

# User's Manual

Regulated DC Power Supply

## PAT-T Series

4 kW type

**PAT20-200T**

**PAT40-100T**

**PAT60-67T**

**PAT160-25T**

8 kW type

**PAT20-400T**

**PAT250-32T**

**PAT30-266T**

**PAT350-22.8T**

**PAT40-200T**

**PAT500-16T**

**PAT60-133T**

**PAT650-12.3T**

**PAT80-100T**

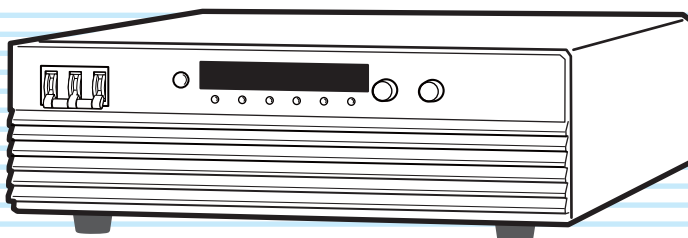
**PAT850-9.4T**

**PAT160-50T**

8 kW type (Custom model)

**PAT1000-8T** (SPEC21163)

**PAT1500-5.3T** (SPEC21164)



Load and cable

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Appx

Thank you for purchasing the PAT-T Series Regulated DC Power Supply.

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

## Notations Used in This Manual

- In this manual, the PAT-T Series regulated DC power supply is often simply referred to as "the PAT."
- The word "PC" used 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, could result in death or serious injury. 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.

 **See** Indicates reference to detailed information.

 **MANUAL** Indicates reference to detailed information product manual (CD-ROM).


 **Open** Indicates reference to detailed information product manual.


## SHIFT+key name (marked in blue)

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

## 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.

 **4kW** Indicates a feature or specification that is only available on the 4 kW type.

 **8kW** Indicates a feature or specification that is only available on the 8 kW type.

 **Memo** Indicates useful information.

## Applicable firmware version of the PAT-T Series

This manual applies to 8 kW type products with firmware version 5.xx and 4 kW type products with firmware version 4.xx.

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)

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

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Both unit specifications and manual contents are subject to change without notice.

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## Checking the Package Contents

When you receive the product, check that all accessories are included and that the unit and 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.

## Accessories

OUTPUT terminal cover set (Output protection covers, Screws)	Model of rated output 20 V to 850 V	2 sets
	Model of rated output 1000 V and 1500 V	—
Output terminal bolt (Bolts, Nuts, Spring washers)	PAT20-400T/ PAT30-266T	M12 (2 sets)
	PAT20-200T/ PAT40-100T/ PAT60-67T/ PAT160-25T/ PAT40-200T/ PAT60-133T/ PAT80-100T/ PAT160-50T	M10 (2 sets)
	PAT250-32T/ PAT350-22.8T/ PAT500-16T/ PAT650-12.3T/ PAT850-9.4T	M8 (2 sets)
J1/ J2 connector kit (Protection covers, sockets, pins)		1 set
Chassis connection wire set (Chassis connection wire, screw)*1		1 set
Heavy object warning label		1 pc.
Setup guide		1 pc.
Quick reference		1 pc. (English)
		1 pc. (Japanese)
Safety information		1 pc.
CD-ROM		1 pc.

\*1. Chassis connection wire only for the PAT1000-8T and PAT1500-5.3T.

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## Contents by Function

### Preparation



• I want to check the accessories.	→1.1, "Checking the Package Contents"	p. 2
• The installation space is limited. How much space is needed around the air inlet and outlet?	→For information about precautions concerning installation, see the accompanying setup guide or safety information.	---
• How do I connect the AC power supply?	→For information about connecting the power cable, see the accompanying setup guide.	---
• What kind of wires should be used to connect to the AC power supply?	→	---
• What kind of wires should be used to connect the load?	→1.2, "Load Cable"	p. 16
• The wire connecting the load is long (distance to the load is long), but stable voltage is required.	→2.11, "Remote Sensing Function"	p. 45
• How do I rack mount the PAT? What kind of parts is needed?	→" Options"	p. 120

### Setting



• How do I set the communication conditions for remote control?	→See the Communication Interface Manual on the CD-ROM.	---
• How do I control the output voltage using an external DC voltage?	→3.4.1, "External Voltage (Vext) Control"	p. 59
• How do I increase the current capacity in parallel operation?	→4.1, "Master-Slave Parallel Operation"	p. 74
• <b>4kW</b> When using the PAT in the single-phase input mode, is there any difference in the setting range compared to the three-phase input power?	→2.1, "Phase input mode" 2.5, "Using the PAT as a CV or CC Power Supply" 2.6.1, "Overvoltage protection (OVP) and overcurrent protection (OCP)"	p. 20 p. 26 p. 28
• How do I reset the PAT to factory default settings?	→2.12, "Factory Default Settings"	p. 49

## Operation



- How can I use the PAT as a constant voltage power supply (CV)? → 2.5, "Using the PAT as a CV or CC Power Supply" p. 26

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- How can I use the PAT as a constant voltage current supply (CC)?

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- I would like to operate the PAT at a given voltage. How do I register the voltage in the preset memory? → 2.8, "Preset Memory Function" p. 43

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- How do I set the upper limit to prevent the voltage from being increased too much? → "Setting limit function" p. 29

---

- How do I set the voltage in fine resolution? → "Fine adjustment function" p. 26

---

- How do I set the protection function to prevent damage to the load? → 2.6, "Protection Functions and Alarms" p. 27  
→ 2.6.1, "Overvoltage protection (OVP) and overcurrent protection (OCP)" p. 28

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- How do I cut off the output at a different time from other power supplies? → "Output on/off delay functions" p. 23

---

- How can I monitor the output voltage and output current? → 3.8, "External Monitoring" p. 71

---

- How do I temporarily lock the keys? → 2.9, "Lock Function" p. 44

---

- How do I use the sample program for remote control? → See the Communication Interface Manual on the CD-ROM. ---

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- How do I display a slave unit's current during parallel operation? → 4.1.1, "Functions during Master-Slave Parallel Operation" p. 74

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- **4kW** How can I use the PAT in the single-phase input? → POWER switch 2.7, "CONFIG Settings"

---

- **4kW** How do I change the phase input mode? (from the single-phase input to the three-phase input) → p. 9

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- **4kW** How do I change the phase input mode? (from the three-phase input to the single-phase input) → p. 33

## Maintenance



- How do I clean the dust filter? → "Cleaning the Dust Filter" p. 88

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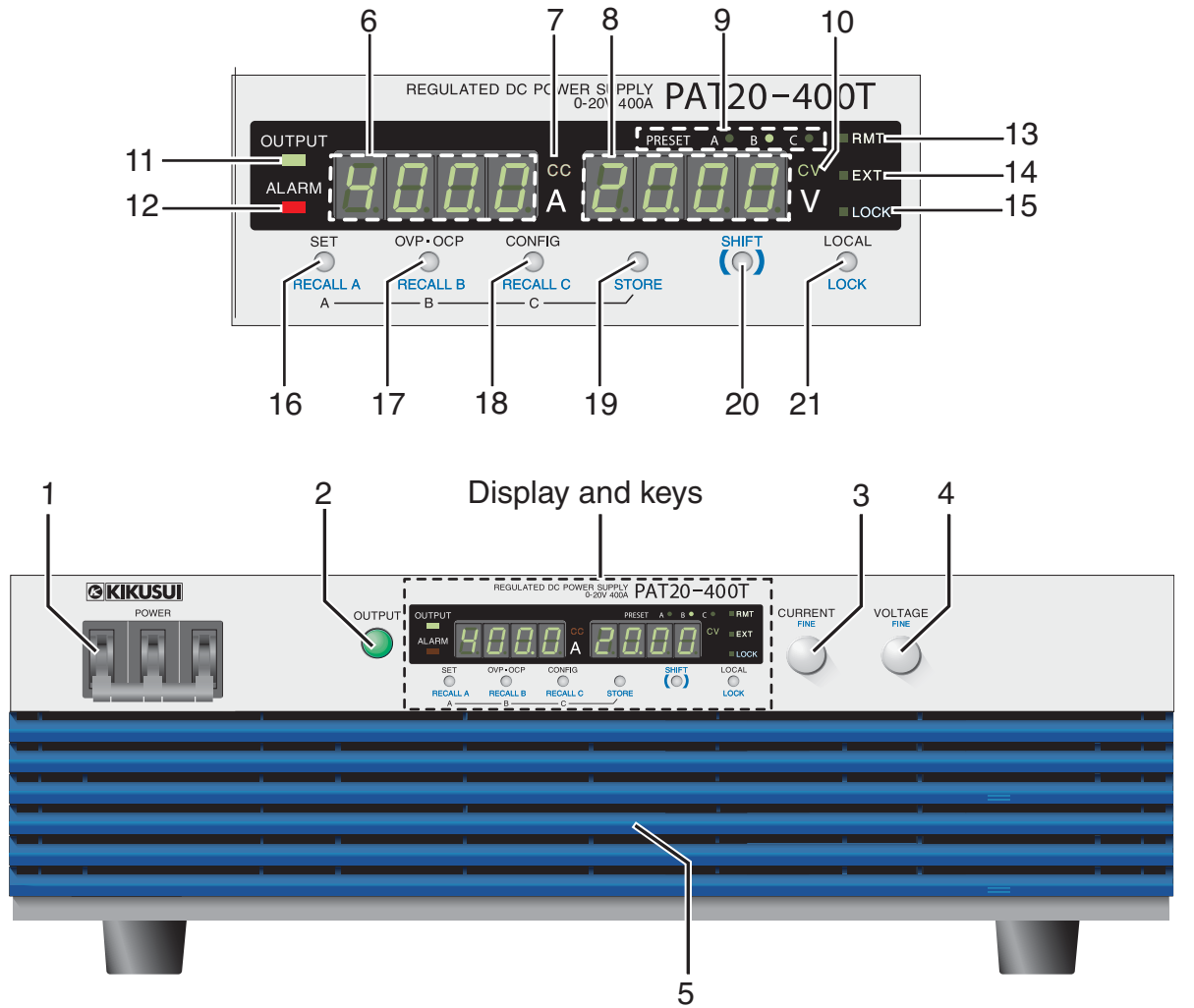
- How do I check for breaks and tears in the insulation? → 5.1, "Inspection" p. 88

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- How do I calibrate the PAT-T series? → 5.2, "Calibration" p. 91

**Troubleshooting...** See "A.2 Troubleshooting" on page 123.

## Front panel



Examples of PAT20-400T

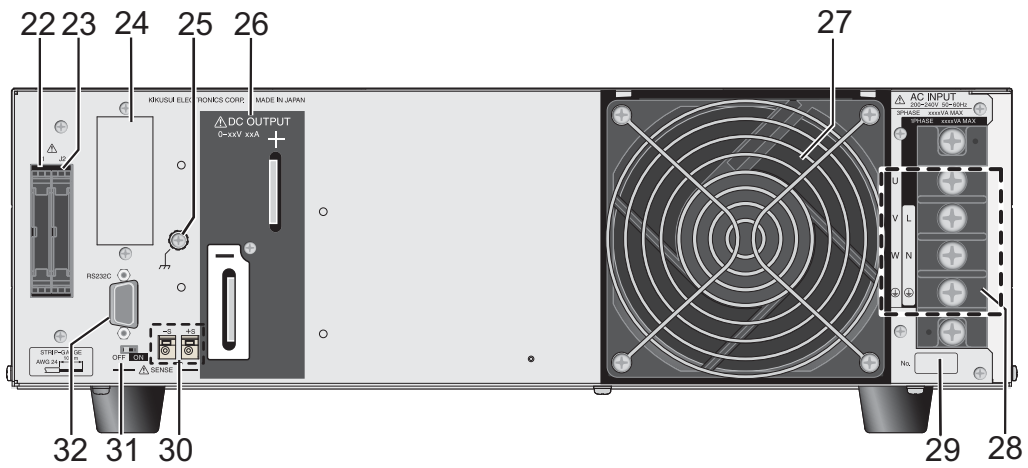




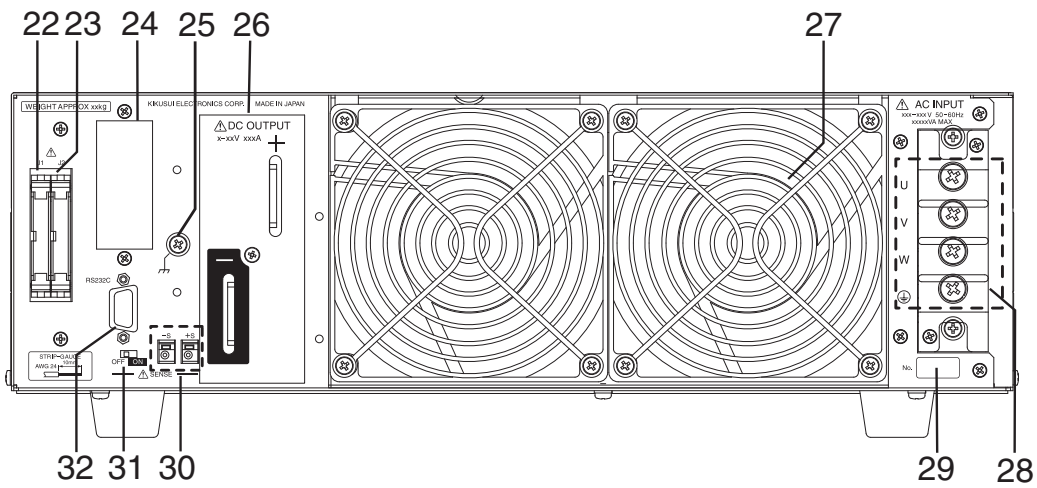
No.	Name		Function	See
		+SHIFT		
1	POWER switch		Power on/off lever Raise the lever to turn the power on ( I ). Lower to turn the power off ( O ).	–
	POWER switch	+STORE	<b>4kW</b> To change the phase input mode to the single-phase input, press the POWER switch with pressing the STORE key.* <sup>1</sup>	–
2	OUTPUT switch		Output on/off switch.	p. 22
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.	p. 26
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.	p. 26
5	Air inlet (louver)		Inlet for taking in air from the outside. A dust filter is built in.	p. 88
6	Ammeter		Displays the current value or the CONFIG parameter number.	–
7	CC		Illuminates in constant current mode.	p. 26
8	Voltmeter		Displays the voltage value or the CONFIG parameter setting.	–
9	PRESET		The LED of the preset memory in use illuminates.	p. 43
10	CV		Illuminates during constant voltage mode.	p. 26
11	OUTPUT LED		Illuminates when output is on and turns off when output is off.	p. 21
12	ALARM LED		Illuminates when a protection circuit is activated.	p. 27
13	RMT LED		Illuminates when operating in remote control.	p. 45
14	EXT LED		Illuminates when operating in external control, or when used as a slave unit in master-slave parallel operation.	p. 52 p. 75
	LOCK LED		Illuminates when panel operations except turning the output on/off and viewing settings.	p. 44
	SET key		Key for setting and checking the output voltage or output current (the key has an LED).	p. 26
15		RECALL A	Key for recalling the value of preset memory A.	p. 43
	A key	+STORE	Key for saving the value to preset memory A. Press STORE and then A.	p. 43
	OVP•OCP key		Key for setting and checking the trip points of the overvoltage protection (OVP) and overcurrent protection (OCP) (the key has an LED).	p. 28
16		RECALL B	Key for recalling the value of preset memory B.	p. 43
	B key	+STORE	Key for saving the value to preset memory B. Press STORE and then B.	p. 43
	CONFIG		Key for setting various conditions concerning the operation (the key has an LED).	p. 33
17		RECALL C	Key for recalling the value of preset memory C.	p. 43
	C key	+STORE	Key for saving the value to preset memory C. Press STORE and then C.	p. 43
	–	STORE	Key for storing the preset memory.	p. 43
18	–	SHIFT	Key for calling up the functions marked in blue characters.	–
19	LOCAL key		Key for changing between remote and local modes.	p. 45
		LOCK	Key for disabling only the operations that change the settings (keeping the display and recall operations enabled).	p. 44

\*1. Once the single-phase input mode is set to turn on the power, the PAT will be turned on in the single-phase input mode for next time.

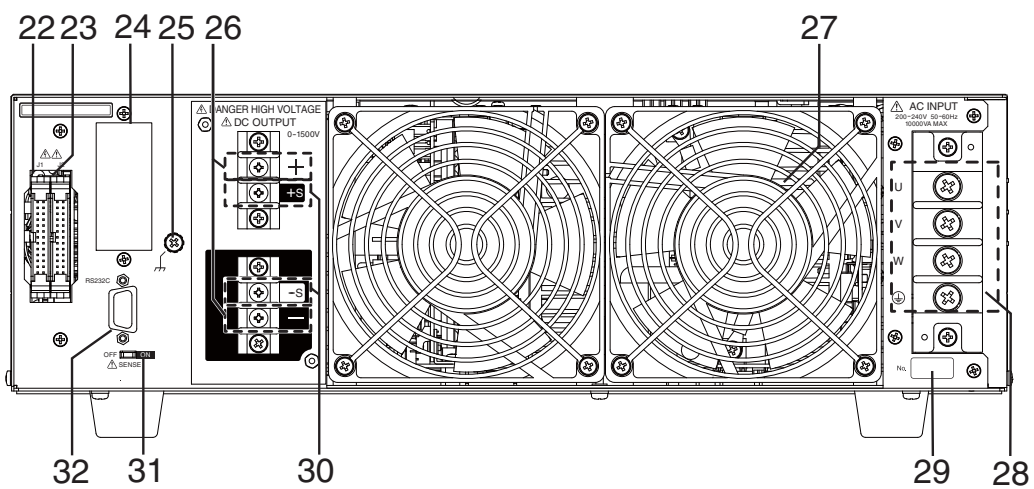
## Rear panel












Examples of 4 kW type



Examples of 8 kW type (Rated output 20 V to 850 V)



Examples of 8 kW type: Custom model (Rated output 1000 V, 1500 V)

No.	Name	Function	 See
22	J1	Connector for external analog control.	p. 52
23	J2	Connector for parallel operation.	p. 76
24	Option slot	Slot for installing the optional interface board (GPIB, USB or LAN). A factory option.	
25	Chassis terminal	Terminal used to ground the output.	
26	DC OUTPUT	  Model of rated output 20 V to 850 V: Output terminal.  Model of rated output 1 000 V, 1 500 V: Output terminal.	p. 16
27	Air outlet	Exhaust port for cooling.	 Setup guide
28	AC INPUT	 Input terminal (Three-phase input/ single-Phase input, Including the GND terminal).  Input terminal (Including the GND terminal).	
29	Serial number	The serial number of the PAT.	—
30	Sensing terminal	A terminal used to connect the sensing wires.	p. 45
31	Sensing switch	Switch for enabling/disabling remote sensing.	
32	RS232C	Connector for the RS-232C cable.	





# 1

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## Load and cable

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

# 1.1 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.

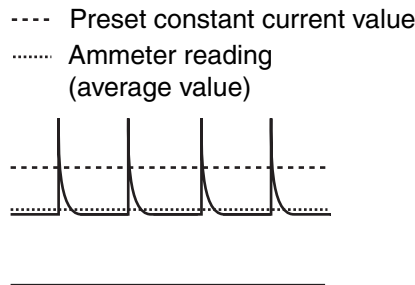


Fig.1-1 Load current with peaks

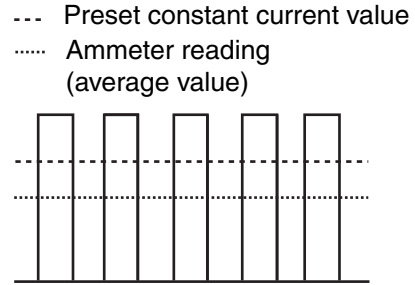


Fig.1-2 Pulse-shaped load current

## 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.1-3 to bypass the reverse current. However, the amount of current to the load decreases by max. reverse current  $I_{rp}$ .

