, the PRESET B LED illuminates.
12. Turn the POWER switch off to finish the calibration of the output current, ammeter, and the overcurrent protection.

Calibration procedure of the output voltage control using external voltage (CAL.5)

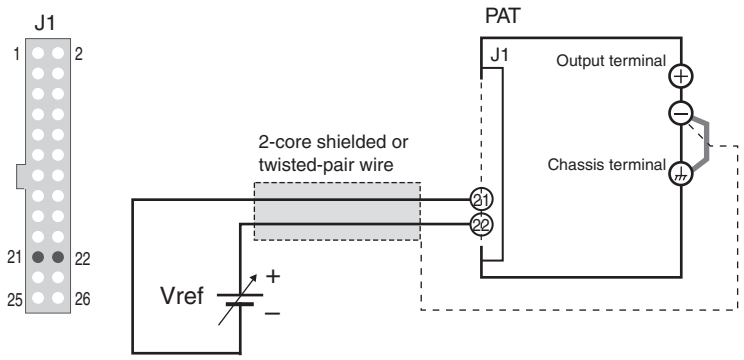


Fig.8-9 Connection for CAL.5

1. Turn the POWER switch off.
2. Connect the voltage source (Vref) to pins 21 and 22 of the J1 connector.
3. While holding down the SET switch, turn on the POWER switch.

   Keep holding the SET switch until the ammeter is showing “CAL.1,” and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.
4. Press the CONFIG switch.

   The ammeter shows “CAL.5,” and the voltmeter shows “0.000.”
5. Set Vref to 0.000 V.
6. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the low end of the EXT CV CONT is set, and the LOCK LED illuminates.
7. Press the CONFIG switch.

   The ammeter shows “CAL.5,” and the voltmeter shows “10.00.”
8. Set Vref to 10.00 V.
9. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the high end of the EXT CV CONT is set, and the EXT LED illuminates.

   Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.
10. Turn the POWER switch off to finish the calibration of the output voltage control using external voltage.

Calibration procedure of the output voltage control using external resistance (CAL.6)

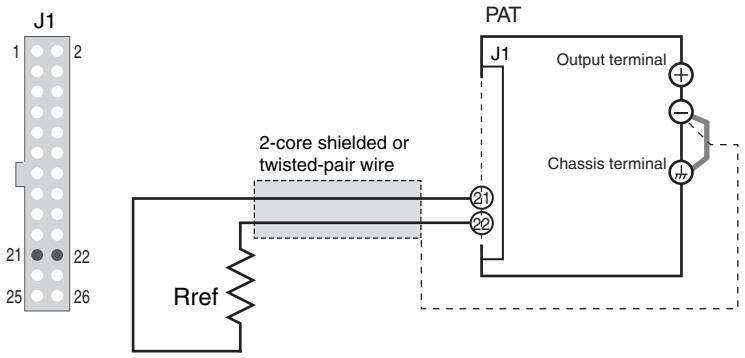


Fig.8-10 Connection for CAL.6

1. Turn the POWER switch off.
2. Connect the 0 Ω resistor (Rref) to pins 21 and 22 of the J1 connector.
3. While holding down the SET switch, turn on the POWER switch.

   Keep holding the SET switch until the ammeter is showing "CAL.1," and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.
4. Press the CONFIG switch.

   The ammeter shows “CAL.5,” and the voltmeter shows “0.000.”
5. Press the LOCK (SHIFT+LOCAL) switch.

   The ammeter shows “CAL.6,” and the voltmeter shows “0.000.”
6. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the low end of the EXT CV CONT resistor is set, and the LOCK LED illuminates.
7. Connect the 10 kΩ standard resistor (Rref) to pins 21 and 22 of the J1 connector.
8. Press the CONFIG switch.

   The ammeter shows “CAL.6,” and the voltmeter shows “10.00.”
9. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the high end of the EXT CV CONT resistor is set, and the EXT LED illuminates.

   Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.
10. Turn the POWER switch off to finish the calibration of the output voltage control using external resistance.

Calibration procedure of the output current control using external voltage (CAL.7)

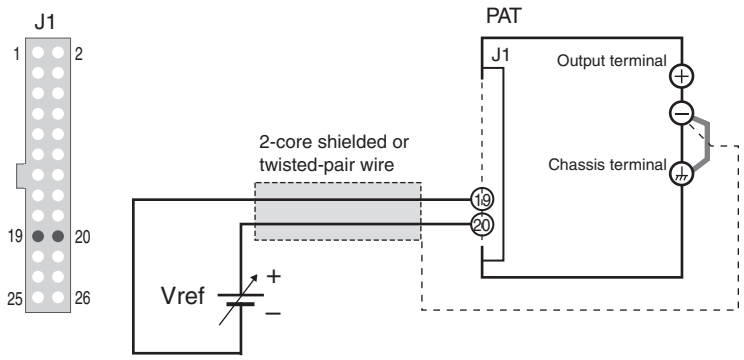


Fig.8-11 Connection for CAL.7

1. Turn the POWER switch off.
2. Connect the voltage source (Vref) to pins 19 and 20 of the J1 connector.
3. While holding down the SET switch, turn on the POWER switch.

   Keep holding the SET switch until the ammeter is showing "CAL.1," and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.
4. Press the STORE switch.

   The ammeter shows "CAL.7," and the voltmeter shows "0.000."
5. Set Vref to 0.000 V.
6. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the low end of the EXT CC CONT is set, and the LOCK LED illuminates.
7. Press the STORE switch.

   The ammeter shows "CAL.7," and the voltmeter shows "10.00."
8. Set Vref to 10.00 V.
9. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the high end of the EXT CC CONT is set, and the EXT LED illuminates.

   Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.
10. Turn the POWER switch off to finish the calibration of the output current control using external voltage.

Calibration procedure of the output current control using external resistance (CAL.8)

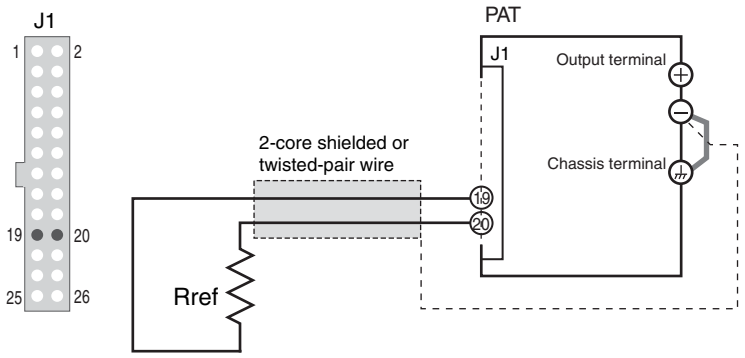


Fig.8-12 Connection for CAL.8

1. Turn the POWER switch off.
2. Connect the 0 Ω resistor (Rref) to pins 19 and 20 of the J1 connector.
3. While holding down the SET switch, turn on the POWER switch.

   Keep holding the SET switch until the ammeter is showing "CAL.1," and the voltmeter is showing 5 % of the rated voltage value. Warm up the PAT for at least 30 minutes.
4. Press the STORE switch.

   The ammeter shows "CAL.7," and the voltmeter shows "0.000."
5. Press the LOCK (SHIFT+LOCAL) switch.

   The ammeter shows "CAL.8," and the voltmeter shows "0.000."
6. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the low end of the EXT CC CONT resistor is set, and the LOCK LED illuminates.
7. Connect the 10 kΩ standard resistor (Rref) to pins 19 and 20 of the J1 connector.
8. Press the STORE switch.

   The ammeter shows "CAL.8," and the voltmeter shows "10.00."
9. Press the RECALL A (SHIFT+SET) switch.

   The calibration of the high end of the EXT CC CONT resistor is set, and the EXT LED illuminates.
   Then, the LOCK LED and EXT LED turn off, and the PRESET A LED illuminates.
10. Turn the POWER switch off to finish the calibration of the output current control using external resistance.

Specifications

This chapter describes the specifications and gives the dimensions of the PAT.

9.1 Specifications

Unless specified otherwise, the specifications are for the following settings and conditions.

- The load is a pure resistance.
- The warm-up time is 30 minutes (with current flowing).
- After warm-up is complete, the PAT must be calibrated correctly according to the procedures given in the operation manual in a 23 ° C ± 5 ° C environment.
- TYP (typical) values do not guarantee the performance.
- rtg: Indicates the rated output.
- rdng: Indicates the reading.
- Rated load and no load are defined as follows:

During constant voltage operation (set the output current at the rated voltage output greater than equal to the rated output current)

Rated load: Refers to a load with a resistance that makes the current that flows when the rated output voltage is applied to be 95 % to 100 % of the rated output current at the rated output voltage.

No load: Refers to a load through which no output current flows or an open output terminal condition with no load connected.

During constant current operation (set the output voltage at the rated output current greater than equal to the rated output voltage)

Rated load: Refers to a load with a resistance that makes the voltage drop when the rated output current is supplied to be 95 % to 100 % of the maximum output voltage at the rated output current.
The output voltage of the PAT including the voltage drop in the load cable must not exceed the maximum output voltage at the rated output current.

No load: Refers to a load with a resistance that makes the voltage drop when the rated output current is supplied to be 10 % of the maximum output voltage or 1 V, whichever is greater, at the rated output current.

AC input

	PAT20-400T	PAT40-200T	PAT60-133T	PAT160-50T
Nominal input rating	200 V to 240 V, 50 Hz to 60 Hz, three-phase			
Input voltage range	180 V to 250 V			
Input frequency range	47 Hz to 63 Hz			
Hold-up time for power interruption	20 ms or greater (at 50 % load), 10 ms or greater (at the rated load) (MIN)			
Current	32.0 A (at the rated load) (MAX)			
Inrush current	100.0 Apeak (MAX)*1			
Wattage	10 kVA (at the rated load) (MAX)			
Power factor	0.95 (input voltage of 200 V, at the rated load) (TYP)			
Efficiency	85 % (input voltage of 200 V, at the rated load) (MIN)			

*1. Excludes the charge current component that flows through the capacitor of the internal EMC filter circuit immediately after the POWER switch is turned on (within approximately 1 ms).

Output specifications

			PAT20-400T	PAT40-200T	PAT60-133T	PAT160-50T
Rating	Output power		8 kW			
	Output voltage		20.00 V	40.00 V	60.00 V	160.0 V
	Output current		400.0 A	200.0 A	133.0 A	50.0 A
Voltage	Preset range		0 % to 105 % of rtg*1			
	Setting accuracy		0.2 % of rtg + 50 mV*2			
	Source effect		0.05 % of rtg + 5 mV *3			
	Load effect		0.1 % of rtg + 5 mV*4			
	Transient response		5 ms*5			
	Ripple noise	(p-p) *6	100 mV	300 mV	350 mV	350 mV
		(rms) *7	10 mV	30 mV	30 mV	30 mV
	Rise time		100 ms (rated load)/100 ms (no load) (MAX)*8			
	Fall time		100 ms (rated load)/2000 ms (no load) (MAX)*9			
	Temperature coefficient		100 ppm/ ° C (during external control) (MAX)*10			
Current	Preset range		0 % to 105 % of rtg*1			
	Setting accuracy		0.5 % of rtg + 50 mA*2			
	Source effect		0.1 % of rtg + 30 mA*3			
	Load effect		0.2 % of rtg +30 mA*4			
	Ripple noise	(rms) *7	500 mA	400 mA	350 mA	200 mA
	Temperature coefficient		200 ppm/ ° C (during external control) (TYP)*10			

*1. The maximum preset voltage and current are used to determine constant voltage or constant current operation when the activation point of the constant voltage or constant current operation is set to the rated output voltage or current. It does not guarantee power supply to the load exceeding the rated output voltage or current.
To establish a constant voltage operation at the activation point (rated output voltage or current), set the output current (I Set) so that rated output current < I Set ≤ maximum preset current.
Likewise, to establish constant current operation, set the output voltage (V Set) so that rate output voltage < V Set ≤ maximum preset voltage.

