

AC Power Regulator APR

SCCR: 100 kA
(Three-phase APR-V 20 A to 250 A)



AC Power Regulator

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AC Power Regulator for Stabilizing Control – Fuji Electric APR

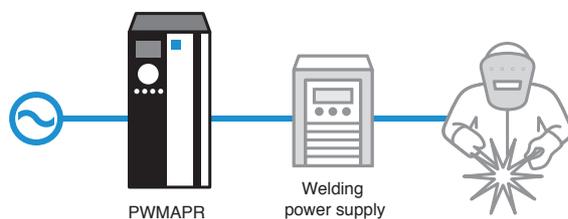
APR is an abbreviation for AC Power Regulator. An APR is a device that can adjust AC voltage, current, and power steplessly. It is widely used for temperature control of electric furnaces and heaters, as well as for light dimming and AC stabilization power supplies.

Fuji Electric's APRs use thyristors, IGBTs, and other semiconductors as main devices to stabilize control.

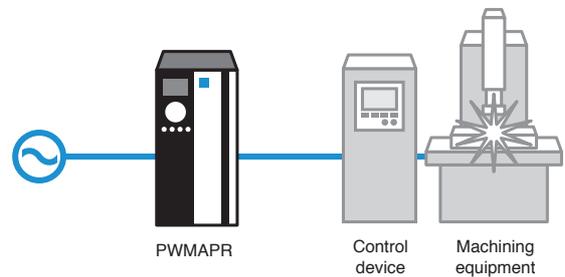
Application examples

Voltage stabilization

< Welding machines >

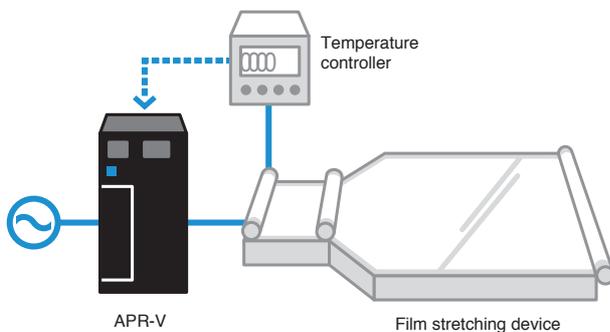


< Electric discharge machines >

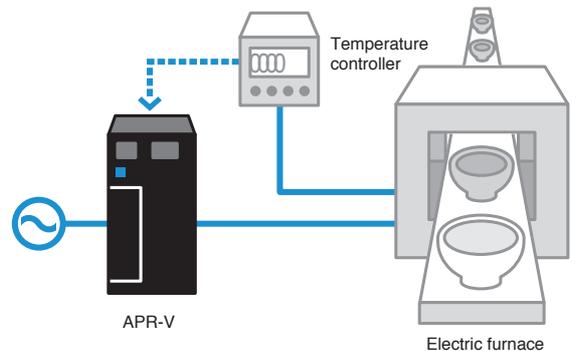


Heat controllers

< Film stretching devices >

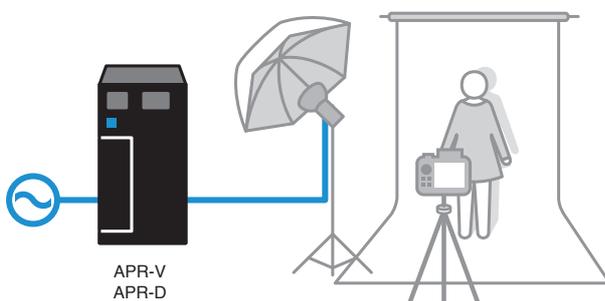


< Electric furnaces >

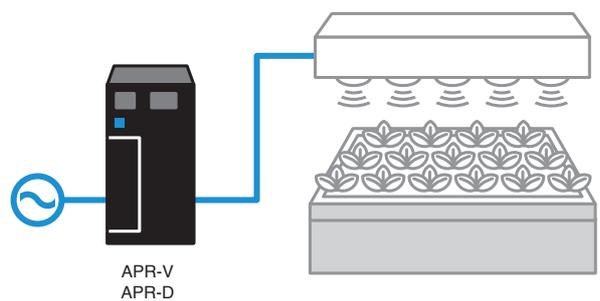


Light dimming

< Photo galleries >



< Plant factories >





Fuji AC Power Regulator [APR]

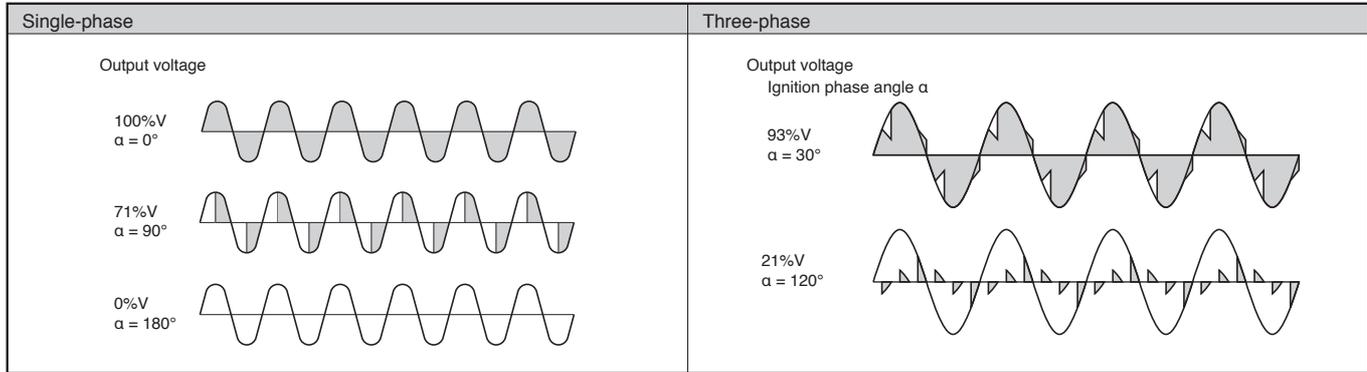
APR Model Selection Items

There are three waveform control methods for APRs: a phase control method for switching with thyristors, a cycle control method, and a PWM control method for switching with IGBTs.

Select a waveform control method after understanding the features of each method.

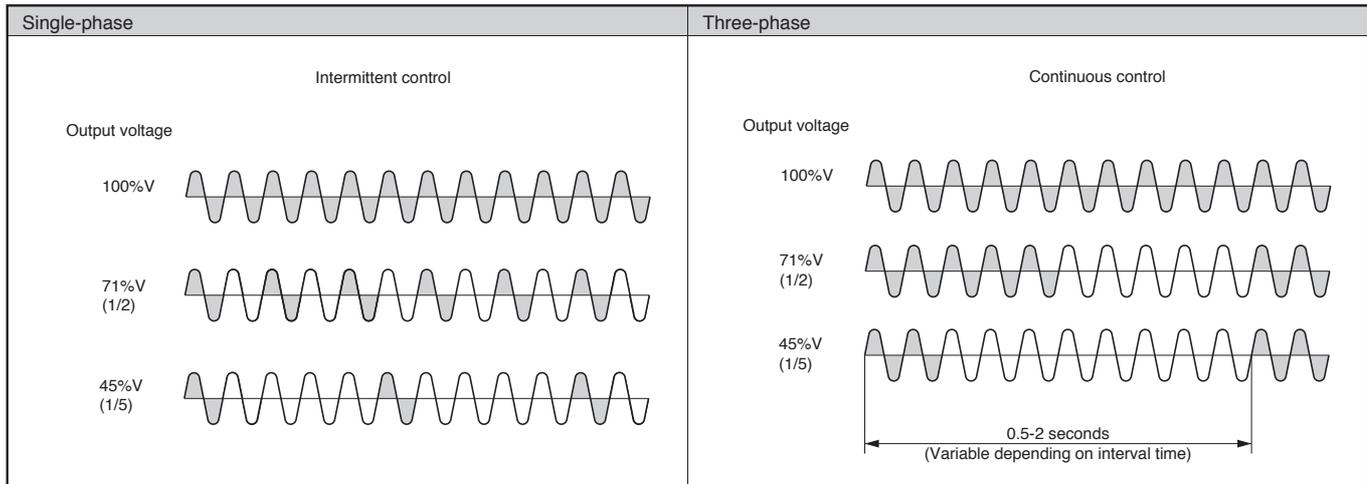
■ Phase control method (APR-V, APR-D)

The phase control method controls the voltage applied to the load from 0 to 100% by controlling the ignition phase angle α at each half cycle of the power supply frequency.



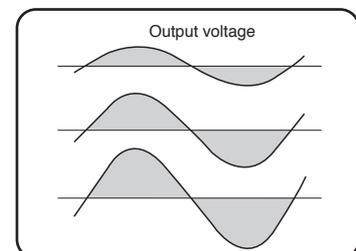
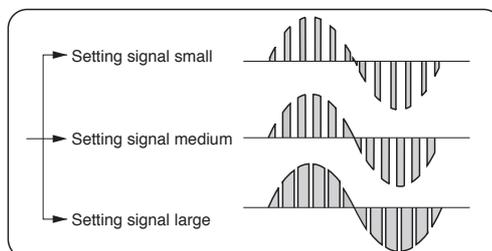
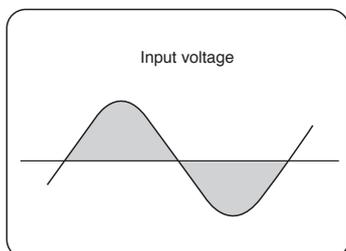
■ Cycle control method (APR-V, APR-D)

The cycle control method controls the voltage applied to the load from 0 to 100% by controlling the ratio of the on and off periods of one power supply voltage cycle within a fixed period (scanning interval).



■ PWM control method (PWMAPR-M, PWM-APR)

PWM (pulse width modulation) is a control method that applies a new main circuit configuration and high-frequency switching to control the amplitude of the output voltage. As a result, its output voltage waveform is a sine wave and it suppresses harmonic currents.



■ Features of each control method

The phase control method, cycle control method, and PWM control method have the following features and are used in various ways.

Item	PWM control method	Phase control method	Cycle control method
Applied load	Applicable to most loads, such as resistive loads, inductive loads, capacitor loads	Applicable to most loads, such as resistive loads, inductive loads (Capacitor loads are not available)	Applicable to nichrome, ferrochromium-based resistive loads (small temperature coefficient of resistance)
Transformer primary control	Available	Available	Not available (Available for types with control method P)
Feedback control (AVR, ACR, etc.)	Available (comes standard)	Available	Not available
Harmonic disturbance	No	Possible occurrence	No
Flicker occurrence	No	No	Possible occurrence
Responsiveness	Very fast	Fast	Slow
Power factor	Very good	Bad	Good

● Circuit classification of harmonic guidelines

- Phase control method : Circuit classification 7
- PWM control method : Circuit classification 6 (single phase),
5 (three phase)
- Cycle control : Not available

“Conversion factor Ki” of AC power regulator

Circuit classification	Circuit type	Conversion factor Ki	Major use cases
5	Self-excited three-phase bridge (Voltage type PWM control) (Current type PWM control)	K5 = 0	<ul style="list-style-type: none"> Uninterruptible power system Power supply device for communication Elevator Distributed power supply for grid connection
6	Self-excited single-phase bridge (Voltage type PWM control)	K6 = 0	<ul style="list-style-type: none"> Power supply device for communication AC electric rolling stock Distributed power supply for grid connection
7	Resistive load	K71 = 1.6	<ul style="list-style-type: none"> Reactive power adjusting device Large lighting system Heater
	Reactance load (Excluding those for AC arc furnaces)	K72 = 0.3	

■ Feedback control method

Control method	Code	Control method overview
No feedback function	T	No built-in CT. (No overcurrent detection, heater disconnection detection, etc.) Applied to loads with little resistance change, such as alloy heaters.
AC CLR	A	CLR = Current limit regulation: Limits output voltage so that output current does not exceed the CLR setting. Applied to applications for limiting the maximum current flowing to the load (e.g., pure metal heaters, etc.).
AC ACR + AC CLR	B	ACR = Automatic current regulation: Controls the flow of output current in proportion to the set value. Applied to pure metal heaters, direct current heating applications, etc. to maintain a constant current.
AC AVR + AC CLR	C	AVR = Automatic voltage regulation: Controls the output voltage in proportion to the set value. Applied to applications that require output voltage accuracy.
AC AWR + AC CLR	D	AWR = Automatic wattage regulation: Controls the output power in proportion to the set value. Applied to silicon carbide heaters and sensorless applications that control the heating amount.
DC feedback control + AC CLR (Feedback input: 0 to 10 V DC)	E	Applied when the secondary side of transformers, rectifiers, etc. require accuracy. Controls the feedback value to be 10 V DC when the set value is 100%.
Transformer primary control via cycle control	P	Single phase only. Can be applied to insulation transformers and resistive loads (resistance change 20% or less). If the load is 30% or less of the APR rated capacity, output will stop due to a load error.

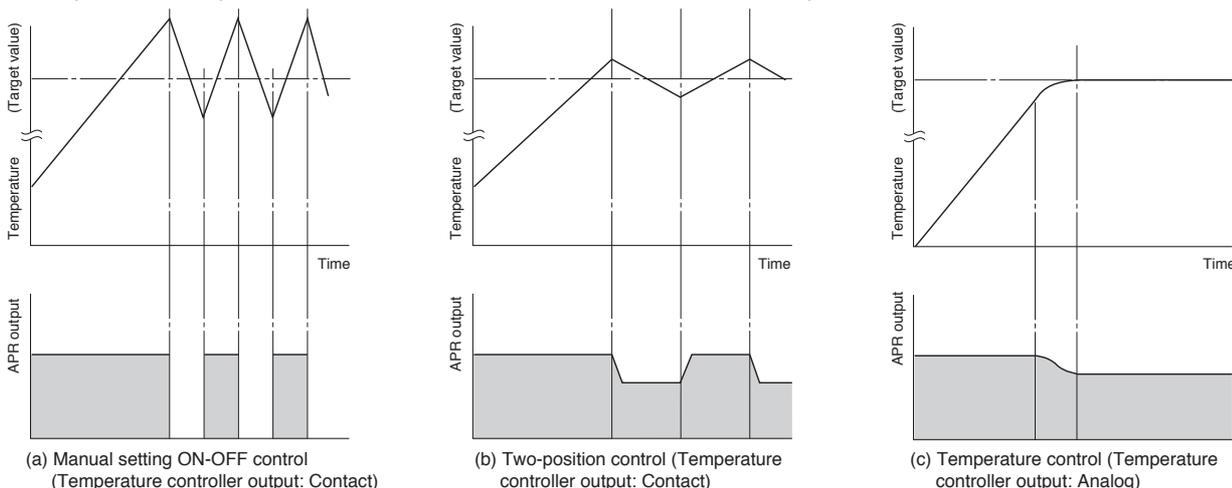
*The PWMAPR-M series supports B, C, and D as standard (switchable using the main unit setting). PWM-APR supports C only. D series single phase products support only T, A, and B, and three phase products support only T. Mini and aA series are not supported. For details, refer to “■ Feedback control method (PWMAPR-M, PWM-APR, APR-V)” on page 6 and the items in each series.

Gradient setter

A gradient setter is used to arbitrarily set the magnitude of the output with respect to the set signal. For example, if a 4 to 20 mA DC setting signal is input, the APR output voltage will be at its maximum value at 20 mA, but a gradient setter can be used to change the APR output voltage as desired. When controlling electric furnaces and other heaters, a gradient setter can play an important role as follows.

- Reduces the rated power of the heater and extends the life of the heater.
- Allows the heater to be preset to a lower voltage in anticipation of aging.
- Enables setting the upper limit of power applied to the load.

● Comparison of temperature control characteristics when combined with a temperature controller





■ Feedback control method (PWMAPR-M, PWM-APR, APR-V)

An APR without a feedback function outputs voltage in proportion to the output setting, but the output voltage and output current may vary due to power supply voltage fluctuations and load fluctuations.

There are also loads such as those of pure metal heaters that draw several to ten times their rated current at low temperatures.

Feedback control is a function that monitors the output status of the APR and automatically corrects the output so that the output is always as specified.

The APR-V series offers the following feedback control methods to meet application needs.

*PWMAPR-M is standard (switchable using the main unit setting). The PWMAPR-M series supports B, C, and D as standard (switchable using the main unit setting). PWM-APR supports C only.

*Select "E" for APR-V if "F" was used for APR-N.

Control method	Required external devices (sold separately)	Code	Control method overview
No feedback function	-	T	No built-in CT. (No overcurrent detection, heater disconnection detection, etc.) Applied to loads with little resistance change, such as alloy heaters.
AC CLR	-	A	CLR = Current limit regulation: Limits output voltage so that output current does not exceed the CLR setting. Applied to applications for limiting the maximum current flowing to the load (e.g., pure metal heaters, etc.).
AC ACR + AC CLR	-	B	ACR = Automatic current regulation: Controls the flow of output current in proportion to the set value. Applied to pure metal heaters, direct current heating applications, etc. to maintain a constant current.
AC AVR + AC CLR	VT (Type: PT-5S) single-phase: 1 unit VT (Type: PT-5S) three-phase: 2 units	C	AVR = Automatic voltage regulation: Controls the output voltage in proportion to the set value. Applied to applications that require output voltage accuracy.
AC AWR + AC CLR	VT (Type: PT-5S) single-phase: 1 unit VT (Type: PT-5S) three-phase: 2 units	D	AWR = Automatic wattage regulation: Controls the output power in proportion to the set value. Applied to silicon carbide heaters and sensorless applications that control the heating amount.
DC feedback control + AC CLR (Feedback input: 0 to 10 V DC)	Insulation converter (Fast-response product)	E	Applied when the secondary side of transformers, rectifiers, etc. require accuracy. Controls the feedback value to be 10 V DC when the set value is 100%.
Cycle control based Transformer primary control	Accessory CT (Type: CT-5S)	P	Single phase only. Can be applied to insulation transformers and resistive loads (resistance change 20% or less). If the load is 30% or less of the APR rated capacity, output will stop due to a load error.

• Advantages of AC CLR

• Advantages of selecting APR rated current

When selecting an APR, capacity should be selected considering safety factors such as the power supply voltage fluctuation +10%, temperature change in heater resistance +10%, and heater production error +10%. However, for APRs with CLR, selection can be made based on load rating because the actual output current is monitored to limit output.

• Expected to extend heater life by limiting the current flowing through the heater to within the rated value.

• Greatly reduces the possibility of damage due to fast fuse breakage or overload by using output current limiting and overcurrent detection functions.

• Feedback control example

Fig.1 shows an automatic voltage regulator for a DC power supply. In this circuit, the APR performs primary control of the transformer on the AC side.

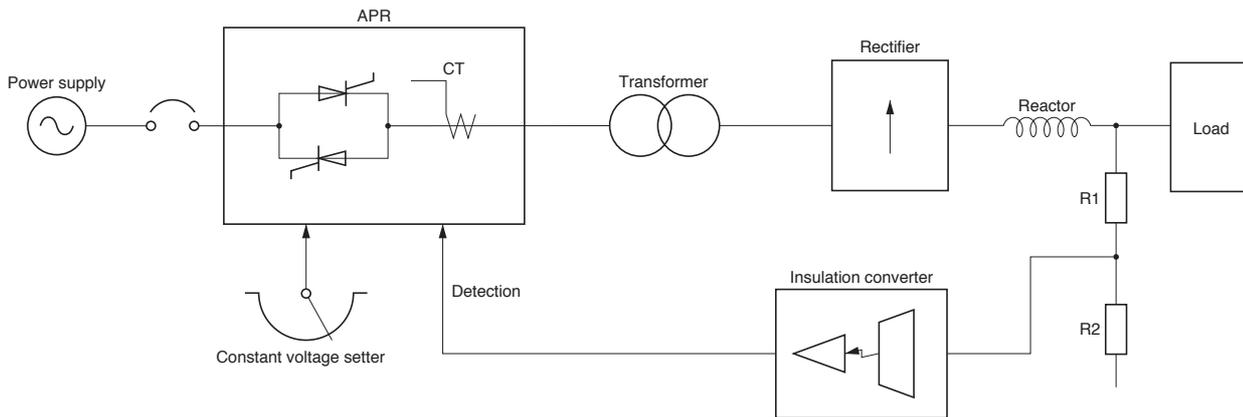


Fig.1 Automatic voltage regulator for DC power supply

The output voltage setting of the APR uses a variable resistance setting. The output voltage is supplied to the load through the transformer, rectifier, and reactor. The DC voltage divided between resistors R1 and R2 connected in front of the load is converted to a voltage insulated from the load side by an insulating converter. This voltage is then input to the APR as a detection value.

APR control uses DC automatic voltage regulation because the DC voltage detection value is input to the set value by the variable resistance setting. The variable resistance setter then serves as the constant voltage setter. The purpose of this control is to always maintain a constant voltage with respect to power

supply voltage fluctuations and load fluctuations.