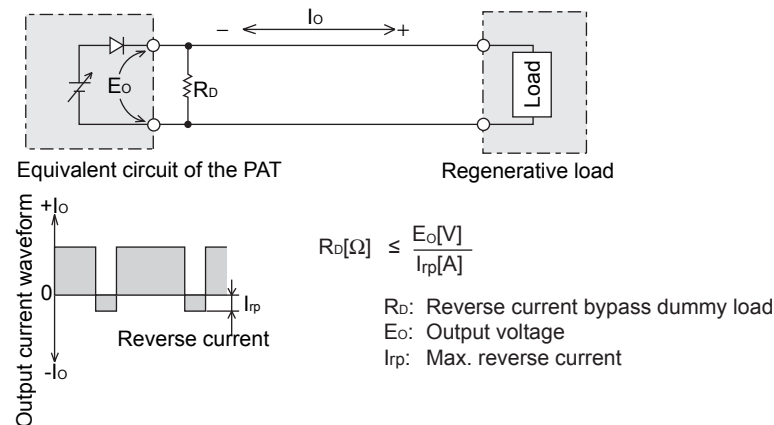


Fig.1-3 Remedy for regenerative load

**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.1-4.

This cannot be used in conjunction with remote sensing.

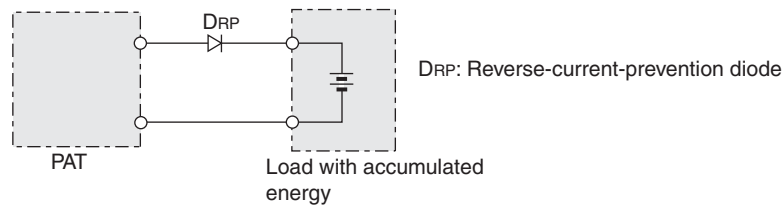


Fig.1-4 Remedy against load with accumulated energy

**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.

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## 1.2 Load Cable

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### 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 an allowable temperature 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



"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 1-1 shows the allowable capacity of current that can flow through a heat-resistant PVC wire (single wire) having an 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 1-1 Nominal cross-sectional area of cables and allowable currents

Nominal cross-sectional area [mm <sup>2</sup> ]	AWG	(Reference cross-sectional area) [mm <sup>2</sup> ]	Allowable current* <sup>1</sup> [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	6	(13.3)	88	50
22	4	(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

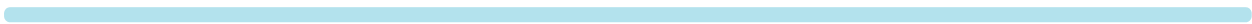
\*1. Excerpts from Japanese laws related to electrical equipment.

### ■ 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 1-1 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 remote 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.



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# 2

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## 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.

## 2.1 Phase input mode 4kW

The input power mode of the PAT (4kW type) can be switched to either three-phase input or the single-phase input.

See p. 33

MANUAL "Specification"

Before starting the operation, confirm the status of phase input mode. To verify the status and setting of the phase input mode, refer to the "2.7 CONFIG Settings".

The principal of difference in specifications for the phase input mode are described as follows.

Descriptions	Three-phase input mode	Single-phase input mode
Output power	4 kW	3 kW
Output current setting range	0 % to 105 % of $rtg^{*1}$	0 % to 105 % of $rtg \times 75\%^{*1}$
Overcurrent protection (OCP) setting range	10 % to 111.5 % of the rated output current	(10 % to 111.5 % $\times$ 75 %) of the rated output current
Input open-phase protection (PHASE)	Turns the output off. ALARM LED illuminates.	Cancels the Input open-phase protection feature.

### ● Monitor signal output

(IMON) (Current) at rated current output	10.00 V $\pm$ 0.25 V	7.50 V $\pm$ 0.25 V The upper limit is set at 75 % of the rating of the three-phase input mode
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### ● External control

EXT-V CC CONT (CC external voltage control)	0 % to 100 % of the rated output current in the range of 0 V to 10 V	0 % to 75% of the rated output current (of the three-phase input mode) in the range of 0 V to 7.5 V.
EXT-R CC CONT (CC external resistance control normal)	0 % to 100 % of the rated output current in the range of 0 k $\Omega$ to 10 k $\Omega$ .	0 % to 75 % of the rated output current (of the three-phase input mode) in the range of 0 k $\Omega$ to 7.5 k $\Omega$
EXT-R CC CONT (CC external resistance control fail safe)	100 % to 0 % of the rated output current in the range of 0 k $\Omega$ to 10 k $\Omega$	75 % to 0 % of the rated output current (of the three-phase input mode) in the range of 0 k $\Omega$ to 7.5 k $\Omega$

\*1.  $rtg$  : Indicates the rated output

#### NOTE

If the input power connected to the single-phase input wiring while the PAT is set to the three-phase input mode, the function of "Input open-phase protection (PHASE)" will be activated and the ALARM LED lights on. On the other hand, If the input power connected to the three-phase input wiring while the PAT is set to the single-phase input mode, the output current will be limited to 75 % of the rating of three-phase input mode. Confirm the status of phase input mode and the input wirings properly.

## 2.2 Measured Value Display and Setting Display

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 keys.

### ■ 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 keys are all off.

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

See p. 26



Fig.2-1 Measured value display example

### ■ Setting display

The following three states are available.

- Setting display of the output voltage and output current

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



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

See p. 43

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 key. The key LED illuminates. The present overvoltage and overcurrent settings are displayed.



Fig.2-3 Setting display example of the overvoltage and overcurrent protection

- Setting display of the system configuration

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

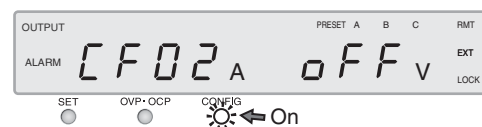


Fig.2-4 Setting display example of the system configuration

## 2.3 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.

### NOTE

**4kW** When the phase input mode is changed to the single-phase input mode from the three-phase input mode for 4kW type, the setting value of the output current and the overcurrent protection (OCP) is limited to 75 % of the three-phase input mode.

See p. 67

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



Fig.2-5 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 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. 49, p. 67

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 key 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.

See p. 35

## Output on/off delay functions

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 key while the OUTPUT LED is blinking to cancel the output on/off delay and forcibly switch the output.

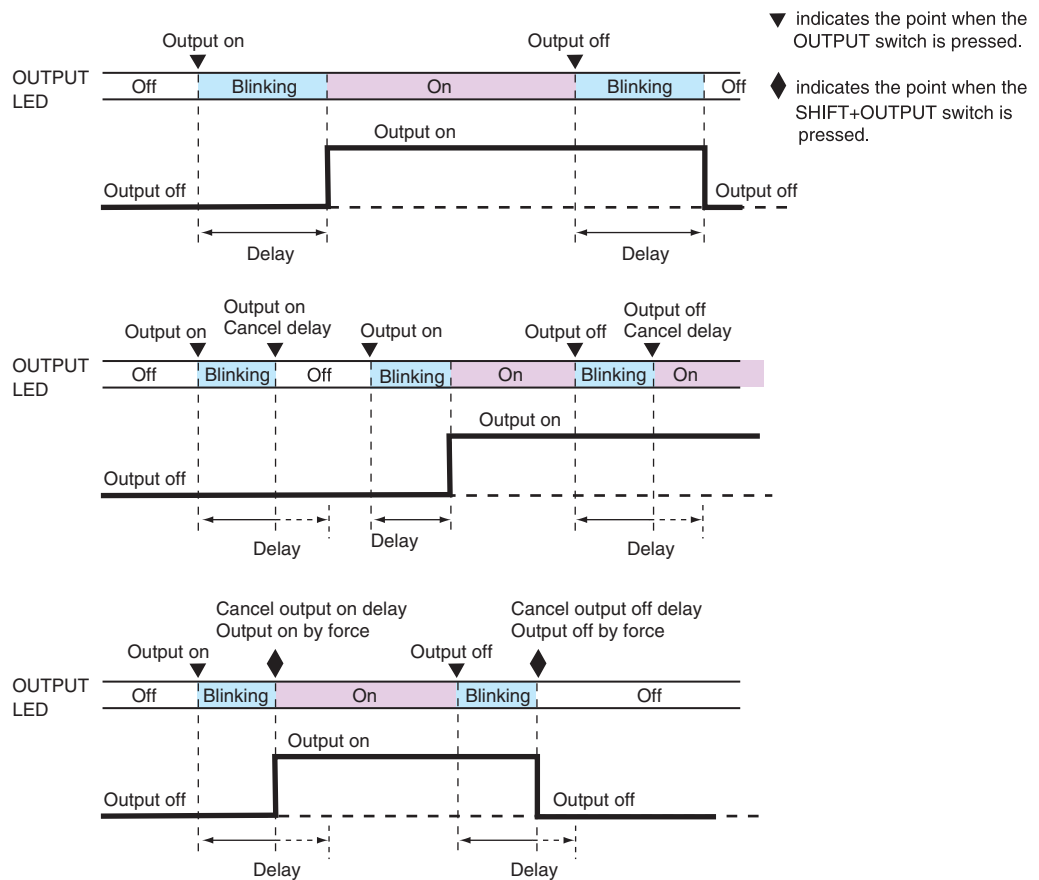


Fig.2-6 Output on/off delay action

## Setting the output-on startup state 8kW

See p. 39

When the output state at power-on is set to on, you can choose to make the PAT start as a constant voltage (CV) power supply or as a constant current (CC) power supply.

To use this function, set the output-on startup state (CF32: CV/CC) in the CONFIG settings. To start the PAT as a constant voltage (CV) power supply, select CV prioritization (CF32: CV). To start the PAT as a constant current (CC) power supply, select CC prioritization (CF32: CC).

## 2.4 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 ( $V_s$ )
- Preset output current ( $I_s$ )
- Load resistance ( $R_L$ )

The operation modes are described below.

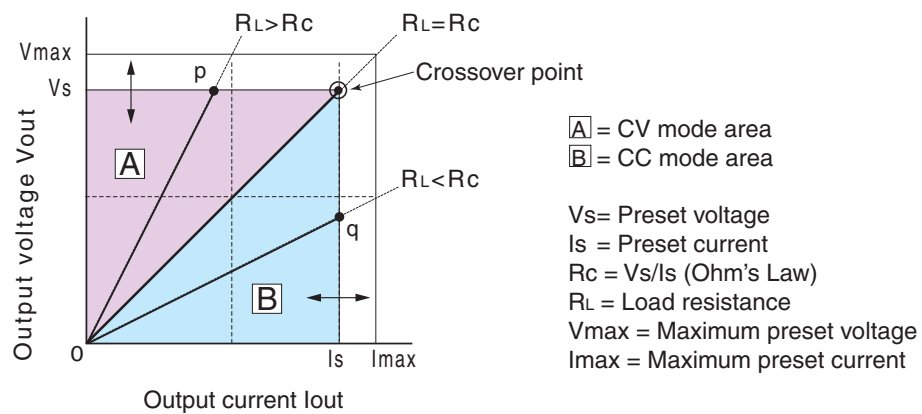


Fig.2-7 Constant voltage operation and constant current operation

Fig.2-7 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  $R_c$  ( $R_c = V_s/I_s$ ). The power supply is designed so that it operates in CV mode in area  $\boxed{A}$  and CC mode in area  $\boxed{B}$ . The boundary is the line defined by  $R_L = R_c$ . 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  $R_c$ , the operating point is in area  $\boxed{A}$ , and the PAT operates in CV mode (point p). In this case, preset current  $I_s$  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  $I = V_s/R_L$ . It is a current less than current limit  $I_s$ . 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  $I_s$  must be set so that the peak value does not reach the current limit.

Conversely, if load resistance  $R_L$  is less than resistance  $R_c$ , the operating point is in area  $\boxed{B}$ , and the PAT operates in CC mode (point q). In this case, preset voltage  $V_s$  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  $V = I_s \times R_L$ . It is a voltage less than voltage limit  $V_s$ . 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  $V_s$  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 ( $R_L$ ) of  $8 \Omega$  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,  $R_c = 30 \text{ V} / 5 \text{ A} = 6 \Omega$ . Since,  $8 \Omega$  is greater than  $6 \Omega$  ( $R_L > R_c$ ), 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:  $V_s = I_s \times R_L$ . Substituting the values, we obtain  $V_s = 5 \text{ A} \times 8 \Omega = 40 \text{ V}$ . 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 ( $R_L$ ) of  $5 \Omega$  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,  $R_c = 30 \text{ V} / 5 \text{ A} = 6 \Omega$ . Since,  $5 \Omega$  is less than  $6 \Omega$  ( $R_L < R_c$ ), 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:  $I_s = V_s / R_L$ . Substituting the values, we obtain  $I_s = 30 \text{ V} / 5 \Omega = 6 \text{ A}$ . 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.

## 2.5 Using the PAT as a CV or CC Power Supply

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.

### NOTE

**4kW** When the phase input mode is changed to the single-phase input mode from the three-phase input mode for 4kW type, the setting value of the output current and the overcurrent protection (OCP) is limited to 75 % of the three-phase input mode.

**1** Check that the POWER switch is turned 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 key is illuminated.

If it is not, press the SET key 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.

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**8kW** You can only use the CONFIG settings to set the output-on startup state (CF32: prioritize CV or CC) for 8kW type.

### 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.

## 2.6 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.

See p. 38

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

See p. 29 to p. 32

- 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 ( **4kW** : for about 4 to 5 seconds, **8kW** : for about 10 to 15 seconds).

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

The ALARM signal is delivered even if the breaker is tripped ( **4kW** : for about 4 to 5 seconds, **8kW** : for about 10 to 15 seconds).

- If the overheat protection (OHP) activates, the breaker trips ( **8kW** only on 400 V input models). The ALARM LED illuminates, and the PAT shows the OHP power-off display for 10 to 15 seconds.

#### ■ 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. 35

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

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## 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.

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

## 2.6.1 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 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 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

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

 See p. 38

## OVP and OCP trip point settings

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### NOTE

**4kW** When the phase input mode is changed to the single-phase input mode from the three-phase input mode for 4kW type, the setting value of the output current and the overcurrent protection (OCP) is limited to 75 % of the three-phase input mode.

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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 key.

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

### 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: CF28).

When the POWER switch is turned off, the ALARM LED illuminates even the power turns off, and the overvoltage protection (OVP) power-off display will be displayed for about a few seconds (4 kW type:4 to 5 seconds, 8 kW type: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.2-8 Overvoltage protection (OVP) alarm display



Fig.2-9 Overvoltage protection (OVP) power-off display

- 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: CF28).

When the POWER switch is turned off, the ALARM LED illuminates even the power turns off, and the overcurrent protection (OCP) power-off display will be displayed for about a few seconds (4kW type:4 to 5 seconds, 8kW type: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.2-10 Overcurrent protection (OCP) alarm display



Fig.2-11 Overcurrent protection (OCP) power-off display

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

## 2.6.2 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 ( **8kW** the breaker trips for 400 V input models when overheat protection (OHP) activates).

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.

**8kW** After the OHP activates on a 400 V input model, it takes between 30 minutes and 1 hour for the internal temperature to decrease. Allow sufficient time for the PAT to cool down before turning the POWER switch on.



Fig.2-12 Overheat protection (OHP) alarm display



Fig.2-13 Overheat protection (OHP) power-off display

( **8kW** only on 400 V input model)



Fig.2-14 Overheat protection alarm display for 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.2-15 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.2-16 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.

### NOTE

**4kW** When the PAT operates in the single-phase input mode for 4kW type, this function (Input open-phase protection (PHASE)), becomes invalid.



Fig.2-17 Alarm display of input open-phase protection (PHASE)

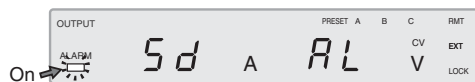
## Shutdown (SD)

See p. 69

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. 38

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



Not set to trip the breaker (OFF)

Fig.2-18 Alarm display of the shutdown (SD)



Set to trip the breaker (ON)

Fig.2-19 Shutdown power-off display (SD)



## 2.7 CONFIG Settings

CONFIG settings are used to set the system configuration of the PAT. You can set or display the parameters in Table 2-1 in the CONFIG settings. On the top panel of the PAT is a label that indicates a list of CONFIG parameters and settings.

Table 2-1 CONFIG parameters

	Parameter number	Indication on the top panel label	Description of the setting or display
SYSTEM	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 <sup>*1</sup>
	CF20	CV CONTROL	CV control source setting <sup>*2</sup>
	CF21	CC CONTROL	CC control source setting <sup>*2</sup>
	CF22	EXT OUT CTRL	External control logic setting of the output on/off <sup>*2</sup>
	CF23	PWR ON/OFF STATUS	Status signal setting of the power on/off <sup>*1</sup>
	CF24	PARALLEL	Setting the number of units in Master-Slave Parallel Operation <sup>*2</sup>
	CF25	POWER ON OUTPUT	Output status setting at power-on
	CF26	MASTER/SLAVE	Master-slave parallel operation setting <sup>*1, *2</sup>
	CF27	BREAKER TRIP (SD)	Breaker trip setting when the shutdown signal is applied <sup>*1</sup>
	CF28	BREAKER TRIP	Breaker trip setting when the OVP or OCP is activated <sup>*1</sup>
	CF29	V SETTING LIMIT	Voltage limit setting <sup>*2</sup>
	CF30	I SETTING LIMIT	Current limit setting <sup>*2</sup>
CF31 <sup>*3</sup>	PHASE SELECT	Phase input mode setting (three-phase input mode or single-phase input mode)	
CF32 <sup>*4</sup>	START UP	Output-on startup state setting <sup>*2</sup>	
RS232C	CF40	BAUDRATE	RS232C data rate setting <sup>*1</sup>
	CF41	DATABITS	RS232C data length setting <sup>*1</sup>
	CF42	STOPBITS	RS232C stop bit setting <sup>*1</sup>
	CF43	FLOW	RS232C flow control setting <sup>*1</sup>
INTERFACE	CF50	VERSION	Interface version display
GPIB	CF51	GPIB ADDRESS	GPIB address setting <sup>*1</sup>
	CF52	VENDOR ID	Vendor ID display
	CF53	PRODUCT ID	Product ID display
INTERFACE	CF54	ADDON I/F	Remote interface setting <sup>*1</sup>
LAN	CF55	DHCP CLIENT	DHCP setting
	CF56	AUTO IP ADDRESS	AUTO IP address setting
	CF57	IP ADDRESS (1)	IP address display (1)
	CF58	IP ADDRESS (2)	IP address display (2)
	CF59	IP ADDRESS (3)	IP address display (3)
	CF60	IP ADDRESS (4)	IP address display (4)
	CF61	LAN STATUS	LAN status display

- \*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 specify this parameter when the product is used as a 4 kW type.
- \*4. Only specify this parameter when the product is used as a 8 kW type.