*2. The difference between the actual output voltage or output current and the preset value under constant voltage or constant current operation.

*3. Output voltage or output current fluctuation with respect to ±10 % fluctuation of the nominal input voltage under constant voltage or current operation.

*4. Output voltage or output current fluctuation when the output voltage or output current is set to the rated output voltage or current and the load is changed from rated load to no load under constant voltage or current operation.

*5. The time it takes for the output voltage fluctuation to recover from outside 0.1 % + 10 mV of the output voltage setting to within 0.1 % + 10 mV when the output current is changed from 100 % to 50 % or 50 % to 100 % of the rated output current under constant voltage operation. The output voltage when the output current is 100 % is used as a reference.

*6. When the measurement frequency bandwidth is 10 Hz to 20 MHz.

*7. When the measurement frequency bandwidth is 5 Hz to 1 MHz.

*8. The time it takes for the output voltage to rise from 10 % to 90 % of the rating when the output is turned on.

*9. The time it takes for the output voltage to fall from 90 % to 10 % of the rating when the output is turned off.

*10. When the ambient temperature is within the range of 0 ° C to 50 ° C.

Display function

		PAT20-400T	PAT40-200T	PAT60-133T	PAT160-50T
Voltmeter	Maximum display	99.99 (fixed decimal point)			999.9 (fixed decimal point)
	Display accuracy	±(0.2 % of rdng + 5 digits) For 23 ° C ± 5 ° C			
Ammeter	Maximum display	999.9 (fixed decimal point)			
	Display accuracy	±(0.5 % of rdng + 5 digits) For 23 ° C ± 5 ° C			
Operation display	OUTPUT ON/OFF	ON: OUTPUT LED illuminates (Green LED). OFF: OUTPUT LED turns off.			
	ALM operation	ALARM LED illuminates (Red LED).*1 , *2			
	CV operation	CV LED illuminates (Green LED).			
	CC operation	CC LED illuminates (Red LED).			
	RMT operation	RMT LED illuminates during remote control (Green LED).			
	EXT operation	EXT LED illuminates during external control (Green LED).			
	LOCK operation	LOCK LED illuminates when the keys are locked (Green LED).			

*1. Illuminates when the overvoltage protection (OVP), overcurrent protection (OCP), overheat protection (OHP), input open-phase protection (PHASE), fan failure protection (FAN), incorrect sensing connection protection (SENSE), overheat protection of the bleeder circuit (BOHP) and so on are activated.

*2. If the breaker is set to trip, the ALARM LED illuminates for approximately 10 to 15 s when the SD signal is applied while the OVP/OCP is activated.

Protection functions

		PAT20-400T	PAT40-200T	PAT60-133T	PAT160-50T
Overvoltage protection (OVP)	Protection action	Turns off the output or trips the breaker (turns the POWER switch off). ALARM LED illuminates.*1			
	Selectable range	10 % to 111.5 % of the rated output voltage			
	Setting accuracy	±(2 % of rtg)			
Overcurrent protection (OCP)	Protection action	Turns off the output or trips the breaker (turns the POWER switch off). ALARM LED illuminates.*1			
	Selectable range	10 % to 111.5 % of the rated output current			
	Setting accuracy	±(3 % of rtg)			
Overheat protection (OHP)	Protection action	Turns the output off. ALARM LED illuminates.			
Input open-phase protection (PHASE)	Protection action	Turns the output off. ALARM LED illuminates.			
Fan failure protection (FAN)	Protection action	Turns the output off. ALARM LED illuminates.			
Incorrect sensing connection protection (SENSE)	Protection action	Turns the output off. ALARM LED illuminates.			
Overheat protection of the bleeder circuit (BOHP)	Protection action	Turns the output off. ALARM LED illuminates.			
Shut down (SD)	Protection action	Turns off the output or trips the breaker (turns the POWER switch off). ALARM LED illuminates.*1			

*1. If the breaker is set to trip, the ALARM LED illuminates for approximately 10 to 15 s when the SD signal is applied while the OVP/OCP is activated.

Output signals

			PAT20-400T	PAT40-200T	PAT60-133T	PAT160-50T
Monitor signal output[*1]	VMON (Voltage)	At rated voltage output	10.00 V ± 0.25 V			
		At 0 V output	0.00 V ± 0.25 V			
	IMON (Current)	At rated current output	10.00 V ± 0.25 V			
		At 0 A output	0.00 V ± 0.25 V Turns on during CC operation.			
Status signal output[*1, *2]	OUTON STATUS		Turns on when the output is on.			
	CV STATUS		Turns on during CV operation.			
	CC STATUS		Turns on during CC operation.			
	ALM STATUS		Turns on when an alarm (OVP, OCP, OHP, BOHP, input open-phase protection, fan failure protection, incorrect sensing connection protection, or shutdown) is detected.			
	PWR OFF STATUS		Stays on for approximately 10 to 15 seconds after the POWER switch turns off.[*3]			
	PWR ON STATUS		Turns on when the POWER switch is on.			

*1. J1 and J2 connectors on the rear panel.
*2. Photocoupler open collector output, maximum voltage 30 V, maximum current (sink) 8 mA, insulated from the output and control circuits, and status signals are not mutually insulated.
*3. If the breaker is set to trip, the ALARM LED illuminates for approximately 10 to 15 s when the SD signal is applied while the OVP/OCP is activated.

Control functions

		PAT20-400T	PAT40-200T	PAT60-133T	PAT160-50T
External control[*1]	EXT-V CV CONT *2 (CV external voltage control)	0 % to 100 % of the rated output voltage in the range of 0 V to 10 V.			
	EXT-R CV CONT (1)[*2] (CV external resistance control normal)	0 % to 100 % of the rated output voltage in the range of 0 kΩ to 10 kΩ.			
	EXT-R CV CONT (2)[*2] (CV external resistance control fail safe)	100 % to 0 % of the rated output voltage in the range of 0 kΩ to 10 kΩ.			
	EXT-V CC CONT[*2] (CC external voltage control)	0 % to 100 % of the rated output current in the range of 0 V to 10 V.			
	EXT-R CC CONT (1)[*2] (CC external resistance control normal)	0 % to 100 % of the rated output current in the range of 0 kΩ to 10 kΩ.			
	EXT-R CC CONT (2)[*2] (CC external resistance control fail safe)	100 % to 0 % of the rated output current in the range of 0 kΩ to 10 kΩ.			
	OUTPUT ON/OFF CONT[*3]	Output on with a low TTL level signal/output on with a high TTL level signal.			
	SHUT DOWN[*4]	Output off with a low TTL level signal.			

*1. J1 connector on the rear panel.
*2. Set EXT-V and (1) and (2) of EXT-R using CONFIG settings. The selected function is enabled for EXT-V and EXT-R separately.
The input impedance EXT-V CV CONT and EXT-V CC CONT is approximately 100 kΩ.
The setting accuracy is ±5 % of the rated output voltage or ±5 % of the maximum output current.
*3. Set the logic low/high using CONFIG settings.
*4. The output turns off even if the breaker trip setting of the CONFIG parameter is set so that the POWER switch does not turn off.

Interface

		PAT20-400T	PAT40-200T	PAT60-133T	PAT160-50T
Common specifications	Soft ware protocol	IEEE Std 488.2-1992			
	Command language	Complies with the SCPI Specification 1999.0 specifications.			
RS232C	Hardware	Complies with EIA232D.			
		D-SUB 9-pin connector (male) *1			
		Baud rate: 1200, 2400, 4800, 9600, 19200, and 38400 bps			
		Data length: 7 bits or 8 bits. Stop bit: 1 bit or 2 bits. No parity.			
		Flow control X-Flow or none.			
	Program message terminator	LF during reception, CR/LF during transmission.			
GPIB*2	Hardware	Complies with IEEE Std 488.1-1987.			
		SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0, and E1.			
		24 pin connector (receptacle)			
	Program message terminator	LF or EOI during reception, LF+EOI during transmission.			
	Primary address	1 to 30			
USB*2	Hardware	Complies with USB 2.0. Data rate: 12 Mbps (full speed).			
		Socket B type			
	Program message terminator	LF or EOM during reception, LF+EOM during transmission.			
	Device class	Complies with the USBTMC-USB488 device class specifications.			
LAN*2	Hardware	IEEE 802.3 100Base-TX/10Base-T Ethernet			
		IPv4, RJ-45 connector *3			
	Communications protocol	VXI-11			
	Program message terminator	LF or EOI during reception, LF+EOI during transmission.			

*1. Use a cross cable (null modem cable).
*2. Factory option.
*3. Category 5, use a straight cable.

Other functions

	PAT20-400T	PAT40-200T	PAT60-133T	PAT160-50T
Master-Slave parallel operation	Up to 5 units including the master unit*1			
Preset function	Stores three preset memory values (A, B, and C)			

*1. The difference in the output voltage and output current between the master unit and the slave unit is within approximately 5 % of the rating.
When the maximum output current value exceeds 999.9, the maximum current displays 9999.
When in the parallel operation, do not combine the firmware version prior to 3.00 of the PAT40-200T.

General specifications

		PAT20-400T	PAT40-200T	PAT60-133T	PAT160-50T
Weight		Approx. 26 kg (main unit only)	Approx. 25 kg (main unit only)	Approx. 24 kg (main unit only)	
Dimensions		See the outline drawing			
Environmental conditions	Operating conditions	Indoor use, Overvoltage Category II			
	Operating temperature	0 ° C to +50 ° C			
	Operating humidity	20 %rh to 85 %rh (no condensation)			
	Storage temperature	-25 ° C to +70 ° C			
	Storage humidity	90 %rh or less (no condensation)			
	Altitude	Up to 2000 m			
Cooling system		Forced air cooling using a fan. (With fan control)			
Grounding polarity		Negative grounding or positive grounding possible.			
Isolation voltage		±250 Vmax			±500 Vmax
Withstand voltage	Across the primary side of the transformer and chassis	No abnormalities at 1500 Vac for 1 minute.			
	Across the primary and secondary sides of the transformer				
	Across the secondary side of the transformer and chassis	No abnormalities at 500 Vdc for 1 minute.			
Insulation resistance	Across the primary side of the transformer and chassis	500 Vdc, 30 MΩ or more. (at a humidity of 70 %rh or less)			
	Across the primary and secondary sides of the transformer				
	Across the secondary side of the transformer and chassis				
Safety *1		Complies with the requirements of the following directives and standards Low Voltage Directive 73/23/EEC EN 61010-1 Class I Pollution degree 2			
Electromagnetic Compatibility (EMC)*1, *2		Complies with the requirements of the following directives and standards. EMC Directive 89/336/EEC EN 61326 EN 61000-3-2 EN 61000-3-3 Applicable condition All of the cables and wires connected to the PAT are less than 3 m in length.			
Accessories	OUTPUT terminal cover	2 sets (with screws)			
	Output terminal bolt set	2 sets (M12 × 25 mm bolts, nuts, and spring washers)	2 sets (M10 × 20 mm bolts, nuts, and spring washers)		
	J1/J2 connector kit	1 set (2 sets of protection covers, 2 plugs, and 30 pins)			
	Chassis connection wire	1 set (with screws)			
	Operation manual	1 pc.			