The above is an example of DC automatic voltage regulation. If the circuit is configured to detect DC current, convert it to an insulated voltage, and input it to the APR, it serves as DC automatic current regulation.

If AC voltage (current) is used as the detection input to the APR instead of detection from a DC circuit as described above, AC automatic voltage regulation (AC automatic current regulation) will be performed.

In other words, the control method is determined based on what is input (feedback) to the APR for detection.

■ Precautions for each load type

APRs can be used for resistive loads (heater loads) and other loads, but the following precautions must be taken: Special attention should be paid to heater loads because the resistance value can vary greatly depending on the heater type and operating temperature, and the resistance values can change due to aging.

● APR selection guidelines

Load type	Model selection guidelines
Resistive load (Heater) <small>*Refer to Table 1.</small>	Nichrome/ferrochrome system In this system, all models can be used because the resistance change is not very large.
	Pure metal system Pure metal systems have a fairly low resistance at room temperature. (Several to dozens of times the rating), so be sure to set current limit regulation (CLR) .
	Silicon carbide Silicon carbide changes considerably with aging. This can cause it to reach 3-4 times its initial resistance over its lifetime. Generally, a transformer with a tap is used to change the voltage accordingly over time. If a transformer is not used, the output value of the APR can be changed as the load changes over time, by performing current limiting or by using a gradient setter. The recommended control method is automatic wattage regulation (AWR) . With this control system, the control follows the load changes over time and always applies a constant amount of power to the load to maintain a high level of control accuracy.
	Carbon Carbon is used in vacuum furnaces. Load shorting may occur in vacuum furnaces. The protection for load short-circuit is a fast-acting fuse, but if there is a current limiting function, the overcurrent gate-off function will also operate, so there are cases where the gate-off function can operate and provide protection without the fast-acting fuse blowing. For this reason, current limit regulation (CLR) is recommended.
Transformer primary control	The start-up sequence is important for transformer primary control. A start-stop signal and soft-start function need to be used to slowly increase the output voltage. In addition, it is necessary to investigate what will be connected to the load to determine the suitability of the model and the control method. If the secondary side of the transformer is open, a bleeder resistor must be added to the primary side to ensure stable control. The reason for this is that if the no-load current of the transformer is small, the thyristor cannot be ignited (turned ON) and only one side of the transformer will be controlled, and a large DC current will flow to the primary side of the transformer, which may cause the fast-acting fuse to blow or the thyristor to break. This abnormally large transformer primary current is called the "bias magnetism phenomenon".
Inductive load	The load current flows with a delay relative to the power supply voltage, so please pay attention to the model to be applied. Models with transformer primary control can handle this inductive load. Also, in the APR capacity calculation, the load capacity should be kVA, not kW.
Rectifier primary control	What is connected to the load is important in rectifier primary control. In general, rectifier primary control requires a transformer in the previous stage and is performed with DC power supply automatic voltage regulation (AVR) or automatic current regulation (ACR) .
Capacitive load (capacitor load)	It is not applicable for phase control APRs, but it can be used with our PWMAPR-M series . For example, it can be used for simple capacitor banks.

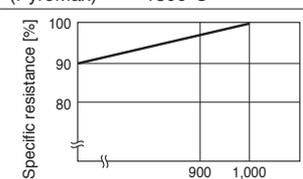
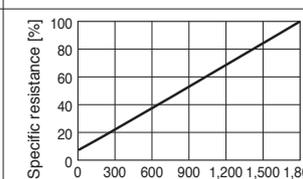
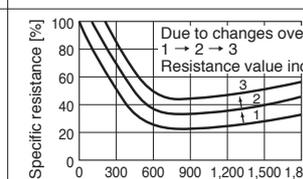
● Applicable models for various loads

Based on the above, the applicable models and recommended control methods for various loads are as follows.

Load type	Applicable models	Recommended control method
Resistive load (heater)	Nichrome/ferrochrome system	All control methods
	Pure metal system	Addition of CLR (A); ACR (B)
	Silicon carbide system	Addition of CLR (A); AWR (D)
	Carbon	Addition of CLR (A)
Transformer primary control	PWMAPR-M, APR-V, single-phase APR-D	Addition of CLR (A)
Inductive load	PWMAPR-M, APR-V, single-phase APR-D	Addition of CLR (A)
Rectifier primary control	PWMAPR-M, APR-V, single-phase APR-D	Addition of CLR (A)
Capacitive load (capacitor load)	PWMAPR-M	-

Table 1. Classification of heating elements

* atmospheric conditions

	Alloy system and carbon system	Pure metal system	Silicon carbide system
Type and maximum operating temperature	Nichrome 1100°C *	Molybdenum 1800°C *	Silicon carbide
Product name in parentheses ()	Ferrochrome 1200°C Graphite (Kanthal) 1300°C * (Kanthal A-1) 1375°C * (PyroMax) 1300°C	Tungsten 2400°C * Platinum 1400°C (Kanthal Super) 1700°C *	Amorphous carbon (GLOBAR) 1600°C * (Siliconit) 1600°C * (Erema) 1600°C *
Resistance temperature characteristics (example)			



■ APR Series selection

The following items must be confirmed in the selection process.

Item	Content		
Waveform control method?	PWM control (amplitude of sine wave), cycle control (ON/OFF for sine wave unit), phase control (change of conduction phase in sine wave)		
Number of power phases?	Single phase or three phase		
Voltage?	100 V system, 200 V system, 400 V system		
Current?	20 A, 45 A, 60 A, 100 A, etc.		
Setting method?	Manual (variable resistance), Automatic (4 to 20 mA, etc.)		
Type of load?	Resistive load	Alloy systems and carbon heaters (Those with resistance change of 10% or less due to temperature change)	Nichrome (including far-infrared), nickel, ferrochrome, graphite (Kanthal A, etc.)
		Pure metal heaters, lamps (Those with a large resistance change of several to dozens of times due to temperature change)	Tungsten (Including incandescent lamps and halogen lamps), platinum, molybdenum, tantalum, ceramic, (Kanthal Super, etc.)
		Silicon carbide heaters (Those with a resistance increase due to aging that is 3-4 times the initial value)	Silicon carbide, amorphous carbon (Erema, Siliconit, Tecorundum, etc.)
	Inductive load	Magnetizers, vibrators, etc.	
	Capacitive load	Capacitors, etc.	
	Transformer primary control	When a transformer is connected to the APR for resistive and inductive loads	
	Rectifier primary control	When a diode rectifier is connected to the APR as a DC power supply (LED lamp)	
Feedback function?	CLR Constant voltage, constant current, constant power		

APR Series Comparison Summary List (◎: Very good ○: Good △: Normal)

Series name	Function	Compact and lightweight
Single-phase PWM-APR-M, three-phase PWM-APR	◎	△
Single-phase APR-V, three-phase APR-V	◎	△
Single-phase APR-D, three-phase APR-D	○	◎

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■ Delivery dates

Please inquire about delivery date.



■ Features, applications, series configuration

Series name	Applications	Features	Appearance	Series	
				Type	Input voltage
Single-phase PWMAPR-M	<ul style="list-style-type: none"> • Test facility/laboratory facility, etc. high-precision constant-voltage power supplies • Rectifier-combined high-precision DC power supplies • Locations with poor power supply conditions (Voltage fluctuation) stabilization power supplies • Heater control • Dimming of various lights 	<ul style="list-style-type: none"> • Utilizes IGBT-equipped PWM control method to achieve sine wave output • No need for harmonic suppression measures 		RPME2□□□-M	200-240 V
Three-phase PWM-APR				RPWD2□□□-1C■	200-220 V
Single-phase APR-V	<ul style="list-style-type: none"> • Heater control • Dimming of incandescent lamps and LEDs • Vibrators • Rectifier-combined DC power supplies 	<ul style="list-style-type: none"> • Multifunction • Various applied loads • Various feedback control functions • Various current and voltage types • Phase control/cycle control • Built-in fast-acting fuse 		RPVE2□□□-□	100-240 V
Three-phase APR-V				RPVE4□□□-□	380-480 V
Single-phase APR-D	<ul style="list-style-type: none"> • Heater control • Dimming of incandescent lamps 	<ul style="list-style-type: none"> • Inexpensive • Compact and lightweight • Various setting inputs • Various applied loads • Phase control/cycle control 		RPDE2□□□-□■	100-240 V
				Three-phase APR-D	RPDW2□□□-T■
				RPDW4□□□-T■	380-440 V 380-480 V (Operating transformer sold separately)

Rated output current [A]																Reference page
6	10	20	30	40	45	60	80	100	150	160	250	350	450	600		
		●					●			●	● (240 A) P22 PWM- APR				12	
				● P22 PWM- APR		● P22 PWM- APR		● P22 PWM- APR								
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		●			●	●		●							40	
		●			●	●		●							46	
		●			●	●		●								



Fuji AC Power Regulator [APR]

PWMAPR-M Series

New release of PWMAPR-M as digitally controlled PWMAPR

Expands the range of applications to include applications that were not possible with conventional power regulators

■ Features

Uses our proprietary PWM control method to eliminate the need for harmonic current countermeasures

- Saves energy because it does not deteriorate the load power factor
- Capable of being used as a test power supply thanks to its sine wave output
- Comes standard with VLR function (voltage limiting) effective for lamp loads, etc.
- Comes standard with setting indicator as a new feature*1
- Volume: 36% reduction, Mass: 40% reduction, Footprint: 25% reduction compared to conventional products
- Slots available for various communication units*2 and analog/digital IO boards
- Lineup of products compliant with overseas standards

*80 A products only (as of June 2024)



Compliant with the new EMC Directive (2014/30/EU)
Compliant with the new Low Voltage Directive (2014/35/EU)

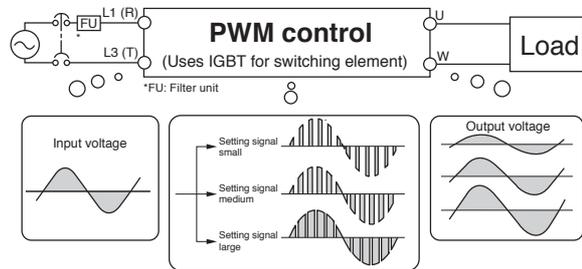
*1: Feedback methods such as automatic current regulation (ACR), automatic voltage regulation (AVR), automatic wattage regulation (AWR), as well as gradient settings are also available.

*2: Modbus RTU, CC-Link, etc.

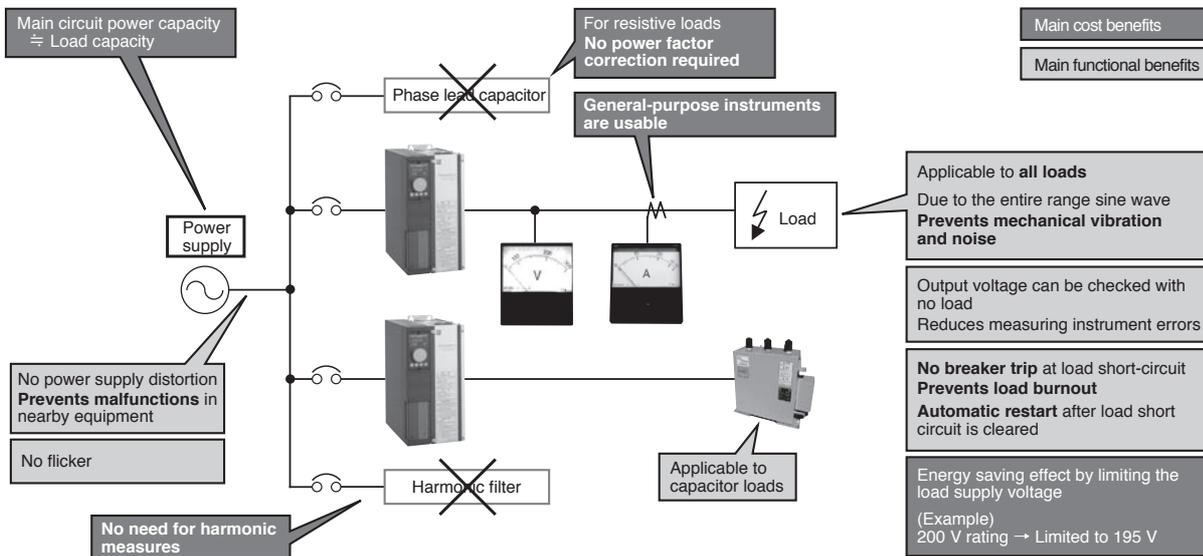


(80 A product: RPME2080-M)

■ Operating principles

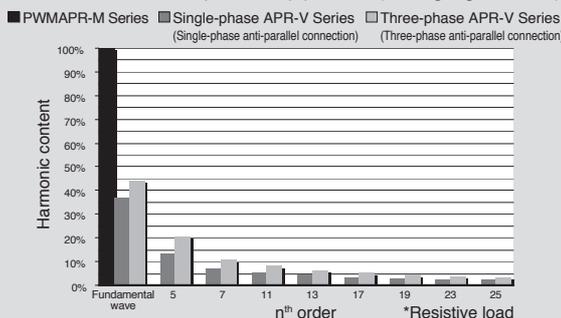


■ Advantages of using PWMAPR-M



■ Advantage of not generating harmonic current

Harmonic current comparison by product (setting signal: 50%)



The PWMAPR-M Series is an APR that does not adversely affect power quality.

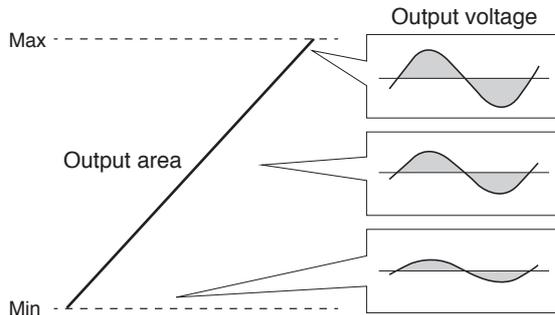
Problems caused by harmonic current

- Prevents overheating and burnout
- Suppresses mechanical vibration and noise
- Prevents malfunctions and control errors in nearby equipment
- Reduces instrument errors

Reduces the financial burden of expensive active and passive filter equipment

■ **Examples of various applications unique to the PWMAPR-M series**

- Outputs a clean sine wave at any output range

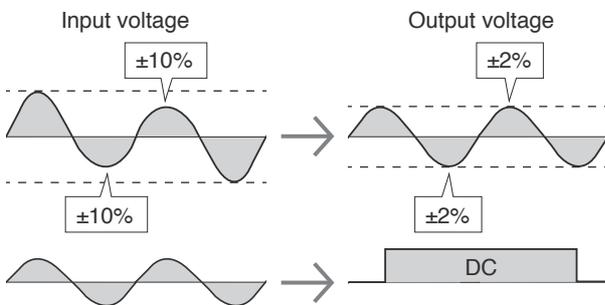


For **laboratory facilities** that require advanced power control!

With PWMAPR-M, you can produce a clean sine wave* at any output range (no transformer for tap-switching is needed).

*The output waveform depends on the input waveform. The distortion rate is also affected by input and output. For details, see the "Distortion rate" on page 15.

■ **Achieves stable output voltage**



For **product inspection testing facilities** that require stable output!

For locations with **voltage fluctuations**, such as overseas where power supply conditions are not good!

With PWMAPR-M, you can always produce a stable output ($\pm 2\%$ FS* output even if the input voltage fluctuates $\pm 10\%$).

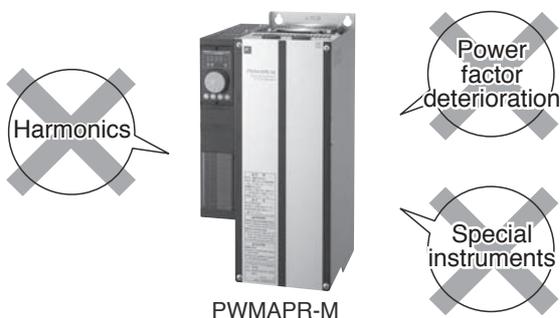
It is also perfect for more advanced DC power control when combined with a rectifier.

* It does not come with a boost function. It may not be effective if the input voltage and the set output voltage are the same (close).

*It does not support instantaneous power failures, etc.

Since it does not contain a battery, it is expected to have a longer maintenance cycle.

■ **Of course, it also supports conventional applications, such as heater control, with high accuracy.**



No need for expensive harmonic countermeasures

Energy saving thanks to no power factor deterioration

Economical thanks to ability to use general-purpose instruments

Unlike waveform control, which uses a thyristor device for switching, PWMAPR-M does not generate harmonics or exhibit flicker, nor does it deteriorate the power factor. In addition, since the output waveform is clean, it is less prone to exert stress on the load (heater, etc.) and can be expected to extend the life of the load. ("Japanese Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage" Conversion factor K5/K6 = 0, Power factor = 1) General-purpose products (not special devices) can be used to measure output voltage, current, etc.



Fuji AC Power Regulator [APR]

PWMAPR-M Series

Order specifications (explanation of order types)

RPM E 2 080 - M - Z70 / UL (Note 3)

Model Classification

Model	Code
PWMAPR-M	RPM

Phase number

Phase number	Code
Single-phase	E

Input voltage

Input voltage	Code
200-240 V	2

Output current

Output current	Code
20 A	020
80 A	080
160 A	160

Overseas safety standards

Overseas safety standards	Code
None specified	Blank
Complies with UL, cUL, and CE marking	UL

Three-phase products are scheduled to acquire overseas safety standards

Special specifications

Special specifications	Code (Notes 1 and 2)
Standard	Blank
Yes	Z special specification No. (2 digits)

If not specified (i.e., left blank), omit it including the hyphen "-".

Control method

Control method	Code
Multi-control method	M

The factory default is set to automatic voltage regulation. The control method can be selected and set using the setting indicator.

(Note 1) List of special specifications

Option specification name	Contents	Type
Printed wiring board coating process	Comes with a printed board coated with a coating agent	RPME2□□□-M-Z70

(Note 2) Please contact us about product types compliant with international standards.

(Note 3) For items not specified, please order with - and / also filled in.

Other options (sold separately)

Product name	Type	Specifications
Setter (Note 3)	RPN001	1 kΩJ, 2.5 W with nameplate, knob, and name label sheet
Remote control connection cable	RPN002-1	Setting indicator For separate installation, length 1 m
	RPN002-3	Setting indicator For separate installation, length 3 m
A/D IO board	RPM003-AA	Analog/digital I/O board
Communication unit	RPM003-AM	Modbus RTU compatible
	RPM003-AC	CC-Link compatible

(Note 3) The setter (used for manual setting, gradient setting, HIGH setting, etc.) is ordered separately.

Rating, type (= product code)

Phase number	Input voltage [V]	Rated current [A]	Rated load capacity [kVA] (Note 4)	Type (= product code)
Single-phase	200-240	20	4-4.8	RPME2020-M
		80	16-19.2	RPME2080-M
		160	32-38.4	RPME2160-M

(Note 4) The rated load capacity is the value calculated by the rated voltage X rated current.

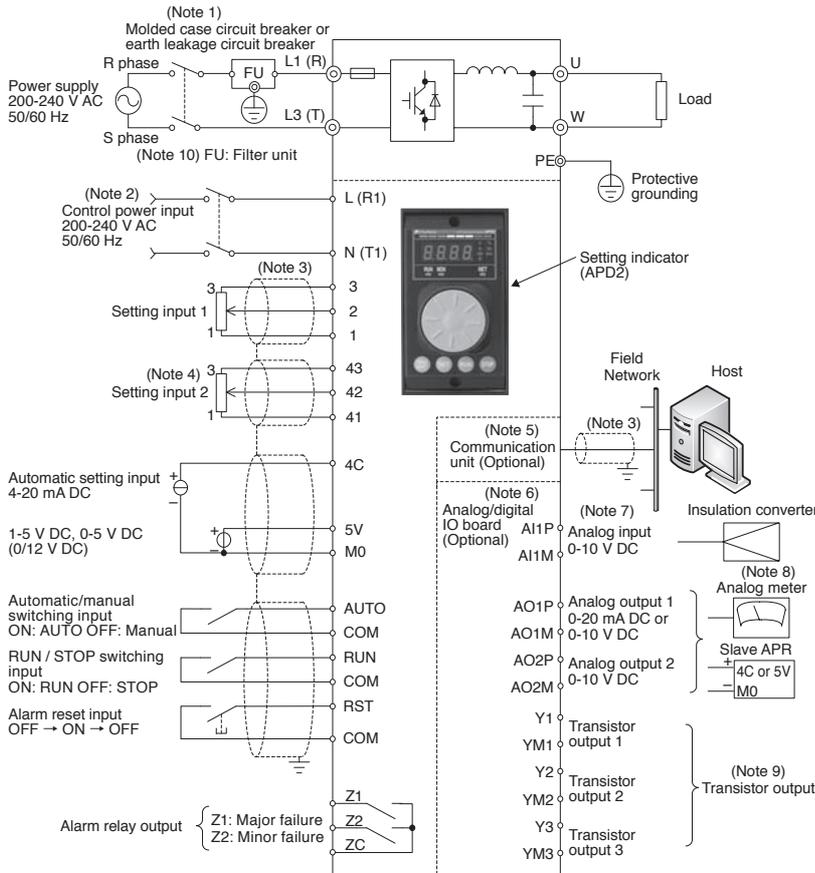
*The release dates and other details for products with specifications not listed in the table above will be announced separately.