## 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.

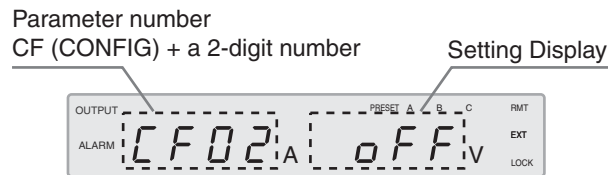


Fig.2-20 CONFIG parameter display example

- 1** Press the CONFIG key.  
The key 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 key. 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 key from SET, OVP•OCP, CONFIG or OUTPUT switch.  
If it is set to the slave unit, press CONFIG key.  
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

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

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

See p. 45

### CF10 Output on delay setting

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

See p. 23

### CF11 Output off delay setting

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

See p. 23

See p. 44

## CF12 Preset recall setting while locked

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

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.

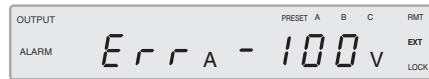


Fig.2-21 Error display example (Err-100 example)

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

## CF20 CV control source setting

See p. 59, p. 61

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 EXT-V
2	External resistance control EXT-R 10 k $\Omega$ $\rightarrow$ MAX OUT
3	External resistance control EXT-R 10 k $\Omega$ $\rightarrow$ 0 OUT (FAIL SAFE)
4	External voltage control EXT-V (FAST) <b>8kW</b>

## CF21 CC control source setting

See p. 63, p. 65

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 EXT-V
2	External resistance control EXT-R 10 k $\Omega$ $\rightarrow$ MAX OUT
3	External resistance control EXT-R 10 k $\Omega$ $\rightarrow$ 0 OUT (FAIL SAFE)
4	External voltage control EXT-V (FAST) <b>8kW</b>

### CF22 External control logic setting of the output on/off

See p. 67

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. 72

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 <b>4kW</b> : for about 4 to 5 seconds, <b>8kW</b> : for about 10 to 15 seconds

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

See p. 74

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.

On the Model of rated output 20 V to 650 V

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

On the Model of rated output 850 V, 1 000 V and 1 500 V

Settings	Description
1	1 unit (factory default)
2	2 units

### CF25 Output status setting at power-on

See p. 22

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. 79

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. 32

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. 28

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. 29

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. 29

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

### CF31 Phase input mode setting (three-phase input mode or single-phase input mode)

Sets the phase input mode. This setting is possible even when the product is used as a slave unit in Master-Slave parallel operation.



Fig.2-22 Three-phase input mode



Fig.2-23 Single-phase input mode

Settings	Description
3PHA	Three-phase input mode (factory default)
1PHA	Single-phase input mode

### CF32 Output-on startup state setting 8kW

You can set the state that the PAT starts up in when the output state at power-on is set to on. This cannot be set when the output is on.

When you select to prioritize CC, set CV to 10 % or more of the rated value. A current that is greater than the CC setting may flow through the load when the output is turned on. Depending on the state of the connected load, the PAT may not start with the settings that you have selected.

Settings	Description
CV	CV (constant voltage) is prioritized (factory default)
CC	CC (constant current) is prioritized

### CF40 RS232C data rate setting

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

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

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

### CF42 RS232C stop bit setting

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

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

### CF43 RS232C flow control setting

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

Sets the GPIB address. The settings are displayed only when the factory option GPIB interface is installed. The setting is possible even when the product is used as a slave unit.

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)

### CF55 DHCP setting

Select whether or not to obtain an IP address from a DHCP server. Displayed only when the factory option LAN interface is installed.

When the fixed IP address is used, set to turning off.

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

## 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.

When the fixed IP address is used, set to turning off.

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

## CF57 to CF60 IP address display

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

The IP address is just displayed-it cannot be set from the panel. To set a fixed IP address, access the PAT through a Web browser.

When you access the PAT through a Web browser, do so under conditions in which a DHCP server or AUTO IP can be used.

For information about the PAT-T series from a Web browser, see the accompanying CD-ROM.

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

## 2.8 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 memory key A (PRESET A), B (PRESET B), or C (PRESET C).

RECALL keys allow you to recall any of the three preset memory values.

### NOTE

**4kW** When the phase input mode is changed to the single-phase input mode from the three-phase input mode for 4kW type, the setting value of the output current and the overcurrent protection (OCP) is limited to 75 % of the three-phase input mode.

### Storing the preset memory values

- 1** Press the SET key.  
The SET key 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 key while holding down the SHIFT key.  
PRESET A, B, and C LEDs blink in the display.
- 4** Press any memory key (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 key turned off). After saving the preset memory values, press the SET key to check them.

### Recalling the preset memory values

- 1** Press the SET key.  
The SET key LED illuminates, and the specified voltage and current are shown on the panel.
- 2** While holding down the SHIFT key, press the RECALL key 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.

You can recall preset memory values by carrying out step 2 above with the output turned on while displaying the measured values (SET key 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. 36

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

## 2.9 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. 36

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



Fig.2-24 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) key.  
The LOCK LED on the display illuminates, and the lock is enabled.

### ■ Release

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

## 2.10 Switching from Remote to Local Mode

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



Fig.2-25 Panel display example in remote mode

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

If the local lockout (llo) is specified in remote mode, the PAT does not switch to local mode (panel operation) even when the LOCAL switch is pressed. Transmist IEEE488.1 ren or SYST:LOC to clear the local lockout (llo).

## 2.11 Remote Sensing Function

See p. 17

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.


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).

### 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  "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.

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

See p. 35

### ■ Model of rated output 20 V to 850 V

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

Remove the covering from the sensing wires appropriately before connecting them.

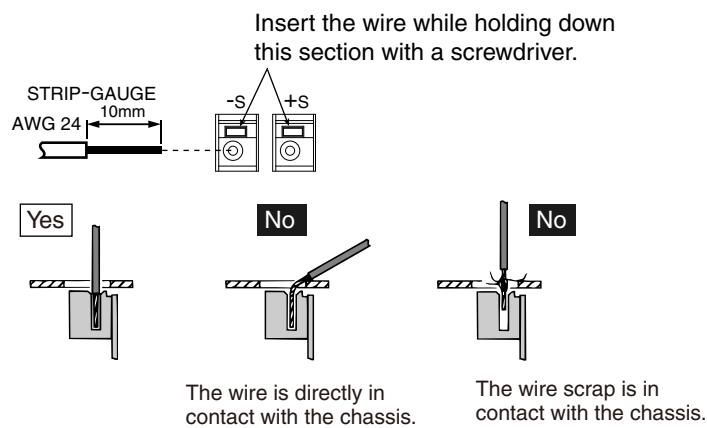


Fig.2-26 Connection to the sensing terminal 1

### ■ Model of rated output 1000 V and 1500 V

Attach crimping terminals that are appropriate for the +S and -S terminal screws and connect them.

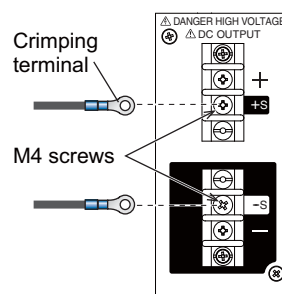


Fig.2-27 Connection to the sensing terminal 2

## Sensing terminal connection

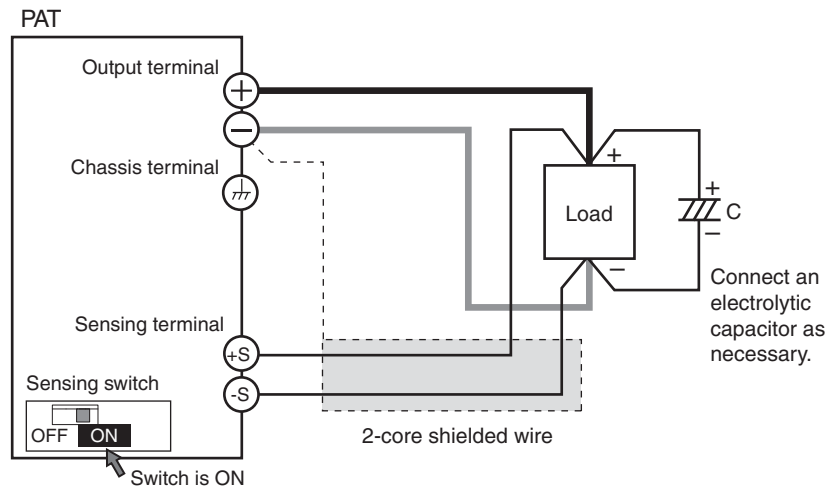


Fig.2-28 Remote sensing connection

- 1 Turn the POWER switch off.
- 2 Turn on the sensing switch on the rear panel.
- 3 As shown in Fig.2-28, 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.

### ■ 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:  $0.1 \mu\text{F}$  to several-hundred  $\mu\text{F}$

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.2-29 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.

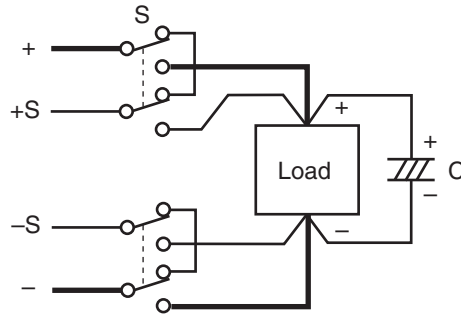


Fig.2-29 On/Off using the mechanical switch



## 2.12 Factory Default Settings

Turning ON the POWER switch while holding down the SHIFT key 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 2-2 Factory default 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 2-3 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)
CF31 <sup>*1</sup>	Phase input mode setting (three-phase input mode or single-phase input mode)	3PHR (three-phase input mode)
CF32 <sup>*2</sup>	Output-on startup state setting	CV (CV is prioritized)
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 <sup>*3</sup>	GPIB address setting	1
CF52 <sup>*3</sup>	Remote interface setting	GPIB, USB or LAN <sup>*4</sup>
CF55 <sup>*3</sup>	DHCP setting	ON (Use the DHCP server)
CF56 <sup>*3</sup>	AUTO IP address setting	ON (Use the AUTO IP function)

\*1. Only specify this parameter when the product is used as a 4 kW type.

\*2. Only specify this parameter when the product is used as a 8 kW type.

\*3. Only when the factory option GPIB, USB or LAN interface is installed.

\*4. Interface installed by factory option.



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# 3

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## External Control

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

## 3.1 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)

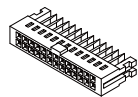
When the PAT is operating under external control, the EXT LED on the front panel display illuminates.



Fig.3-1 Display example during external control operation

## 3.2 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.3-2 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.

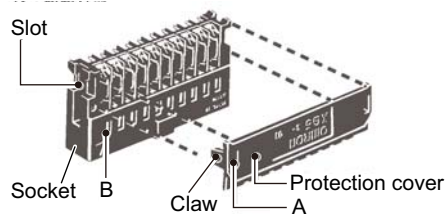
The single contact connection tool and contact removal tool are not provided. Please obtain your own tools.

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

Table 3-1 Connector parts by Omron needed to connect the J1 connector

Product	Model	Kikusui2 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			
Model of rated output 20 V to 850 V (semi cover)	XG5S-1301	84-49-0161	—
Model of rated output 1 000 V, 1 500 V (Hood cover)	XG5S-2612	84-49-0140	—

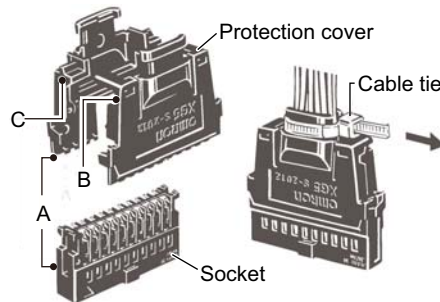
### ■ How to use the protection cover for rated output 20 V to 850 V



\* Excerpt from OMRON's catalog

- 1 Insert part A of the Protection cover into part B of the Socket.
- 2 Push the claws on both sides of the Protection cover onto the Socket.
- 3 Make sure the claws are firmly inserted in the slots.

### ■ How to use the protection cover for rated output 1000 V and 1500 V

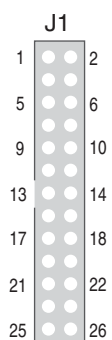


\* Excerpt from OMRON's catalog

- 1 Insert the claws of part A of the Protection cover into the slots.
- 2 Insert claws B on the Protection cover into part C on the other part of the Protection cover.
- 3 Wrap the wires with a cable tie.

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

Table 3-2 J1 connector pin arrangement



A position of the pin number that looked at from the panel side.

Pin No.	Signal Name	Description
1	STATUS COM	Common for status signals from pin 3 through 7. <sup>*1</sup>
2	STATUS COM	Common for status signals from pin 3 through 7. <sup>*1</sup>
3	PWR ON/OFF STATUS <sup>*2</sup>	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 <sup>*3</sup> )
4	OUT ON STATUS	On when the output is on (open collector output by a photocoupler <sup>*3</sup> ).
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). <sup>*3</sup>
6	CC STATUS	On during CC operation (open collector output by a photocoupler <sup>*3</sup> ).
7	CV STATUS	On during CV operation (open collector output by a photocoupler <sup>*3</sup> ).
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. <sup>*1</sup> 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. <sup>*1</sup> 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.



## 3.3 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  "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).

### 3.3.1 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.3-3.

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.

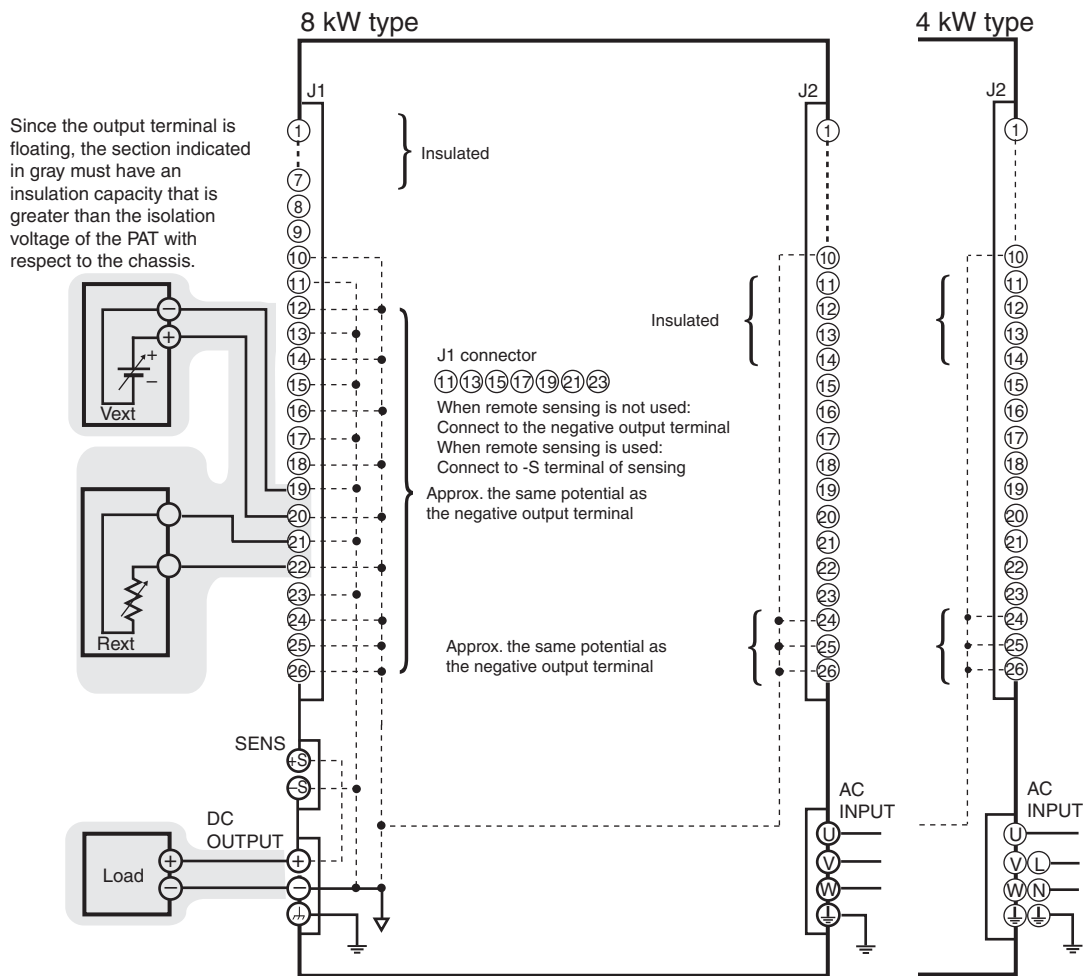


Fig.3-3 When the output terminal is not grounded



### 3.3.2 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.3-4. 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.

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.

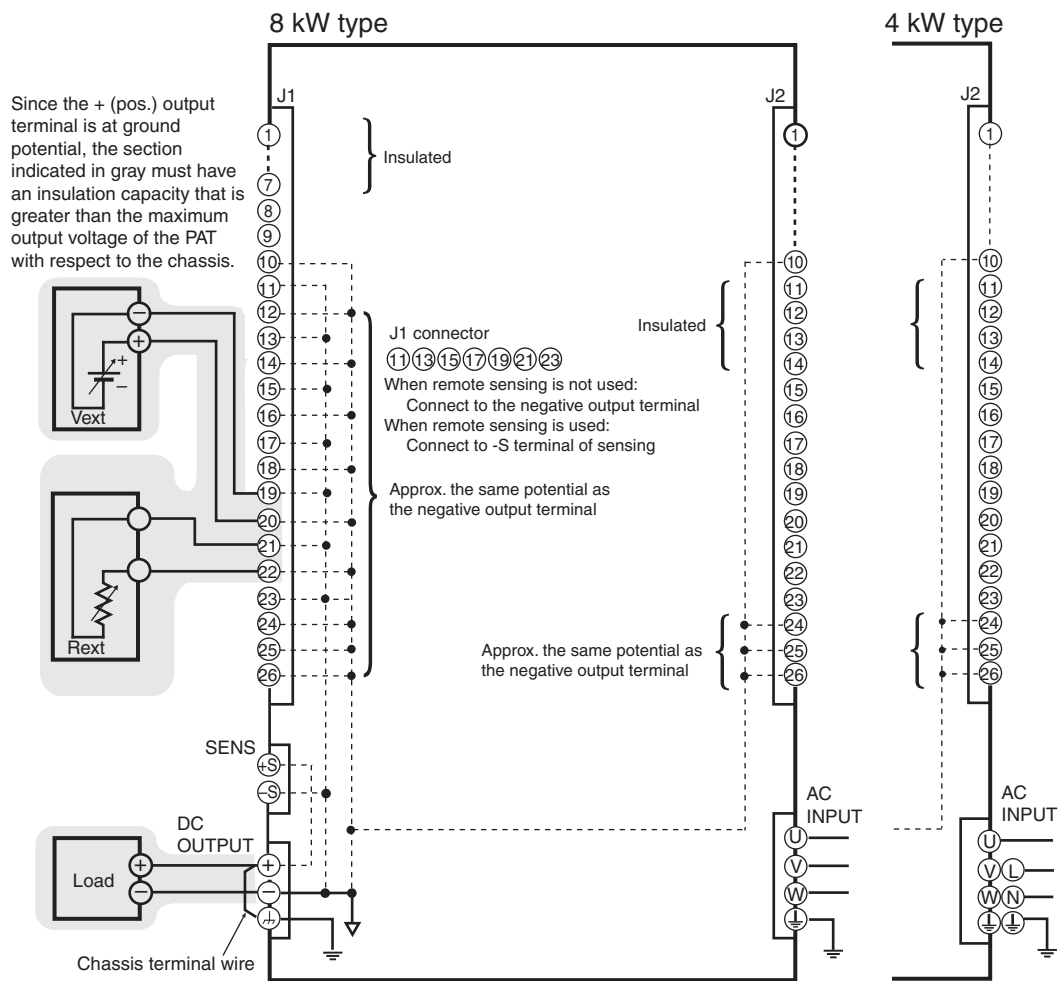


Fig.3-4 When the output terminal is grounded

If the external voltage (Vext) output is grounded for the case shown in Fig.3-4, 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.3-5 and Fig.3-6.