*1. Not applicable to custom order models.
*2. Applies only to models that have CE marking on the panel.

9.2 Dimensions

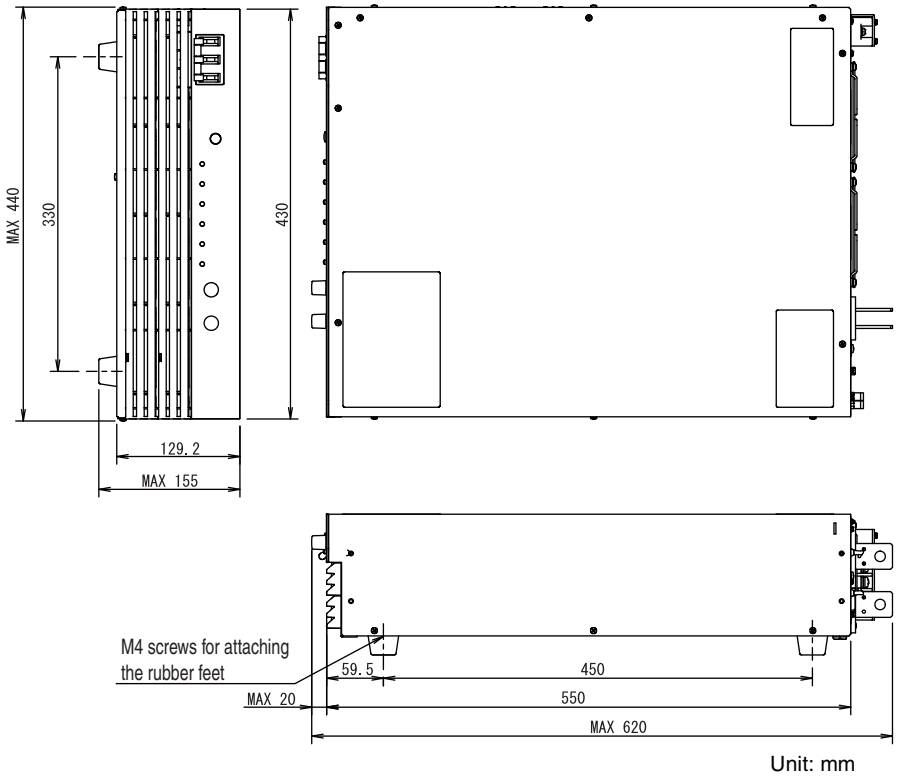


Fig.9-1 PAT-T series outline drawing

Appendix

The appendix contains lists of messages, lists of command errors, Access and operation for the built-in Web site, tutorials, sample programs, and troubleshooting.

A.1 Lists of Messages

SCPI command: Command name in the short form

*RST: Yes for commands that are affected by *RST

R/W: Query command (R)/set command (W).

†: 1, 2, and 3 indicate SCPI standard command, command in review, and KIKUSUI original command, respectively.

Table A-1 FETCh | MEASure subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
FETC[:SCAL] | MEAS[:SCAL]									
:VOLT			A		NR3		Queries the measured voltage output.	R	1
:CURR			V		NR3		Queries the measured current output.	R	1

Table A-2 MEMory subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
MEM									
:KLOCK	bool			ON	NR1		Sets the preset memory recall while locked.	R/W	3
:RCL	numeric	1 to 3					Recalls a preset memory.	W	3
:SAV	numeric	1 to 3					Saves to a preset memory.	W	3

Table A-3 OUTPut subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
OUTP									
[:STAT]	bool			OFF	NR1	Yes	Output on/off.	R/W	1
[:STAT]:TRIG	bool			OFF	NR1	Yes	Sets whether to turn the output on/off using a trigger.	R/W	3
:EXT	char	NORM | INV		NORM	char	Yes	Sets the logic of the output on/off using external contact.	R/W	3
:PROT:CLE							Clears the alarm.	W	1
:PON:STAT	char	RST | AUTO		RST	char	Yes	Output status at power-on.	W	3

Table A-4 SENSe subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
SENS:AVER:CLE							Clears the measured date.	W	3

Table A-5 SOURce subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
[SOUR]									
:VOLT									
[:LEV][:IMM][:AMPL]	numeric	0 % to 105 % of the rated output voltage	V	0	NR3	Yes	Sets the voltage.	R/W	1
:EXT:SOUR	char	NONE | VOLT | RES | IRES		NONE	char	Yes	Sets the CV control mode setting.	R/W	3
:LIM									
[:AMPL]			V		NR3	Yes	Queries the voltage limit setting.	R	3
:AUTO	bool			OFF	NR1	Yes	Enables/Disables the voltage limit setting.	R/W	3
:PROT									
[:LEV]	numeric	10 % to 111.5 % of the rated output voltage	V	111.5 % of the rated output voltage	NR3	Yes	Sets the OVP.	R/W	1
:TRIG	numeric	0 % to 105 % of the rated output voltage	V	0	NR3	Yes	Target voltage using a trigger.	R/W	1
:CURR									
[:LEV][:IMM][:AMPL]	numeric	0 % to 105 % of the rated output current	A	105 % of the rated output current	NR3	Yes	Sets the current.	R/W	1
:EXT:SOUR	char	NONE | VOLT | RES | IRES		NONE	char	Yes	Sets the constant current control mode.	R/W	3
:LIM									
[:AMPL]			A		NR3		Queries the current setting limit.	R	3
:AUTO	bool			OFF	NR1	Yes	Enables/Disables the current setting limit.	R/W	3
:PROT									
[:LEV]	numeric	10 % to 111.5 % of the rated output current	A	111.5 % of the rated output current	NR3	Yes	Sets the OCP.	R/W	1
:TRIG	numeric	0 % to 105 % of the rated output current	A	105 % of the rated output current	NR3	Yes	Target current using a trigger.	R/W	1

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Table A-6 STATus subsystem

SCPI Command		Setting	Response	Description	R/W	†
Program header	Parameter					
STAT						
:OPER						
[:EVEN]			NR1	Event.*1	R	1
:COND			NR1	Register status.*1	R	1
:ENAB	NR1	0 to 32767	NR1	Enable.*1	R/W	1
:PTR	NR1	0 to 32767	NR1	Positive transition.*1	R/W	1
:NTR	NR1	0 to 32767	NR1	Negative transition.*1	R/W	1
:PRES				Resets the enable register.	W	1
:QUES						
[:EVEN]			NR1	Event.*2	R	1
:COND			NR1	Register status.*2	R	1
:ENAB	NR1	0 to 32767	NR1	Enable.*2	R/W	1
:PTR	NR1	0 to 32767	NR1	Positive transition.*2	R/W	1
:NTR	NR1	0 to 32767	NR1	Negative transition.*2	R/W	1

*1. OPERation status register.
*2. QUEStionable status register.

Table A-7 SYSTem subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
SYST									
:CONF									
:BTR									
[:IMM]							Breaker trip.	W	3
:PROT	bool			OFF	NR1	Yes	Turns breaker trip on/off when the OCP/OVP activates.	R/W	3
:SHUT	bool			OFF	NR1	Yes	Turns the breaker trip on/off when the SD signal is applied.	R/W	3
:PAR	NR1	1 to 5		1	NR1		Setting the number of units in Master-Slave Parallel Operation.	R/W	3
:PST	char	NORM | INV		NORM	char		Sets the status signal of the power on/off.	R/W	3
:RSEN					NR1		Queries the sensing switch status.	R	3
:MSL	char	MAST | PAR		MAST	char		Sets the status during parallel operation.	R/W	3
:TRAC	bool			OFF	NR1		Sets whether to display or hide the communication error.	R/W	3
:ERR[:NEXT]?					string		Read the error information.	R	3
:KLOC	bool				NR1		Panel operation lock.	R/W	1
:LOC							Sets to local.	W	1
:OPT					char		Queries the option interface board.	R	3
:REM							Sets the operation to remote. Locks the panel keys except the LOCAL switch.	W	3
:RWL							Sets the operation to remote. Locks the panel operation.	W	3
:VERS							Queries the SCPI specification version with which the PAT complies.	R	1

Table A-8 TRIGger subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
ABOR							Aborts the operation of all sequences.	W	1
INIT									
[:IMM]									
:NAME	char	TRAN | OUTP| ACQ					Sequence 1, 2, and 3: Starts the trigger function.	W	1
:SEQ1							Sequence 1: Starts the voltage/current setting trigger function.	W	1
:SEQ2							Sequence 2: Starts the output on/off delay trigger function.	W	1
:SEQ3							Sequence 3: Starts the measurement trigger function.	W	1
:CONT									
:NAME	char	ACQ				Yes	Sequence 3: Sets the auto continue mode.	R/W	1
	bool			OFF	NR1				
:SEQ3	bool			OFF	NR1	Yes			
TRIG[SEQ[1]] | TRIG[:TRAN]									
[:IMM]							Sequence 1: Software trigger.	W	1
:SOUR	char	IMM | BUS		BUS	char	Yes	Sequence 1: Trigger source.	R/W	1
TRIG:SEQ2 | TRIG:OUTP									
[:IMM]							Sequence 2: Software trigger.	W	1
:DEL									
:OFF	numeric	0.0 to 10.0	S	0.0	NR3	Yes	Sequence 2: Sets the output off delay.	R/W	1
:ON	numeric	0.0 to 10.0	S	0.0	NR3	Yes	Sequence 2: Sets the output on delay.	R/W	3
:SOUR	char	IMM | BUS		BUS	char	Yes	Sequence 2: Trigger source.	R/W	3
TRIG:SEQ3 | TRIG:ACQ									
[:IMM]							Sequence 3: Software trigger.	W	1
:SOUR	char	IMM | BUS		IMM	char	Yes	Sequence 3: Trigger source.	R/W	1

Table A-9 IEEE488.2 common commands

IEEE488.2 common command	Parameter	Description	R/W
*CLS		Clears all the event registers.	W
*ESE	NR1	Sets the event status enable register bits.	R/W
*ESR		Queries the event status register.	R
*IDN		Queries the identification string (manufacturer information).	R
*OPC		Causes the device to generate the operation complete message in the event status register when all pending selected device operations have been finished.	R/W
*OPT		Queries the hardware interface board that is installed	R
*PSC	0 | 1	Initializes *ESE and *SRE.	R/W
*RST		Performs a device reset. Configures the PAT to a known condition independent from the usage history of the device.	W
*SRE	NR1	Sets the service request enable register bits.	R/W
*STB		Reads the status byte and master summary status bits.	R
*TRG		Trigger command	W
*TST		Executes a self-test	R
*WAI		Prevents the device from executing subsequent commands or queries until the No Operation Pending flag becomes true.	W

A.2 A List of Errors

Command errors

An error in the range [-199, -100] indicates that an IEEE 488.2 syntax error has been detected by the instrument's parser. The occurrence of any error in this class shall cause the Command Error (bit 5) in the event status register to be set.