Fuji AC Power Regulator [APR]

PWMAPR-M Series

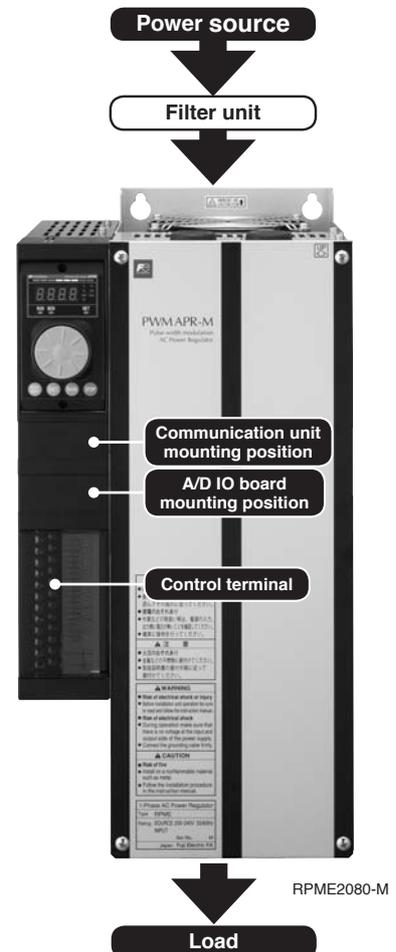
External connection diagram (single-phase 200-240 V AC)



- (Note 1) In order to protect the wiring on the input side (primary side) of the APR, install the molded case circuit breaker or earth leakage circuit breaker recommended for each APR. Do not use circuit breakers that exceed 1.5 times the product rating.
- (Note 2) Keep wires as far away as possible from other control terminal wiring and do not place them in the same duct. When crossing other control terminal wires, make sure that they are nearly orthogonal.
- (Note 3) For \square wiring, be sure to use twisted or shielded wiring. Keep main circuit wires and control power supply wires as far away from each other as possible and do not place them in the same duct. When crossing main circuit wires and control power supply wires, make sure that they are nearly orthogonal.
- (Note 4) Setting input 2 can be set to gradient setting input, CLR setting input, or VLR setting input using APD2.
- (Note 5) The communication unit is optional.
- (Note 6) The A/D IO board is optional.
- (Note 7) The analog input is used to apply types with control method E. Input the analog signal of 0-10 V DC that was output from the insulation converter, etc.
- (Note 8) Analog output is performed by converting the output voltage, output current, or output power of the APR into a current signal or voltage signal and outputting it.
- (Note 9) The transistor output is performed by outputting the APR alarm status.
- (Note 10) Be sure to use one filter unit (accessory) for each PWMAPR-M unit.

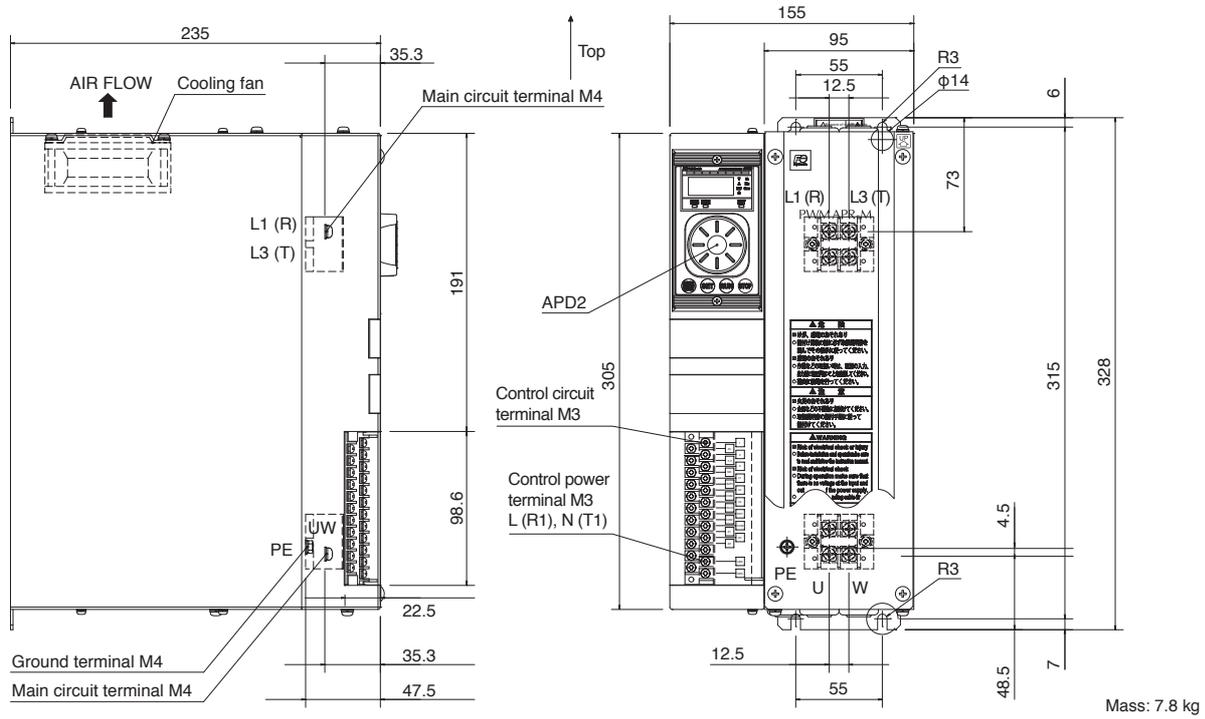
Terminal function (single phase)

Terminal position	Symbol	Name	Function description
Filter unit	IN	Input terminal	Main circuit input (connected to power supply)
Main circuit terminal	OUT	Output terminal	Filter unit output [connected to L1 (R)]
PWMAPR-M Main circuit terminal	L1 (R)	Input terminal	Filter unit input [connected to OUT]
	L3 (T)	Input terminal	Main circuit input (connected to power supply)
	U	Output terminal	PWMAPR-M output (connected to load)
	W	Output terminal	PWMAPR-M output (connected to load)
	Ⓧ(PE)	Ground terminal	Main body grounding terminal Be sure to ground the ground.
Control Terminal	1, 2, 3	Setting input 1	It can be used as a manual setting input, current limit setting input, voltage limit setting input, or LOW setting by connecting a variable resistor.
	41, 42, 43	Setting input 2	It can be used as a gradient setting input, current limit setting input, voltage limit setting input, or HIGH setting by connecting a variable resistor.
	4C, M0	Automatic setting input	Current signal 4-20 mA DC input, such as a temperature controller
	5V, M0	Automatic setting input	Voltage signal 0-5 V DC, 1-5 V DC input, such as a temperature controller, or SSR signal 0/12 V DC input Voltage signal 1-5 V DC input can be assigned to gradient setting input
	AUTO, COM	Automatic/manual switching input	Automatic setting when the external contact is closed Manual setting when the external contact is open
	RUN, COM	RUN / STOP input	RUN state when the external contact is closed Output off (STOP) state when the external contact is opened
	RST, COM	Alarm reset input	Resets alarm display and alarm contact output when the external contact is closed
	Z1, ZC	Alarm contact output	Internal contact ON when alarm occurs (major failure)
	Z2, ZC	Alarm contact output	Internal contact ON when alarm occurs (minor failure)
	L (R1)	Control power supply terminal	Power input for control circuit (connected to power source)
	N (T1)	Control power supply terminal	Power input for control circuit (connected to power source)

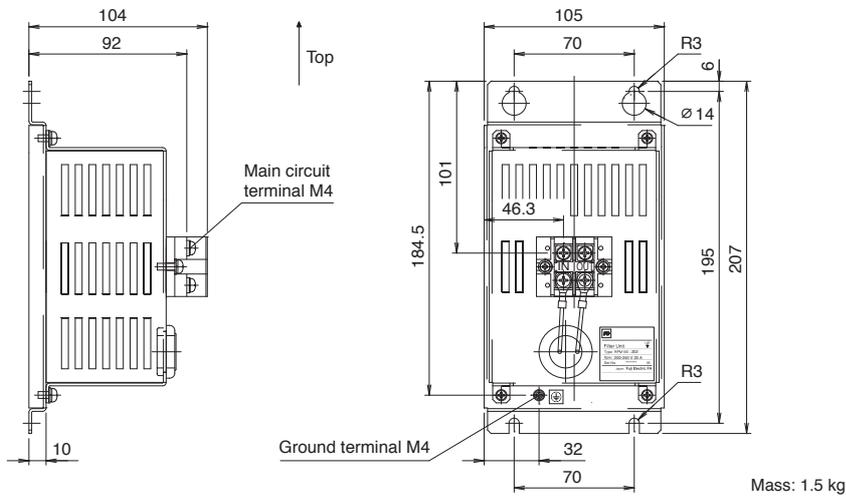


■ External dimension diagram [Unit: mm]

- RPME2020-M (single phase 200-240 V AC rated 20 A)



- Single phase 20 A filter unit

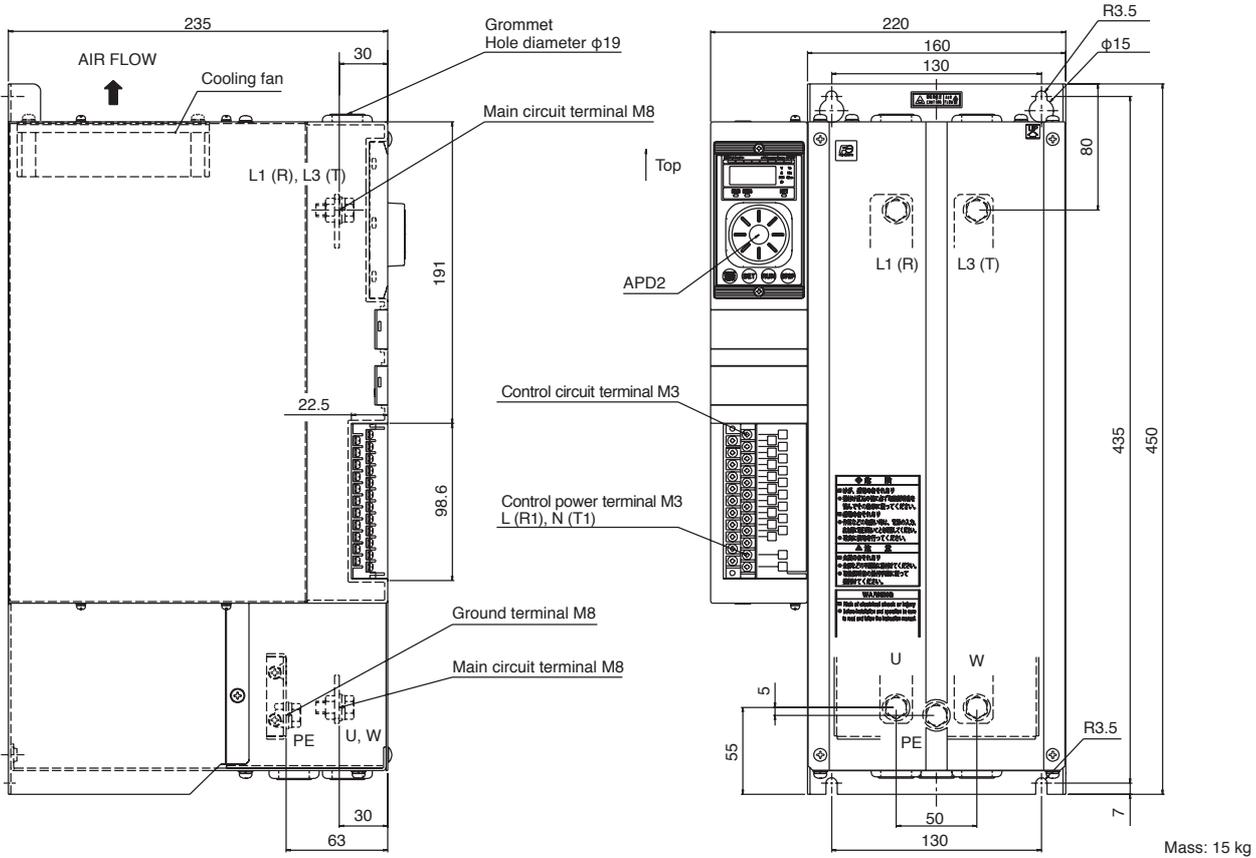


*A filter unit is included as standard. Be sure to install it and connect it to the APR primary side.

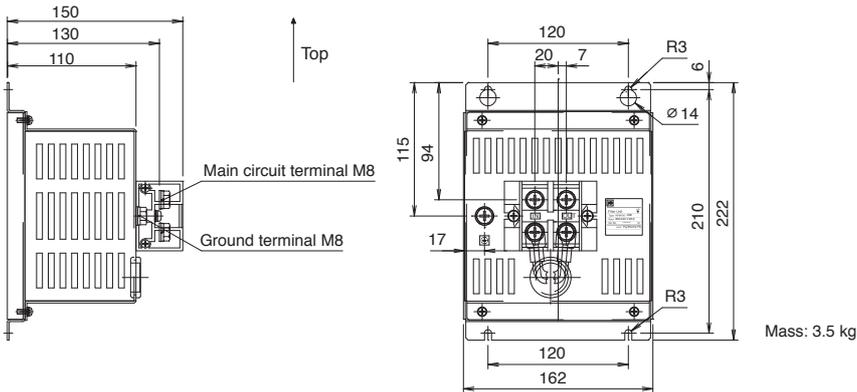


■ External dimension diagram [Unit: mm]

- RPME2080-M (single phase 200-240 V AC rated 80 A)



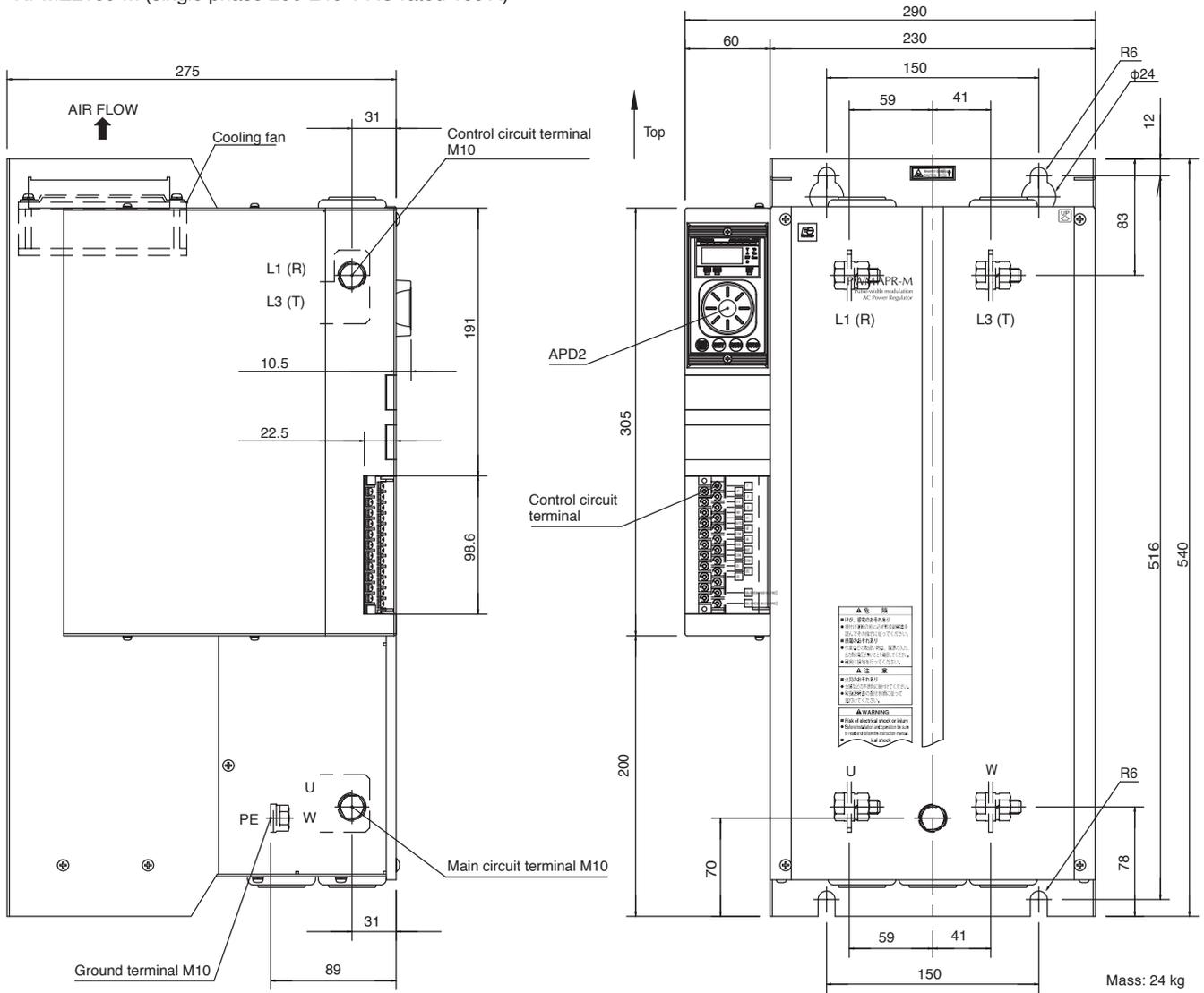
- Single phase 80 A filter unit



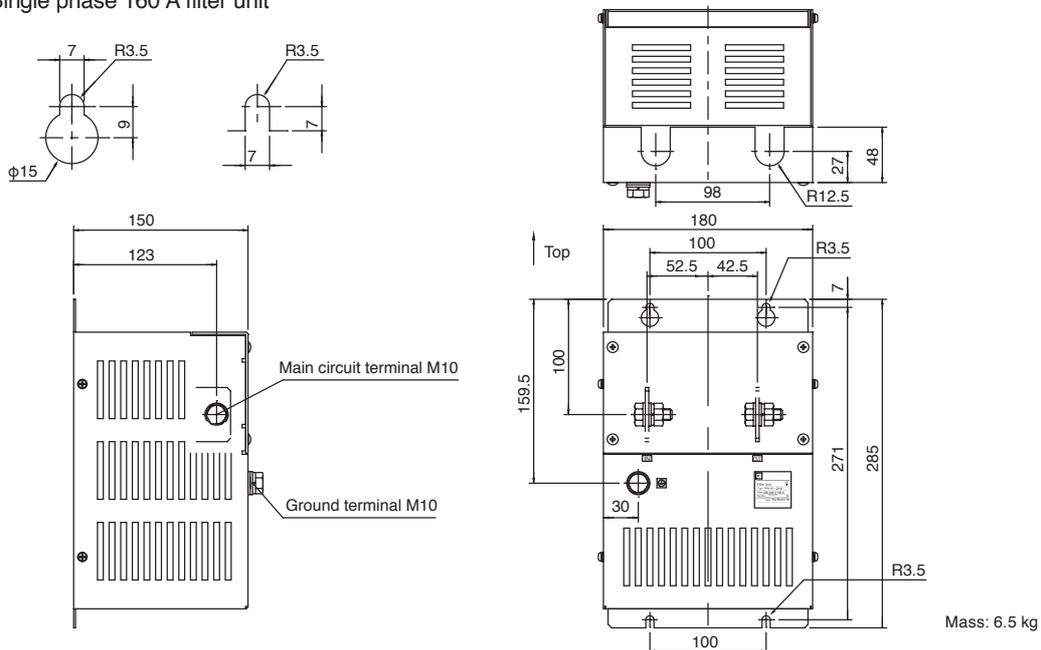
*A filter unit is included as standard. Be sure to install it and connect it to the APR primary side.

■ External dimension diagram [Unit: mm]

- RPME2160-M (single phase 200-240 V AC rated 160 A)



- Single phase 160 A filter unit



*A filter unit is included as standard. Be sure to install it and connect it to the APR primary side.



■ Terminal screw size (single phase)

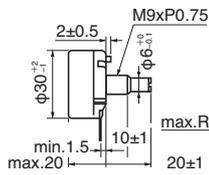
Terminal		Terminal screw size	Tightening torque [N·m] ±10%
Main circuit input/output terminal	L1 (R), L3 (T), U, W, IN, OUT	20 A: M4	1.8 (18 kg·cm)
		80 A: M8	13.3 (135 kg·cm)
		160 A: M10	24 (245 kg·cm)
Ground	⊕(PE)	20 A: M4	1.8 (18 kg·cm)
		80 A: M8	13.3 (135 kg·cm)
		160 A: M10	24 (245 kg·cm)
Control power supply	L (R1), N (T1)	M3	0.5 (5 kgf·cm)
Control terminal	Other than the above	M3	0.5 (5 kgf·cm)

■ Separately sold

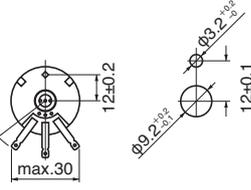
Setter type: RPN001 Used for manual setting, two-position control, gradient setting, etc.