**WARNING**

**Possible electric shock.**

**Do not use 2-core shielded cables for the PAT1000-8T or PAT1500-5.3T. You will not be able to maintain the spatial distance required between the chassis electric potential and output potential.**



**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.

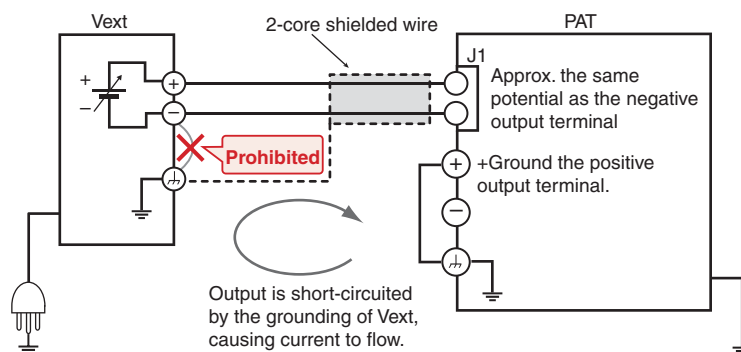


Fig.3-5 A connection in which the output is short-circuited by the grounding of Vext (example of a prohibited connection)

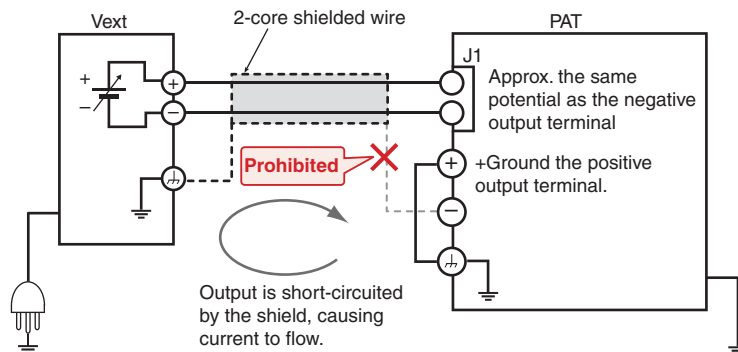


Fig.3-6 A connection in which the output is short-circuited by the shield (example of a prohibited connection)

## 3.4 Controlling the Output Voltage


This section explains the method used to control the output voltage using an external voltage ( $V_{ext}$ ) in the range 0 V to approx. 10 V or an external resistor ( $R_{ext}$ ) in the range 0 k $\Omega$  to approx. 10 k $\Omega$ .

The output voltage will change approximately 5 ms after the value of the applied external voltage or resistance changes.

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



### **WARNING** Possible electric shock.

- The insulation of the  $V_{ext}$  or  $R_{ext}$  and the connected cable should be greater than the isolation voltage of the PAT. For the isolation voltage of each model, see  "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.

### 3.4.1 External Voltage ( $V_{ext}$ ) Control

 p. 36

To control the output voltage using  $V_{ext}$ , select the CV control source in the CONFIG settings from the following modes.

4 kW type is a set of only EXT-V CV CONT (CF20:1).

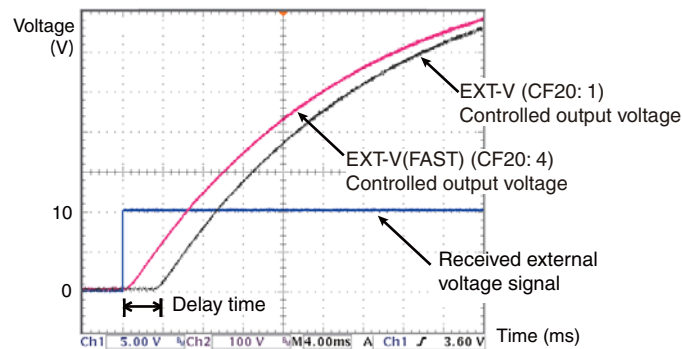


Fig.3-7 Voltage change example with CV control (external voltage signal: 0 V to 10 V)

- EXT-V CV CONT (CF20: 1)

The output voltage ( $E_o$ ) varies in the range of 0 to the rated output voltage ( $E_{rtg}$ ) by setting the external voltage ( $V_{ext}$ ) in the range of 0 V to 10 V.

$$E_o = E_{rtg} \times V_{ext} / 10 \text{ [V]} \quad V_{ext} = 10 \times E_o / E_{rtg} \text{ [V]}$$

Because the PAT processes the signal internally, there is a delay between when the input signal is received and when the output voltage starts changing.

- EXT-V (FAST) CV CONT (CF20: 4) **8kW**

The output voltage ( $E_o$ ) varies in the range of 0 to the rated output voltage ( $E_{rtg}$ ) by setting the external voltage ( $V_{ext}$ ) in the range of 0 V to 10 V.

$$E_o = E_{rtg} \times V_{ext} / 10 \text{ [V]} \quad V_{ext} = 10 \times E_o / E_{rtg} \text{ [V]}$$

The output voltage starts changing at almost the same time that the input signal is received. There is almost no delay.

In this mode, you cannot perform calibration of the output voltage control using external voltage. You can approach the desired output by making subtle adjustments to the input signal.

**CAUTION**

- The signal wire may burn out. Leave the  $V_{ext}$  output floating.
- Make sure the polarity of  $V_{ext}$  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 ( $V_{ext}$ ) connection**

Use a low-noise and stable voltage source for  $V_{ext}$ . The noise in  $V_{ext}$  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  $V_{ext}$ . 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  $V_{ext}$  side, See "When using the external voltage ( $V_{ext}$ )" on page 3-58.

Pins 21 and 22 of the J1 connector are used.

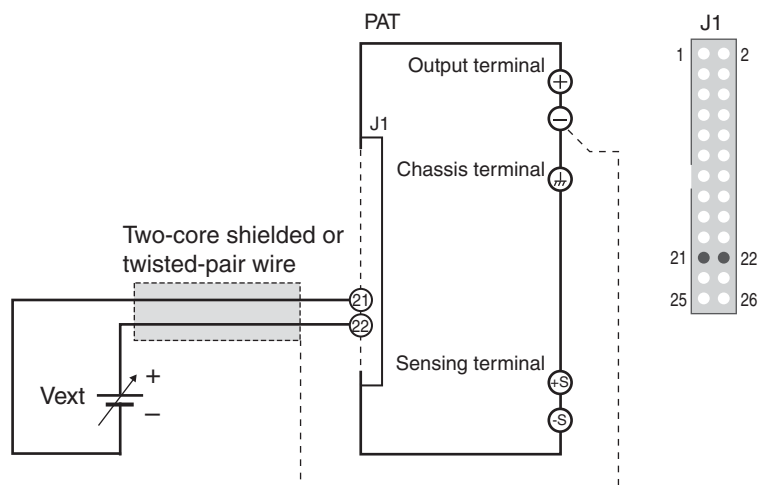


Fig.3-8 Connection of the output voltage control using external voltage



## 3.4.2 External resistance (R<sub>ext</sub>) control

See p. 36

To control the output voltage using R<sub>ext</sub>, select the CV control source in the CONFIG settings from the following modes.

- EXT-R CV CONT 10 kΩ → MAX OUT (CF20: 2)

The output voltage (E<sub>o</sub>) varies in the range of 0 to the rated output voltage (E<sub>rtg</sub>) by setting the external resistance (R<sub>ext</sub>) in the range of 0 kΩ to 10 kΩ

$$E_o = E_{rtg} \times R_{ext} / 10 \text{ [V]} \quad R_{ext} = 10 \times E_o / E_{rtg} \text{ [V]}$$

- EXT-R (FAIL SAFE) CV CONT 10 kΩ → 0 OUT (CF20: 3)

The output voltage (E<sub>o</sub>) varies in the range of the rated output voltage (E<sub>rtg</sub>) to 0 by setting the external resistance (R<sub>ext</sub>) in the range of 0 kΩ to 10 kΩ

$$E_o = E_{rtg} \times (10 - R_{ext}) / 10 \text{ [V]} \quad R_{ext} = 10 \times (E_{rtg} - E_o) / E_{rtg} \text{ [V]}$$

### NOTE

- If R<sub>ext</sub> comes loose when using the 10 kΩ → MAX OUT CV mode, excessive voltage may be applied to the load. For safety reasons, it is recommended that fail-safe 10 kΩ → 0 OUT CV mode be used.
- If you are using fixed resistors for R<sub>ext</sub> 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.

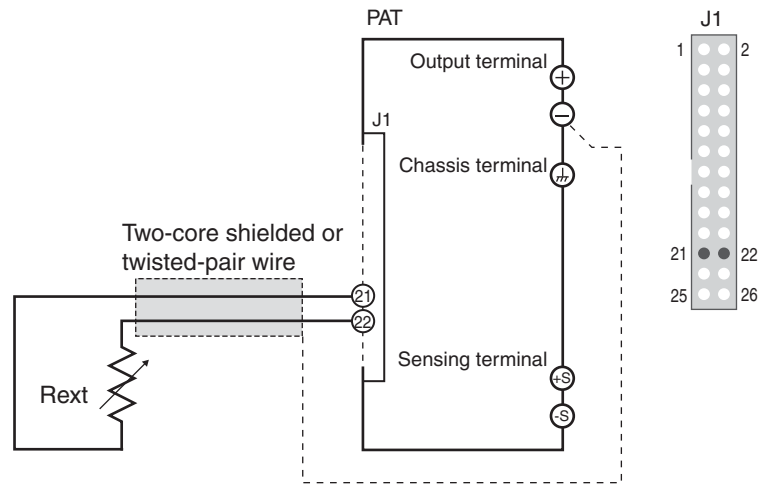
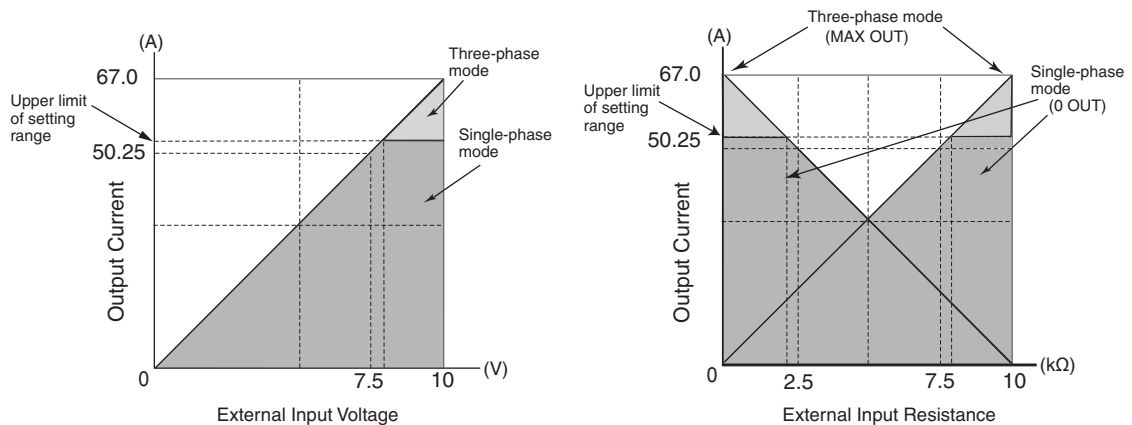


Fig.3-9 Connection of the output voltage control using Rext

## 3.5 Controlling the Output Current

This section explains the method used to control the output current using an external voltage ( $V_{ext}$ ) in the range 0 V to approx. 10 V or an external resistor ( $R_{ext}$ ) in the range 0 k $\Omega$  to approx. 10 k $\Omega$ .

**4kW** When controlling the output current in the single-phase input mode for 4kW type, the setting value of the output current is limited to 75 % of the rating in the three-phase input mode.



Example of PAT60-67T



### **WARNING** Possible electric shock.

- The insulation of the  $V_{ext}$  or  $R_{ext}$  and the connected cable should be greater than the isolation voltage of the PAT. For the isolation voltage of each model, see [MANUAL](#) "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.

### 3.5.1 External Voltage ( $V_{ext}$ ) Control

[See](#) p. 36, p. 59

To control the output voltage using  $V_{ext}$ , select the CV control source in the CONFIG settings from the following modes.

4 kW type is a set of only EXT-V CC CONT (CF21:1).

- EXT-V CC CONT (CF21: 1)

The output current ( $I_o$ ) varies in the range of 0 to the rated output current ( $I_{rtg}$ ) by setting the external voltage ( $V_{ext}$ ) in the range of 0 V to 10 V.

$$I_o = I_{rtg} \times V_{ext} / 10 \text{ [A]} \quad V_{ext} = 10 \times I_o / I_{rtg} \text{ [A]}$$

Because the PAT processes the signal internally, there is a delay between when the input signal is received and when the output current starts changing.

- EXT-V (FAST) CC CONT (CF21: 4) **8kW**

The output current ( $I_o$ ) varies in the range of 0 to the rated output current ( $I_{rtg}$ ) by setting the external voltage ( $V_{ext}$ ) in the range of 0 V to 10 V.

$$I_o = I_{rtg} \times V_{ext} / 10 \text{ [A]} \quad V_{ext} = 10 \times I_o / I_{rtg} \text{ [A]}$$

The output current starts changing at almost the same time that the input signal is received. There is almost no delay.

In this mode, you cannot perform calibration of the output current control using external voltage. You can approach the desired output by making subtle adjustments to the input signal.

**CAUTION**

- The signal wire may burn out. Leave the  $V_{ext}$  output floating.
- Make sure the polarity of  $V_{ext}$  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 ( $V_{ext}$ ) connection**

Use a low-noise and stable voltage source for  $V_{ext}$ . The noise in  $V_{ext}$  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  $V_{ext}$ . 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  $V_{ext}$  side, See "When using the external voltage ( $V_{ext}$ )" on page 3-58.

Pins 19 and 20 of the J1 connector are used.

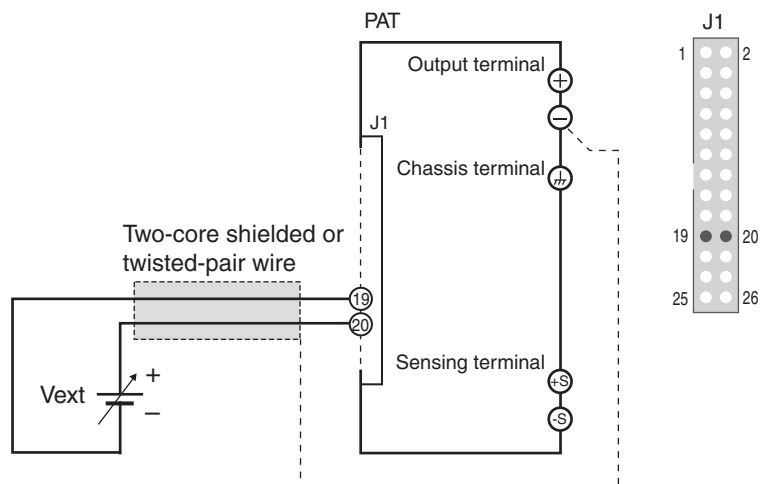


Fig.3-10 Connection of the output current control using  $V_{ext}$





## 3.5.2 External Resistance (R<sub>ext</sub>) Control

See p. 36

To control the output current using R<sub>ext</sub>, select the CC control source in the CONFIG settings from the following modes.

- EXT-R CC CONT 10 kΩ → MAX OUT (CF21: 2)

The output current (I<sub>o</sub>) varies in the range of 0 to the rated output current (I<sub>rtg</sub>) by setting the external resistance (R<sub>ext</sub>) in the range of 0 kΩ to 10 kΩ.

$$I_o = I_{rtg} \times R_{ext} / 10 \text{ [A]} \quad R_{ext} = 10 \times I_o / I_{rtg} \text{ [A]}$$

- EXT-R (FAIL SAFE) CC CONT 10 kΩ → 0 OUT (CF21: 3)

The output current (I<sub>o</sub>) varies in the range of the rated output current (I<sub>rtg</sub>) to 0 by setting the external resistance (R<sub>ext</sub>) in the range of 0 kΩ to 10 kΩ.

$$I_o = I_{rtg} \times (10 - R_{ext}) / 10 \text{ [A]} \quad R_{ext} = 10 \times (I_{rtg} - I_o) / I_{rtg} \text{ [A]}$$

### NOTE

- If R<sub>ext</sub> comes loose when using the 10 kΩ → MAX OUT CC mode, excessive current may flow through the load. For your safety, it is recommended that fail-safe 10 kΩ → 0 OUT CC mode be used.
- If you are using fixed resistors for R<sub>ext</sub> 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.

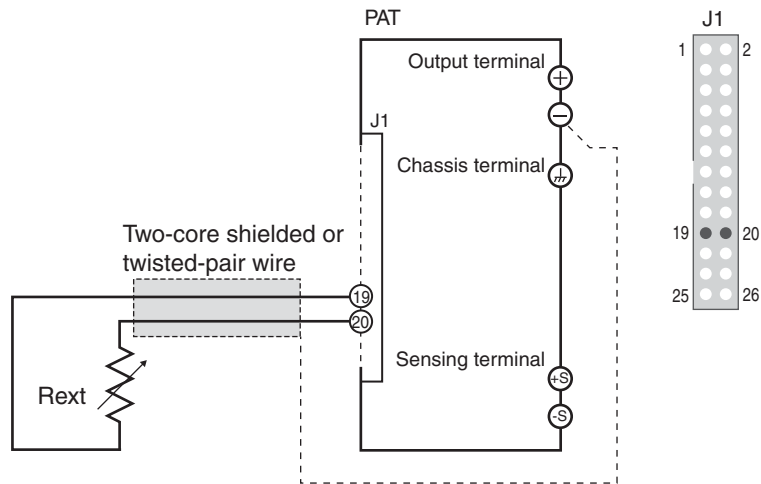


Fig.3-11 Connection of the output current control using Rext

## 3.6 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 [MANUAL](#) "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. 37

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).

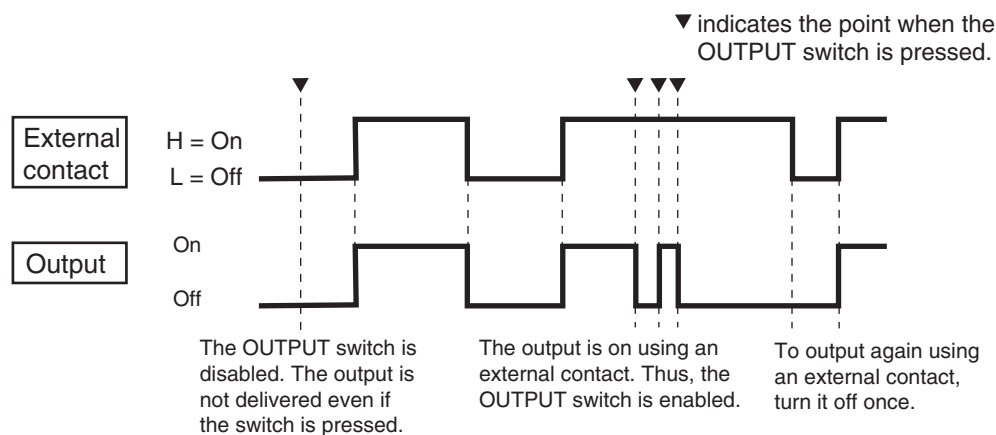


Table 3-3 Output on/off control (example in which the output is on at high)

## 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  $\mu$ A maximum. (The internal circuit is pulled up to 5 V through 10 k $\Omega$ )

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.