Table A-10 Command errors

Error Code		Error Message Description
-100	Command error	Generic syntax error.
-101	Invalid character	A syntactic element contains a character which is invalid.
-102	Syntax error	An unrecognized command or data type was encountered.
-103	Invalid separator	The parser was expecting a separator and encountered an illegal character.
-104	Data type error	The parser recognized a data element different than one allowed.
-105	GET not allowed	A Group Execute Trigger was received within a program message.
-108	Parameter not allowed	More parameters were received than expected for the header.
-109	Missing parameter	Fewer parameters were received than required for the header.
-110	Command header error	An error was detected in the header.
-120	Numeric data error	Generated when parsing a data element which appears to be numeric, including the nondecimal numeric types.
-130	Suffix error	Generated when parsing a suffix.
-131	Invalid suffix	The suffix does not follow the syntax, or the suffix is inappropriate for the PAT.
-134	Suffix too long	The suffix contained more than twelve characters.
-138	Suffix not allowed	A suffix was encountered after a numeric element which does not allow suffixes.
-140	Character data error	Generated when parsing a character data element.
-141	Invalid character data	Either the character data element contains an invalid character, or the element is not valid.
-144	Character data too Long	The character data element contains more than twelve characters.
-148	Character data not allowed	A legal character data element was encountered where prohibited by the PAT.
-150	String data error	Generated when parsing a string data element
-160	Block data error	Generated when parsing a block data element.
-170	Expression error	Generated when parsing an expression data element.
-180	Macro error	Generated when defining a macro or executing a macro.

Execution errors

An error in the range [-299, -200] indicates that an error has been detected by the instrument's execution control block. The occurrence of any error in this class shall cause the Execution Error (bit 4) in the event status register to be set.

Table A-11 Execution errors

Error Code		Error Message Description
-200	Execution error (generic)	A generic error for this PAT.
-203	Command protected	Password protected program or query command cannot be executed.
-210	Trigger error	A trigger error.
-211	Trigger ignored	A trigger was received but discarded.
-213	Init ignored	Measurement initiate operation was ignored because measurement is in progress.
-214	Trigger deadlock	Dead lock occurred because a query was received before the software trigger.
-220	Parameter error	A program data element related error occurred.
-221	Settings conflict	Received a command that cannot be executed in the current condition of the PAT.
-222	Data out of range	Parameter value was outside the legal range.
-223	Too much data	Too many parameters were received than the requirements.
-224	Illegal parameter value	Received an invalid parameter data.
-230	Data corrupt or stale	Received a data query before the measurement was completed.
-241	Hardware missing	Cannot be executed because the optional hardware is not installed.

Device-specific errors

The occurrence of any error in this class shall cause the Device Dependent Error (bit 3) in the event status register to be set.

Table A-12 Device-specific errors

Error Code		Error Message Description
-360	Communication error	Communication error when the flow control is turned off. This error applies when the RS232C is used.
-362	Framing error in program message	Framing error. This error applies when the RS232C is used.
-363	Input buffer overrun	Buffer overrun error. This error applies when the RS232C is used.
-364	Time out error	Time out error. This error applies when the RS232C is used.

Query errors

An error in the range [-499, -400] indicates that the output queue control of the instrument has detected a problem with the message exchange protocol described in IEEE 488.2, chapter 6. The occurrence of any error in this class shall cause the Query Error (bit 2) in the event status register to be set.

Table A-13 Query errors

Error Code		Error Message Description
-400	Query error (generic)	This is the generic query error for devices that cannot detect more specific errors.
-410	Query INTERRUPTED	Received a new command before the response was read.
-420	Query UNTERMINATED	The controller attempted to read the response after the device received an unsupported query or has not received a query. The -100 "COMMAND ERROR" and this error is stored in the error queue. The controller will time out.
-430	Query DEADLOCKED	The error queue, input buffer, and output buffer are full when sending large binary data as a response, and the transmission timing is off.
-440	Query UNTERMINATED after indefinite response	Received a separate query in semicolon-delimited format after a query that returns a response in an indefinite form. (Example: A command such as the following. *IDN?;SYST:ERR?)

Operation complete event errors

An error in the range [-899, -800] is used when the PAT wishes to report an IEEE488.2 operation complete event. This event occurs when the instrument's synchronization protocol, having been enabled by an *OPC command, completes all selected pending operations.

The occurrence of any event error in this class shall cause the Operation Complete (bit 0) in the event status register to be set.

Table A-14 Operation complete event errors

Error Code		Error Message Description
-800	Operation complete	All selected pending operations in accordance with the IEEE 488.2, 12.5.2 synchronization protocol has completed.

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Device-dependent errors

The occurrence of any error in this class shall cause the Device Dependent Error (bit 3) in the event status register to be set.

Table A-15 Device-dependent errors

Error Code		Error Message Description
101	Operation denied while in LOCal state	Operation is denied because the PAT is in local mode.
102	Operation denied while in OUTPut ON state	Operation is denied because the OUTPUT is on.
103	Operation denied while in PROTection state	Operation is denied because a protection function is activated.
104	Operation denied while in SLAVe mode	Operation is denied because the PAT is set to slave mode.

A.3 Default Conditions

See p. 7-18

Table A-16 shows how the PAT is set when the *RST command is executed, at the time of factory shipment, and when the power is turned on.

Table A-16 Conditions after sending a *RST and at power-on

Setup item	Setting			Unit	Function
	*RST	Factory default	At power-on		
OUTP	0/OFF	0/OFF	0/OFF[*1]	–	Output on/off setting
OUTP:PON:STAT	RST[*2]	RST[*2]	Setting immediately before turning the POWER switch off	–	Output condition at power-on
OUTP:EXT	NORM	NORM		–	Logical setting of the output on/off using external contact
VOLT	0	0		V	Voltage setting
VOLT:EXT:SOUR	NONE[*3]	NONE[*3]		–	Control mode setting of constant voltage
VOLT:LIM:AUTO	0/OFF	0/OFF		–	Voltage limit setting
VOLT:PROT	111.5 % of the rated output voltage			V	OVP setting
VOLT:TRIG	0	0		V	Target voltage using a trigger
CURR	105.0 % of the rated output current			A	Current setting
CURR:EXT:SOUR	NONE[*3]	NONE[*3]		–	Control mode setting of constant current
CURR:LIM:AUTO	0/OFF	0/OFF		–	Current limit setting
CURR:PROT	111.5 % of the rated output current			A	OCP setting
CURR:TRIG	105.0 % of the rated output current			A	Target current using a trigger
OUTP:TRIG	0/OFF	0/OFF		–	Setting of whether to turn the output on/off using a trigger
TRIG:SOUR	BUS[*4]	BUS[*4]	BUS[*4]	–	Sequence 1 trigger source
TRIG:SEQ2:DEL:ON / TRIG:OUTP:DEL:ON	0.0	0.0	Setting immediately before turning the POWER switch off	S	Output on delay setting
TRIG:SEQ2:DEL:OFF / TRIG:OUTP:DEL:OFF	0.0	0.0		S	Output off delay setting
TRIG:SEQ2:SOUR / TRIG:OUTP:SOUR	BUS[*4]	BUS[*4]	BUS[*4]	–	Sequence 2 trigger source
TRIG:SEQ3:SOUR / TRIG:ACQ:SOUR	IMM[*5]	IMM[*5]	IMM[*5]	–	Sequence 3 trigger source
INIT:CONT:SEQ3 / INIT:CONT:NAME ACQ	0/OFF	0/OFF	0/OFF	–	Sequence operation auto continue mode of sequence 3
SYST:CONF:BTR:PROT	0/OFF	0/OFF	Setting immediately before turning the POWER switch off	–	Breaker trip setting when the OVP or OCP is activated
SYST:CONF:BTR:SHUT	0/OFF	0/OFF		–	Breaker trip setting when the SD signal is applied
SYST:CONF:MSL	MAST	MAST		–	Status setting during parallel operation
SYST:CONF:PAR	No change	1		–	Setting the number of units in Master-Slave Parallel Operation
SYST:CONF:PST	NORM[*6]	NORM[*6]		–	Status signal setting of the output on/off
SYST:CONF:TRAC	No change	0/OFF		–	Communication error display/hide setting
SYST:KLOC				–	Panel operation lock
MEM:KLOC		1/ON		–	Preset memory recall setting while locked

*1. The PAT may power up at 1/ON depending on the OUTP:PON:STAT setting.
*2. RST: Output turns off at power-on.
*3. NONE: Panel control
*4. BUS: Wait for a software trigger to start the measurement
*5. IMM: Start the measurement immediately
*6. NORM: Output a low level signal while the power is on.

A.4 Processing time of Commands

The command processing time is the time until the next command is accepted.

It does not include the response time of the hardware.

The processing times indicated here are typical values.

They are not warranted.

Table A-17 Processing time of main commands

Command	GPIB*1 Processing Time (ms)	USB Processing Time (ms)	RS232C*2 Processing Time (ms)	LAN*3 Processing Time (ms)	Description
VOLT 20	10	10	8	11	Sets the voltage.
MEAS:VOLT?	30	27	32	27	Queries the measured voltage output.
CURR	10	10	8	11	Sets the current.
MEAS:CURR?	28	27	32	27	Queries the measured current output.
*RST	102	102	100	102	Performs a device reset.

*1. Using GPIB-USB-B by National Instruments.
*2. Data rate setting: 38400 bps. Flow control: On
*3. 100BASE-TX Ethernet

A.5 Access and Operation for the Built-in Web site (LAN interface)

For LAN interface, the detailed setting can be operated from the browser on the PC.

The URL of Web site is defined as adding "http://" in front of the IP address.

When VISA library is used, there is the function to retrieve the VXI-11 measuring instrument by the application program provided by VISA vendors (National Instruments NI-MAX, Agilent Connection Expert, and Kikusui KI-VISA Instrument Explorer, etc.). Once you click on the web link from the retrieval result, the built-in Web site can be opened.

The URL can be entered directly on the address bar of the browser by confirming the IP address of the config setting (CF57 to CF60).

(Example) When the IP address is 169.254.7.8

http://169.254.7.8

The following browsers are applied.

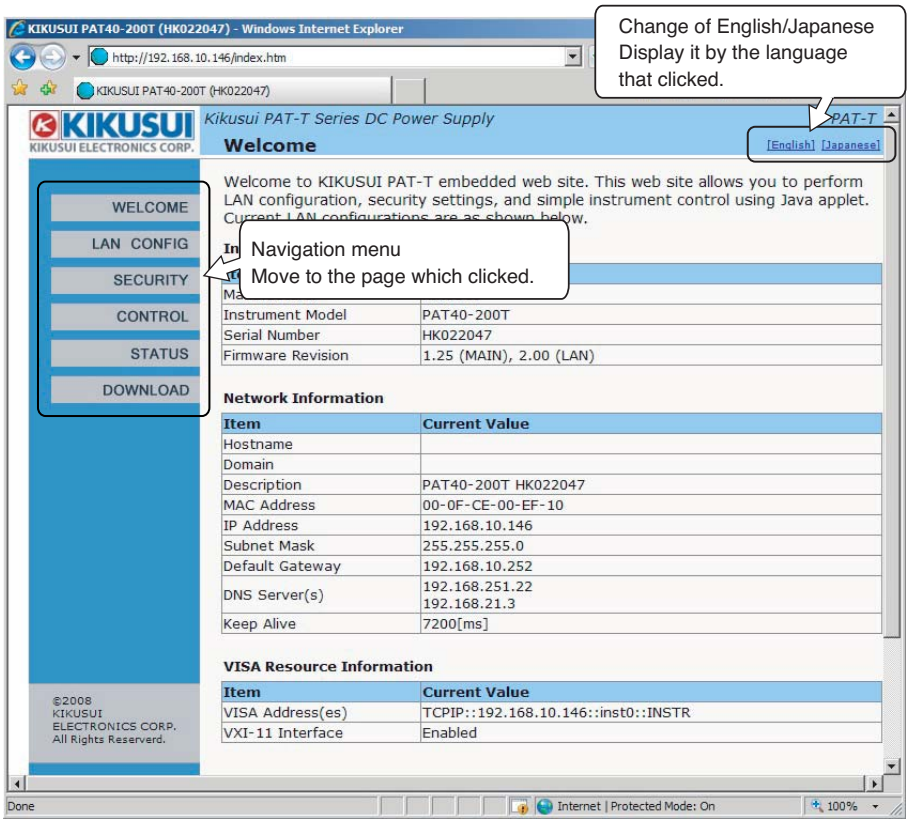
- Internet Exprorer 5.5/6.0/7.0
- Mozilla Firefox 2.0
- Opera 9.0
- Netscape 7.1
- Safari 3.0

WELCOME page

Firstly, WELCOME page is displayed when the built-in Web site is connected.