Rating: 1 kΩ 2.5 W Type: RA30Y20SB102J (Manufacturer: Tokyo Cosmos)

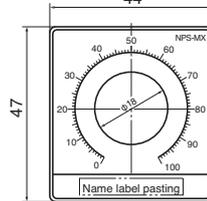
Variable resistor



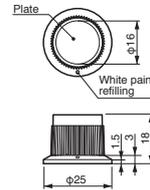
Mounting hole machining diagram



Nameplate



Knob



Name label sheet (Japanese and English, 12 types)

Manual setting	MANUAL SET.
Gradient setting	GRADE SET.
CLR setting	CLR SET.
VLR setting	VLR SET.
HIGH setting	HIGH SET.
LOW setting	LOW SET.

Setting indicator enables multiple settings not available in other company products!!

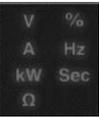
■ Features

- Various types of feedback control are available without adding extra options. (AVR/ACR/AWR, CLR/VLR)
 - The LED monitor displays various types of information such as output voltage, output current, output power, power supply voltage, output setting signal,% display, etc. Setting and display of various alarms are also very accurate because they are digital.
 - The multi-indicator provides visual status confirmation.
- 
- Features a dial to make various settings more user-friendly. It can also be used as an alternative to gradient setting volume, etc.
 - Enables setting of various network parameter settings. (Modbus RTU/CC-Link)
 - Comes with a heater disconnection detection function as standard. (Capable of detecting one disconnection for every five alloy heaters)
 - Mountable to panel surfaces, etc., using a remote control connection cable (RPN002-1 or RPN002-3).



*This product is a standard accessory.

■ Display and key operation

Display unit and operation unit			Operation mode		SET mode		MON (monitor) mode		
			Function	Display	RUN/STOP	Running	RUN/STOP	Running	
Display unit	Multi Indicator		Function	When the multi-indicator is fixed, each type of operation information, communication monitor, etc. is displayed in 8 segments					
			Display	ON/Blinking					
	LED monitor		Function	Function code and function code data display		Displays operation information such as output voltage and output current			
			Display	When an alarm occurs, it displays an alarm code					
Status display		Function	Displays various states						
		Display	●RUN-LED OFF	●RUN-LED ON	●RUN-LED OFF	●RUN-LED ON			
			●MON-LED OFF		●MON-LED ON				
Unit display		Function	Displays the unit of data displayed on the LED monitor						
		Display	●V-LED	Voltage display					
			●A-LED	Current display					
			●kW-LED	Power display					
			●%-LED	Percent display					
			●Hz-LED	Frequency display					
●Sec-LED	Setting time display								
Operating unit	Dial		Function	Function code and increase/decrease of function code data		Switching the display mode of each type of operation information			
	MODE/RESET key		Function	Change to MON (monitor) mode		Change to SET mode			
	SET key		Function	Displays function code data and sets data		-			
	RUN key		Function	RUN start	-	RUN start	-		
	STOP key		Function	-	RUN/STOP	-	RUN/STOP		



The APR-V Series is the successor to the APR-N Series. It is a highly functional APR with improved functions and performance and maintains installation and wiring compatibility.

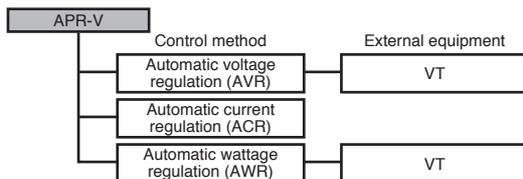
■ Features

● **Switchable between phase control and cycle control**

- Capable of load-sharing using anti-flicker cycle control (staggered energization cycles for up to 50 units). (Optional specifications: ZAP or ZAX required)
- Enables cycle control for loads with large resistance fluctuations (e.g., pure metals) by using an automatic rush current suppression function (combined control) that is independent of the soft start time. (Types with control method A only)
- Allows switching between phase control and cycle control while running.
(By setting indicator (APD3), network communication, etc.)

● **Built-in high-precision feedback control function (except types with control method T)**

Achieves control accuracy of $\pm 1\%$ FS for automatic current regulation, automatic voltage regulation, and automatic wattage regulation.
Contributes to improved temperature control accuracy, space savings, wiring savings, and total cost reduction by incorporating a high-precision control circuit.



● **Supports imbalance correction (three-phase)**

If there is load imbalance or power supply imbalance, the imbalance can be corrected by setting the setting indicator (APD3).

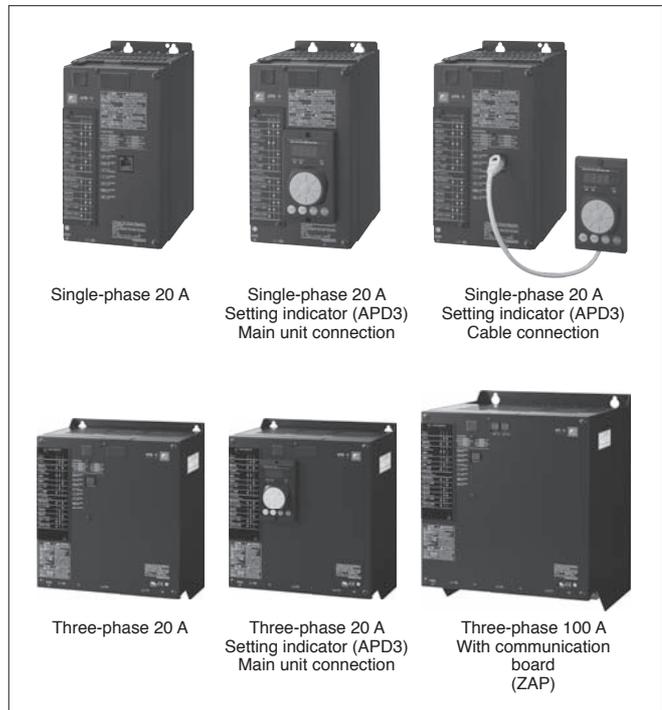
● **Supports three-phase four-wire circuits (three-phase, control methods T and A types only)**

Achieves $\pm 3\%$ FS linearity in three-phase, four-wire circuits. (Optional specification: Please specify ZB4)
In addition, it does not require an external diode connection to the neutral phase.
(Note) Do not use in a three-phase, three-wire circuit, since the control phase angle is different from that of three-phase standard products.

● **Enables individual setting of soft start time and soft up/down times**

● **Does not require a 400 V system operating transformer**

Allows operation using a 200 V power supply, since it does not require a dedicated operating transformer for the control power input of 400 V products.
(Can perform control even if the main circuit power supply and control power supply are not of the same phase)



● **External dimensions and mounting dimensions are compatible with APR-N**

External dimensions, mounting dimensions, and wiring positions are 100% compatible with those of the APR-N Series.

● **Does not require a communication board for setting indicator (APD3) connection**

Comes standard with a dedicated APD3 connector on the front panel.
Connection can be made with a single cable.

● **Full lineup of options**

- Enables a variety of monitors and high-precision digital settings and function settings using the setting indicator (APD3)
- Supports various communication specifications using additional communication boards.
Makes it easy to operate, monitor, and change settings by linking with PLCs and touch panels.
Capable of analog output of operation status
- Capable of outputting the present operating status (output current, output voltage, etc.) using analog signals (4 to 20 mA DC, etc.).
- Capable of outputting a contact point for power-on confirmation
- Finger guard (IP20) and others



- Built-in high-performance heater disconnection detecting function (except types with control method T. The function requires setting indicator (APD3))**

Single phase can detect up to 1-wire/10-wire disconnections using the high-function heater disconnection detecting function (equivalent to LA-3AR) .

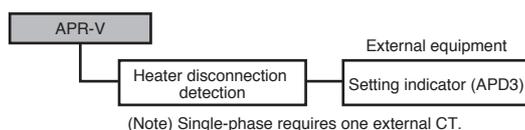
Three-phase three-wire types can detect up to 1-wire/9-wire disconnections.

(Line current detection method)

Three-phase four-wire types can detect up to 1-wire/15-wire disconnections.

(Line current detection method)

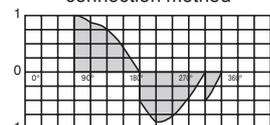
Applicable to various types of heaters (alloy, pure metal, silicon carbide, etc.) of the same material and capacity.



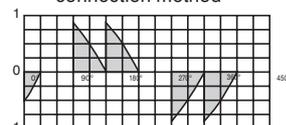
- Standardized thyristor pure anti-parallel system (six-arm) (three-phase)**

- Since it generates almost no even-order harmonic currents, it makes it easier to implement harmonic current countermeasures than with mixed anti-parallel systems.
- Transformer primary control reduces the likelihood of the phenomenon of bias magnetism, thus allowing transformers to be made smaller and more efficient.
- Improves control characteristics under unbalanced loads.

E.g. of load current waveform (phase angle $\alpha = 90^\circ$)
Mixed anti-parallel connection method



Thyristor anti-parallel connection method



- Enhances abnormality detection**

Displays twelve types of failures, including major and minor ones, using its alarm LEDs.

- Thyristor abnormalities (except types with control method T)
- Current limit detection (except types with control method T)
- External setting input not connected (disconnection) and others

- Compliant with the EU RoHS Directive (2011/65/EU+(EU)2015/863)**

Complies with the EU Restriction of Hazardous Substances (RoHS) Directive as standard.

It is an environmentally friendly APR that restricts the use of the 10 hazardous substances.

<10 Hazardous Substances>

Lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), polybrominated diphenyl ethers (PBDE) Phthalates (DHEP, BBP, DBP, DIBP)

- Complies with revised Chinese RoHS**

All APR-V Series models are supported as standard.



- Lineup of products compliant with overseas standards**



SCCR: 100 kA

(Three-phase APR-V 20 A to 250 A)

(Note) Please contact us for information on acquisition status.



Fuji AC Power Regulator [APR]

APR-V Series

SCCR: 100 kA

Order specifications (explanation of order types)

RPV W 2 0 2 0 - T - Z 06 / UL (Note 1)

APR-V Series

Phase number

Phase number	Code
Single-phase thyristor anti-parallel connection	E
Three-phase thyristor anti-parallel connection	W

Input voltage

Input voltage	Code
100 to 240 V	2
380 to 480 V	4
Special voltage	9

Please contact us for information on special voltages.

Rated current

Rated current	Code
20 A	020
45 A	045
60 A	060
100 A	100
150 A	150
250 A	250
350 A (Single-phase only)	350
450 A	450
600 A	600

Control method

Control method	Required external devices (sold separately)	Code	Control method overview
No feedback function	-	T	No built-in CT. (No overcurrent detection, heater disconnection detection, etc.) Applied to loads with little resistance change, such as alloy heaters.
AC CLR	-	A	CLR = Current limit regulation: Limits output voltage so that output current does not exceed the CLR setting. Applied to applications for limiting the maximum current flowing to the load (e.g., pure metal heaters, etc.).
AC ACR + AC CLR	-	B	ACR = Automatic current regulation: Controls the flow of output current in proportion to the set value. Applied to pure metal heaters, direct current heating applications, etc. to maintain a constant current.
AC AVR + AC CLR	VT (Type: PT-5S) single-phase: 1 unit Three-phase: 2 units	C	AVR = Automatic voltage regulation: Controls the output voltage in proportion to the set value. Applied to applications that require output voltage accuracy.
AC AWR + AC CLR	VT (Type: PT-5S) single-phase: 1 unit Three-phase: 2 units	D	AWR = Automatic wattage regulation: Controls the output power in proportion to the set value. Applied to silicon carbide heaters and sensorless applications that control the heating amount.
DC feedback control + AC CLR (Feedback input: 0 to 10 V DC)	Insulation converter (Fast-response product)	E	Applied when the secondary side of transformers, rectifiers, etc. require accuracy. Controls the feedback value to be 10 V DC when the set value is 100%.
Cycle control based Transformer primary control	Accessory CT (Type: CT-5S)	P	Single phase only. Can be applied to insulation transformers and resistive loads (resistance change 20% or less). If the load is 30% or less of the APR rated capacity, output will stop due to a load error.

(Note 1) For items not specified, please order with - and / also filled in.

(Note 2) Optional accessories for main unit

Main option specification name	Content	Option specification number (Note 3)
Soft start time minimum of 0.05 sec (applicable only to types with control methods T and A)	Variable soft start time range 0.05 to 10 sec/0.5 to 100 sec	RPV□□□□□-□-Z06
Incorporates base load setting	Incorporates base load setting on control circuit PCB	RPV□□□□□-□-Z07
Incorporates gradient setting	Incorporates gradient setting on control circuit PCB	RPV□□□□□-□-Z43
PCB coating process	Incorporates PCB with coating applied	RPV□□□□□-□-Z70
Control power separation	Eliminates internal wiring of control power supply terminal block (L11-L21)	RPVW2□□□□□-□-Z72
Communication board) Supports parallel run	Parallel run communication board mounting with anti-flicker function (Note 4)	RPV□□□□□-□-ZAP
Communication board) Supports MX compatible parallel run	MX, MX2 Series compatible parallel run communication board mounting (Note 5)	RPV□□□□□-□-ZAX
Communication board) Supports Modbus RTU	Modbus RTU communication board mounting (Note 6)	RPV□□□□□-□-ZAM
Communication board) Supports CC-Link	CC-Link communication board mounting (Note 6)	RPV□□□□□-□-ZAC
APD3 main unit mounting (cable connection connector accessory)	Mounts APD3 on the front surface of the main unit	RPV□□□□□-□-ZB3
Supports three-phase four-wire type	Control board change for three-phase four-wire type (types with control methods T and A only)	RPVW□□□□□-□-ZB4
Function code changed type	Shipped with the function code changed to the specified one (Note 7)	RPV□□□□□-□-ZC■
Input voltage) Supports special voltages	Supports special voltages other than rated voltage (Note 8)	RPV□□□□□-□-ZE■
Analog output board) Supports current signals	4 to 20 mA DC output Analog output board mounting (Note 9)	RPV□□□□□-□-ZAA
Analog output board) Supports voltage signals	0 to 10 V DC output Analog output board mounting (Note 9)	RPV□□□□□-□-ZAB

(Note 3) When specifying multiple main unit options, please list the specification numbers after Z.

E.g.: Order format for specifying "Soft start time minimum 0.05 sec," "Communication board) Supports parallel run," and "APD3 main unit mounting" as optional items for the main unit.
Order format: RPVE□□□□□-□-Z06APB3

(Note 4) Not compatible with MX and MX2 Series. Compatible with N Series. Does not support cycle control in combination with three-phase products.

The APD3 heater disconnection detection function is not available for slave units.
Flicker suppression is activated during cycle control.

(Note 5) Compatible with MX and MX2 Series. Does not support cycle control in combination with three-phase products.

The APD3 heater disconnection detection function is available for slave units. Flicker suppression is activated during cycle control.

(Note 6) Please purchase APD3 when selecting optional specification numbers ZAM and ZAC. This is required when making settings.

(Note 7) Shipped after setting changes are made in-house using the setting indicator (APD3). The setting indicator (APD3) is not included in the shipment. Customization is available. Please contact us for more information.

(Note 8) Please contact us regarding available input voltages.

(Note 9) The output signal content can be changed using the APD3.

(Note 10) Only UL-certified 20-250 A models have a SCCR (short circuit current rating) of 100 kA.

Overseas safety standards

Overseas safety standards	Code
None specified	Blank
Complies with UL, cUL, and CE marking	UL

Single-phase
20-450A: UL Recognized, cUL Recognized
600A: UL Recognized

Three-phase
20-250A: UL Listed, cUL Listed, SCCR: 100 kA (Note 10)
450A: UL Recognized, cUL Recognized
600A: UL Recognized

Specifications

Specifications	Code
Standard	Blank
Optional accessories for main unit	Z (Note 3)

■ Specifications

Item	Specifications											
Type (product code)	RPV□□□□□□□□□□											
Rated current [A]	Single phase (ambient temperature 50°C)	20	45	60	100	150	250	350	450	600		
	Three phase (ambient temperature 40°C)	-										
Main circuit power supply	Power supply voltage	Single-phase 100 to 240 V AC, 380 to 480 V AC $\pm 10\%$ Three-phase 200 to 240 V AC, 380 to 480 V AC $\pm 10\%$										
	Frequency	50/60 ± 2.5 Hz (Frequency is automatically detected and switched)										
Control circuit power supply (Note 1)	Power supply voltage	Single-phase 100 to 240 V AC $\pm 10\%$ (However, only sine wave operation is guaranteed. Must operate in phase with the main circuit power supply.)										
	Frequency	50/60 ± 2.5 Hz (Frequency is automatically detected and switched)										
	Power capacity [VA]	Single-phase	36				40	45				
Internal heating value [W] (at rated current)	Single-phase	47	74	89	124	190	320	377	510	700		
	Three-phase	90	170	210	330	560	840	-	1490	2070		
Cooling system	Self-cooled					Air cooling						
Applied load	Phase control	Resistive load, inductive load, transformer primary control, rectifier primary control										
	Cycle control (Note 2)	Resistive load, inductive load, transformer primary control (applicable to single-phase control method P type only)										
Control	Waveform control method	Phase control or cycle control (intermittent) (Function selection switch SW2 switching)										
	Output voltage adjustment range	0 to 100% of main circuit power supply voltage (RMS value) (Except thyristor voltage drop)										
	Input-output characteristics	RMS value linear characteristic, linear characteristic $\pm 2\%$ FS or less (Limited to the case of resistive loads. At automatic setting signal 10 to 90%)										
	Power supply voltage compensation (Applicable to types with control methods T, A)	Compensates for power supply voltage fluctuations of $\pm 10\%$ by reducing output fluctuations to $\pm 3\%$ FS or less (However, this applies at 10 to 90% of automatic setting signal)										
	Setting signal	Manual setting	External variable resistor: 1 k Ω (B characteristic 1/2 W or higher) HIGH-LOW (two-position control) contact signal: Configured with external wiring									
		Automatic setting	Current signal: 4 to 20 mA DC ($Z_{in} = 100 \Omega$) Voltage signal: 0 to 5 V DC, 1 to 5 V DC ($Z_{in} = 10 \text{ k}\Omega$) (Function selection switch SW4 switching)									
	Gradient setting	Output magnitude can be set as desired for the setting signal (1) External variable resistor 1 k Ω (B characteristic 1/2 W or higher) (standard), (2) Built-in (optional), (3) Control circuit terminal Selectable using "5V-M0" voltage signal setting (Function selection switch SW5 off. Supports 1 to 5 V DC only) Enables reverse gradient characteristics in combination with base load setting										
	Base load setting	0 to 100% of the output voltage (Optional: built-in)										
	Soft start and soft up/down time (Note 3)	0.5 to 10 seconds or 5 to 100 seconds (function selection switch SW1 switching), and the soft up/down time can be fixed at 0.5 seconds. (function selection switch SW7 off)										
	Feedback control method (Phase control method only)	AC CLR (Types with control method A) AC ACR + AC CLR (Types with control method B) AC AVR + AC CLR (Types with control method C) AC AWR + AC CLR (Types with control method D) DC feedback control + AC CLR (Types with control method E)							For types with control methods B, C, D, and E, priority is given to the AC CLR function. AC CLR (types with control method A) becomes selected when the function selection switch SW6 is turned off.			
Automatic inrush current suppression (Note 4) (Cycle control method only)	When CLR setting is 100%, it uses its built-in CT to detect a load current of about 90% or more of the rated current. Reduces it by switching the phase angle (Applicable only to types with control method A. Function selection switch SW6 off)											
Error detection and protection	CPU memory error	CPU memory error detected at startup; output disabled										
	Power supply error	(1) Detects control power supply frequencies other than 45 to 65 Hz (2) Detects sudden control power supply frequency change of ± 2.5 Hz or more										
	Undervoltage (Note 5)	Single-phase	Detects power supply undervoltage (100 V series: 85 V or less; 200 V series: 165 V or less; 400 V series: 315 V or less)									
		Three-phase	Detects power supply undervoltage (200 V series: 165 V or less; 400 V series: 315 V or less)									
	Overvoltage (Note 5)	Single-phase	Detects power supply overvoltage (100 V series: 140 V or more; 200 V series: 265 V or more; 400 V series: 535 V or more)									
		Three-phase	Detects power supply overvoltage (200 V series: 265 V or more; 400 V series: 535 V or more)									
	Overcurrent	Detects currents of about 120% or more of rated current using built-in CT (Supports types with control methods A, B, C, D, E, and P)										
	Main fuse blown	Uses built-in quick-acting fuse to stop output and protect main elements										
	Heater disconnection (Note 6)	Uses built-in CT to detect when load current becomes less than disconnection threshold (Supports types with control methods A, B, C, D, and E)										
	Current limit detection	Detects load current exceeding the CLR setting values and switches the phase angle to reduce it to within the CLR setting values (Supports types with control methods A, B, C, D, E, and P)										
	Thyristor abnormality	Detects short-circuit of thyristor using built-in CT (Supports types with control methods A, B, C, D, E, and P) Stops arc pulse. However, there are cases where it is not possible to stop output.										
	Overheating error	Detects using temperature sensor										
	Communication error (Optional)	Detects transmission errors between APRs during parallel operation										
	Cooling fan life (air-cooled products only)	Detects 70% or less of steady-state rotation speed										
External setting input disconnection (Note 7)	(1) Detects disconnection of current and voltage setting signals (2) Detects disconnection of manual and gradient setters											
Environment	Load error (Only types with control method P)	(1) Detects when load is open (2) If the load current is delayed by 30° or more										
	Analog output current error (Optional)	Detects when the allowable load resistance is exceeded when using current signals from analog output boards										
	Alarm contact output	Relay contact: Major failure + minor failure [1a + 1a contact, 250 V AC, 1 A]										
	Ambient temperature	Single-phase	-5 to +50°C (reduces load current to the rated current value when the temperature is between +50°C and +55°C)									
		Three-phase	-5 to +40°C (reduces relative to rated current value when the temperature is between +40°C and +55°C)									
Insulation	Storage temperature	-20 to +60°C										
	Ambient humidity	30 to 90% RH (no condensation)										
	Others	No corrosive gases, dust, substances and actions that promote insulation deterioration, or vibration; Use indoors at an altitude of 1000 m or less										
Insulation	Dielectric strength (Main circuit to ground)	2000 V AC for 1 minute (100 to 240 V), 2500 V AC for 1 minute (380 to 480 V) (Note 8)										
	Insulation resistance (To ground)	10 M Ω or higher, measured with 500 V DC megger tester										

- (Note 1) The rated voltage always operates as either 110 V or 220 V. For use at 230 V or 240 V, adjust the maximum output voltage at the power supply voltage compensation setting (PVC setting).
 (Note 2) When cycle control is used, connecting a transformer such as a VT to the output side may cause the bias magnetism phenomenon. Use after disconnecting transformers such as VTs. "Transformer primary control via cycle control" is valid only for types with control method P.
 (Note 3) For types with control methods B, C, D, and E, even if the soft start and soft up/down time are set to be short, there may be cases when the time may not be shortened because priority is given to the response speed of feedback control.
 The time can be set longer.
 (Note 4) Automatic inrush current suppression suppresses the occurrence of overcurrent through control in combination with phase control. If a transformer such as a VT is connected to the output side, please use it after disconnecting transformers such as VTs because cycle control could cause the bias magnetism phenomenon.
 (Note 5) Control power supply voltage is automatically detected when power is turned on. Therefore, if the power supply voltage is slowly increased or decreased, or if a 110 V series power supply is switched with a 220 V series power supply, an "overvoltage" or "undervoltage" alarm will be detected.
 (Note 6) For cycle control (types with control method A), the alarm is "load open detection".
 (Note 7) It does not operate for the voltage signal 0 to 5 V DC setting (function selection switch SW4 off).
 (Note 8) Since the DC power supply for the cooling fan is supplied from the secondary side of the power circuit, there is no need to unplug the cooling fan power connector during insulation dielectric strength testing.