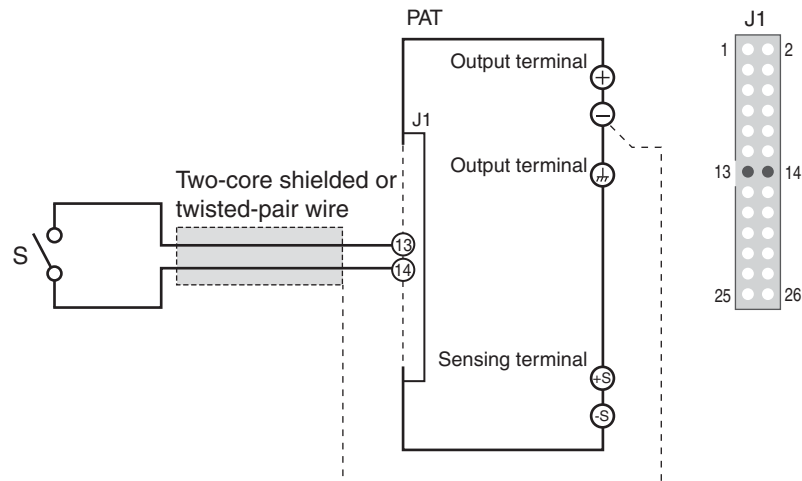


Fig.3-12 On/Off control connection using an external contact

### ■ For long-distance wiring

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

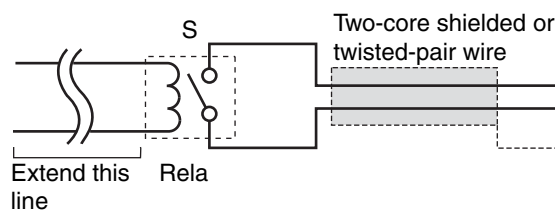


Fig.3-13 On/Off control using an external contact (for long-distance wiring)


## 3.7 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  "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.

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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  $\mu\text{A}$  maximum. (The internal circuit is pulled up to 5 V through 10 k $\Omega$ )

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

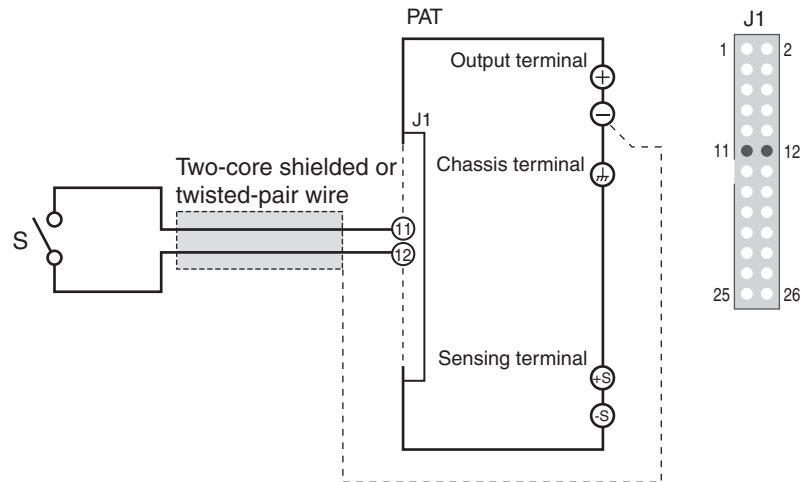


Fig.3-14 Shutdown control connection using an external contact

### ■ For long-distance wiring

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

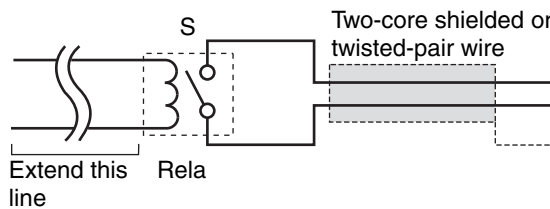


Fig.3-15 Shutdown control connection using an external contact (for long-distance wiring)

## 3.8 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 3-4 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
16	I MON	Monitor output of output current 0 V to approx. 10 V for 0 to the rated output current <b>4kW</b> When the phase input mode is changed to the single-phase input mode from the three-phase input mode, the setting value of the output current and the overcurrent protection (OCP) is limited to 75 % of the rated value of output current and the overcurrent protection of the three-phase input mode.
18	V MON	Monitor output of output voltage 0 V to approx. 10 V for 0 to the rated output voltage

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

- Monitor output rating  
Output impedance: 1 k $\Omega$  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 3-5 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. 37

\*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).





# 4

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## 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.

## 4.1 Master-Slave Parallel Operation



In master-slave parallel operation, PATs of the same model are connected to form a system, and one PAT is designated as the master, while the other PATs are designated as slaves. You can control the whole system by operating the master.

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. (Two for the PAT850-9.4T/ PAT1000-8T/ PAT1500-5.3T.)

The difference in the output voltage and output current between the master unit and the slave unit is within approximately 5 % of the rating.

### CAUTION

- Only PATs of the same model can be connected in master-slave parallel operation.
- When using the PAT by itself, disconnect the parallel operation connections. Otherwise, the PAT may not operate properly.
-  In Master-Slave parallel operation, the master unit and all of the slave units connected to the system must be set in the same phase input mode.  
Three-phase input mode : Max. output current = rated output current of single unit X number of units connected in the system  
Single-phase input mode : Max. output current = rated output current of single unit X number of units connected in the system X 75 %
-  If the phase input mode is not set in the same mode for the master unit and slave units, it may cause a damage to the unit in the system.

### 4.1.1 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. When the maximum output current value exceeds 999.9, the maximum current displays 9999.

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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.

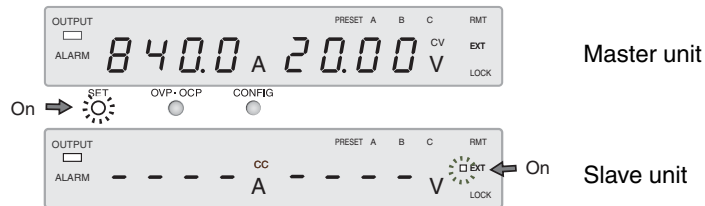


Fig.4-1 Panel display example during parallel operation (examples of output current 840 A)

**8kW** You can only display the current on a slave unit for 8kW type. The current appears on the ammeter when the STORE key is pressed.

When a device whose firmware version is earlier than 5.00 is being used as a slave unit, the currents of the slave units cannot be displayed.

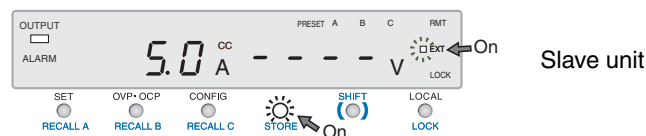


Fig.4-2 Slave unit display example during parallel operation (examples of output current is 5 A)

### CAUTION

If the firmware version of the PAT40-200T (200 V input) 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 (200 V input), it may causes the mis-operation.

Contact your Kikusui distributor/agent when the firmware version prior to 3.00 of the PAT40-200T (200 V input) is combined in the system of master slave parallel operation. Refer to the Setup guide, "Turning On" for confirmation of the firmware version.

See p. 45

### Remote sensing

Available only on the master unit.

See Chapter 3

### External control

Available only on the master unit.

See p. 71

### 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.

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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.

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### ■ 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.

## 4.1.2 Connection (Parallel Operation)

Up to five units including the master unit (Two for the PAT850-9.4T/ PAT1000-8T/ PAT1500-5.3T) can be connected.

### Connecting the signal wires (parallel operation)

Fig.4-5 and Fig.4-6 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.

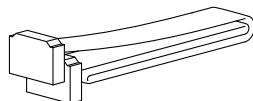
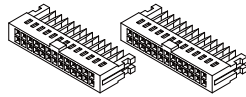


Fig.4-3 Optional parallel operation power cable (PC01-PAT)

If you are using the J1/J2 connector kit that comes with the package, refer to Fig.4-5 to make the connection. For tools needed for the connection, see Table 3-1.

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.4-4 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.
- When in operation, do not touch the J1/J2 connector or the parallel operation cable.

**⚠ CAUTION**

- To prevent errors, if the firmware versions of the devices are different when you perform master-slave parallel operation, use a device whose firmware version is 4.0X for 4kW type or later, firmware version is 5.0X for 8kW type or later as the master unit.

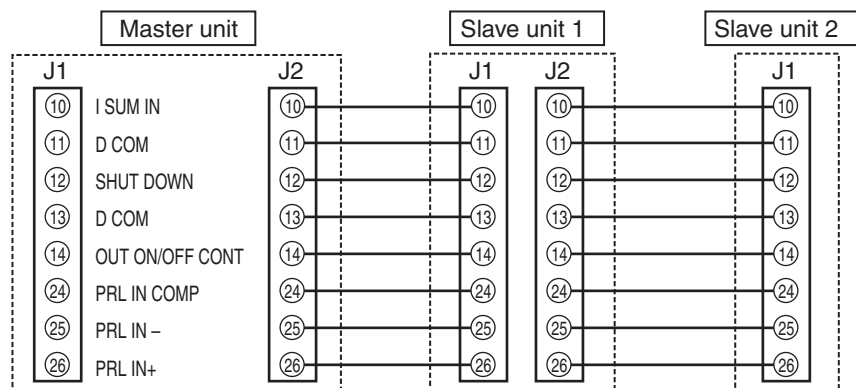


Fig.4-5 Connection for parallel operation (two slave units)

- 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  $\mu\text{F}$  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.
- Twist the positive and negative wires together and make the connection to the load using the shortest wire length possible. Oscillation may occur as a result of wiring inductance.

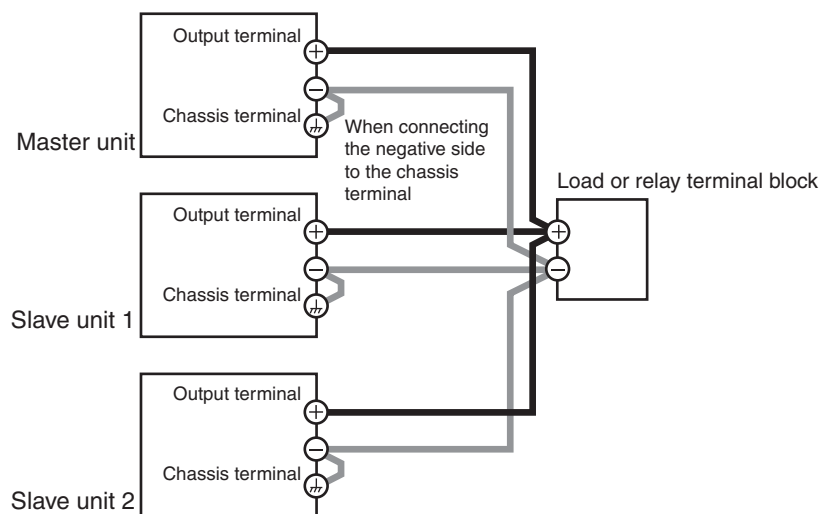


Fig.4-6 Load connection for parallel operation (two slave units)

- 1 Turn off the POWER switches on all power supply units to be connected in parallel.
- 2 Remove the OUTPUT terminal cover.
- 3 Connect the load wires to the output terminals of the master and slave units.
- 4 As shown in Fig.4-6, connect the load wires of the master and slave units to the load. If you use a relay terminal block, make sure that the

See p. 16

wires used to connect the master and slave units are as short as possible.

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.

## 4.1.3 Master-Slave Parallel Operation Setup

### Designating the master and slave units



**CAUTION** If the firmware versions of the devices are different when you perform master-slave parallel operation, use a device whose firmware version is 4.0X for 4kW type or later, firmware version is 5.0X for 8kW type or later as the master unit.

See p. 38

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. 37

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. 74

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 is set, and its value will be displayed when it is set to the setting value display (lights up the SET key).

Three-phase input mode **4kW** **8kW** : 105 % of the rated output current of the product times number of units connected in parallel operation

Single-phase input mode **4kW** : 75 % of the rated output current of the product times number of units connected in parallel operation

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. 28

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 its value will be displayed when it is set to the OVP/OCP setting value display (lights up the OVP/OCP key).

Three-phase input mode **4kW** **8kW** : 115 % of the rated output current of the product times number of units connected in parallel operation

Single-phase input mode **4kW** : 75 % of the rated output current of the product times number of units connected in parallel operation

The value of over voltage protection is set with the last setting of the master unit.

See p. 33

### CONFIG parameters that can be set on the slave unit

- 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
- CF54 Remote interface 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.

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## 4.1.4 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 (40 seconds for 400 V input model) 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.

## 4.2 Series Operation

**WARNING** • Models with output voltages of 250 V or more cannot be connected in series. Connecting the models in series would be dangerous because the output voltage would exceed the isolation voltage of the PAT.

**CAUTION** • **4kW** Make sure that the unit connected in the series operation are set in the same phase input mode. If the phase input mode is not set in the same mode, it may cause a damage to the unit.

See p. 55

Two of any one of the following models can be connected in series: Output voltage is a model of less than 250 V. 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.

### 4.2.1 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.4-7 Panel display example during series operation

See Chapter 3

#### External control

Can be used.

See p. 71

#### 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.

## Remote sensing

See p. 45

When you perform remote sensing, connect the PATs in series, and then connect the sensing line to them as shown in Fig.4-8.

### CAUTION

- If the sensing wires are not connected properly, the load may be exposed to excessive voltage and the PATs may be damaged.
- Connect an electrolytic capacitor (C) with a capacitance of a few hundreds of  $\mu\text{F}$  to a few tens of thousands of  $\mu\text{F}$  to the load terminals as necessary. The wiring inductance and capacitance can cause phase shifting at a level that must be dealt with and can also cause oscillation. Connecting an electrolytic capacitor will prevent such oscillation. Use an electrolytic capacitor with a withstand voltage that is 120% or more of the total of the rated output voltages of the PATs that are connected in series.

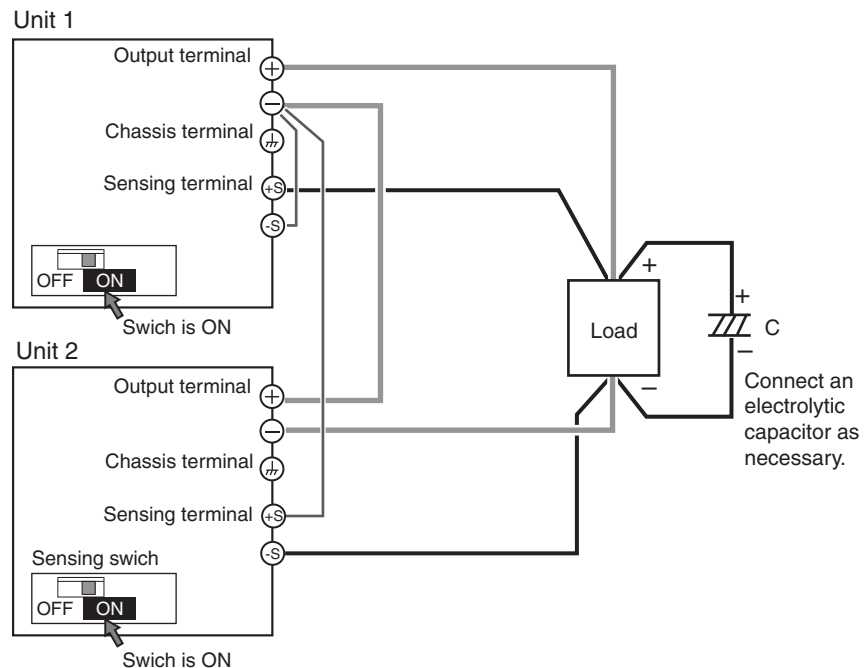


Fig.4-8 Connecting the sensing wires during series operation

## Alarm

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

See p. 28, p. 85

### ■ 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.

## 4.2.2 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.

**⚠ CAUTION** • Connect an electrolytic capacitor (C) with a capacitance of a few hundreds of  $\mu\text{F}$  to a few tens of thousands of  $\mu\text{F}$  to the load terminals as necessary. The wiring inductance and capacitance can cause phase shifting at a level that must be dealt with and can also cause oscillation. Connecting an electrolytic capacitor will prevent such oscillation. Use an electrolytic capacitor with a withstand voltage that is 120% or more of the total of the rated output voltages of the PATs that are connected in series.

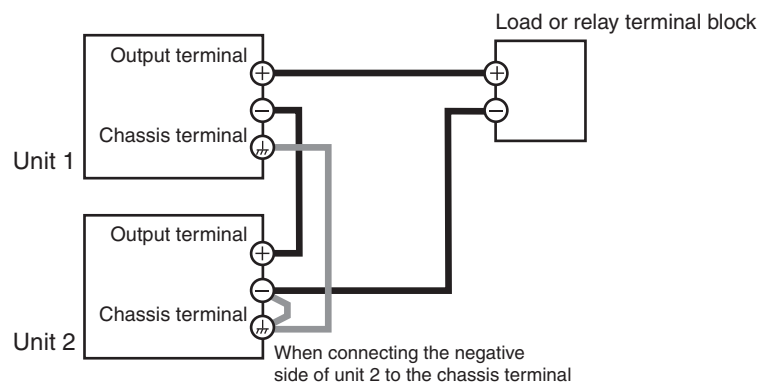


Fig.4-9 Load connection for series operation  
(Example in which the negative terminal of unit 2 is connected to the chassis terminal)

- 1 Turn off the POWER switches on all power supply units to be connected in series.
- 2 Remove the OUTPUT terminal cover.
- 3 As shown in Fig.4-9, connect the load and the PAT using the load wires. 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.

See p. 16

- 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.

## 4.2.3 Series Operation Setup

### Setting the voltage and current

 p. 24

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)

 p. 28

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.

## 4.2.4 Starting the Series Operation

### Turning the power on/off

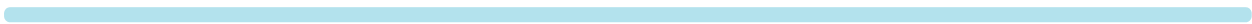
Turn on/off the POWER switches on unit 1 and unit 2.

#### CAUTION

When turning the POWER switch off and then back on, allow at least 10 seconds (at least 40 seconds for 400 V input model) 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.



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# 5

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## Maintenance

This chapter describes maintenance such as cleaning, and calibrating.

## 5.1 Inspection

To purchase accessories or options, contact your Kikusui agent or distributor.