The instrument information, network information, and VISA resource information appear on the display.

Click the navigation menu to move to the other page.



LAN CONFIG page

Update page for the network settings.

This page can allow you to set the allocation of IP address and the host name, etc. Once you set the host name, you can access to the LAN interface by using the host name instead of IP address. It is recommended to check for the "DHCP", "AUTO IP", "Dynamic DNS", and "Net BIOS" for normal operation.

SECURITY page

This page is for the security setting.

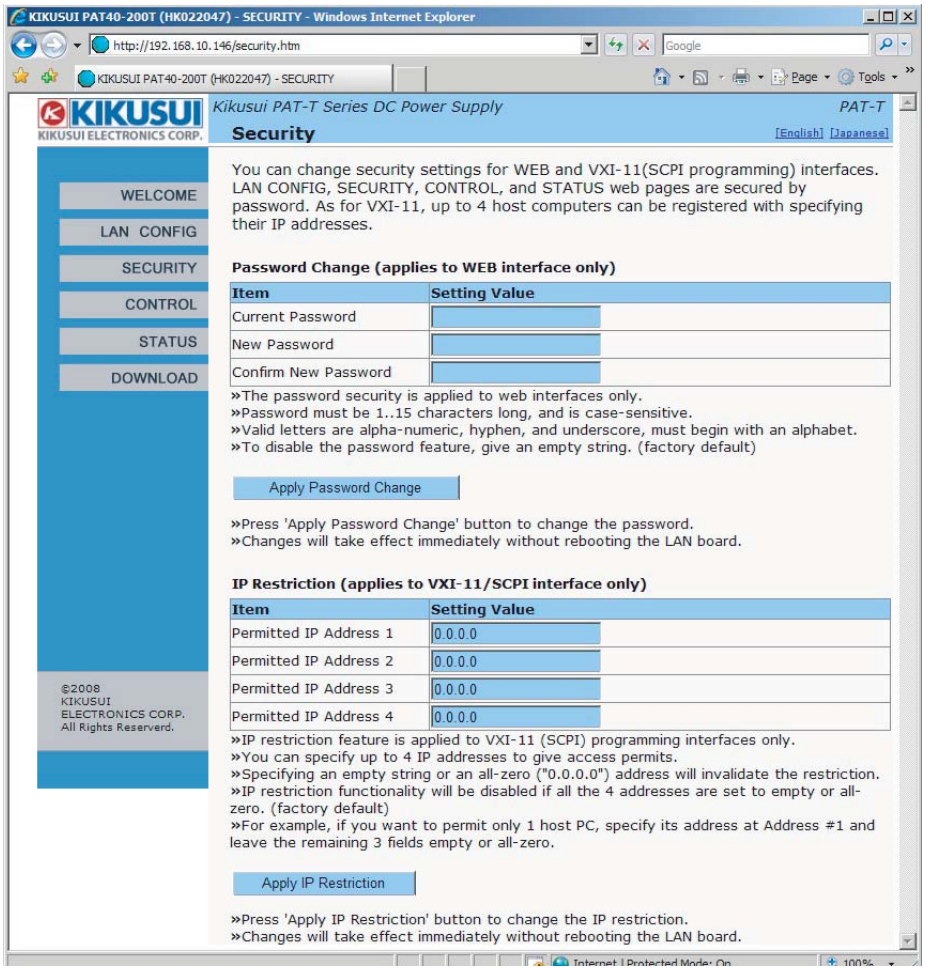
This page can allow you to set the change of the password protection, and the host limit function by the IP address.

The password protection is an effective security features to the Web site. It prevents from being changed inadvertently. The password can be used for any alphanumeric characters, the hyphen, and the underscore. The first character should be an alphabet, with maximum of 15 characters.

The web page which can be set by the password protection are the "LAN CONFIG" page, "SECURITY" page, "CONTROL" page, and "UPDATE" page.

The host limitation by the IP address is an effective security feature for the VXI-11. Having at least one unit is registered, it prevents from being used by non-registered host.

The IP address on the host side can be registered up to 4 units.

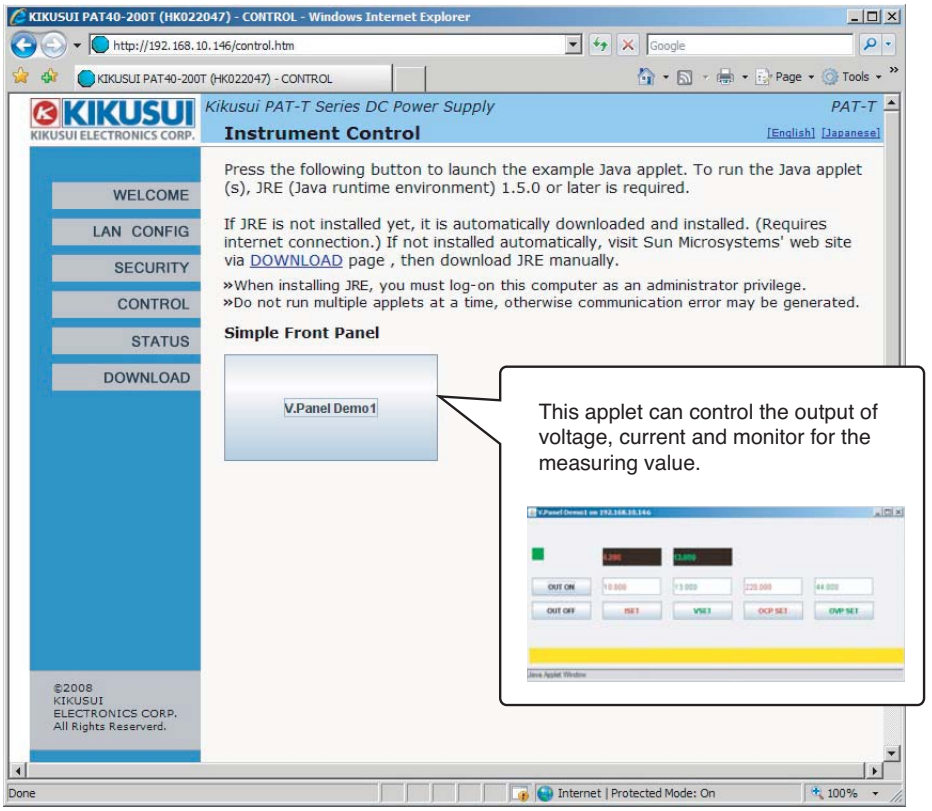


CONTROL page

This page can allow you to set up the simple power supply control application program using the JAVA applet.

It can set the output of voltage, current and monitor for the measuring value.

It is required for the JRE (JAVA runtime environment) to be installed beforehand.



STATUS page

This page is to display the LAN status and for the setting of "identify" display on/off of the product.

When turning on the "Identify" display, you can confirm the unit controlled by the LAN interface with blinking the display of "LAN" on the front panel of the product.

DOWNLOAD page

Displays the web site link of which down load service of KI-VISA or SUN Java Software are available.

An internet connection is required to access.

UPDATE page

This is firmware update page for the LAN interface.

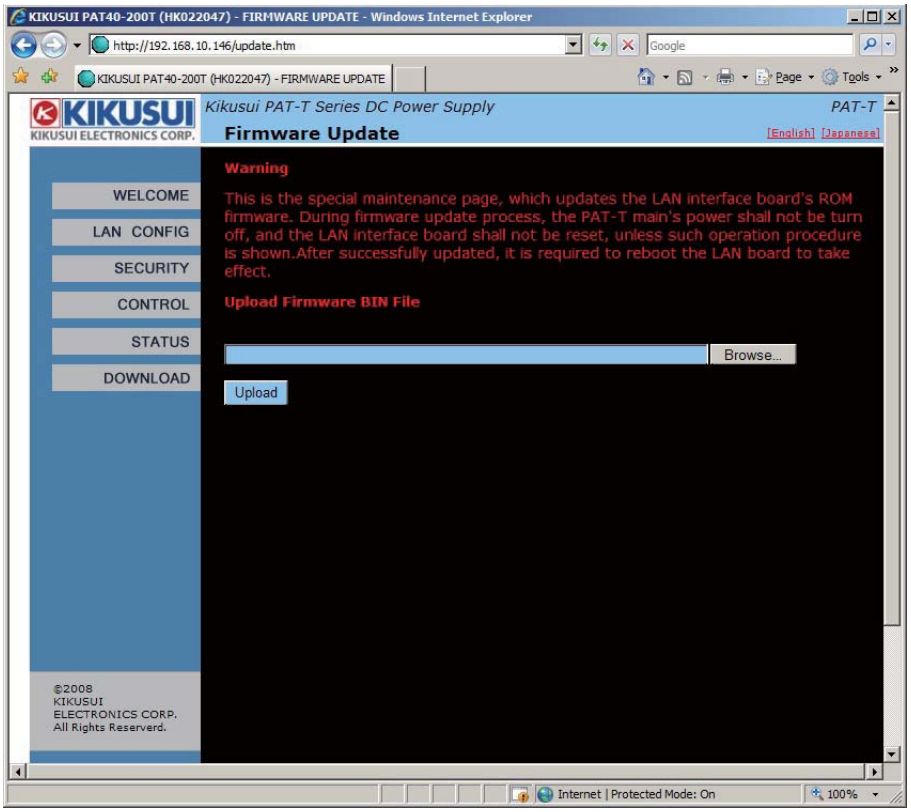
On this page, you can update by downloading the latest firmware version from the download service of our Web site (http://www.kikusui.co.jp/en/download/).

For details of updating firmware, refer to the document in the download module.

To avoid opening the UPDATE page inadvertently, it can not be moved from the navigation menu to the UPDATE page. If you wish to move the navigation menu to the UPDATE page, specify the URL(update.htm) directly.

(Example) When you wish to move to the UPDATE page by the IP address 169.254.7.8

http://169.254.7.8/update.htm



A.6 Tutorial

This section describes the procedures to make measurements through remote control on the PAT.

A.6.1 Turning the Power On and Resetting the Instrument

When the PAT is turned on, all panel settings are set to the state when it was turned off the last time. The output state varies depending on the output state setting (OUTPut:PON:STATe) at power-on.

There are settings specific to remote control that are not related to the panel settings. They are the SYSTem, TRIGger, and STATus subsystems. Most of the settings are reset when the PAT is turned on. The following commands are implicitly executed at power-on.

```
*CLS
*SRE 0
*ESE 0
:SYSTem:REMote
:SYSTem:PRESet
:OUTPut OFF      ' OUTPut ON is executed if OUTP:PON:STAT is
                 ' set to AUTO.
:OUTPut:PROTection:CLEar
:TRIGger:SEQuence1:SOURce BUS
:TRIGger:SEQuence2:SOURce BUS
:TRIGger:SEQuence3:SOURce IMMediate
:INITiate:CONTinuous:SEQuence3 OFF
```

Reset command

The *RST command is used to initialize the panel settings of the PAT.

```
*RST
```

The *RST command is used to reset the panel settings to their default conditions. However, some items are not affected by the *RST command.