Fuji AC Power Regulator [APR]

APR-V Series

SCCR: 100 kA

■ Rating, type (= product code)

Phase number	Input voltage [V]	Rated current [A]	Rated load capacity [kVA] (Note 1)	Built-in fast-acting fuse (Note 2)	Type (= product code)	
Single-phase	100 to 240 V	20	2-4.8	CR6L-30G/UL	RPVE2020-T RPVE2020-A	
		45	4.5-10.8	CR6L-75G/UL	RPVE2045-T RPVE2045-A	
		60	6-14.4	CR6L-100G/UL	RPVE2060-T RPVE2060-A	
		100	10-24	CR6L-150G/UL	RPVE2100-T RPVE2100-A	
		150	15-36	CR6L-200G/UL	RPVE2150-T RPVE2150-A	
		250	25-60	6, 9URD30TTF0350	RPVE2250-T RPVE2250-A	
		350	35-84	6, 9URD31TTF0500	RPVE2350-T RPVE2350-A	
		450	45-108	6, 9URD31TTF0630	RPVE2450-T RPVE2450-A	
		600	60-144	CS5F-800/UL	RPVE2600-T RPVE2600-A	
		380 to 480 V	20	7.6-9.6	CR6L-30G/UL	RPVE4020-T RPVE4020-A
	45	17.1-21.6	CR6L-75G/UL	RPVE4045-T RPVE4045-A		
	60	22.8-28.8	CR6L-100G/UL	RPVE4060-T RPVE4060-A		
	100	38-48	CR6L-150G/UL	RPVE4100-T RPVE4100-A		
	150	57-72	CR6L-200G/UL	RPVE4150-T RPVE4150-A		
	250	95-120	6, 9URD30TTF0350	RPVE4250-T RPVE4250-A		
	350	133-168	6, 9URD31TTF0500	RPVE4350-T RPVE4350-A		
	450	171-216	6, 9URD31TTF0630	RPVE4450-T RPVE4450-A		
	600	228-288	CS5F-800/UL	RPVE4600-T RPVE4600-A		
	Three-phase	200 to 240 V	20	6.9-8.3	CR6L-30G/UL	RPVW2020-T RPVW2020-A
			45	15.6-18.7	CR6L-75G/UL	RPVW2045-T RPVW2045-A
60			20.8-24.9	CR6L-100G/UL	RPVW2060-T RPVW2060-A	
100			34.6-41.6	CR6L-150G/UL	RPVW2100-T RPVW2100-A	
150			52.0-62.4	Standard : CR6L-200G/UL UL : CR6L-250G/UL	RPVW2150-T RPVW2150-A	
250			86.6-103.9	Standard : 6, 9URD30TTF0350 UL : 6, 9URD30TTF0400	RPVW2250-T RPVW2250-A	
450			155.9-187.1	6, 9URD31TTF0630	RPVW2450-T RPVW2450-A	
600			207.8-249.4	CS5F-800/UL	RPVW2600-T RPVW2600-A	
380 to 480 V			20	13.2-15.2	CR6L-30G/UL	RPVW4020-T RPVW4020-A
45			29.6-34.3	CR6L-75G/UL	RPVW4045-T RPVW4045-A	
60		39.5-45.7	CR6L-100G/UL	RPVW4060-T RPVW4060-A		
100		65.8-76.2	CR6L-150G/UL	RPVW4100-T RPVW4100-A		
150		98.7-114.3	Standard : CR6L-200G/UL UL : CR6L-250G/UL	RPVW4150-T RPVW4150-A		
250		164.5-190.5	Standard : 6, 9URD30TTF0350 UL : 6, 9URD30TTF0400	RPVW4250-T RPVW4250-A		
450		296.2-342.9	6, 9URD31TTF0630	RPVW4450-T RPVW4450-A		
600		394.9-457.3	CS5F-800/UL	RPVW4600-T RPVW4600-A		

(Note 1) Rated load capacity is calculated using the following formula.

Rated load capacity (single-phase) = Rated input voltage × Output current

(Three-phase) = $\sqrt{3}$ rated input voltage × Output current

(Note 2) When replacing only the built-in quick-acting fuse, use the type listed in the table. In the case of a microswitch type (CR6L), replace "G" with "S".

■ Cooling fan

The average life of the cooling fan is about 40,000 hours. (At an ambient temperature of 50°C and 100% output. 600 A products have an average life of about 23,000 hours.)

Replace with a new product as soon as required in consideration of this service life.

An alarm will trigger when the cooling fan reaches the end of its service life. (Green or yellow LED blinking)

Cooling fan, order type

Single-phase

APR rated current	Cooling fan, order type	Required qty.
150 A	RPVE150 fan motor	1 pc. / 1 unit
250 A	RPVE250 fan motor	
350 A	RPVE350 fan motor	
450 A	RPVE450 fan motor	
450 A	RPVE450 fan motor	
600 A	RPVE600 fan motor	

Three-phase

APR rated current	Cooling fan, order type	Required qty.
150 A	RPVW150 fan motor	2 pcs. / 1 unit
250 A	RPVW250 fan motor	
450 A	RPVW450 fan motor	
450 A	RPVW450 fan motor	
600 A	RPVW600 fan motor	

(Note) Please contact us for fan guard orders of cooling fans.

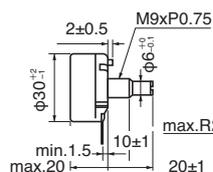
■ Other optional items (sold separately)

● Setter

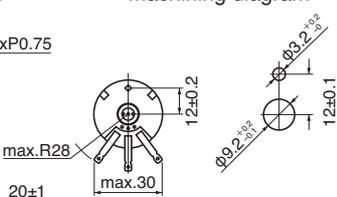
Setter type: RPN001	Used in setting method "variable resistor setting, two-position control, gradient setting," etc.
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Rating: 1 kΩJ 2.5 W Type: RA30Y20SB102J (Manufacturer: Tokyo Cosmos)

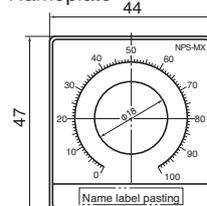
Variable resistor



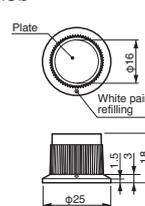
Mounting hole machining diagram



Nameplate



Knob



Name label sheet (Japanese and English)

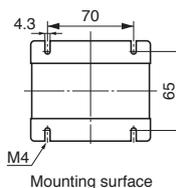
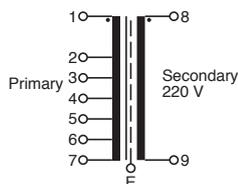
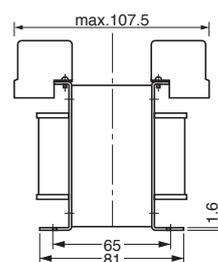
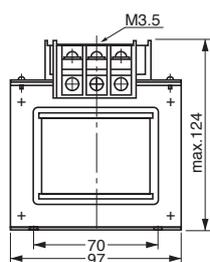
Manual setting	MANUAL SET.
Gradient setting	GRADE SET.
CLR setting	CLR SET.
HIGH setting	HIGH SET.
LOW setting	LOW SET.

(Note) Control circuit terminal block allocation using a setting indicator (APD3) is required, except for manual setting and gradient setting.

Label sheets not used by the APR-V Series are also included.

● Transformer for control power supply (UL certified products)

Operating transformer (single-phase) Type: TR1-70R/UL



Output current	For single-phase 20 to 600 A
Rated	1 φ, 380, 400, 415, 440, 460, 480 V/220 V 70 VA
Type	TR1-70R/UL

Primary voltage	Terminal number
380 V	1-2
400 V	1-3
415 V	1-4
440 V	1-5
460 V	1-6
480 V	1-7

Mass: 3.5 kg

General-purpose low-voltage operating transformers can also be used. (Not UL compliant) Catalog No. HS192

Ex. CU1F-050-A4020

● Mounting bracket for external cooling installation

For single-phase (RPV004-E□□)

Type	Content
RPV004-E02	For RPVE□020-□
RPV004-E06	For RPVE□045-□, RPVE□060-□
RPV004-E10	For RPVE□100-□
RPV004-E15	For RPVE□150-□
RPV004-E25	For RPVE□250-□
RPV004-E45	For RPVE□350-□, RPVE□450-□
RPV004-E60	For RPVE□600-□

For three-phase (RPV004-W□□)

Type	Content
RPV004-W02	For RPVW□020-□
RPV004-W06	For RPVW□045-□, RPVW□060-□
RPV004-W10	For RPVW□100-□
RPV004-W15	For RPVW□150-□
RPV004-W25	For RPVW□250-□
RPV004-W45	For RPVW□450-□
RPV004-W60	For RPVW□600-□



Fuji AC Power Regulator [APR]

APR-V Series

SCCR: 100 kA

• Finger guard

For single-phase (RPV005-E□□)

Type	Content
RPV005-E02	For RPVE□020-□
RPV005-E06	For RPVE□045-□, RPVE□060-□
RPV005-E10	For RPVE□100-□
RPV005-E15	For RPVE□150-□
RPV005-E25	For RPVE□250-□
RPV005-E45	For RPVE□350-□, RPVE□450-□
RPV005-E60	For RPVE□600-□

For three-phase (RPV005-W□□)

Type	Content
RPV005-W02	For RPVW□020-□
RPV005-W06	For RPVW□045-□, RPVW□060-□
RPV005-W10	For RPVW□100-□
RPV005-W15	For RPVW□150-□
RPV005-W25	For RPVW□250-□
RPV005-W45	For RPVW□450-□
RPV005-W60	For RPVW□600-□

• CT and VT for feedback control

Product name	Type	Rated primary input	Rated secondary output, etc.
CT	CT-5S	20 A/0.1 A	Rated secondary: 0.1 A Rated load: 5 VA Accuracy class: Class 1
		to 600 A/0.1 A	
VT	PT-5S	100 V/10 V	Rated secondary: 10 V Rated load: 5 VA Accuracy class: Class 1
		200 V/10 V	
		230 V/10 V	
		380 V/10 V	
		400 V/10 V	
		415 V/10 V	
		420 V/10 V	
		440 V/10 V	

(Note) CT-5S primary through-hole turns: 5 turns for 20 A, 3 turns for 45 A, 2 turns for 60 A, and 1 turn for others.

The primary voltage of PT-5S is a 2-tap input except for 380 V and 415 V.

• Main circuit terminal cover

For three-phase (RPV006-W□□)

Type	Content
RPV006-W02	For RPVW□020-□
RPV006-W06	For RPVW□045-□, RPVW□060-□
RPV006-W10	For RPVW□100-□
RPV006-W15	For RPVW□150-□
RPV006-W25	For RPVW□250-□
RPV006-W45	For RPVW□450-□
RPV006-W60	For RPVW□600-□

(Note) Single-phase has no main circuit terminal cover because it is already supported as standard.

• Setting indicator, remote control connection cable

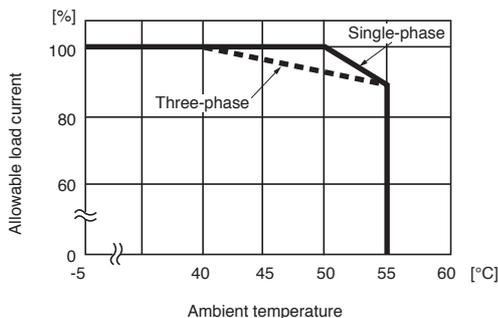
Product name	Type	Name	Specifications
Setting indicator	APD3	—	—
Cable	RPN002-1	Remote control connection cable	Length: 1 m
	RPN002-3	Remote control connection cable	Length: 3 m
	RPN002-5	Remote control connection cable	Length: 5 m

■ Important notes in selecting products

• Allowable load current - ambient temperature characteristics

The rated current value for single-phase is based on an ambient temperature of 50°C (40°C for three-phase).

If the ambient temperature is higher than this, use it after reducing the load current as shown below.



• Transformer primary control

- (1) The wiring of a three-phase transformer should be the Δ/Δ method, not Δ/Y .
- (2) If there is a risk of the transformer becoming unloaded, connect a resistor in parallel with the primary winding so that about 0.5 A (at rated voltage) flows through it.
- (3) Allow enough margin for magnetic flux density to prevent bias magnetism.
(1.0 to 1.2 T or less)
- (4) Do not use in cycle control except for single-phase P types.
- (5) In the case of three-phase, the load imbalance should be 10% or less.

• Important notes for power cycle life expectancy

If RUN and STOP are repeated at short-period cycles (for example, 30-minute RUN and 30-minute STOP), a large difference in temperature occurs in the thyristor element, significantly shortening its life expectancy due to thermal fatigue.

For such applications, select a capacity with a load current less than 80% of the rated current.

■ Control function

● Input-output characteristic

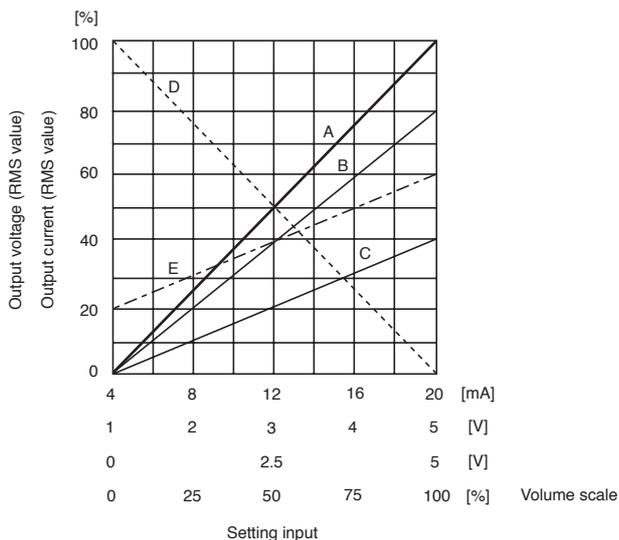
Setting signal, gradient setting, base load setting - output characteristics (for resistive load, operating principle characteristics)

The figure below shows characteristic A when the base load setting and gradient setting are not used.

Output varies linearly with various setting inputs.

By using the gradient setting and base load setting (optional) together, the input-output characteristics can be changed as desired, as shown in the example in the graph below.

It is common to phase control, cycle control, or each feedback control method.



The left graph shows examples of base load setting and gradient setting

Characteristic	Output adjustment range [%]	Base load setting [%]	Gradient setting [%]
A	0 to 100	0	100
B	0 to 80	0	80
C	0 to 40	0	40
D	100 to 0	100	0
E	20 to 60	20	60

*Gradient setting: Set the output value at the maximum setting input in the input-output characteristics

*Base load setting: Set the output value at the minimum setting input in the input-output characteristics

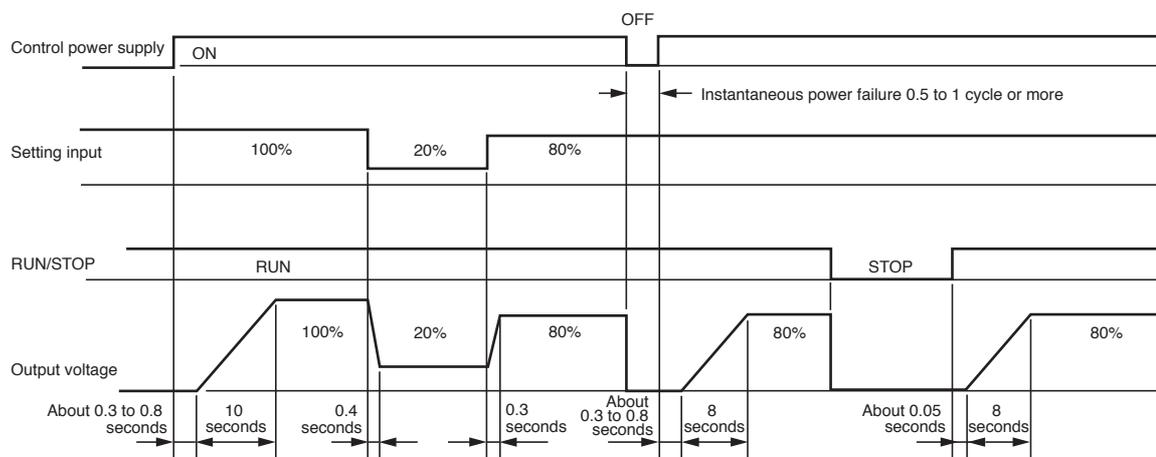
● RUN/STOP (gate on/off) function

Output is turned on by soft start when the RUN-COM terminal is "shorted" and turned off immediately when it is "open" regardless of the setting input. The figure below shows the operation timing. (When a setting indicator is connected or network communication control is used, there are cases where it will not run by only short-circuiting RUN-COM.)

● Soft start and soft up/down function

It activates and gradually changes the output when the control power is turned on, immediately after an instantaneous power failure, when the RUN/STOP signal is turned on, or when the setting signal changes. Therefore, in the case of transformer loads or pure metal heaters or lamp loads, the inrush current can be suppressed by using it in combination with the current limiting function.

The soft start time can be set as desired in the range of 0.5 to 10 seconds or 5 to 100 seconds, respectively. The variable range can be switched by changing DIP switch SW1. The figure below shows the operation timing.



E.g. of RUN/STOP, soft start, and soft up/down time charts
(Soft start setting: 10 seconds; Soft up/down: 0.5 second fixed setting; Control method: T and A types)

(Note)

- The soft start setting time is the time after RUN during which the output increases from 0% to 100%.
- The soft start setting time can be set independently of feedback control.
- Soft start setting time and soft up/down setting time can be set as desired by using the setting indicator (APD3).
(Setting time: 0 to 100 seconds)



Fuji AC Power Regulator [APR]

APR-V Series

SCCR: 100 kA

Setting indicator APD3

■ Features

The APR-V Series can be operated and configured in a variety of ways.