### 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.

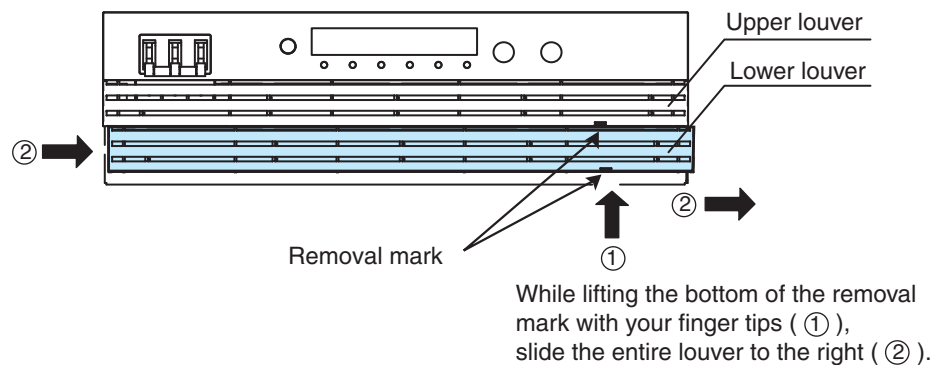


Fig.5-1 Louver removal

#### 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.

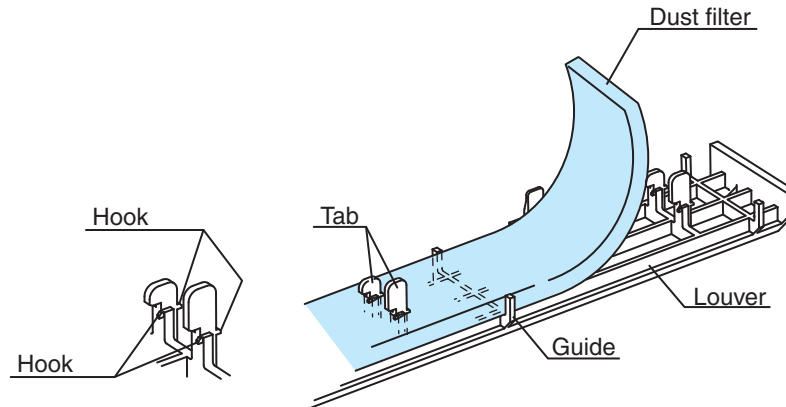


Fig.5-2 Dust filter removal

### 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 dust filter.

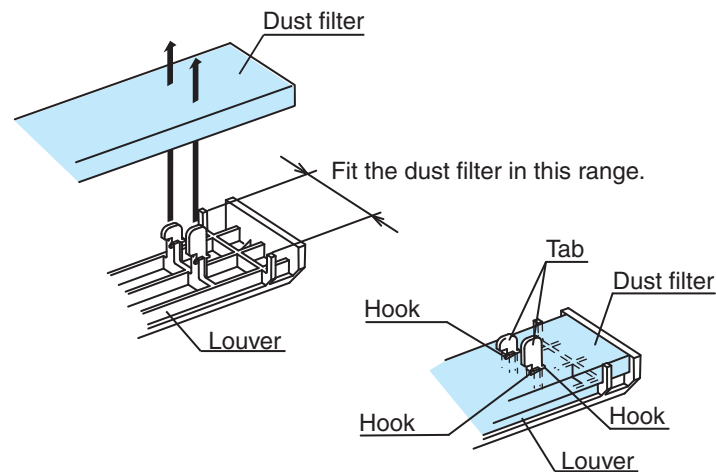


Fig.5-3 Dust filter attachment

#### 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.

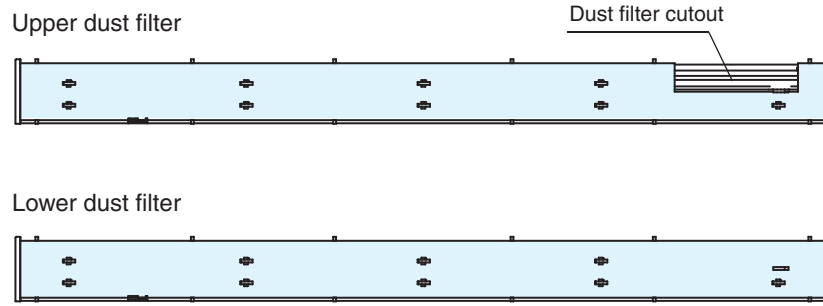


Fig.5-4 Dust filter as seen from the rear

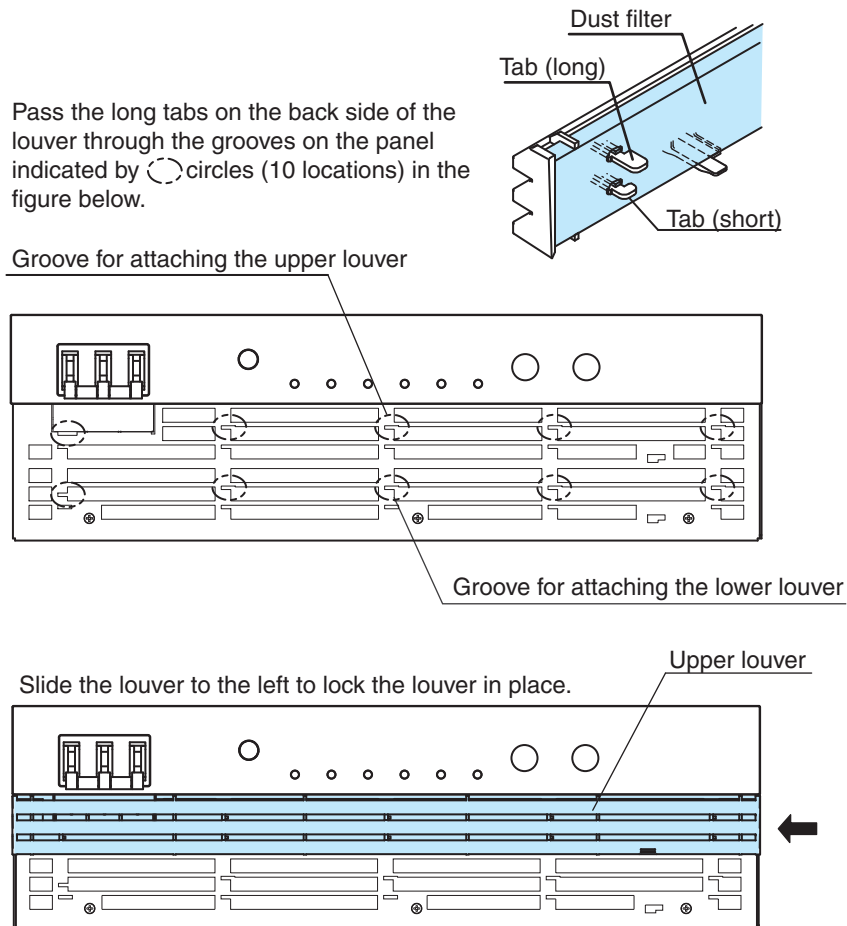


Fig.5-5 Louver attachment

**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.



## 5.2 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.

### NOTE

**4kW** 4 kW type is calibration in a three-phase input mode.

### 5.2.1 Calibration Overview

The following six calibration items are available.

- Output voltage and voltmeter
- Output current and ammeter
- Output voltage control
- Output current control
- Overvoltage protection
- Overcurrent protection

#### Test Equipment Required

For calibration, the following equipment is necessary.

- DC voltmeter (DVM) with measuring accuracy of 0.02 % or better.
- Shunt

Model		Shunt resistors	
4 kW type	8 kW type	Rating	Tolerance
–	PAT20-400T	500 A/50 mV (0.1 mΩ)	$< \pm 0.1 \%$
–	PAT30-266T	300 A/50 mV (0.17 mΩ)	
PAT20-200T	PAT40-200T	200 A/50 mV (0.25 mΩ)	
–	PAT60-133T	150 A/50 mV (0.3 mΩ)	
PAT40-100T/ PAT60-67T	PAT80-100T	100 A/50 mV (0.5 mΩ)	
–	PAT160-50T	50 A/50 mV (1 mΩ)	
PAT160-25T	PAT250-32T	50 A/50 mV (1 mΩ)	
–	PAT350-22.8T	30 A/50 mV (1.67 mΩ)	
–	PAT500-16T	20 A/50 mV (2.5 mΩ)	
–	PAT650-12.3T	15 A/50 mV (3.34 mΩ)	
–	PAT850-9.4T	10 A/50 mV (5 mΩ)	
–	PAT1000-8T	10 A/50 mV (5 mΩ)	
–	PAT1500-5.3T	10 A/50 mV (5 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:  $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$
- 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.

## 5.2.2 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.

In the CAL. 5 and CAL. 7 calibration modes, you cannot calibrate EXT-V (FAST) CV CONT or EXT-V (FAST) CC CONT.

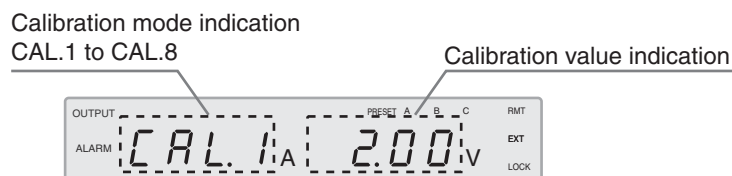


Fig.5-6 Panel display example of calibration mode

- 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.

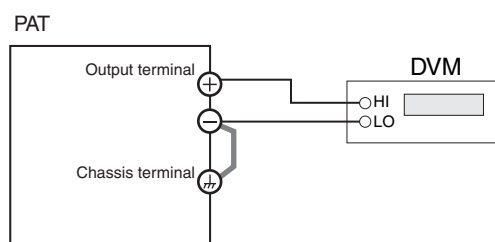


Fig.5-7 Connection for CAL.1 and CAL.2

- 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.

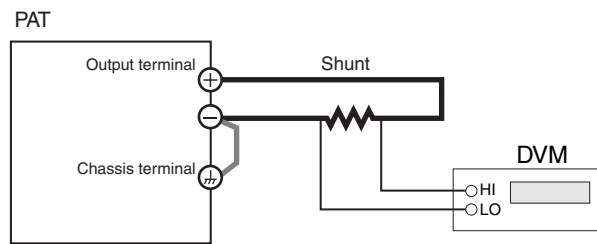


Fig.5-8 Connection for CAL.3 and CAL.4

- 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)

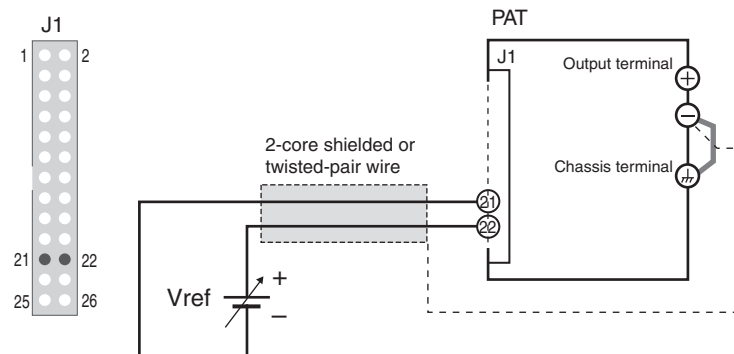


Fig.5-9 Connection for CAL.5

- 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)

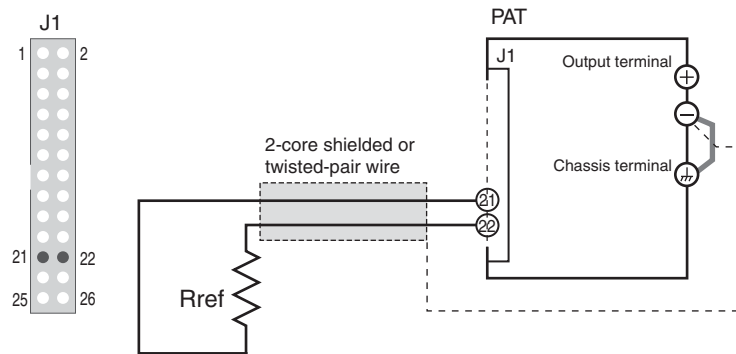


Fig.5-10 Connection for CAL.6

- 1 Turn the POWER switch off.
- 2 Connect the  $0\ \Omega$  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  $10\ \text{k}\Omega$  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)

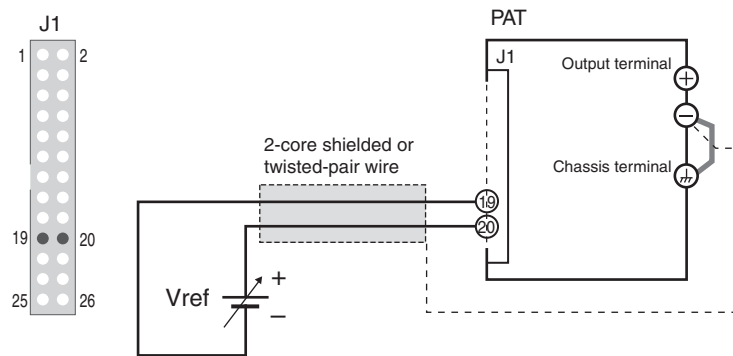


Fig.5-11 Connection for CAL.7

- 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)

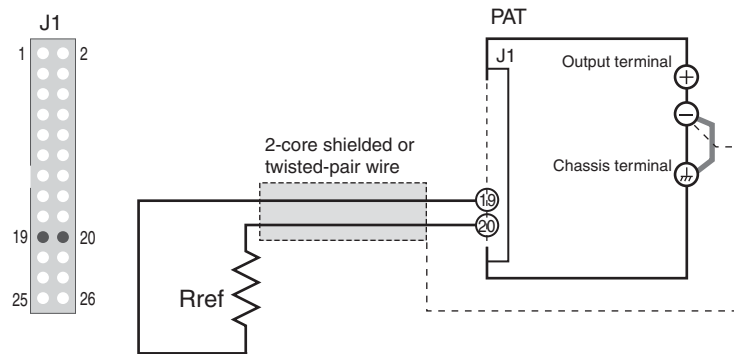


Fig.5-12 Connection for CAL.8

- 1 Turn the POWER switch off.
- 2 Connect the  $0\ \Omega$  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  $10\ \text{k}\Omega$  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.



# 6

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## Specifications and functions

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

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  $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  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.

## 6.1 4 kW type

### AC input

		PAT20-200T	PAT40-100T	PAT60-67T	PAT160-25T
Nominal input rating		200 V to 240 V, 50 Hz to 60 Hz			
Input voltage range		180 V to 250 V			
Input frequency range		47 Hz to 63 Hz			
Input phase	three-phase input mode	Three-phase (at the rated load)			
	single-phase input mode	Single-phase (at 3 kW)			
Hold-up time for power interruption		20 ms or greater (at 50 % load), 10 ms or greater (at the rated load)			
Current	three-phase input mode	17 A or less (at the rated load)			
	single-phase input mode	22 A or less (at 3 kW)			
Inrush current (MAX) <sup>*1</sup>		50.0 Apeak			
Wattage (MAX)	three-phase input mode	5 kVA (at the rated load)			
	single-phase input mode	4 kVA (at 3 kW)			
Power factor (TYP) <sup>*2</sup>		0.95			
Efficiency (TYP) <sup>*2</sup>		84.0 %	85.0 %		

\*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).

\*2. Input voltage of 200 V, at the rated load.

## Output

			PAT20-200T	PAT40-100T	PAT60-67T	PAT160-25T
Rating	Output power	three-phase input mode	4 kW			
		single-phase input mode	3 kW			
	Output voltage		20.00 V	40.00 V	60.00 V	160.00 V
	Output current <sup>*1</sup>		200.0 A	100.0 A	67.0 A	25.0 A
Voltage	Preset range <sup>*2</sup>		0 % to 105 % of rtg			
	Setting accuracy <sup>*3</sup>		± (0.2 % of rtg +50 mV)			
	Line regulation <sup>*4</sup>		± (0.05 % of rtg +5 mV)			
	Load regulation <sup>*5</sup>		± (0.1 % of rtg +5 mV)			
	Transient response <sup>*6</sup>		5 ms			
	Ripple noise	(p-p) <sup>*7</sup>	100 mV	300 mV	350 mV	350 mV
		(rms) <sup>*8</sup>	10 mV	30 mV	30 mV	30 mV
	Rise time (MAX) <sup>*9</sup>	rated load	100 ms			
		no load	100 ms			
	Fall time (MAX) <sup>*10</sup>	rated load	100 ms			
no load		2000 ms				
Temperature coefficient (MAX) <sup>*11</sup>		100 ppm/°C (during external control)				
Current	Preset range <sup>*2</sup>	three-phase input mode	0 % to 105 % of rtg			
		single-phase input mode	0 % to 105 % of rtg x 75 %			
	Setting accuracy <sup>*3</sup>		± (0.5 % of rtg +50 mA)			
	Line regulation <sup>*4</sup>		± (0.1 % of rtg +30 mA)			
	Load regulation <sup>*5</sup>		± (0.2 % of rtg +30 mA)			
	Ripple noise (rms) <sup>*8</sup>		400 mA	300 mA	250 mA	200 mA
	Temperature coefficient (TYP) <sup>*11</sup>		200 ppm/°C (during external control)			

- \*1. In the single-phase input mode, the output current is limited to 75 % of the rating of three-phase input mode.
- \*2. 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 rated output voltage < V Set ≤ maximum preset voltage.
- \*3. The difference between the actual output voltage or output current and the preset value under constant voltage or constant current operation.
- \*4. Output voltage or output current fluctuation with respect to ±10 % fluctuation of the nominal input voltage under constant voltage or current operation.
- \*5. 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.
- \*6. 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.
- \*7. When the measurement frequency bandwidth is 10 Hz to 20 MHz.
- \*8. When the measurement frequency bandwidth is 5 Hz to 1 MHz for the output voltage from 10 % to 100 % of the rating.
- \*9. The time it takes for the output voltage to rise from 10 % to 90 % of the rating when the output is turned on.
- \*10. The time it takes for the output voltage to fall from 90 % to 10 % of the rating when the output is turned off.
- \*11. When the ambient temperature is within the range of 0 °C to 50 °C.

## Display function

		PAT20-200T	PAT40-100T	PAT60-67T	PAT160-25T
Voltmeter	Maximum display (fixed decimal point)	99.99			999.9
	Display accuracy	± (0.2 % of rdng +5 digits)			
Ammeter	Maximum display (fixed decimal point)	999.9	99.99		
	Display accuracy	± (0.5 % of rdng +5 digits)			
Operation display	OUTPUT ON/OFF	ON: OUTPUT LED illuminates (Green LED) OFF: OUTPUT LED turns off			
	ALARM operation *1	ALARM LED illuminates (Red LED)			
	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.  
If the breaker is set to trip, the ALARM LED illuminates for approximately 10 s to 15 s when the SD signal is applied while the OVP/OCP is activated.

## Protection functions

		PAT20-200T	PAT40-100T	PAT60-67T	PAT160-25T
Overvoltage protection (OVP)		Turns off the output or trips the breaker (turns the POWER switch off) ALARM LED illuminates.*1			
Setting range		10 % to 111.5 % of the rated output voltage			
Setting accuracy		± (2 % of rtg)			
Overcurrent protection (OCP)		Turns off the output or trips the breaker (turns the POWER switch off) ALARM LED illuminates.*1			
Setting range	three-phase input mode	10 % to 111.5 % of the rated output current			
	single-phase input mode	10 % to 111.5 % X 75 % of the rated output current			
Setting accuracy		± (3 % of rtg)			
Overheat protection (OHP)		Turns the output off. ALARM LED illuminates.			
Input open-phase protection (PHASE)	three-phase input mode	Turns the output off. ALARM LED illuminates.			
	single-phase input mode	Cancels the Input open-phase protection feature.			
Fan failure protection (FAN)		Turns the output off. ALARM LED illuminates.			
Incorrect sensing connection protection (SENSE)		Turns the output off. ALARM LED illuminates.			
Overheat protection of the bleeder circuit (BOHP)		Turns the output off. ALARM LED illuminates.			
Shut down (SD)		Turns off the output or trips the breaker (turns the POWER switch off) ALARM LED illuminates.*1			

- \*1. Illuminates even when the breaker trips (even when the POWER switch is turned off). In this case, the LED illuminates for approximately 10 to 15 seconds.

## Output signals

			PAT20-200T	PAT40-100T	PAT60-67T	PAT160-25T	
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					
		three-phase input mode		10.00 V±0.25 V			
		single-phase input mode		7.50 V ± 0.25 V The upper limit is set at 75 % of the rating of the three-phase input mode			
	At 0 A output		0.00 V ± 0.25 V				
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, PHASE, FAN, SENSE, or SD) is detected.				
	PWR OFF STATUS		Stays on for approximately 10 s to 15 s after the POWER switch turns off.				
	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.