See p. A-10

If you want to completely reset the panel settings, the items below must be changed to the initial settings after executing the *RST command.

- Communication error display setting
- Master-Slave parallel operation setting
- Lock function
- Remote interface setting

NOTE

- Turning on the POWER switch while holding down the SHIFT switch initializes the PAT settings to factory default. All the panel settings, panel memory contents, and configuration settings are reset.

A.6.2 Output programming

Voltage and current

The output voltage and output current are controlled by the VOLTage and CURRent commands. The output ON/OFF state is controlled by the OUTPut command.

```
:VOLTage 13.5          ' Set the voltage to 13.5 V
:CURRent 4.5           ' Set the current to 4.5 A
:OUTPut ON             ' Turn the output on
```

To set the preset current to the maximum value, set the value of the CURRent command to MAXimum.

The current setting limit is set to approximately 95 % of the value specified by the CURRent:PROTection command if the CURRent:LIMit:AUTO command is set to ON (1). The setting limit cannot be set above this value. If the CURRent:LIMit:AUTO command is set to OFF (0), the setting limit is the maximum value of preset range (105 % of the rated output current).

```
:VOLTage 13.5          ' Set the voltage to 13.5 V
:CURRent MAXimum       ' Set the current to the max.value
```

To set the preset voltage to the maximum value, set the value of the VOLTage command to MAXimum.

The voltage limit setting is set to approximately 95 % of the value specified by the VOLTage:PROTection command if the VOLTage:LIMit:AUTO command is set to ON (1). The setting limit cannot be set above this value. If the VOLTage:LIMit:AUTO command is set to OFF (0), the setting limit is the maximum value of preset range (105 % of the rated output voltage).

```
:CURRent 4.5           ' Set the current to 4.5 A
:VOLTage MAXimum       ' Set the voltage to the max.value
```

You can confirm the maximum allowed value that can be specified in the VOLTage and CURRent commands by specifying the MAXimum parameter in the VOLTage? and CURRent? queries, respectively.

```
:VOLTage? MAXimum
                                    ← Read the response
:CURRent? MAXimum
                                    ← Read the response
```

The values that the queries above return may vary depending on the VOLTage:PROTection (OVP) and CURRent:PROTection (OCP) settings.

If a value exceeding the upper limit is specified with the VOLTage or CURRent command, it is interpreted as MAXimum and does not result in an error.

Setting the protection functions

The PAT provides overvoltage protection (OVP) and overcurrent (OCP) functions that can be configured. The VOLTage:PROTection and CURRent:PROTection commands are used to set the OVP and OCP, respectively.

```
:VOLTage:PROTection 16.0        ' Set the OVP to 16 V
:CURRent:PROTection 7.5         ' Set the OCP to 7.5 A
```

If you want to set the OVP or OCP setting to the maximum or minimum value, you can specify MAXimum or MINimum for the parameter.

```
:VOLTage:PROTection MAXimum     ' Set the OVP to the max value
:CURRent:PROTection MAXimum     ' Set the OCP to the max value
```

The output turns off if an OVP or OCP activates. Whether the breaker is to be tripped at this point can be specified using the SYSTem:CONFigure:BTRip:PROTection command.

```
SYSTem:CONFigure:BTRip:PROTection ON
                ' Setting in which the breaker is tripped when the OVP or
                ' OCP activates
```

A.6.3 Using Triggers

PAT has three different trigger subsystems: TRANsient, OUTPut, and ACQuire. In the normal SCPI specifications, each trigger subsystem is grouped into a numbered trigger sequence. TRANsient, OUTPut, and ACQuire are mapped to SEQuence1, SEQuence2, SEQuence3, respectively.

The functional assignments of each sequence number are specific to the PAT. The assignment is not necessarily the same as other models that have the SCPI language implemented.

■ Sequence 1 (TRANsient) group

A trigger subsystem that changes the output voltage and output current settings.

■ Sequence 2 (OUTPut) group

A trigger subsystem for the output on/off delay

■ Sequence 3 (ACQuire) group

A trigger subsystem for measurements

When the PAT is turned on, all the trigger subsystems are in the IDLE state. In this state, the trigger subsystems ignore all triggers. Sending one of the following commands at any time also causes the trigger subsystems to return to the IDLE state.

```
:ABORt
*RST
```

Device clear (GPIB and USB) or break signal (RS232)

Setting changes (Sequence 1: TRANsient)

Using the TRIGger:SEQuence1 (or TRIGger:TRANsient) subsystem allows the VOLTage and CURRent settings to be synchronized using triggers. This is convenient if you want to synchronize output changes with the action of other instruments such as electronic loads. To reserve triggered settings, use the VOLTage:TRIGgered and FREQuency:TRIGgered commands.

```
:VOLTage 12.0          ' Set the voltage to 12.0 V
:CURRent 1.5           ' Set the current to 1.5 A

:VOLTage:TRIGgered 13.5
                       ' Set so that the voltage is13.5 V when triggered
:CURRent:TRIGgered 2.5
                       ' Set so that the current is 2.5 A when triggered
:TRIGger:SEQuence1:SOURce BUS
                       ' Set the trigger source to BUS
```

```
:INITiate:SEQuence1
                        ' Initiate sequence 1
:TRIGger:SEQuence1
                        ' Apply a software trigger to sequence 1
```

The TRIGger:SEQuence1:SOURce command sets the trigger source to BUS or IMMediate. The INITiate command makes the trigger subsystem leave the IDLE state and go the initiated state. When the Trigger Source is set to IMMediate, the transient action is executed immediately causing the voltage and/or current to change to a new setting. When the Trigger Source is set to BUS, the trigger subsystem goes to the WTG (Waiting For Trigger) state.

If the trigger subsystem is in the WTG state and a software trigger is applied with the TRIGger:SEQuence1 or *TRG common command, the transient action is executed. When the operation is completed, the trigger subsystem returns to the IDLE state again. When an ABORt or an equivalent command is sent without executing the trigger, the transient action is cancelled, and then the trigger subsystem returns to the IDLE state.

The TRIGger:SEQuence1 command applies a software trigger to the sequence 1 group. The *TRG command or the IEEE488.1 get (Group Execute Trigger) command applies a software trigger to all sequence groups in which the trigger function is initiated.

Output on/off delay function (Sequence 2: OUTPut)

The TRIGger:SEQuence2 (or TRIGger:OUTPut) subsystem allows you to use the output on/off delay function. To reserve the operation of the output change using triggers, use the OUTPut:TRIGgered command.

```
:TRIGger:SEQuence2:SOURce BUS
                        ' Set the trigger source to BUS
:TRIGger:SEQuence2:DELay:ON 0.5
                        ' Set the output on delay to 0.5 s
:OUTPut:TRIGgered ON
                        ' Set the output to be turned on
                        ' when a trigger is applied
:INITiate:SEQuence2
                        ' Initiate sequence 2
:TRIGger:SEQuence2
                        ' Apply a software trigger to sequence 2
```

The TRIGger:SEQuence2:SOURce command sets the trigger source (BUS or IMMediate). The :TRIGger:SEQuence2:DELay:ON command sets the delay for turning on the output after the trigger is applied. If this value is set to 0, the output is turned on without delay. Though not used in the example above, the :TRIGger:SEQuence2:DELay:OFF command sets the delay for turning off the output after the trigger is applied.

The INITiate:IMMediate:SEQuence2 command makes the trigger subsystem leave the IDLE state and go the initiated state. If the trigger source is set to IMMediate, the output on/off delay starts immediately. If the trigger source is set to BUS, the trigger subsystem moves to the WTG (Waiting For Trigger) state. When a software trigger is applied with the TRIGger:SEQuence2 or *TRG common command, the delay action is executed. When the operation is completed, the trigger subsystem returns to the IDLE state again. If an ABORt or an equivalent command is sent without executing the trigger, the delay action is cancelled, and then the trigger subsystem returns to the IDLE state.

If the on or off state specified with the OUTPut:TRIGgered command is the same as the present output state, the SEQuence2 (OUTPut) trigger subsystem completes the apparent action immediately, because there is no actual action that needs to be taken. No error is generated in this case.

If the delay action in progress is aborted by sending an abort command, Device Clear (GPIB/USB), or break signal (RS232), the output state returns to the state that existed before the delay action was executed. Likewise, the *RST command also aborts the operation, but the output state is always set to off.

If the output state is set by force with an OUTPut command while the delay action is in progress, the delay action is aborted, and the output is set to the state specified by the OUTPut command.

Measurement (sequence 3: ACQuire)

The PAT has the capability to return voltage and current measurement values. The easiest way is use the MEASure commands. The trigger function is not used.

The MEASure commands immediately start a new measurement. Simultaneity for multi-item measurements are lost, because each MEASure command starts a new measurement. Advanced measurement allows separate control for measurement initiation and data query.

To measure the voltage and current, use the following queries.

```
:MEASure:VOLTage?        ' Query the voltage output
:MEASure:CURRent?        ' Query the current output
```

The PAT also supports the READ command that initiates a new measurement and queries the data. READ and MEASure are aliases; they operate exactly the same.

Advanced Measurement

The TRIGger:SEQuence3 (or TRIGger:ACQuire) subsystem allows you to control the start of the measurement and the data query separately.

To start a new measurement, set the trigger source to IMMediate and use the INITiate command.

```
:TRIGger:SEQuence3:SOURce IMMediate
                         ' Set the trigger source to IMM
:INITiate:SEQuence3      ' Initiate sequence 3
```

If you want the measurement of the sequence3 group to start on a software trigger, change the trigger source to BUS.

```
:TRIGger:SEQuence3:SOURce BUS
                                ' Set the trigger source to BUS
:INITiate:IMMediate:SEQuence3
                                ' Initiate sequence 3
:TRIGger:SEQuence3:IMMediate
                                ' Apply a software trigger to sequence 3
```

When the measurement is completed, measurement data can be queried with the FETCh query commands.

```
:FETCh:VOLTage?          ' Query the voltage output
:FETCh:CURRent?          ' Query the current output
```

The TRIGger:SEQuence3:SOURce command sets the trigger source to BUS or IMMediate. The INITiate:SEQuence3 command makes the trigger subsystem leave the IDLE state and go the initiated state. If the trigger source is set to IMMediate, the measurement starts immediately. When the Trigger Source is set to BUS, the trigger subsystem goes to the WTG (Waiting For Trigger) state. When a software trigger is applied with the TRIGger:SEQuence3 or *TRG common command, the measurement action is executed. When an ABORt or an equivalent command is sent without executing the trigger, the measurement action is cancelled, and then the trigger subsystem returns to the IDLE state.

The ABORt command and IEEE488.1 sdc/dcl commands simply abort the measurement task that is in progress. It does not have a feature to invalidate any measurement data that has been acquired. On the other hand, the *RST and *RCL common commands not only abort the measurement task, but also invalidate the acquired measurement data. This means that the “*RST;:FETC:VOLT?” command will generate an error, because no measurement data can be fetched and there is no new measurement is scheduled.

The only difference between MEASure (or READ) and FETCh commands is that the MEASure command starts a new measurement while the FETCh command does not. Availability for measurement items is exactly the same for MEASure and FETCh.