- Enables quick selection and display switching using dial operation.
- Capable of displaying two elements at the same time with data display and multi-indicators.
- Capable of diagnosing the main unit without a tester by using the input signal check function.
- Comes with an error detection history display function.
- Capable of high-precision digital setting.
- Enables customization of functions by changing function codes.
(Alarm output assignment and terminal block assignment of internal volume function, etc.)
- Capable of copying function codes.
- Complies with revised Chinese RoHS.
- Not compatible with APD1 or APD2.

■ Specifications

Item	Specifications
Type	APD3
Protective structure	Panel side: IP40; Back side (mounting surface): IP20
Location of use	Indoor
Ambient temperature	-5 to +50°C
Ambient humidity	30 to 90% RH (no condensation)
Atmosphere	Locations free from dust, corrosive gases (especially sulfide gas, ammonia gas, etc.), flammable gases, oil mist, vapor, water droplets, and direct sunlight. Locations not subject to salt damage. Ensure no condensation due to sudden temperature changes.
Altitude	1000 m or less
Ambient storage temperature	-20 to +60°C
Ambient storage humidity	30 to 90% RH (no condensation)
Mounting method	Vertical mounting (wall-mounted)
Tightening torque for main unit mounting	
Mounting screws	M3 x16 2 pcs.
Tightening torque (±10%)	0.7 N·m (7 kgf·cm)
Mass	55 g



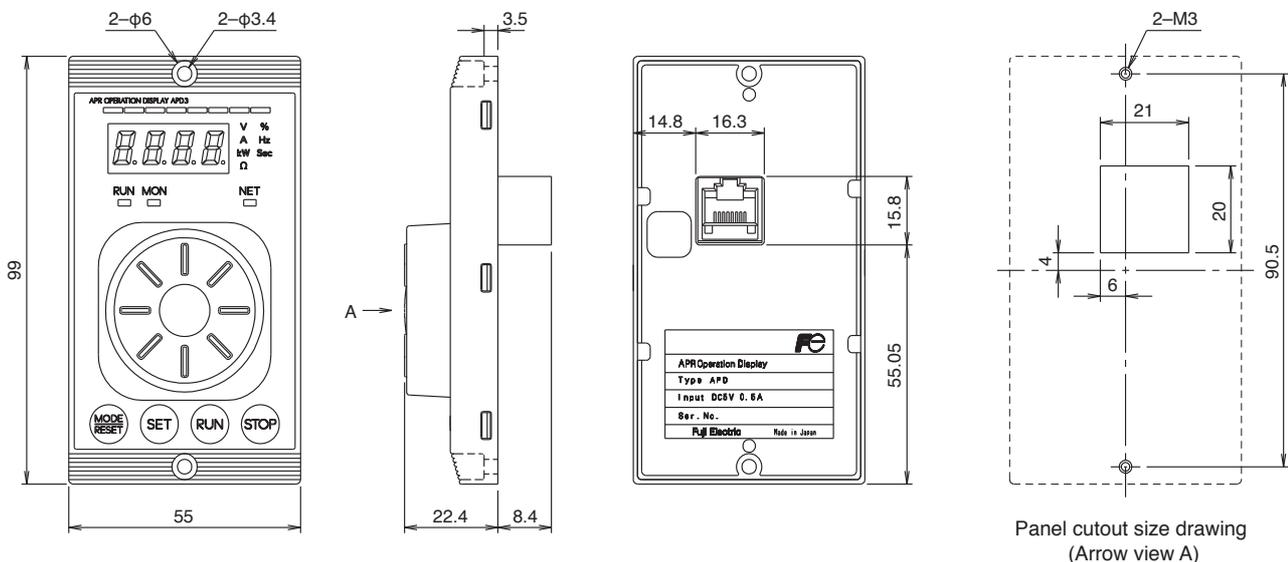
■ Hardware specifications

Item	Specifications
Remote control connection cable	Straight cable (for 10BASE-T/100BASE-TX) complying with US ANSI/TIA/EIA-568A Category 5 standards
Maximum communication distance	20 m (not insulated)
External connection terminal	RJ-45 connector (modular jack connector)

(Note 1) A remote control connection cable (RPN002-□) is required when using the setting indicator.

(Note 2) Do not use STP (shielded) cables when using commercial products.

■ External dimension diagram (unit: mm)



■ Setting indicator (APD3) Part names and functions

LED monitor
7-segment LED monitor. Displays the following information for each operation.

- During MON (monitor) mode
Displays operating information (output voltage, output current, load resistance, etc.).
Displays the alarm code when an alarm occurs.
- During SET mode
Displays function code and function code data.

Multi-indicator
Displays the LED monitor display value in 8 segments. It also displays the internal I/O monitor and communication monitor.

Unit display LED (7 items)
Displays the unit of data displayed on the LED monitor by means of LEDs.

- V..... Voltage value display
- A..... Current value display
- kW... Power value display
- Ω Resistance value display
- %..... Percentage display
- Hz... Frequency display
- Sec... Setting time display

(Note)Some control methods cannot be displayed.

Status indication LED (3 items)
Displays various statuses using LEDs.

- RUN-LED (run indication)
Lights up when the APR is running.
- MON-LED (detection indication)
Lights up in MON (monitor) mode.
- NET-LED (network communication indication)
Lights up when APR is operating under the direction of the host via network communication.

Dial
Selects setting items and detection values displayed on the LED monitor, and changes function code data.

MODE/RESET key
Switches the operation mode between MON (monitor) mode and SET (setting) mode.

- During MON (monitor) mode
Press this key to switch to setting mode.
- During SET mode
Press this key to switch to monitor mode.

SET key
Pressing this key in setting mode displays function code data and confirms the data.

STOP key
Stops APR operation.

RUN key
Starts APR operation.

■ Display and key operation

Display unit and operation unit	Operation mode	SET mode		MON (monitor) mode		
		RUN/STOP	Running	RUN/STOP	Running	
Display unit		Function	Displays operation data outputs for fixed display of multi-indicator.		Displays in 8 segments various operation data, internal I/O, and communications monitors.	
		Function	Function code and function code data display When an alarm occurs, it displays an alarm code		Displays output voltage, output current, output power, load resistance value, and output %. When an alarm occurs, it displays an alarm code	
		Function	Displays various states			
		Function	Displays the unit of data displayed on the LED monitor			
Operating unit		Function	Function code and increase/decrease of function code data		Switching the display mode of each type of operation information	
		Function	Change to MON (monitor) mode		Change to SET mode RESET after removing error cause	
		Function	Displays function code data and sets data		-	
		Function	RUN start	-	RUN start	-
		Function	-	RUN/STOP	-	RUN/STOP



Fuji AC Power Regulator [APR]

APR-V Series

SCCR: 100 kA

• Feedback control

Feedback control accuracy (for resistive loads)

(Ta = 25°C)

Control method	Variable element	Control accuracy (Note)	Conditions
Current limit regulation (CLR)	Power supply voltage fluctuation $\pm 10\%$	$\pm 1\%$ FS	Constant load
	Load fluctuation 4x	$\pm 2\%$ FS	Constant power supply voltage
Automatic current regulation (ACR)	Power supply voltage fluctuation $\pm 10\%$	$\pm 1\%$ FS	Constant load
	Load fluctuation 4x	$\pm 2\%$ FS	Constant supply voltage
Automatic voltage regulation (AVR)	Power supply voltage fluctuation $\pm 10\%$	$\pm 1\%$ FS	Constant load
	Load fluctuation 4x	$\pm 2\%$ FS	Constant supply voltage
Automatic wattage regulation (AWR)	Power supply voltage fluctuation $\pm 10\%$	$\pm 1\%$ FS	Constant load
	Load fluctuation 4x	$\pm 1\%$ FS	Constant supply voltage

(Note) · The control accuracy is a % value of the rated output.
 · The accuracy of DC feedback control depends on the accuracy of the external converter.
 · Control accuracy is $\pm 4\%$ FS for 10 times load fluctuation.
 · The rated voltage or rated current is the upper limit of feedback control.

• Waveform control method

The phase control method and cycle control method can be selected by using the DIP switch.

For types with control method A, inrush current automatic suppression cycle control (combined control) can be selected.

Item	Phase control method	Cycle control method	Combined control method (Types with A only) (Note)
Applied load	Applicable to most loads, including resistive and inductive loads (excluding capacitor loads)	Applicable to nichrome and ferrochrome resistance loads (with low temperature coefficient of resistance)	Most resistive loads including pure metal and silicon carbide types
Transformer primary control	Available	Not available (Available for types with control method P)	Not available
Feedback control (AVR, ACR, etc.)	Available	Not available	Not available
Harmonic disturbance	Possible occurrence	No	No (except during suppression)
Flicker occurrence	No	Possible occurrence	Possible occurrence
Responsiveness	Fast	Slow	Slow
Power factor	Bad	Good	Good (except during suppression)

(Note) During current-limiting operation, it temporarily switches to phase control to limit the current flowing to the load to 90% or less of the CLR setting.

■ Heater disconnection detection (except for types with control method T)

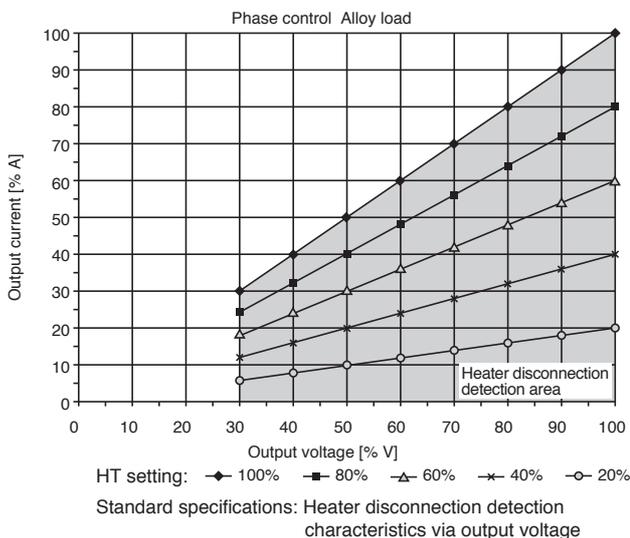
At the time of standard shipment, it is set to operate only in the standard specification of single-phase.

To enable the heater disconnection detection function of the high-performance specification, the setting must be changed using the setting indicator (APD3).

• Standard specification (single-phase only)

Detects a disconnection when the load current drops below the current value set by the heater disconnection determination setting volume "HT".

- Applicable heaters
Alloy types: 3 or less in parallel
(Must be of the same material and of the same capacity)
- Applicable load capacity
A load that draws 40 to 100% of the APR rated current at 100% APR output voltage.
- Disconnection determination setting volume "HT"
When setting less than 3%: Disconnection determination invalid
When setting 3% or higher: Disconnection determination valid
- Detection range
Output setting range 30 to 100% (including gradient setting)
Output voltage range 30 to 100% V

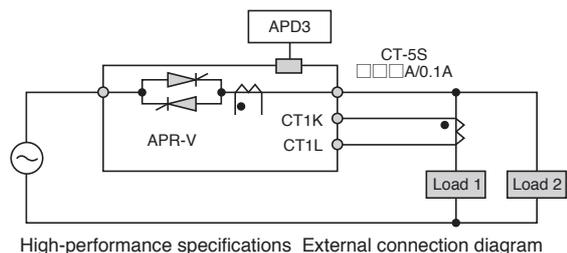


• High-performance specifications (for single-phase)

The load is divided into two, and the currents are compared with each other to detect disconnections.

- Applicable heaters
Various heaters: 10 (5+5) lines or less in parallel
(Must be of the same material and of the same capacity)
- Applicable load capacity
A load that draws 50 to 100% of the APR rated current at 100% APR output voltage.
- Disconnection determination setting
Settings (number of heaters, determination time, etc.) using setting indicator (APD3)
- Number of parallel lines and detection range

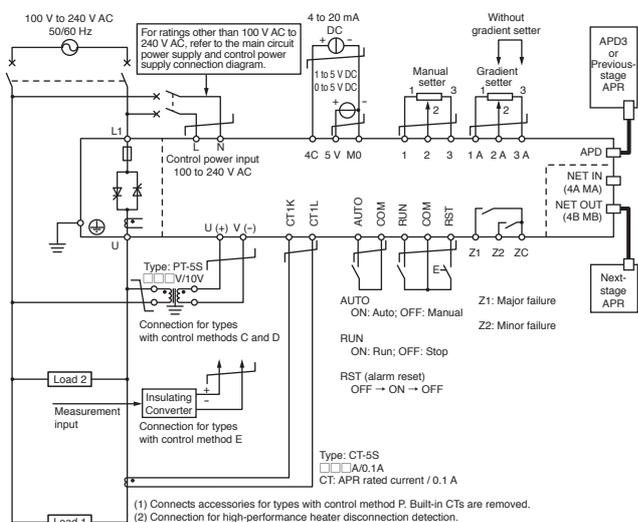
Total number	Load 1 Number of parallel lines	Load 2 Number of parallel lines	Detection range (APR output voltage)
2	1	1	30 to 100%
3	1	2	
4	2	2	
5	2	3	
6	3	3	40 to 100%
7	3	4	
8	4	4	50 to 100%
9	4	5	
10	5	5	



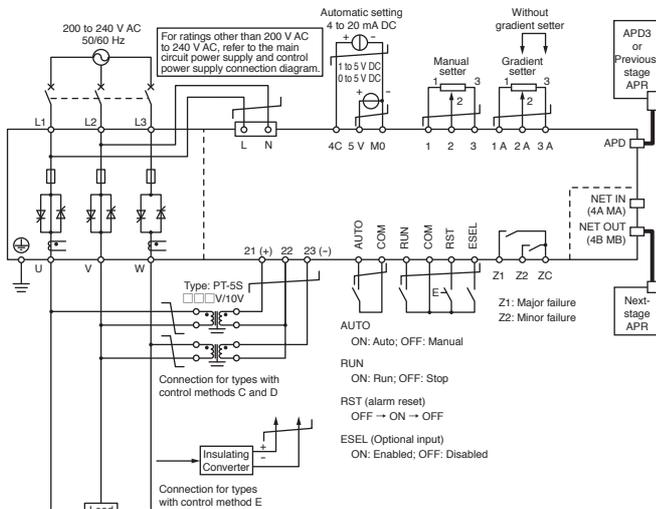
- For three-phase types, an external CT connection is not required.
- For three-phase three-wire types, a total of 9 lines can be detected.
For three-phase four-wire types, a total of 15 lines can be detected.

External connection

External connection diagram (In case of single-phase, full connection, with no change in function allocation)



External connection diagram (In case of three-phase, full connection, with no change in function allocation)

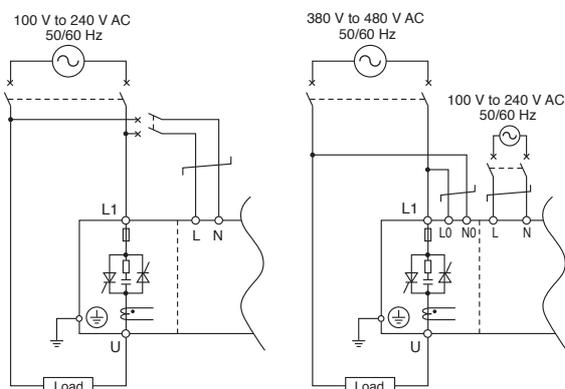


Control terminal function when setting indicator (APD3) is available (SW8: ON)

You can make function code settings using the setting indicator (APD3) and omit external wiring or change functions using network communication.

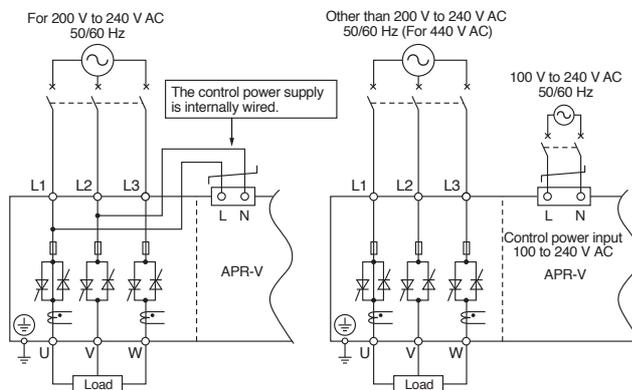
Control terminal	Wiring	Remarks
RUN	Required	Operation is not performed when the RUN terminal is OFF. When the RUN terminal is ON, the unit will run or stop when the RUN/STOP key is pressed on the setting indicator (APD3). Operation using the RUN/STOP key on the setting indicator is recorded in non-volatile memory. If the last operation is RUN, the unit will run or stop according to the RUN terminal ON/OFF status. If the last operation is STOP, the unit will not run even if the RUN terminal is ON. *If function code 6.o11 is set to OFF, the unit will run or stop according to the RUN terminal ON/OFF status only. *The unit can be started or stopped using network communications if the RUN terminal is ON.
1, 2, 3 1A, 2A, 3A	Select	Settings can be made using the setting indicator (APD3) or network communications, and so wiring is not required. *The functions of the CLR setting can be allocated to an external setter.
AUTO RST	Select	The AUTO terminal can be allocated to HIGH setting/LOW setting switching input for two-position control. The RST terminal cannot be assigned two-position control.
4C, 5V, M0	Select	Control can be performed using network communications if control is made using PLC output.
Z1, Z2, ZC	Select	Alarm codes are displayed on the setting indicator (APD3). Network communications can be used to read alarm codes and check if there are major failures or minor failures.

Main circuit and control power supply connection diagram (single-phase)



*Be sure to check that the main circuit power supply and the input power supply detection terminals are in phase. It is not necessary for the L and N terminals of the 400 V system to be in-phase.

Main circuit and control power supply connection diagram (three-phase)



Check that the phase order of the main circuit power supply is L1 → L2 → L3. If the phase order is not correct, an alarm will occur (red/green LED lights up).



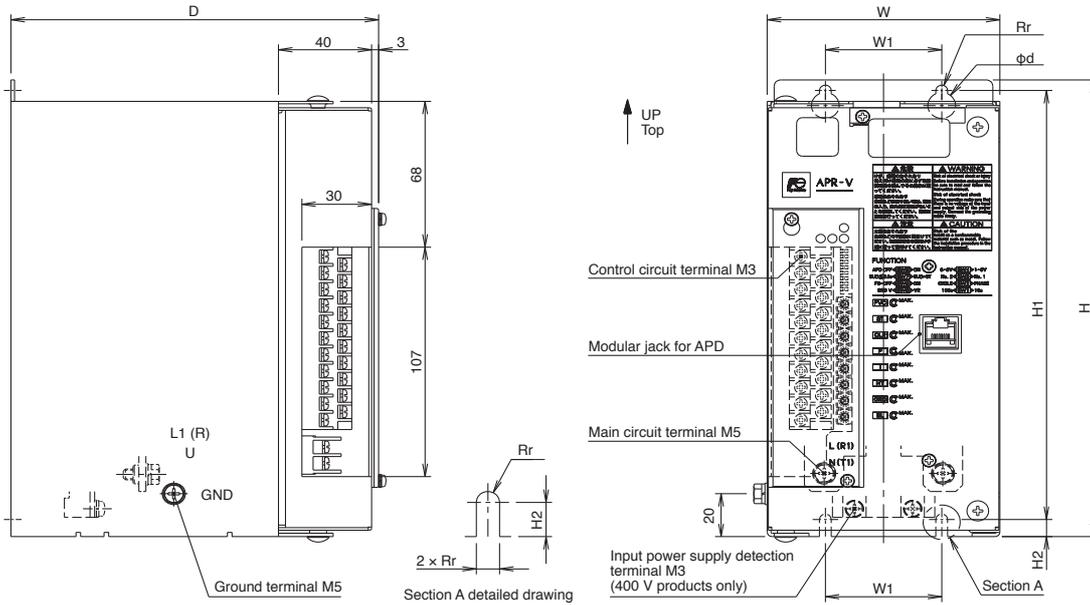
Fuji AC Power Regulator [APR]