## Control function

			PAT20-200T	PAT40-100T	PAT60-67T	PAT160-25T
External control *1	EXT-V CV CONT *2, *3 (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 *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 (FAIL SAFE) CV CONT *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, *3 (CC external voltage control)					
		three-phase input mode	0 % to 100 % of the rated output current in the range of 0 V to 10 V.			
		single-phase input mode	0 % to 75 % of the rated output current in the range of 0 V to 7.5 V.			
	EXT-R CC CONT *2 (CC external resistance control normal)					
		three-phase input mode	0 % to 100 % of the rated output current in the range of 0 kΩ to 10 kΩ.			
		single-phase input mode	0 % to 75 % of the rated output current in the range of 0 kΩ to 7.5 kΩ.			
	EXT-R (FAIL SAFE) *2 CC CONT (CC external resistance control FAIL SAFE)					
		three-phase input mode	100 % to 0 % of the rated output current in the range of 0 kΩ to 10 kΩ.			
		single-phase input mode	75 % to 0 % of the rated output current in the range of 0 kΩ to 7.5 kΩ.			
	OUTPUT ON/OFF CONT *4		Output on with a low TTL level signal/output on with a high TTL level signal.			
SHUT DOWN *5		Output off with a low TTL level signal.				

\*1. J1 connector on the rear panel.

\*2. Set EXT-V, EXT-R and EXT-R (FAIL SAFE) in the CONFIG settings. The selected function is enabled.

\*3. 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.

\*4. Set the logic low/high using CONFIG settings.

\*5. 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

		PAT20-200T	PAT40-100T	PAT60-67T	PAT160-25T
Common specifications	Software 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) <sup>*1</sup>			
		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 <sup>*2</sup>	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 <sup>*2</sup>	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 <sup>*2</sup>	Hardware	IEEE 802.3 100Base-TX/10Base-T Ethernet Complies with the LXI Class C, Specification 1.2.			
		IPv4, RJ-45 connector <sup>*3</sup>			
	Communications protocol	VXI-11			
Program message terminator	LF or END during reception, LF+END during transmission.				

\*1. Use a cross cable (null modem cable).

\*2. Factory option.

\*3. Category 5, use a straight cable.

## Other functions

- Master-Slave parallel operation
- Output status setting at power-on setting
- Output on / off delay setting
- Preset memory
- Lock
- Fine adjustment
- Voltage / current setting limit
- Communication error display



## General specifications

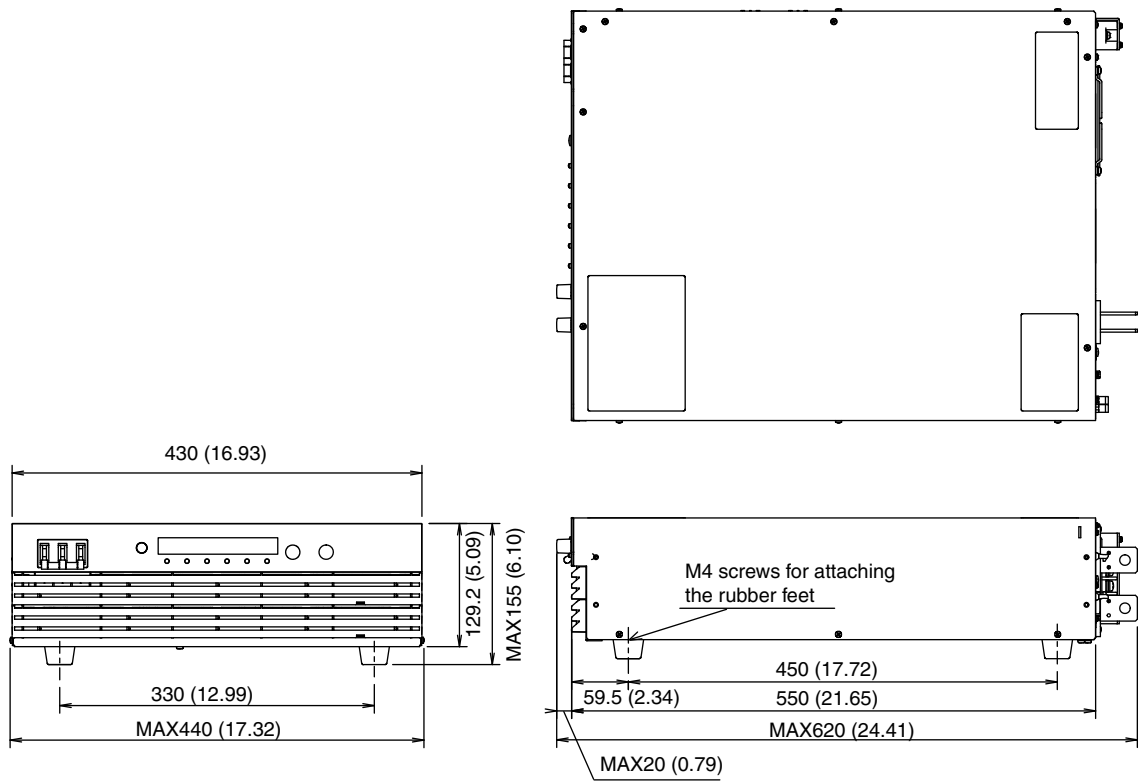
		PAT20-200T	PAT40-100T	PAT60-67T	PAT160-25T
Weight (main unit only)		Approx. 20 kg (Approx. 44 lbs.)	Approx. 19 kg (Approx. 42 lbs.)	Approx. 18 kg (Approx. 40 lbs.)	
Dimensions		See the outline drawing			
Environmental conditions	Operating conditions	Indoor use, Overvoltage Category II			
	Operating temperature	0 °C to +50 °C (+32 °F to +122 °F)			
	Operating humidity	20 %rh to 85 %rh (no condensation)			
	Storage temperature	-25 °C to +70 °C (-13 °F to +158 °F)			
	Storage humidity	90 %rh or less (no condensation)			
	Altitude	Up to 2000 m (Approx. 6560 ft)			
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 circuit and chassis	No abnormalities at 1500 Vac for 1 minute.			
	Across the primary and secondary circuits				
	Across the secondary circuit and chassis	No abnormalities at 500 Vdc for 1 minute.			
Insulation resistance	Across the primary circuit and chassis	500 Vdc, 30 MΩ or more. (at a humidity of 70 %rh or less)			
	Across the primary and secondary circuits				
	Across the secondary circuit and chassis				
Safety *1		Designed based on the requirements of the following standard. IEC 61010-1: 2001 (Class I <sup>*2</sup> , Pollution degree 2 <sup>*3</sup> )			
Accessories	OUTPUT terminal cover	2 sets (with screws)			
	Output terminal bolt set	2 sets (M10×20 mm Bolts, nuts, spring washers)			
	Heavy object warning label	1 pc.			
	J1/J2 connector kit	1 set (2 sets of protection covers, 2 sockets, and 30 pins)			
	Chassis connection wire	1 set (with screws)			
	Quick reference	Japanese: 1 copy, English: 1 copy			
	Setup Guide	1 copy			
	Safety information	1 copy			
	CD-ROM	1 pc.			

\*1. Not applicable to custom order models.

\*2. This is a Class I equipment. Be sure to ground the PAT's protective conductor terminal. The safety of this product is only guaranteed when the product is properly grounded.

\*3. Pollution is addition of foreign matter (solid, liquid or gaseous) that may produce a reduction of dielectric strength or surface resistivity. Pollution Degree 2 assumes that only non-conductive pollution will occur except for an occasional temporary conductivity caused by condensation.

## Dimensions



Unit: mm (inch)

Fig.6-1 PAT-T series 4 kW type outline drawing

## 6.2 8 kW type

### Model-specific specifications (Models rated output < 250 V)

#### AC input

		PAT20-400T	PAT30-266T	PAT40-200T	PAT60-133T	PAT80-100T	PAT160-50T
Nominal input rating	200 V input	200 V to 240 V, 50 Hz to 60 Hz, three-phase					
	400 V input	400 V, 50 Hz to 60 Hz, three-phase					
	Input voltage between U-G, V-G, and W-G <sup>*1</sup>	±254 Vmax					
Input voltage range	200 V input	180 V to 250 V					
	400 V input	360 V to 440 V					
Input frequency range		47 Hz to 63 Hz					
Hold-up time for power interruption	200 V input	20 ms or greater (at 50 % load), 10 ms or greater (at the rated load)					
	400 V input	20 ms or greater (at 50 % load), 5 ms or greater (at the rated load)					
Current (MAX) <sup>*2</sup>	200 V input	32.0 A					
	400 V input	18.0 A					
Inrush current (MAX) <sup>*3</sup>	200 V input	100 Apeak					
	400 V input	40 Apeak					
Wattage (MAX) <sup>*2</sup>		10 kVA					
Power factor (TYP) <sup>*4</sup>		0.95					
Efficiency (TYP) <sup>*4</sup>		85 %					

\*1. At input terminals of the PAT.

\*2. At the rated load.

\*3. 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).

\*4. Input voltage of 200 Vac (400 V input voltage of 400 Vac), at the rated load.

## Output

		PAT20-400T	PAT30-266T	PAT40-200T	PAT60-133T	PAT80-100T	PAT160-50T	
Rating	Output power	8 kW						
	Output voltage	20.00 V	30.00 V	40.00 V	60.00 V	80.00 V	160.0 V	
	Output current	400.0 A	266.0 A	200.0 A	133.0 A	100.0 A	50.0 A	
Voltage	Preset range <sup>*1</sup>	0 % to 105 % of rtg						
	Setting accuracy <sup>*2</sup>	± (0.2 % of rtg +50 mV)						
	Line regulation <sup>*3</sup>	± (0.05 % of rtg +5 mV)						
	Load regulation <sup>*4</sup>	± (0.1 % of rtg +5 mV)						
	Transient response <sup>*5</sup>	5 ms						
	Ripple noise	(p-p) <sup>*6</sup>	100 mV	300 mV	300 mV	350 mV		
		(rms) <sup>*7</sup>	10 mV	20 mV	30 mV	30 mV		
	Rise time (MAX) <sup>*8</sup>	Rated load	100 ms					
		No load	100 ms					
	Fall time (MAX) <sup>*9</sup>	Rated load	100 ms					
No load		2000 ms						
Temperature coefficient (MAX) <sup>*10</sup>	100 ppm/°C (during external control)							
Current	Preset range <sup>*1</sup>	0 % to 105 % of rtg						
	Setting accuracy <sup>*2</sup>	± (0.5 % of rtg +50 mA)						
	Line regulation <sup>*3</sup>	± (0.1 % of rtg +30 mA)						
	Load regulation <sup>*4</sup>	± (0.2 % of rtg +30 mA)						
	Ripple noise (rms) <sup>*7</sup>	500 mA	400 mA	400 mA	350 mA	300 mA	200 mA	
	Temperature coefficient (TYP) <sup>*10</sup>	200 ppm/ °C (during external control)						

- \*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. When the remote sensing function is used.
- \*6. When the measurement frequency bandwidth is 10 Hz to 20 MHz.
- \*7. Output voltage is 10 % to 100 % of the rating 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.

## General specifications

		PAT20-400T	PAT30-266T	PAT40-200T	PAT60-133T	PAT80-100T	PAT160-50T
Weight (main unit only)	200 V input	Approx. 26 kg (57.32 lb)	Approx. 27 kg (59.52 lb)	Approx. 25 kg (55.12 lb)	Approx. 24 kg (52.91 lb)		
	400 V input	Approx. 27 kg (59.52 lb)	Approx. 27 kg (59.52 lb)	Approx. 25 kg (55.12 lb)	Approx. 24 kg (52.91 lb)		
Dimensions		See the outline drawing					
Environ-mental conditions	Operating conditions	Indoor use, Overvoltage Category II					
	Operating temperature	0 °C to +50 °C (32 °F to +122 °F)					
	Operating humidity	20 %rh to 85 %rh (no condensation)					
	Storage temperature	-25 °C to +70 °C (-13 °F to +158 °F)					
	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 circuit and chassis						
	200 V input	No abnormalities at 1500 Vac for 1 minute.					
	400 V input	No abnormalities at 1500 Vac for 5 seconds.					
	Across the primary and secondary circuits						
	200 V input	No abnormalities at 1500 Vac for 1 minute.					
	400 V input	No abnormalities at 1500 Vac for 5 seconds.					
Across the secondary circuit and chassis		No abnormalities at 500 Vdc for 1 minute.					
Insulation resistance	Across the primary circuit and chassis	500 Vdc, 30 MΩ or more. (at 70 %rh or less)					
	Across the primary and secondary circuits						
	Across the secondary circuit and chassis						
Safety *1		Designed based on the requirements of the following standard. IEC 61010-1 (Class I <sup>2</sup> , Pollution degree 2 <sup>*3</sup> )					
Accesso- ries	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)		
	Heavy object warning label	1 pc.					
	J1/J2 connector kit	1 set (2 sets of protection covers, 2 plugs, and 30 pins)					
	Chassis connection wire	1 set (with screws)					
	Quick reference	Japanese: 1 copy, English: 1 copy					
	Setup guide	1 copy					
	Safety information	1 copy					
	CD-ROM	1 pc.					

- \*1. Not applicable to custom order models.
- \*2. This is a Class I equipment. Be sure to ground the PAT's protective conductor terminal. The safety of this product is only guaranteed when the product is properly grounded.
- \*3. Pollution is addition of foreign matter (solid, liquid or gaseous) that may produce a reduction of dielectric strength or surface resistivity. Pollution Degree 2 assumes that only non-conductive pollution will occur except for an occasional temporary conductivity caused by condensation.

## Model-specific specifications (Models rated output $\geq 250$ V)

### AC input

		PAT250-32T	PAT350-22.8T	PAT500-16T	PAT650-12.3T	PAT850-9.4T	PAT1000-8T	PAT1500-5.3T
Nominal input rating	200 V input	200 V to 240 V, 50 Hz to 60 Hz, three-phase						
	400 V input	400 V, 50 Hz to 60 Hz, three-phase					-	-
	Input voltage between U-G, V-G, and W-G <sup>*1</sup>	$\pm 254$ Vmax					-	-
Input voltage range	200 V input	180 V to 250 V						
	400 V input	360 V to 440 V					-	-
Input frequency range		47 Hz to 63 Hz						
Hold-up time for power interruption	200 V input	20 ms or greater (at 50 % load), 10 ms or greater (at the rated load)						
	400 V input	20 ms or greater (at 50 % load), 5 ms or greater (at the rated load)					-	-
Current (MAX) <sup>*2</sup>	200 V input	32.0 A						
	400 V input	18.0 A					-	-
Inrush current (MAX) <sup>*3</sup>	200 V input	100 Apeak						
	400 V input	40 Apeak					-	-
Wattage (MAX) <sup>*2</sup>		10 kVA						
Power factor (TYP) <sup>*4</sup>		0.95						
Efficiency (TYP) <sup>*4</sup>		85 %						

- \*1. At input terminals of the PAT.
- \*2. At the rated load.
- \*3. 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).
- \*4. Input voltage of 200 Vac (400 V input voltage of 400 Vac), at the rated load.

## Output

		PAT250-32T	PAT350-22.8T	PAT500-16T	PAT650-12.3T	PAT850-9.4T	PAT1000-8T	PAT1500-5.3T	
Rating	Output power	8 kW							
	Output voltage	250.0 V	350.0 V	500.0 V	650.0 V	850.0 V	1000.0 V	1500.0 V	
	Output current	32.00 A	22.80 A	16.00 A	12.30 A	9.40 A	8.00 A	5.30 A	
Voltage	Preset range <sup>*1</sup>	0 % to 105 % of rtg							
	Setting accuracy <sup>*2</sup>	± (0.2 % of rtg +50 mV)							
	Line regulation <sup>*3</sup>	± (0.05 % of rtg +5 mV)							
	Load regulation <sup>*4</sup>	± (0.1 % of rtg +5 mV)							
	Transient response <sup>*5</sup>	5 ms							
	Ripple noise								
	(p-p) <sup>*6</sup>	200 V input	450 mV	450 mV	600 mV		800 mV	1200 mV	
		400 V input	540 mV	540 mV	720 mV		-	-	
	(rms) <sup>*7</sup>		50 mV	50 mV	100 mV		150 mV	200 mV	
	Rise time (MAX) <sup>*8</sup>	Rated load	100 ms						
		No load	100 ms						
Fall time (MAX) <sup>*9</sup>	Rated load	100 ms	200 ms						
	No load	2000 ms	4000 ms			5000 ms	6000 ms		
Temperature coefficient (MAX) <sup>*10</sup>		100 ppm/°C (during external control)							
Current	Preset range <sup>*1</sup>	0 % to 105 % of rtg							
	Setting accuracy <sup>*2</sup>	± (0.5 % of rtg +50 mA)			± (1.0 % of rtg +100 mA)				
	Line regulation <sup>*3</sup>	± (0.1 % of rtg +30 mA)							
	Load regulation <sup>*4</sup>	± (0.2 % of rtg +30 mA)							
	Ripple noise (rms) <sup>*7</sup>		200 mA	200 mA	200 mA	150 mA	120 mA		
	Temperature coefficient (TYP) <sup>*10</sup>		200 ppm/°C (during external control)						

- \*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 rated 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.  
When the remote sensing function is used.
- \*6. When the measurement frequency bandwidth is 10 Hz to 20 MHz.
- \*7. Output voltage is 10 % to 100 % of the rating 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.

## General specifications

		PAT250-32T	PAT350-22.8T	PAT500-16T	PAT650-12.3T	PAT850-9.4T	PAT1000-8T	PAT1500-5.3T	
Weight (main unit only)	200 V input	Approx. 23 kg (50.71 lb)			Approx. 22 kg (48.50 lb)	Approx. 23 kg (50.71 lb)			
	400 V input	Approx. 23 kg (50.71 lb)	Approx. 24 kg (52.91 lb)		Approx. 22 kg (48.50 lb)	Approx. 24 kg (52.91 lb)	-		
Dimensions		See the outline drawing							
Environmental conditions	Operating conditions	Indoor use, Overvoltage Category II							
	Operating temperature	0 °C to +50 °C (32 °F to +122 °F)							
	Operating humidity	20 %rh to 85 %rh (no condensation)							
	Storage temperature	-25 °C to +70 °C (-13 °F to +158 °F)							
	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		±500 Vmax		±800 Vmax		±1000 Vmax	±1250 Vmax	±2000 Vmax	
Withstand voltage	Across the primary circuit and chassis								
	200 V input		No abnormalities at 1500 Vac for 1 minute.						
	400 V input		No abnormalities at 1500 Vac for 5 seconds.					-	
	Across the primary and secondary circuits								
	200 V input		No abnormalities at 1500 Vac for 1 minute.						
	400 V input		No abnormalities at 1500 Vac for 5 seconds.					-	
Across the secondary circuit and chassis		No abnormalities at 500 Vdc for 1 minute.	No abnormalities at 800 Vdc for 1 minute.		No abnormalities at 1000 Vdc for 1 minute.	No abnormalities at 1250 Vdc for 1 minute.	No abnormalities at 2000 Vdc for 1 minute.		
Insulation resistance	Across the primary circuit and chassis		500 Vdc, 30 MΩ or more. (at 70 %rh or less)	800 Vdc, 30 MΩ or more. (at 70 %rh or less)	1000 Vdc, 30 MΩ or more. (at 70 %rh or less)	1250 Vdc, 30 MΩ or more. (at 70 %rh or less)	2000 Vdc, 30 MΩ or more. (at 70 %rh or less)		
	Across the primary and secondary circuits								
	Across the secondary circuit and chassis								
Safety *1		Designed based on the requirements of the following standard. IEC61010-1 (Class I <sup>2</sup> , Pollution degree 2 <sup>3</sup> )					-		





		PAT250-32T	PAT350-22.8T	PAT500-16T	PAT650-12.3T	PAT850-9.4T	PAT1000-8T	PAT1500-5.3T	
Accessories	OUTPUT terminal cover	2 sets (with screws)					1 set (with screws)		
	Output terminal bolt set	2 sets (M8 × 20 mm bolts, nuts, and spring washers)					-		
	Heavy object warning label	1 pc.							
	J1/J2 connector kit	1 set (2 sets of protection covers, 2 plugs, and 30 pins)							
	Chassis connection wire	1 set (with screws) <sup>*4</sup>							
	Quick reference	Japanese: 1 copy, English: 1 copy							
	Setup guide	1 copy							
	Safety information	1 copy							
	CD-ROM	1 pc.							