Generating and Crearing the measurement data

The measurement data is stored in the measurement data cache for the mean value of the moving average deviations of 64 times measured in every 4 ms. The mean value of the moving average returns after 4 ms counted from the measurement begins upon receipt of the "INIT:SEQ3" command. Despite the setting of the "INIT:CONT:SEQ3" whether on or off, it will start the measurement in every 4 ms and display the mean value of the moving average deviations of 64 times.

The "INIT:SEQ3/INIT:NAME ACQ" command is a command that invalidates the current measurement data stored in the present measurement data cache and it begins a new measurement. The new measurement data will be established after 4 ms.

The "SENSe:AVERage:CLEar" command clears the measurement data stored in the cache and it does not return the query of "FETC" command until the moving average of 64 times is established. This "SENSe:AVERage:CLEar" command is a command that clears all the measurement data of the mean value of the moving average deviations of 64 times as when the setting of the voltage or the current value changes frequently or to change rapidly to be monitored. Therefore, after transmitting the command, new moving average of another deviations of 64 times will be generated after 256 ms.

Auto continue

To keep the trigger subsystem initiated for multiple actions without having to send an initiate command for each trigger, use the CONTinuous option. This enables measurement data to be automatically refreshed as if the PAT is operating in local mode.

```
INITiate:CONTinuous:SEQuence3 ON
```

If the auto continue mode is on, measurement data and the front panel displays are automatically refreshed by the internal trigger loop. In this state, MEASure/READ/FECh query commands work equivalently. New measurements are automatically repeated. This means that sending multiple FETCh queries results in different measurement results, and simultaneity is lost. When the continuous operation is enabled, the ABORt command is ignored because the trigger subsystem automatically exits the IDLE state even if it is aborted.

The *RST command sets CONTinuous to OFF.

Waiting for operation complete

The *OPC common command has a capability to wait for an operation to complete. In case the output on/off delay function is in used, the command will take the delay time (up to 10 s) which is set by this function.

When the *OPC command is sent, the PAT goes to Operation Complete Command Active State (OCAS). When the measurement is completed and there is no other operation pending, the PAT returns to Operation Complete Command Idle State (OCIS) and sets the OPC bit (bit 0) of the Standard Event Status Register to TRUE (1). This information can be confirmed with the OPC bit (bit 0) of the *ESR? query.

The following example starts the output on/off delay action and sends the *OPC command. When the measurement is completed, an SRQ (Service Request) is generated, as the Standard Event Status Enable Register and the Service Request Enable Register are unmasked so that an SRQ is signaled when the delay action completes.

```
*ESE 1;*SRE 32;*CLS;:INITiate:SEQuence2;*TRG;*OPC
```

Using the *OPC? query command instead of the *OPC command makes the PAT go to Operation Complete Query Active State (OQAS). When the measurement is completed and there is no other operation pending, the PAT returns to Operation Complete Query Idle State (OQIS) and sets a response data “1” (in NR1 format) in the output queue.

At power-on or when the IEEE488 sdc/dcl or *RST command is received, the PAT is in the OCIS and OQIS state.

NOTE

- When using the RS232C interface, the SRQ function cannot be used. However, the MSS bit of the *STB query can be used in the same manner as the SRQ function.

A.6.4 Status Monitoring

The PAT has two mandatory SCPI standard registers, STATus:OPERation and STATus:QUEStionable, in addition to the IEEE488.2 standard registers.

Register basics

See p. 7-42

All SCPI registers have standard event/filter architecture, employing CONDition, EVENt, ENABle, and optionally PTRansition and NTRansition. The CONDition and EVENt are read-only registers working as status indicators, and the ENABle, PTRansition and NTRansition are read-write registers working as event and summary filters.

STATus:OPERation

See p. 7-46

The STATus:OPERation register records events or signals that occur during normal operation.

For example, to check if the PAT is being regulated in CV state, check the CV bit (bit 8) on the STATus:OPERation register.

```
:STATus:OPERation?
                              ' Check whether the CV is set
```

STATus:QUEStionable

See p. 7-48

The STATus:QUEStionable register records events or signals that indicate abnormal operation.

To check if the protection function is working, check the 0V bit (bit 0) on the STATus: QUEStionable register.

```
:STATus:QUEStionable?
                              ' Check whether the OV bit is set
```

PON (Power ON) bit

The PON bit (bit 7) in the event status register is set whenever the PAT is turned on. The most common use for the PON is to generate an SRQ at power-on keeping track of unexpected loss of power or power line failure. To do this, follow the steps shown below.

1. Set *PSC (Power-on Status Clear) to 0 (or OFF).

   Enable the backup function of the event status enable register and service request enable register (*PSC 0).

2. Set the PON bit (bit 7) of the event status enable register.

   Permit the transmission of a power-on event to the upper layer (*ESE 128).

3. Set the ESB bit (bit 5) of the status byte enable register.

   Permit the generation of an SRQ caused by a standard event (*SRE 32).

```
*PSC 0;*ESE 128;*SRE 32
```

When using the RS232C interface, the PON bit cannot be assigned to the service request, because SRQs are not generated.

Though the SRQ feature itself is provided by the USBTMC Interrupt-IN endpoint on the USB interface or LAN interface, a Connection Lost error in the VISA I/O session occurs immediately before the power-on event. It may be difficult to handle PON events when using the USB interface.

A.6.5 Error Checking

Error/event queue

The SCPI specifications define a standard error reporting scheme, Error/Event Queue. This is a FIFO (First In First Out) queue, which records errors and events. The maximum number of errors/events that the PAT can record is 255. Each error/event can be read with the SYSTem:ERRor query.

```
:SYSTem:ERRor?
```

The response to this query contains a numeric part (error/event number) and a textual description, such as:

```
-222,"Data out of range"
```

The error/event queue is empty when the *CLS common command is sent, when the last item in the queue is read, or when the PAT is turned on. When the error/event queue is empty, the query returns the following:

```
0,"No error"
```

Displaying communication errors

The PAT has a debug trace function. The oldest item among the errors and events (if they are present) can be displayed on the PAT. This function is convenient when you debug your remote applications.

While an error/event item is displayed on the panel, the normal voltmeter and ammeter are disabled.

If the error/event queue is empty, the debug trace function does not display any errors. Sending the *CLS command clears the communication error display.

If in local mode, the debug trace function is temporarily disabled.

The communication error display can be enabled or disabled with the SYSTem:CONFigure:TRACe command.

```
SYSTem:CONFigure:TRACe <ON|OFF>
```

A.7 Sample Programs

See p. 7-3

The samples given in this section assumes Microsoft Visual Basic 6.0 for the development platform and VISA library (VISA COM) for the I/O library.

The format of the VISA resource string that is substituted in the variable strVisaAddress varies for GPIB, RS232C, USB and LAN interface.

For the GPIB operation, device address of 1 is assumed.

For the RS232C, the communication parameters are required for 19200 bps, Data 8 bits, Stop 1 bit, Parity NONE, and the COM port 1 is also required. Set the PAT interface to match these conditions.

For the USB operation, there are no interface parameters that need to be set on the PAT, but the USB VID (vendor ID), PID (product ID), and serial number must be specified explicitly in the VISA resource string. The VID and PID values can be verified also on the CONFIG setting display of the PAT. The serial number can be verified on the rear panel of the PAT.

For the LAN interface connection, it is required the IP address determined by the interface setting of the product to specify the VISA resource character string clearly. The value of IP address can be confirmed by the config setting display (CF57 to CF60).

Sample 1 (Voltage and current output and measurement)

This sample is an example to query the Output voltage/current value after the output is turned on through the communication by RS232C having with voltage/current setting and overvoltage/overcurrent setting. The queried value will be converted from the text to the numerical value and each of those will be substitute for the variable in double data type.

```
Private Sub main_EZ_Click()

    ' These variables are necessary to operate the VISA COM
    Dim rm As IResourceManager
    Dim io As IMessage
    Dim serial As ISerial

    ' This variable specifies the VISA address
    Dim strVisaAddress As String
    strVisaAddress = "ASRL1::INSTR"                                 ' Sets the port setting of the PC to COM 1 when RS232C is
                                                                    ' used
    ' strVisaAddress = "GPIB0::1::INSTR"                            ' Sets the GPIB address of the PAT unit to 1 when GPIB is
                                                                    ' used
    ' strVisaAddress = "USB0::0x0B3E::0x100E::AB123456::INSTR"      ' when USB is used, VID::PID::Serial number (each unit
                                                                    ' has different number)
    ' strVisaAddress = "TCPIP0::192.168.10.1::inst0::INSTR"        ' The IP address is different depends on the connecting
                                                                    ' environment when using LAN


    ' Create the Resource Manager object

    Set rm = CreateObject("VISA.GlobalRM")

    ' Open the VISA session
    Set io = rm.Open(strVisaAddress, NO_LOCK)

    ' Set additional attributes for Serial I/O communications
    If io.HardwareInterfaceType = 4 Then
        Set serial = io
        serial.BaudRate = 19200                                     ' Baudrate : 19200bps
        serial.DataBits = 8                                         ' data length : 8 bit
        serial.StopBits = ASRL_STOP_ONE                             ' stop bit length : 1 bit
        serial.Parity = ASRL_PAR_NONE                               ' Parity : unused
        serial.FlowControl = ASRL_FLOW_XON_XOFF                     ' Flow control : xon/off
        serial.EndIn = ASRL_END_TERMCHAR                            ' Input terminate character : LF
        serial.EndOut = ASRL_END_TERMCHAR                           ' Output terminate character : LF
    End If

    ' Changing the instrument to remote                             ' Shift to Remote
    io.WriteString ":SYST:REM"
    ' Resets the instrument
    io.WriteString "*RST"

    ' Query the instrument identity
    Dim strIDN As String
    io.WriteString "*IDN?"                                          ' ID Query command, send *IDN?
    strIDN = io.ReadString(256)                                     ' Read 256 bite from the Receiving buffer,
                                                                    ' substitute for the strIDN variable


    ' Give setting values for this example
    Dim dVolt As Double
    Dim dCurr As Double
    Dim dOVP As Double
    Dim dOCP As Double

    dVolt = 13.5    'volts                                          ' voltage setting value : 13.5V
    dCurr = 150     'amps                                           ' current setting value : 150A
    dOVP = 15       'volts                                          ' overvoltage protection setting value : 15V
    dOCP = 200      'amps                                           ' overcurrent protection setting value : 200A
```

```
    ' Set the voltage
    io.WriteString ":VOLT" & Str$(dVolt)

    ' Set the current
    io.WriteString ":CURR" & Str$(dCurr)

    ' Set the overvoltage protection
    io.WriteString ":VOLT:PROT:LEV" & Str$(dOVP)

    ' Set the overcurrent protection
    io.WriteString ":CURR:PROT:LEV" & Str$(dOCP)

    ' Turn the output on
    io.WriteString ":OUTP ON"

    ' Measure the output voltage and current
    Dim dVoltMeasure As Double
    Dim dCurrMeasure As Double
    io.WriteString ":MEAS:VOLT:DC?"                 ' Send the query command for output voltage
    dVoltMeasure = Val(io.ReadString(256))          ' Read 256 bite from the Receiving buffer,
                                                    ' convert from the text to numerical value and
                                                    ' substitute for the dVoltMeasure variable
    io.WriteString ":MEAS:CURR:DC?"                 ' Send the query command for output current
    dCurrMeasure = Val(io.ReadString(256))          ' Read 256 bite from the Receiving buffer,
                                                    ' convert from the text to numerical value and
                                                    ' substitute for the dCurrMeasure variable

    ' Check if there is an instrument error
    Dim strErr As String
    io.WriteString ":SYST:ERR?"                     ' Send the query command for system error
    strErr = io.ReadString(256)                     ' Read 256 bite from the Receiving buffer,
                                                    ' substitute for the strErr variable

    ' Close the VISA session
    io.Close                                        ' Issue the Close command

End Sub
```