APR-V Series

SCCR: 100 kA

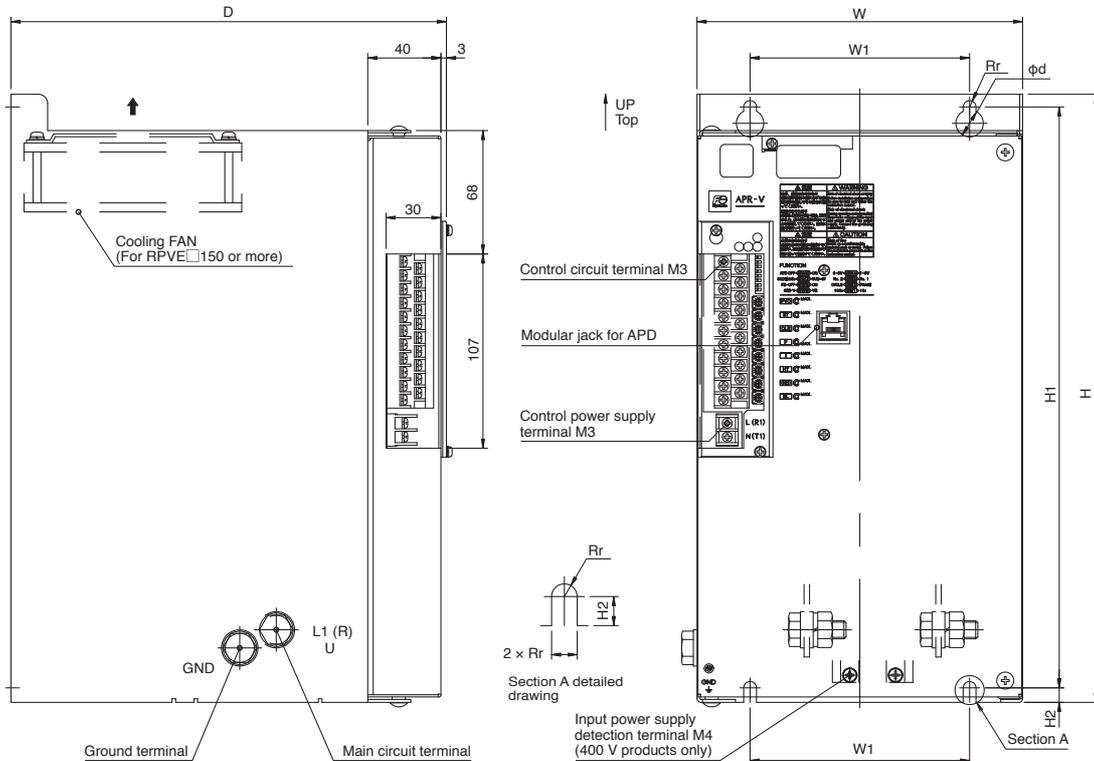
External dimension diagram (single-phase) [unit: mm]

- RPVE□020, RPVE□045, RPVE□060



Type	W	H	D	W1	H1	H2	d	r	Mass [kg]
RPVE□020	100	213	158	50	200	8	12	2.5	2.6
RPVE□045	114	213	183	60	200	8	12	2.5	3.6
RPVE□060									

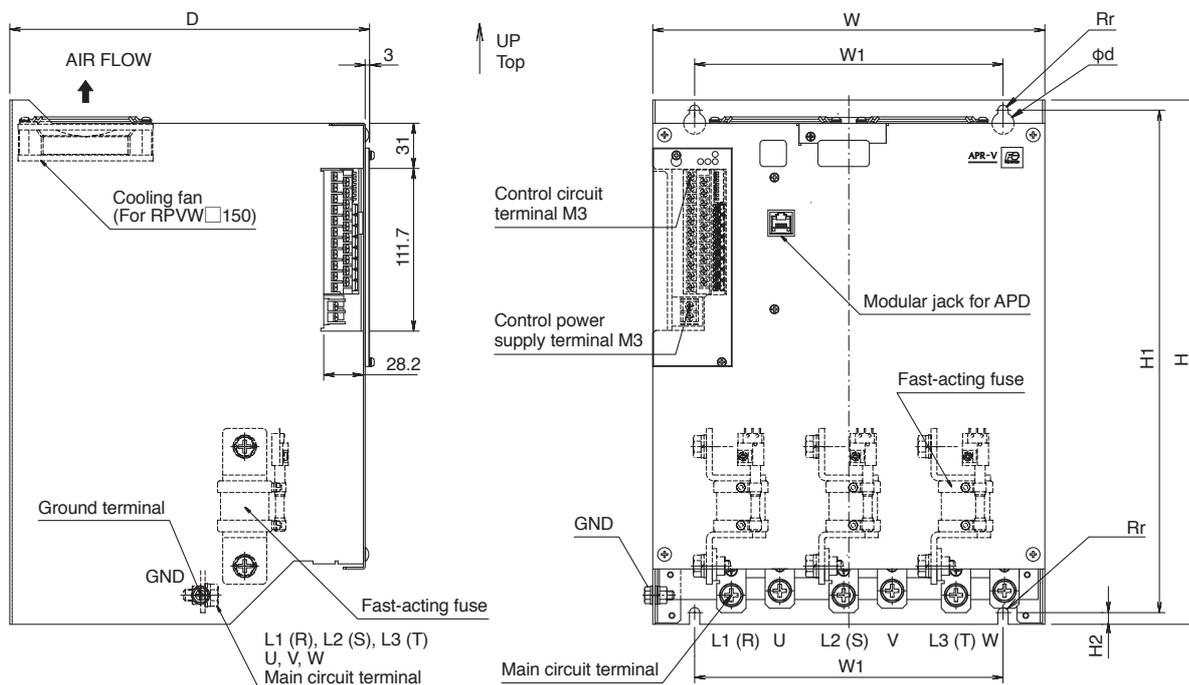
- RPVE□100, RPVE□150, RPVE□250, RPVE□350, RPVE□450, RPVE□600



Type	W	H	D	W1	H1	H2	d	r	Mass [kg]	Main circuit terminal	Ground terminal
RPVE□100	144	224	238	90	210	8	14	3	5.3	M8	M8
RPVE□150	160	273	238	90	260	7	14	3	6.4		
RPVE□250	178	335	238	120	320	8	15	3.5	9.0	M10	M10
RPVE□350	200	345	263	150	330	8	15	3.5	10.6		
RPVE□450											
RPVE□600	207	360	288	157	345	8	15	3.5	13.7	M12	M10

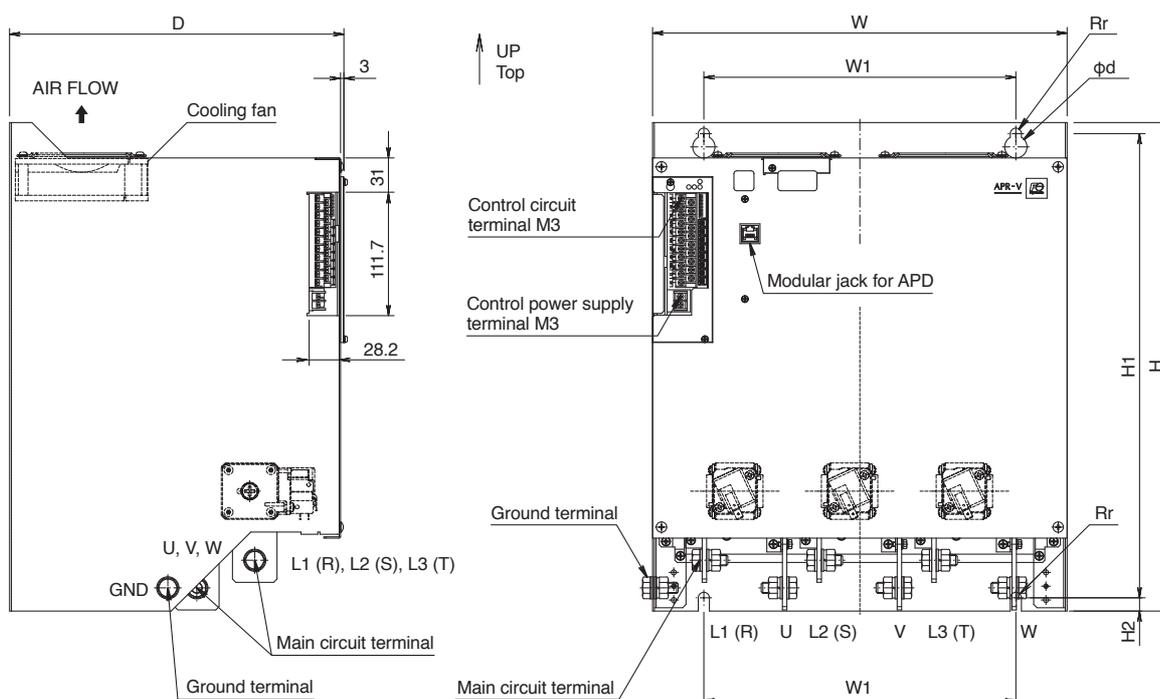
■ External dimension diagram (three-phase) [unit: mm]

- RPVW□020, PVV□045, RPVW□060, RPVW□100, RPVW□150



Type	W	H	D	W1	H1	H2	d	r	Mass [kg]	Main circuit terminal	Ground terminal
RPVW□020	230	273	160	200	260	6	14	3	5.0	M5	M5
RPVW□045	238	293	210	205	280	6	14	3	9.5		
RPVW□060											
RPVW□100	267	330	245	210	315	8	15	3.5	11.8	M8	M6
RPVW□150	267	360	245	210	345	8	15	3.5	13.2		

- RPVW□250, RPVW□450, RPVW□600



Type	W	H	D	W1	H1	H2	d	r	Mass [kg]	Main circuit terminal	Ground terminal
RPVW□250	267	384	280	200	365	9	20	5	14.3	M10	M8
RPVW□450	372	442	300	280	420	12	20	5	28.1	M10	M10
RPVW□600	372	528	310	280	505	11	24	6	36.8	M12	M10

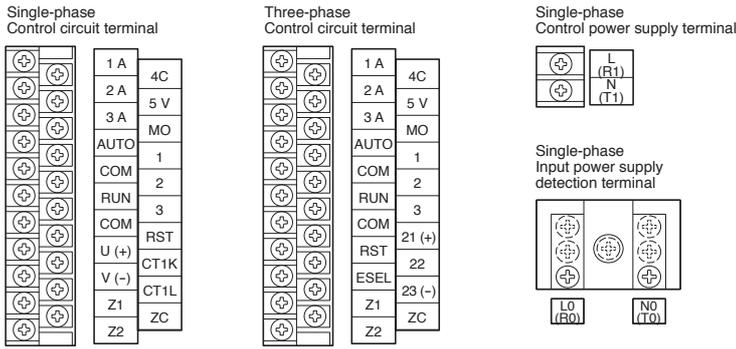


Fuji AC Power Regulator [APR]

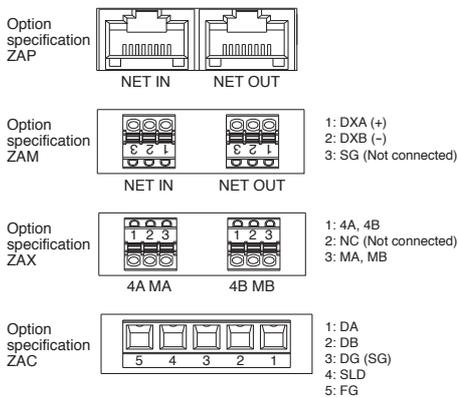
APR-V Series

SCCR: 100 kA

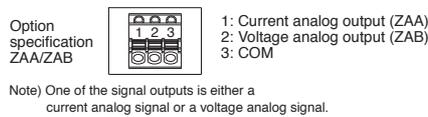
Terminal block detailed drawing



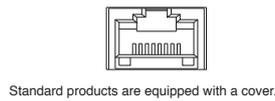
Communication board connector diagram wiring specifications



Analog output connector diagram Wiring specifications



Modular jack for APD

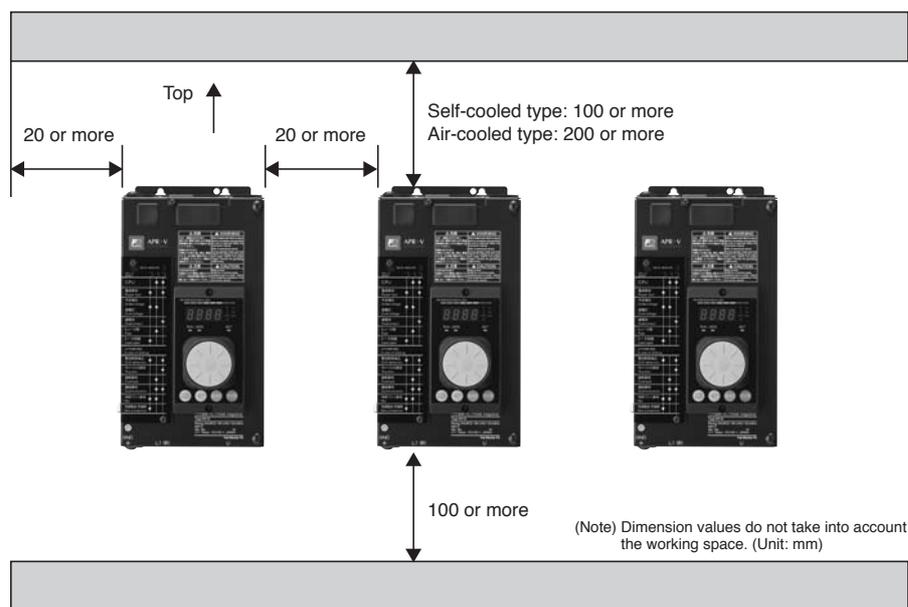


Category	Name	Symbol	When not in use	Function description
Control power supply	Control power supply terminal	L (R1), N (T1)	-	Control circuit power supply Single-phase 100 V to 240 V AC input
Input power supply detection	Input power supply detection terminal (Single-phase 400 V products only)	LO (R0), NO (N0)		Input power monitored using in-phase input with main circuit power supply
Control circuit	Manual setting input	1, 2, 3	Open	Manual setting input and HIGH setting input using connection of variable resistor
	Gradient setting input	1A, 2A, 3A	2A-3A short circuit	Gradient setting input and LOW setting input using connection of variable resistor
	Automatic setting input	4C, 5V, MO	Open	Voltage and current signal input of controller
	Auto/manual switchover input	AUTO, COM	-	Automatic setting input when the external contact is closed Manual setting input when the external contact is open
	RUN / STOP input	RUN, COM	Short circuit	RUN status when the external contact is closed and output OFF when the external contact is open
	Alarm reset	RST, COM	Open	Alarm release when the external contact is closed
	Alarm contact output	Z1, ZC		Internal contacts turn ON when alarm occurs for major failure
	Alarm contact output	Z2, ZC		Internal contacts turn ON when alarm occurs for minor failure
	External detection input	U (+), V (-) 21 (+), 22, 23 (-)		Feedback detection input with connection of VT and various DC converters
Parallel operation/ Modbus RTU/ CC-Link	External CT input (single-phase only)	CT1K, CT1L		CT connection using advanced heater disconnection alarm
	External selection input (three-phase only)	ESEL, COM		
	APD I/O	APD		Sending and receiving setting values with connection of a setting indicator (APD3) Receiving parallel operation signals from previous-stage APR in parallel operation
	Parallel run I/O	NET IN NET OUT		Sending and receiving setting values from the host in network communications Sending parallel operation signals to next-stage APR in parallel operation
			4A, MA 4B, MB	MX and MX2-series compatible input terminal MX and MX2-series compatible output terminal

(Note) The function description for the control circuit applies when there are no changes in function allocations.

● Mounting method

- To ensure heat radiation from APRs, mount the APR on a vertical metal surface, make sure the vertical mounting direction is as shown in the figure below, and provide sufficient space both vertically and horizontally. In particular, when using APRs in a dense configuration, there may be heat interference between APRs, so when mounting APRs, separate them by at least the dimensions shown below.
- The temperature inside the panel rises due to the heat generated by the APR, so please take measures to ensure ventilation, etc.
- The left and right sides and top of the APR radiate the most amount of heat, so be careful of the impact of temperature rise on nearby objects.
- Ensure sufficient space with regard to nearby objects when wiring the main circuit terminals, control power supply terminals, and control circuit terminals, as well as for tools used in replacing quick-acting fuses (removing and replacing screws on front panel) and replacing cooling fans (removing and replacing fan mounting screws on the top).
- The mounting interval of the APR is the same for single-phase and three-phase units.



● Wiring method

- For main circuit terminals (single-phase: L1, U; three-phase L1, L2, L3, U, V, W), use the screws (bolts) provided. Parts with dimensions larger than the specified dimensions will lack sufficient insulation from surrounding parts. Also, use insulation caps for crimp terminals.
- To ensure safety, always connect the ground terminal. Since this terminal is similar to the main circuit terminal, be careful not to mistake them. Wire the ground terminal independently and ensure that you do not wire more than one line.
- Use circuit protective circuit breakers or earth leakage circuit breakers on the main circuit input side and control power supply input side for short circuit protection and overload protection.
- The input power supply detection terminal of single-phase 400 V products monitors the main circuit power supply status. Wire the input power supply detection terminal block (single-phase: L0, N0) so that it is in-phase with the main circuit power supply.
- The main circuit terminal of three-phase products monitors the main circuit power supply status. Wire so that the phase order of the main circuit power supply is L1 → L2 → L3.
- When wiring to control power supply terminal blocks (L, N), input power supply detection terminal blocks, and control circuit terminal blocks (Z1, Z2, ZC terminals), use crimp terminals with sufficient insulation coating to ensure insulation with nearby terminals.
- When wiring to the signal terminals of the control circuit terminal block, in order to prevent noise, do not wire them close to the main circuit terminals (single-phase: L1, U; three-phase: L1, L2, L3, U, V, W) and control power supply terminals (L, N), and do not wire them in the same duct. If the wires intersect, arrange them orthogonally. The wires should be twisted for each signal group (twist 4 to 7 times per 10 cm). When using a shielded wire, connect the shielded outer jacket on the receiving side to the ground terminal and leave the other terminal open.
- For contact specifications of relays used for contact input, use twin gold-plated contacts for long-term continuous energization at low currents and voltages.
- For external detection signal terminals (single-phase: U (+), V (-), CT1K, CT1L; three-phase: 21 (+), 22, 23 (-)), use a CT, VT, or insulating converter to isolate the signal from the main circuit.
- When mounting the setter (type: RPN001), mount it after drilling mounting holes to prevent rotation.
- When connecting the setting indicator, secure it after taking into account the cable take-out direction so that no excessive force will be applied to the cable connector connection.

● Others

- In terms of output measurement instruments, use an RMS value type instrument for phase control and a cycle control waveform type instrument for cycle control. The use of other instruments will cause errors.
- Please understand that no compensation will be provided for damages caused by the failure of any individual delivered product.



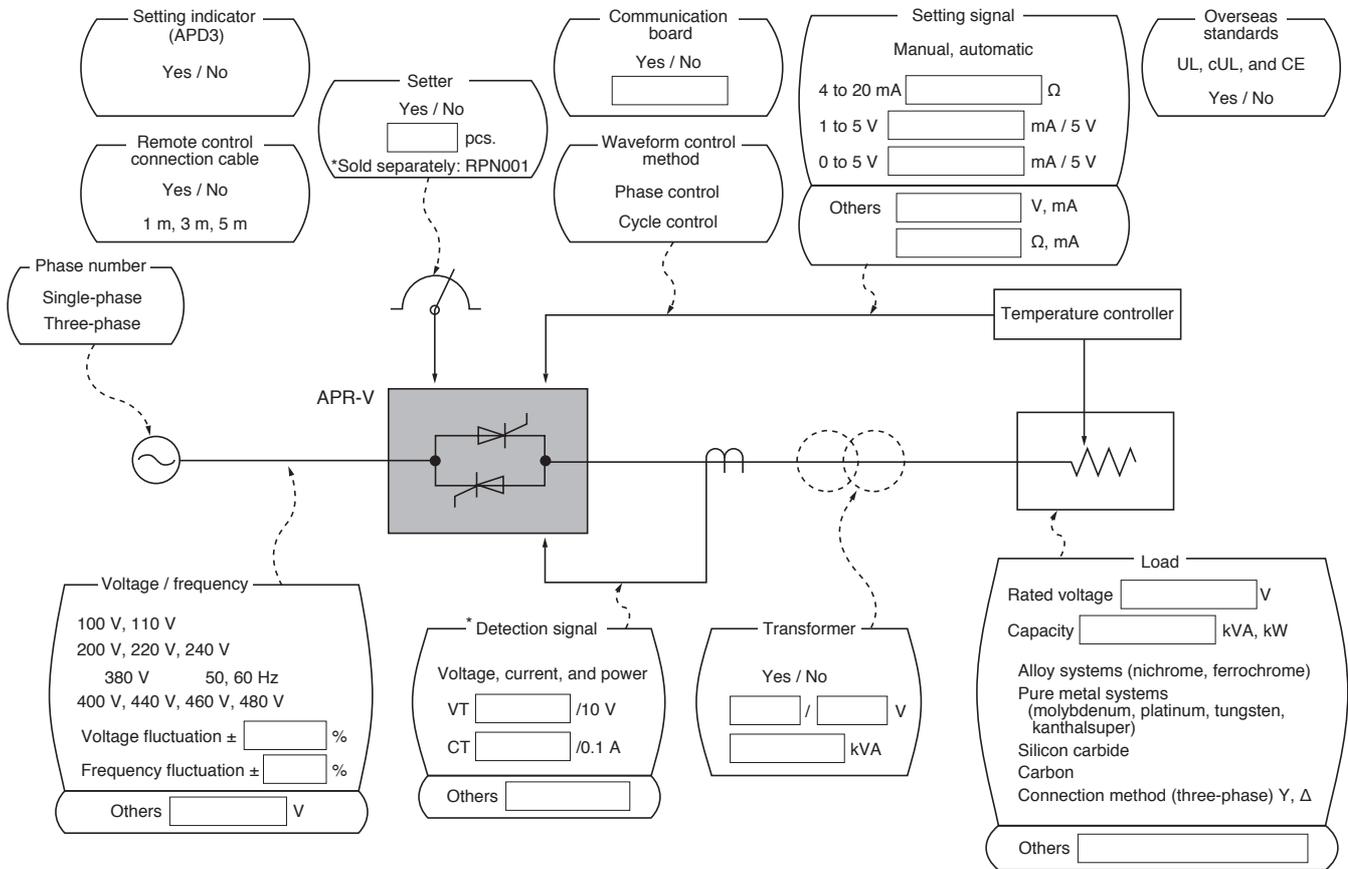
Fuji AC Power Regulator [APR]

APR-V Series

SCCR: 100 kA

Inquiries

1. Please circle the appropriate content for each relevant item. Please fill in the values or details in the enclosed blank spaces.