\*1. Not applicable to custom order models.

\*2. This is a Class I equipment. Be sure to ground the PAT's protective conductor terminal. The safety of this product is only guaranteed when the product is properly grounded.

\*3. Pollution is addition of foreign matter (solid, liquid or gaseous) that may produce a reduction of dielectric strength or surface resistivity. Pollution Degree 2 assumes that only non-conductive pollution will occur except for an occasional temporary conductivity caused by condensation.

\*4. Chassis connection wire only for the PAT1000-8T and PAT1500-5.3T. Screws are not included.

## 8 kW type Common specifications

### Display function

Common specifications			
Voltmeter	Maximum display	Models rated below 100 V	99.99 (fixed decimal point)
		Models rated 100 V or greater or rated below 1 000 V	999.9 (fixed decimal point)
		Models rated at 1 000 V or greater	9999
	Display accuracy		$\pm(0.2\% \text{ of rdng} + 5 \text{ digits})$ at 23 °C $\pm$ 5 °C
Ammeter	Maximum display	Models rated below 50.0 V	99.99 (fixed decimal point)
		Models rated at 50.0 V or greater	999.9 (fixed decimal point)
	Display accuracy		$\pm(0.5\% \text{ of rdng} + 5 \text{ digits})$ at 23 °C $\pm$ 5 °C
Operation display	OUTPUT ON/OFF		ON: OUTPUT LED illuminates (Green LED). OFF: OUTPUT LED turns off.
	ALARM operation		ALARM LED illuminates (Red LED). *1
	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. Illuminates even when the breaker trips (even when the POWER switch is turned off). In this case, the LED illuminates for approximately 10 to 15 seconds.

## Protection functions

Common specifications	
Overvoltage protection (OVP)	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)	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)	Turns the output off (the breaker trips for 400 V input model). ALARM LED illuminates. *1
Input open-phase protection (PHASE)	Turns the output off. ALARM LED illuminates.
Fan failure protection (FAN)	Turns the output off. ALARM LED illuminates.
Incorrect sensing connection protection (SENSE)	Turns the output off. ALARM LED illuminates.
Overheat protection of the bleeder circuit (BOHP)	Turns the output off. ALARM LED illuminates.
Shut down (SD)	Turns off the output or trips the breaker (turns the POWER switch off). ALARM LED illuminates. *1

\*1. Illuminates even when the breaker trips (even when the POWER switch is turned off). In this case, the LED illuminates for approximately 10 to 15 seconds.

## Output signals

Common specifications			
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
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.
	PWR ON STATUS		Turns on when the POWER switch is on.

\*1. J1 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.

## Control functions

Common specifications		
External control *1	EXT-V CV CONT *2 *3 (CV external voltage control)	0 % to 100 % of the rated output voltage in the range of 0 V to 10 V.
	EXT-V (FAST) CV CONT *2 *3 (CV external voltage control FAST)	0 % to 100 % of the rated output voltage in the range of 0 V to 10 V.
	EXT-R CV CONT *2 (CV external resistance control)	0 % to 100 % of the rated output voltage in the range of 0 kΩ to 10 kΩ.
	EXT-R (FAIL SAFE) CV CONT *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 *3 (CC external voltage control)	0 % to 100 % of the rated output current in the range of 0 V to 10 V.
	EXT-V (FAST) CC CONT *2 *3 (CC external voltage control FAST)	0 % to 100 % of the rated output current in the range of 0 V to 10 V.
	EXT-R CC CONT *2 (CC external resistance control)	0 % to 100 % of the rated output current in the range of 0 kΩ to 10 kΩ.
	EXT-R (FAIL SAFE) CC CONT *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 *4	Output on with a low TTL level signal/output on with a high TTL level signal.
	SHUT DOWN *5	POWER switch off with a low TTL level signal.

\*1. J1 connector on the rear panel.

\*2. Set EXT-V, EXT-V (FAST), EXT-R, and EXT-R (FAIL SAFE) in the CONFIG settings. The selected function is enabled.

\*3. The input impedance EXT-V CV CONT, EXT-V (FAST) CV CONT and EXT-V CC CONT, EXT-V (FAST) CC CONT is approximately 100 kΩ.

The setting accuracy is  $\pm 5$  % of the rated output voltage or  $\pm 5$  % of the maximum output current.

\*4. Set the logic low/high using CONFIG settings.

\*5. 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

Common specifications		
Common specifications	Software 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) <sup>*1</sup>
		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 <sup>*2</sup>	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 <sup>*2</sup>	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 <sup>*2</sup>	Hardware	IEEE 802.3 100Base-TX/10Base-T Ethernet
		Complies with the LXI Class C, Specification 1.2.
	Communications protocol	IPv4, RJ-45 connector <sup>*3</sup>
	Program message terminator	VXI-11
		LF or END during reception, LF+END during transmission.

\*1. Use a cross cable (null modem cable).

\*2. Factory option.

\*3. Category 5, use a straight cable.

## Other functions

- Master-Slave parallel operation
- Output status setting at power-on setting
- Output on / off delay setting
- Preset memory
- Lock
- Fine adjustment
- Voltage / current setting limit
- Communication error display

## Dimensions

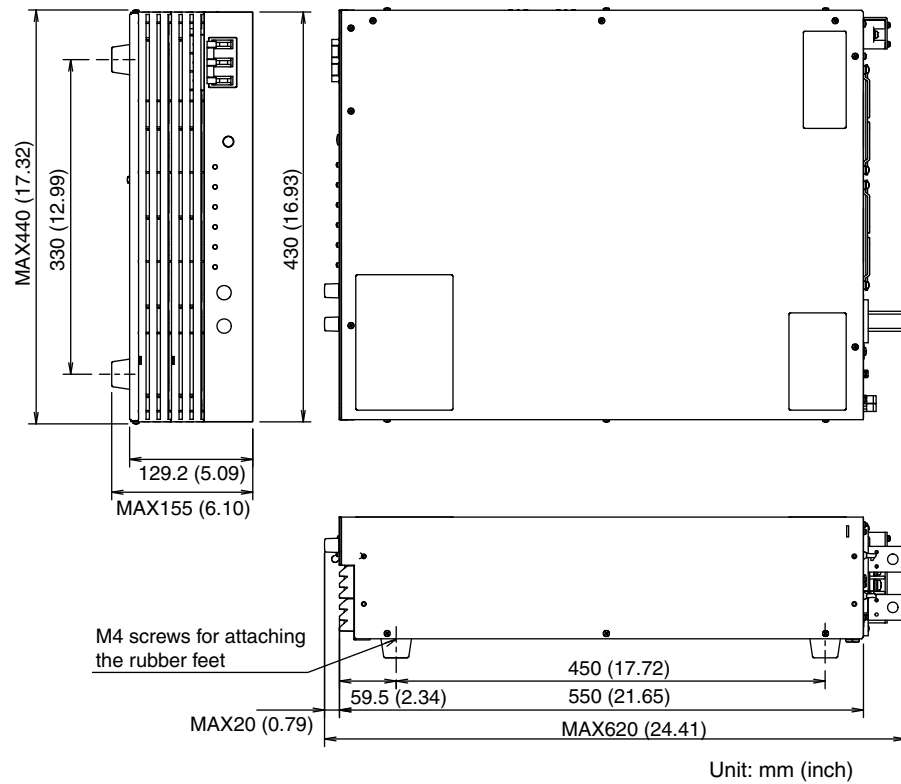


Fig.6-2 PAT-T series 8 kW type  
Model of rated output 20 V to 850 V outline drawing

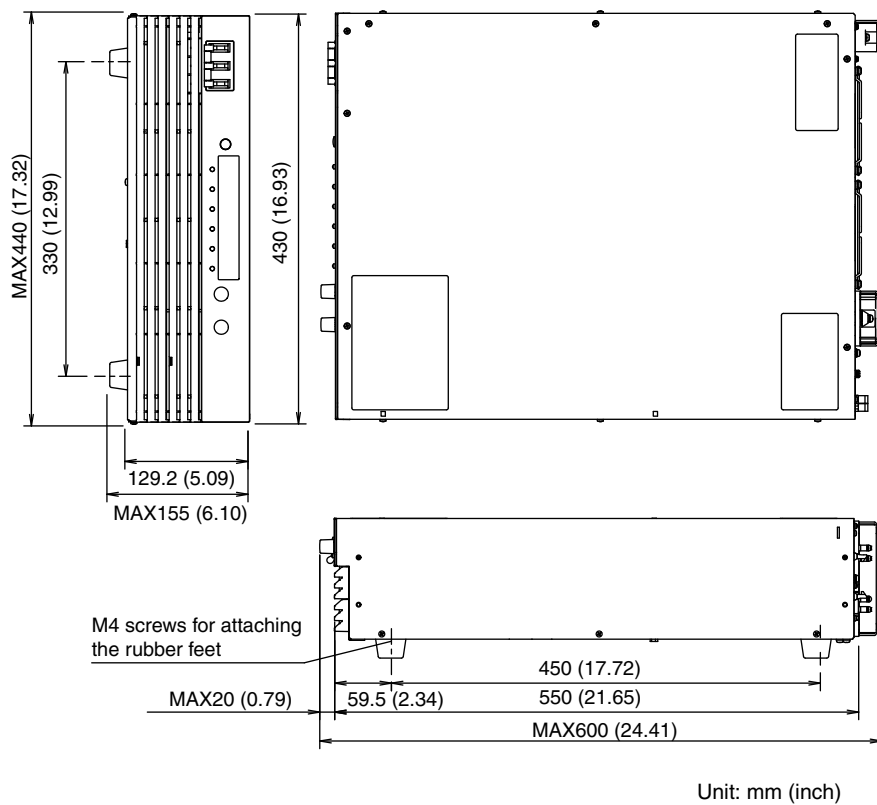


Fig.6-3 PAT-T series 8 kW type  
Model of rated output 1000 V and 1500 V outline drawing



# Appendix

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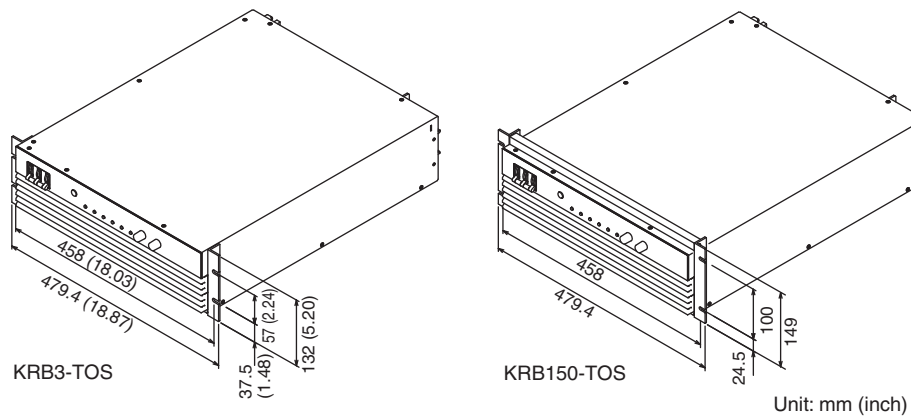
The appendix contains options and troubleshooting.

# A.1 Options

The options listed below are available for the PAT-T Series.  
 For details on the options, contact your Kikusui agent or distributor.

## Rack mounting option

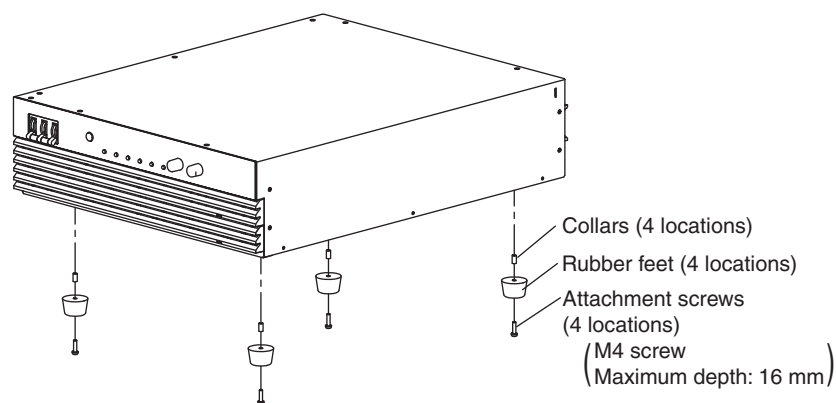
Product	Model	Note
Rack mount bracket	KRB3-TOS	Inch rack EIA standard
	KRB150-TOS	Milli rack JIS standard



For details on rack mounting, see the KRB3-TOS or KRB150-TOS Manual.  
 Install the suitable support angles applying to the used rack system to support the instrument.

### ■ Removing the rubber feet

Remove the rubber feet before rack mounting the product to a frame.  
 Unfasten the screws and remove the four rubber feet.  
 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.

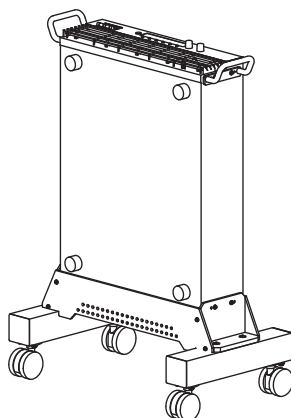




## Vertical stand

A vertical stand is used as a stand to hold the equipment 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)



## Power cable (for three-phase input)

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

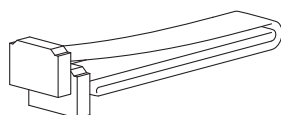


See p. 76

## Cable for parallel operation

A cable used when performing parallel operation.

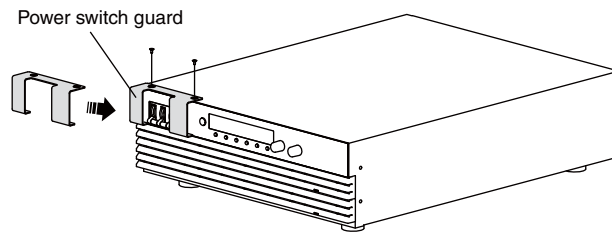
Product	Model	Note
Cable for parallel operation	PC01-PAT	250 mm 26 pins



## Power switch guard

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

Product	Model	Note
Power switch guard	OP01-PAT	-





## A.2 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.

 p. 49


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	
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.	–
	Is the wiring to the U, V, W, and GND of the AC INPUT terminal correct?	Connect the cable correctly.	–
	 When the unit is operated under the three-phase input mode, is the wiring connected to the single-phase input power?	Connect the cable correctly.	–
On the 400 V input model, when the POWER switch is turned on, it is turned off again immediately.	Are you turn the POWER switch on and off at an interval of 40 s or less?	After you turn the POWER switch off, wait for at least 40 s before you turn it back on.	–
	Is the input voltage too high (above 440 Vac)?	If you experience this problem even when the input voltage is within the specified input voltage range, the PAT may be broken. Contact your Kikusui agent or distributor.	–
	Is the overheat protection (OHP) feature activated?	The internal temperature is abnormally high. Check the operating conditions. After you have removed the cause of the abnormal temperature, turn the power switch on.	p. 31
The dust filter may be clogged, or the fan may be broken. Check them.		p. 88	

Appx

### The OVP is activated and the POWER switch is turned off.

Symptom	Check Items	Remedy	
When the POWER switch is turned on, the OVP is activated, and the POWER switch is turned off.	Use external control to turn the output off (short pins 13 and 14 on the J1 connector), and then turn the POWER switch on. Afterwards, check the following: 1. Is the output status setting at power-on set to on (CF25: ON)? 2. Is the breaker trip setting when the OVP or OCP is activated set to trip (CF28: ON)? 3. Is the OVP trip point set to a voltage that is below the output voltage?	If the answers to questions 1, 2, and 3 are yes, when you turn the POWER switch on, the OVP will be activated, and the POWER switch will be turned back off again. Either change the OVP trip point, or reset the PAT to its factory default settings.	p. 22

## 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.	p. 26	
	Are you performing output on/off control using an external contact?	Yes	Turn the output on using the external contact.	p. 67
		No	Set the external control logic setting of the output on/off to "turn the output on with a high signal" (CF22: H).	p. 37

## 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).	p. 38
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)	p. 38
Unable to set the output current to the rated value.	<b>4kW</b> Is the product used in the single-phase input mode?	When the phase input mode is set to the single-phase input mode, the output current is limited to 75 % of the rated value of the three-phase input mode.	p. 20

## 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.	p. 24 p. 26
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.	p. 45
	Are both the CV LED and the CC LED turned on?	<ul style="list-style-type: none"> <li>If the output is oscillating when using remote sensing, insert a capacitor across the load.</li> <li>The circuitry may have malfunctioned. Immediately stop the use of the PAT and request repairs.</li> </ul>	p. 45
	Does the sensing cable or load cable have poor contact or is the cable broken?	Turn off the POWER switch and check the wiring.	–
	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.	p. 26
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.	–

Appx

## 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.	–
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.	p. 45

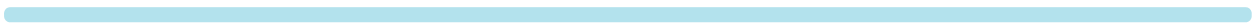
## The ALARM indicator illuminates when the OUTPUT switch is turned on.

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.	p. 28
	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.	p. 28
	Is the remote sensing function turned on?	If you are not using the remote sensing function, turn off the sensing switch.	p. 45
	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.	p. 45
	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).	p. 45
	Is the control cable loose in the external control?	Connect it correctly.	Chap 3
	Is the external voltage excessive in the external control?	Apply the correct voltage.	p. 59 p. 63
	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.	–
	Is the internal temperature is abnormally high?	The overheat protection function is activated. Check the operating environment.	p. 31
		The dust filter may be clogged, or the fan may be broken. Check them.	p. 88
 When the product is set to the three-phase input mode, isn't the power distribution line arranged for the single-phase input?	Confirm the status of the input power phase mode.	p. 33	
The ALARM LED illuminates when the load is changed.	Is a large external voltage applied such as with a battery load?	<ul style="list-style-type: none"> <li>The overvoltage protection function or the overcurrent protection function may be activated. Check them.</li> <li>The PAT may be overloaded. Check the load.</li> </ul>	p. 24
	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	
Unable to operate the panel switch.	Is the LOCK LED illuminated?	Release the panel operation lock.	p. 44
	Is the REMOTE LED illuminated?	To control the PAT from the panel, press the LOCAL switch to enable local mode	p. 45
	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) specified to the communication interface?	Use a communication command to clear the local lockout (llo).	p. 45



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