Sample 2 (Voltage and current output and measurement (using triggers))

This sample is an example to change the setting condition from the present voltage/current setting to the preset value of the trigger voltage/current when *TRG command is sent. It is required to send ":INIT:SEQ1" before the *TRG command is sent. The querried value will be converted from the text to the numerical value and each of those will be substitute for the variable in double data type.

```
Private Sub main_Trig_Click()

    ' These variables are necessary to operate the VISA COM
    Dim rm As IResourceManager
    Dim io As IMessage
    Dim serial As ISerial

    ' This variable specifies the VISA address
    Dim strVisaAddress As String
    strVisaAddress = "ASRL1::INSTR"                             ' Sets the port setting of the PC to COM 1 when RS232C is
                                                                ' used
    ' strVisaAddress = "GPIB0::1::INSTR"                        ' Sets the GPIB address of the PAT unit to 1 when GPIB is
                                                                ' used
    ' strVisaAddress = "USB0::0x0B3E::0x100E::AB123456::INSTR"  ' when USB is used, VID::PID::Serial number (each unit
                                                                ' has different number)
    ' strVisaAddress = "TCPIP0::192.168.10.1::inst0::INSTR"     ' The IP address is different depends on the connecting
                                                                ' environment when using LAN


    ' Create the Resource Manager object

    Set rm = CreateObject("VISA.GlobalRM")

    ' Open the VISA session
    Set io = rm.Open(strVisaAddress, NO_LOCK)

    ' Set additional attributes for Serial I/O communications
    If io.HardwareInterfaceType = 4 Then
        Set serial = io
        serial.BaudRate = 19200                                 ' Baudrate : 19200bps
        serial.DataBits = 8                                     ' data length : 8 bit
        serial.StopBits = ASRL_STOP_ONE                         ' stop bit length : 1 bit
        serial.Parity = ASRL_PAR_NONE                           ' Parity : unused
        serial.FlowControl = ASRL_FLOW_XON_XOFF                 ' Flow control : xon/off
        serial.EndIn = ASRL_END_TERMCHAR                        ' Input terminate character : LF
        serial.EndOut = ASRL_END_TERMCHAR                       ' Output terminate character : LF
    End If

    ' Changing the instrument to remote                         ' Shift to Remote
    io.WriteString ":SYST:REM"
    ' Resets the instrument
    io.WriteString "*RST"

    ' Query the instrument identity
    Dim strIDN As String
    io.WriteString "*IDN?"                                      ' ID Query command, send *IDN?
    strIDN = io.ReadString(256)                                 ' Read 256 bite from the Receiving buffer,
                                                                ' substitute for the strIDN variable

    ' Give setting values for this example
    Dim dVolt As Double
    Dim dCurr As Double
    Dim dVoltTrig As Double
    Dim dCurrTrig As Double

    dVolt = 13.5         'volts                                 ' voltage setting value : 13.5V
    dCurr = 150          'amps                                  ' current setting value : 150A
```

```
    dVoltTrig = 15       'volts                              ' trigger voltage setting value : 15V
    dCurrTrig = 200      'amps                               ' trigger current setting value : 200A

    ' Set the immediate voltage
    io.WriteString ":VOLT" & Str$(dVolt)

    ' Set the immediate current
    io.WriteString ":CURR" & Str$(dCurr)

    ' Set the triggered voltage
    io.WriteString ":VOLT:TRIG" & Str$(dVoltTrig)

    ' Set the triggered current
    io.WriteString ":CURR:TRIG" & Str$(dCurrTrig)

    ' Turn the output on
    io.WriteString ":OUTP ON"

    ' Measure the output voltage and current,
    ' before sending the trigger
    Dim dVoltMeasure As Double
    Dim dCurrMeasure As Double
    io.WriteString ":MEAS:VOLT:DC?"                          ' Send the query command for output voltage
    dVoltMeasure = Val(io.ReadString(256))                   ' Read 256 bite from the Receiving buffer,
                                                             ' convert from the text to numerical value and
                                                             ' substitute for the dVoltMeasure variable
    io.WriteString ":MEAS:CURR:DC?"                          ' Send the query command for output current
    dCurrMeasure = Val(io.ReadString(256))                   ' Read 256 bite from the Receiving buffer,
                                                             ' convert from the text to numerical value and
                                                             ' substitute for the dCurrMeasure variable

    ' Initiate the trigger subsystem and send the trigger
    io.WriteString ":INIT:SEQ1"                              ' Send the Initiate Sequence 1
    io.WriteString "*TRG"                                    ' Send the Trigger command

    ' Measure the output voltage and current,
    ' after the triggered change
    io.WriteString ":MEAS:VOLT:DC?"                          ' Send the query command for output voltage
    dVoltMeasure = Val(io.ReadString(256))                   ' Read 256 bite from the Receiving buffer,
                                                             ' convert from the text to numerical value and
                                                             ' substitute for the dVoltMeasure variable
    io.WriteString ":MEAS:CURR:DC?"                          ' Send the query command for output current
    dCurrMeasure = Val(io.ReadString(256))                   ' Read 256 bite from the Receiving buffer,
                                                             ' convert from the text to numerical value and
                                                             ' substitute for the dCurrMeasure variable

    ' Check if there is an instrument error
    Dim strErr As String
    io.WriteString ":SYST:ERR?"                              ' Send the query command for system error
    strErr = io.ReadString(256)                              ' Read 256 bite from the Receiving buffer,
                                                             ' substitute for the strErr variable

    ' Close the VISA session
    io.Close                                                 ' Issue the Close command

End Sub
```

A.8 Troubleshooting

This section introduces troubleshooting measures. Typical symptoms are listed. Check whether any of the items below apply to your case. In some cases, the problem can be solved quite easily.

See p. 4-28

If none of the items apply to your case, we recommend that you initialize the PAT to factory default settings. If the remedy does not correct the problem, contact your Kikusui agent or distributor.

The power does not turn on.

Symptom	Check Items	Remedy	See
The PAT does not operate when the POWER switch is turned on.	Is the power cable is broken?	Replace the power cable with a new one.	1-5
	Is the wiring to the U, V, W, and GND of the AC INPUT terminal correct?	Connect the cable correctly.	2-6

No output is delivered.

Symptom	Check Items		Remedy	See
No output is confirmed even when the OUTPUT switch is turned on.	Is the output voltage set to 0 V, and the output current set to 0 A?		Turn the knobs to set the output voltage and output current to the required values.	4-7
	Are you performing output on/off control using an external contact?	Yes	Turn the output on using the external contact.	5-17
		No	Set the external control logic setting of the output on/off to “turn the output on with a high signal” (CF22: H).	4-18

Unable to set the output voltage or output current.

Symptom	Check Items	Remedy	See
Unable to set the output voltage.	Are you trying to set a voltage higher than the OVP trip point?	Change the OVP trip point or disable the voltage limit setting (CF29: OFF).	4-19
Unable to set the output current.	Are you trying to set a current higher than the OCP trip point?	Change the OCP trip point or disable the current setting limit (CF30: OFF)	4-19

The ALARM indicator illuminates when the OUTPUT switch is turned on.

Symptom	Check Items	Remedy	See
The ALARM LED illuminates when the OUTPUT switch is turned on.	Is the OVP trip point set less than or equal to the output voltage?	Set the OVP trip point to a voltage greater than or equal to the output voltage.	4-10
	Is the OCP trip point set less than or equal to the output current?	Set the OCP trip point to a current greater than or equal to the output current.	4-10
	Is the remote sensing function turned on?	If you are not using the remote sensing function, turn off the sensing switch.	4-25
	Is the polarity of remote sensing cable connection reversed?	The polarity of the remote sensing cable may be reversed, or the ends may be shorted. Check the load cable.	4-25
	Are you using remote sensing with a long load cable?	Set up the environment so that the voltage drop in the load cable is within the compensation voltage range (0.6 V for a single line).	4-25
	Is the control cable loose in the external control?	Connect it correctly.	Chap 5
	Is the external voltage excessive in the external control?	Apply the correct voltage.	5-9 5-13
	Is one of the phases of the three-phase input open?	The distribution system is abnormal or one of the phases of the three-phase input is open. Check the distribution system and the three-phase input cable, and connect the PAT to an AC power supply that matches with the specifications of the PAT.	2-6
	Is the internal temperature is abnormally high?	• The overheat protection function is activated. Check the operating environment. • The dust filter may be clogged, or the fan may be broken. Check them.	2-3 4-12 8-2
The ALARM LED illuminates when the load is changed.	Is a large external voltage applied such as with a battery load?	• The overvoltage protection function or the overcurrent protection function may be activated. Check them. • The PAT may be overloaded. Check the load.	4-5
	Is the actual output voltage is higher than the preset voltage shown on the panel?		
	Is a special load is connected?		

Unable to operate the panel switch.

Symptom	Check Items	Remedy	See
Unable to operate the panel switch.	Is the LOCK LED illuminated?	Release the panel operation lock.	4-24
	Is the REMOTE LED illuminated?	To control the PAT from the panel, press the LOCAL switch to enable local mode	4-24
	Is the PAT being controlled via the RS232C, GPIB, USB or LAN interface?		
The PAT does not switch to local mode even when I press the LOCAL switch.	Was a local lockout (LLO) command sent via the communication interface?	Use a communication command to clear the local lockout (LLO) command.	7-42

The output ripple is large.

Symptom	Check Items	Remedy	See
The ripple sometimes becomes large.	Is the input voltage outside the range?	Supply a voltage that is within the input voltage range.	9-2
The ripple increased when the installation location was changed.	Is there a source of strong magnetic or electrical field nearby?	Take measures such as moving the PAT away from generating sources and twisting cables.	–
The output ripple is large when using external control.	Is the noise on the external voltage large?	Take measures against noise.	–
The ripple increased when the load cable was changed.	Is the remote sensing function turned on?	If you are not using the remote sensing function, turn off the sensing switch on the rear panel.	4-25

The output is unstable.

Symptom	Check Items	Remedy	See
Some output levels are unstable when I turn the VOLTAGE or CURRENT knob while the output is on.	Is the operation mode switching from CV to CC or CC to CV?	Change the setting (output voltage or output current) that is limiting the output to a value greater than the present setting. If the preset value is at maximum, you must use a power supply with a larger output voltage or current.	4-5 4-7
The output voltage or output current fluctuates.	Are you using master-slave parallel operation?	The performance degrades slightly during master-slave parallel operation.	–
	Is the remote sensing function turned on?	If you are not using the remote sensing function, turn off the sensing switch on the rear panel.	4-25
	Are both the CV LED and the CC LED turned on?	• If the output is oscillating when using remote sensing, insert a capacitor across the load. • The circuitry may have malfunctioned. Immediately stop the use of the PAT and request repairs.	4-25
	Does the sensing cable or load cable have poor contact or is the cable broken?	Turn off the POWER switch and check the wiring.	2-6
	Does the load current have peaks or is it pulse-shaped?	The peak value may be exceeding the preset current. Increase the preset current or increase the current capacity.	4-7
The output voltage is offset from the value at power-on.	Did 30 minutes pass since the power was turned on?	Warm up the PAT with the power turned on for at least 30 minutes.	–

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