*Select the following control method according to the detection signal.

- T: No feedback function
- A: AC CLR (current limit regulation)
- B: AC ACR (automatic current regulation) + AC CLR (current limit regulation)
- C: AC AVR (automatic voltage regulation) + AC CLR (current limit regulation)
- D: AC AWR (automatic wattage regulation) + AC CLR (current limit regulation)
- E: DC feedback control + AC CLR (current limit regulation)
- P: Transformer primary control via cycle control (single-phase only)

2. Surrounding temperature (panel inside temperature when stored in-panel) to °C

3. Order type (= Product code)

RPV - - /

4. Quantity: pcs.

⇒ The following can be omitted depending on the specifications.

5. Delivery date: YYYY MM DD

6. Company name

7. Other remarks

MEMO



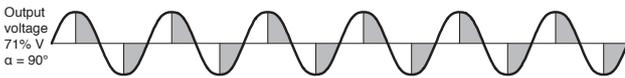
The single-phase APR-D Series is the successor to the APR-aB and aC. It is a space-saving, wiring-saving, low-cost APR with greatly improved functionality and performance thanks to its built-in CPU.

■ Features

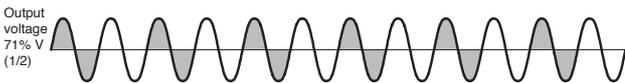
- Applicable to inductive loads, transformer primary control, and rectifier primary control through continuous comb-tooth pulse control.

- Able to switch the waveform control method (phase control, cycle control, and phase angle proportion control).

Phase control (0 to 100%)

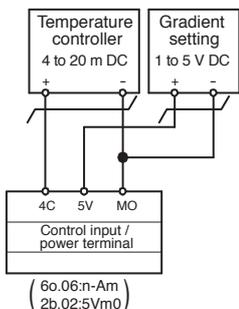
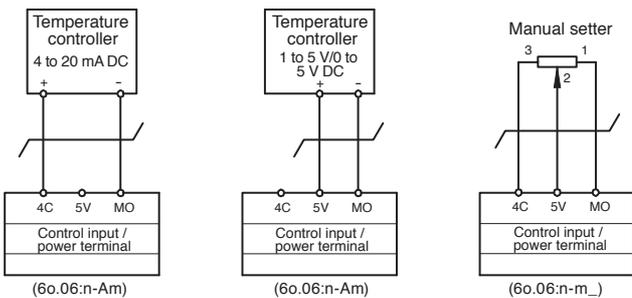


Cycle control (intermittent control)

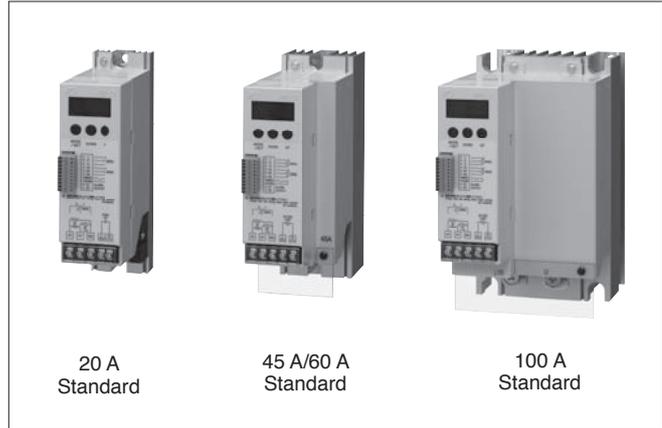


• Example of control input wiring

For auto setting or manual setting only, it is possible to adjust the device by changing the function of the control input terminal block.

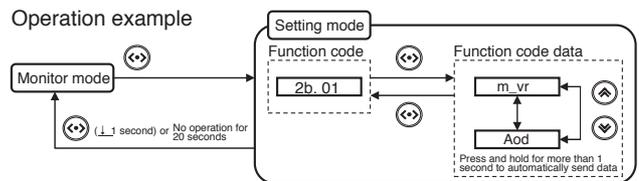


(Note) When shipped from the factory, 6o.06 is set to n-Am, and 2b.02 is set to Aod. Function codes and terminal functions are shown in parentheses ().



- Achieves space savings thanks to a class-minimal dense array (minimum interval in width: 2 mm).

- Base load setting, digital settings including gradient setting, and monitor functions are available as part of the standard configuration.



- Allows soft start time, soft up time, and soft down time to be individually set between 0 to 100.0 seconds.

- Performs auto identification of 100 to 240 V AC and 50/60 Hz with respect to control power.

- As a control method, current limit control and automatic current feedback control are available. You can also detect heater disconnection (cycle control: load opening).

(Note) It is possible to detect disconnection of one to three lines in an alloy heater where there are small changes in resistance depending on the temperature.

- Allows communication control as an optional function.

Main unit option type:

ZAP: Up to 50 units can be operated in parallel.

For cycle control, a flicker prevention function is available.

ZAM: Various settings and monitors are possible by means of RS485 (Modbus RTU).

- All models are compliant with CE marking / EU revised RoHS Directive (2011/65/EU + (EU)2015/863).



Compliant with the new EMC Directive (2014/30/EU)

Compliant with the new Low Voltage Directive (2014/35/EU)

- Complies with revised Chinese RoHS

All single-phase APR-D Series models are supported as standard.





Fuji AC Power Regulator [APR]

APR-D Series (Single-phase)

■ Specifications

Item		Specifications				
Type (product code)		RPDE2020-□	RPDE2045-□	RPDE2060-□	RPDE2100-□	
Input	Main circuit / control circuit	Rated input voltage and frequency	Single-phase 100 to 240 V AC 50 Hz/60 Hz (auto identification)			
		Input voltage range	Rated input voltage $\pm 10\%$ (Performance guarantee) (Note 1) Rated input voltage $\pm 15\%$ (Operation guarantee)			
		Input frequency range	50 Hz/60 Hz ± 2.5 Hz			
	Control circuit	input capacity	15 VA or less			
Output	Rated current (at ambient temperature 40°C) [A]	20	45	60	100	
	Cooling system	Self-cooled				
	Applied load	Resistive load, inductive load, transformer primary control, rectifier primary control (For cycle control, resistive load (alloy) only)				
	Minimum load current	0.5 A (However, at 100% output at the rated input voltage)				
	Generated loss (at rated current) [W]	30	55	70	110	
Control	Waveform control method		Single-phase thyristor anti-parallel connection Phase control / cycle control (intermittent) / phase angle proportion control			
	Output voltage adjustment range		0 to 100% (RMS value) of the main circuit power supply voltage (excluding thyristor voltage drop portion)			
	Input-output characteristics		Linear characteristic of RMS value, linearity : $\pm 5\%$ FS or less (phase control) (However, at resistive load / setting signal 10 to 90%) Linearity: $\pm 5\%$ FS or less (cycle control)			
	Setting signal	Auto setting	Current signal : 4 to 20 mA DC ($Z_{in} = 100 \Omega$) Voltage signal : 0 to 5 V DC, 1 to 5 V DC ($Z_{in} = 11 \text{ k}\Omega$) SSC signal: 0/12 V DC ($Z_{in} = 11 \text{ k}\Omega$)			
		Manual setting	External variable resistor: 1 k Ω (B characteristic 1/2 W or higher)			
		Digital setting	Front key input (direct drive possible)			
		HIGH-LOW setting (Two-position control)	Can be combined with digital setting and external variable resistor Switching contact signal via digital setting or external contact switching via control input connector			
	Gradient setting	Setting range	0 to 100% of output voltage			
		Setter	Voltage signal setting through digital setting, external variable resistor 1 k Ω , or control circuit terminal (5V-M0) (1 to 5 V DC only) Enables reverse gradient characteristics in combination with base load setting			
	Base load setting	Setting range	0 to 100% of output voltage			
		Setter	Digital setting			
	Soft start time	Setting range	Control method T, A types : 0 to 100 seconds			
	Soft up time	Setting range	Control method B : 0.5 to 100 seconds (Note 2)			
	Soft down time	Setter	Digital setting. Each time can be individually set			
Feedback control method (Phase control only)		AC CLR (Types with control method A) AC ACR + AC CLR (Types with control method B) (prioritizes AC CLR)				
Manual/auto Switching signal		Non-voltage contact				
Communication (Note 4)	Parallel run Master/slave	Maximum number of connectible units: 50 Main unit's option type "ZAP" (Not compatible with the APR-N Series)				
	Network communication	RS-485 compliant Two-wire system Half duplex start-stop synchronization Protocol: Modbus RTU compliant Maximum number of connectible units: 31 Main unit's option type "ZAM"				
Error detection and protection	CPU memory error		CPU memory error detection at startup			
	Power supply error		Detects control power frequencies other than 45 to 65 Hz			
	Auto setting input not connected		Detection of non-connection of current signal (4 to 20 mA DC) and voltage signal (1 to 5 V DC) (Only with auto setting)			
	Manual setting input not connected		Detection of non-connection of a manual setter (external variable resistor) (Only with manual setting)			
	Gradient setting input not connected		Detection of non-connection of a gradient setter (external variable resistor or 1 to 5 V DC)			
	Reverse phase detection		Detection when the main circuit power phase and control power phase are reverse (Main unit's option type "Z45" only)			
	Data writing/reading error		Detection of read/write errors from/to EEPROM			
	Thyristor abnormality		Detection of thyristor shorting through built-in CT (Types with control methods A, B)			
	Communication error		Data transmission failure (main unit's option type "ZAP" or "ZAM") at the time of parallel run or network communications			
	Current limit detection		Detects load current exceeding the CLR setting value and switches the phase angle to reduce it to within the CLR setting value (Types with control methods A, B)			
	Heater disconnection		Detection of APR output current values lower than the disconnection determination value (types with control methods A, B) (Note 3)			
	Alarm output		Open collector 24 V DC/ 0.1 A 1 circuit			
	Operating environment	Ambient temperature		-10 to +55°C (reduces load current to the rated current value when the temperature is between +40°C and +55°C)		
Storage temperature		-20 to +60°C				
Ambient humidity		+5 to +95% RH (no condensation)				
Others		No corrosive gases, dust, substances and actions that promote insulation deterioration, or vibration. Use indoors at an altitude of 1000 m or less				
Insulation	Dielectric strength (Main circuit to ground)		2000 V AC for 1 minute			
	Insulation resistance (To ground)		10 M Ω or higher, measured with 500 V DC megger tester			

(Note 1) Performance guarantee refers to satisfying specifications and assuring proper run of the product. Operation guarantee refers to assurance of damage-free parts and proper run of the product.

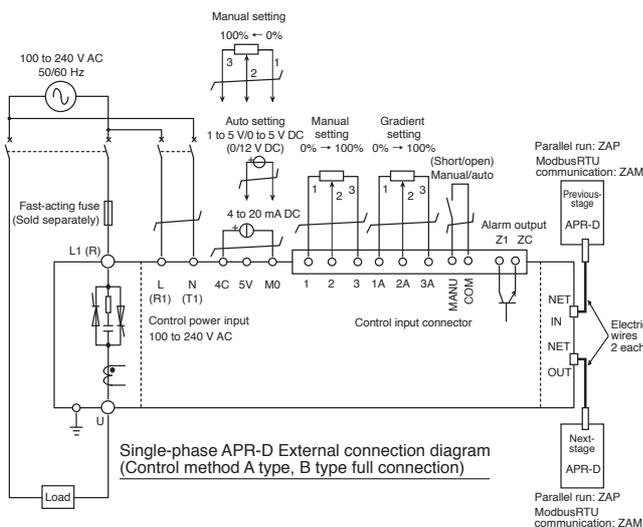
(Note 2) Soft start and soft up/down time for types with control method B are disabled even if set to a time which is shorter than the response speed in terms of PI control.

This is because PI control is prioritized over soft start and soft up/down time.

(Note 3) For cycle control, load open detection is performed.

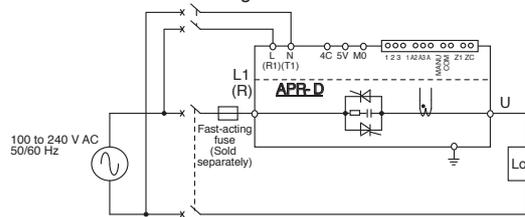
(Note 4) Only one type of communication board can be mounted before shipment.

■ Connection diagram

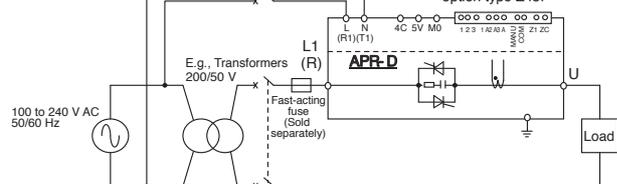


• Wiring of the main circuit terminals and control power terminals

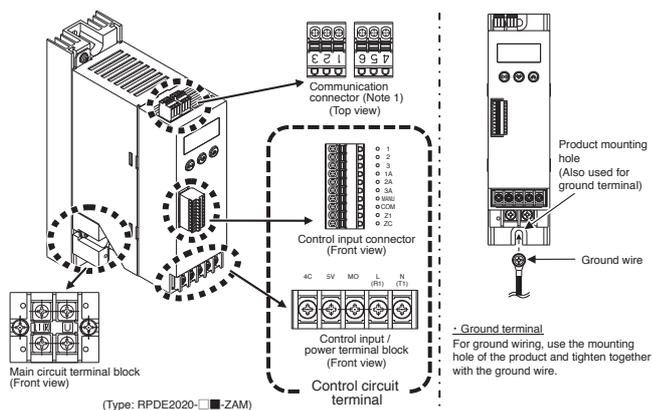
(1) When the main circuit voltage is 100 to 240 V AC



(2) When the main circuit voltage is other than 100 to 240 V AC (Note) Not applicable for main unit option type Z45.



• Positions and functions of connection terminals



(Note 1) It is provided when the main unit option (ZAP, ZAM) is specified.

• Screw size and tightening torque

Terminal	Screw size	Tightening torque [N · m] ±10%
Main circuit terminal block	L1 (R), U	20 A M4 1.8 (18 kgf · cm)
		45 A M5 2.7 (27 kgf · cm)
		60 A M5
		100 A M8 12.0 (120 kgf · cm)
Control input · Power terminal block	L (R1), N (T1), 4C, 5V, M0	M3 0.5 (5 kgf · cm)
	Control input connector	1 to ZC
Communication connector	NET IN, NET OUT	-
Main unit mounting screws (also used for the ground terminals)	20 to 60 A, M5	3.5 (35 kgf · cm)
	100 A M6	5.8 (58 kgf · cm)

■ Other options (sold separately)

• Replacement adapter for APR-aB and aC (RPD002-E□□)

Type	Content
RPD002-E02	For RPDE2020-□
RPD002-E06	For RPDE2045-□, RPDE2060-□
RPD002-E10	For RPDE2100-□

(Note) Attach the adapter to the mounting holes (for APR-aB and aC) on the panel surface, and then attach the APR-D to the adapter. For RPCE2020-□, please apply RPD002-E06.

• Fast-acting fuse

Rated current (APR type)	Fast-acting fuse (rated current)	Fast-acting fuse holder	Base and cap
20 A (RPDE2020)	CR2LS-30 (30 A) or BLC045-1 (45 A)	CM-1A (For CR2LS, tripolar product)	AFa60 + Pa60 (for BLC)
45 A (RPDE2045)	CR2LS-75 (75 A) or BLC075-1 (75 A)		AFa100 + Pa100 (For BLC)
60 A (RPDE2060)	CR2LS-100 (100 A) or BLC090-1 (90 A)		
100 A (RPDE2100)	CR2L-150 (150 A)	CM-2A (Tripolar product)	-

• Terminal function

Terminal type	Symbol	Name	Function description		
Terminal position	Pin				
Main circuit Terminal block	L1 (R)	Main circuit power input terminal	L1 (R): Main circuit power input terminal		
	U	APR output (connected to load)	U: APR output (connected to load)		
Control circuit terminal block	-	Ground terminal	Main unit's ground terminal (shared mounting hole)		
	4C (3)	Automatic setting input (Function code 60.06 = n-Am (factory default))	4C-M0: 4 to 20 mA DC input; (Zin = 100 Ω) 5V-M0: 1 to 5 V DC; 0 to 5 V (SSC signal: 0/12 V); (Zin = 11 kΩ) 5V-M0 can be allocated to the gradient setting input of 1 to 5 V DC		
	5V (2)				
	M0 (1)	Manual setting input (Function code 60.06 = n-m_)	Connecting a variable resistor makes it possible to use as manual setting input *When using this terminal as manual setting input, detection of manual setting non-connection is not performed		
	L (R1)	Control power terminal	Control power input. Input the same phase as that of the main circuit		
	N (T1)				
	1	Manual setting Input	Connecting a variable resistor makes it possible to use as manual setting input		
	2				
	3				
	4	1 A	Gradient setting Input	Connecting a variable resistor makes it possible to use as gradient setting input	
5	2 A				
6	3 A				
7	MANU	Auto/manual switching input	External contact Open: Auto setting Closed: Manual setting		
8	COM				
9	Z1	Alarm output Terminal	When an alarm occurs, the internal open collector turns ON. Operation can be selected by changing the function code setting.		
10	ZC				
Communication connector (Optional)	Network	1, 2	NET IN	RS-485	
		4, 5	NET OUT	Input-output	
	Parallel run	1, 2	NET IN	Parallel run input	When in network communications (option type: ZAM), various kinds of data are sent to and received from a host using the ModbusRTU protocol.
		4, 5	NET OUT	Parallel run output	When in parallel run (option type: ZAP), parallel run signals are received from the previous-stage APR. When in parallel run (option type: ZAP), parallel run signals are sent to the next-stage APR.

• DIN rail-mounting adapter

Type	Content
RPD004-E02	DIN rail-mounting adapter for RPDE2020-□



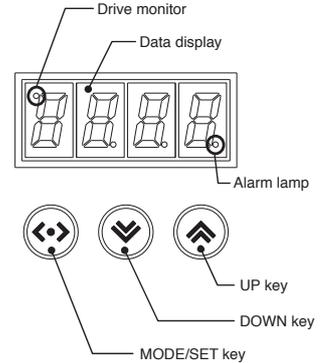
Fuji AC Power Regulator [APR]

APR-D Series (Single-phase)

■ The standard configuration of the APR-D Series contains display/operation units for various monitors and settings.

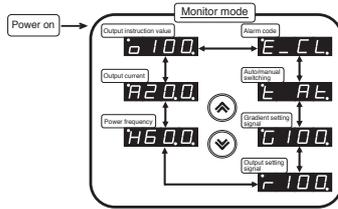
● Names and functions of the individual parts

Name	Function	Name	Function
Drive monitor	Data display unit 4th digit DP Run output Presence (light up) / absence (turn off)	UP key DOWN key	Use to select run information shown on the data display unit and to change the function code data. *Press and hold for one second or longer to perform auto switch of the data display.
Data display	4-digit 7-segment LED monitor Displays the following information for each operation mode. ●During MON (monitor) mode Run information (Output instruction value, output current, input signal, etc.) Displays the alarm code when an alarm occurs. The 4th digit shows items for various types of run information. ●During SET mode Displays function code and function code data, etc.	MODE/SET key	Use to switch the operation mode. ●During MON (monitor) mode Press and release to switch to the setting mode. ●When selecting a function code in setting mode Press and release to switch to function code data display. Press and hold for 1 second or longer to switch to the monitor mode. ●When setting function code data in setting mode Press and release to confirm data. Press and hold for 1 second or longer to cancel the setting and return to the monitor mode.
Alarm lamp	Data display unit 1st digit DP Alarm Presence (blink) / absence (turn off)		



● Monitor mode

Operating the UP and DOWN keys causes the monitor items below to be shown. (The alarm code is shown only when a failure occurs.)



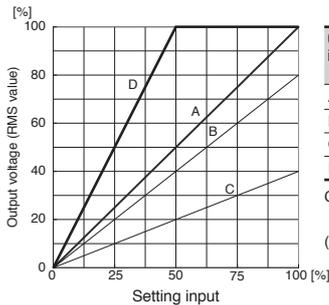
No.	Monitor item	Function Item Display	Display	Unit	Display description	Monitor accuracy (Note)
1	Output instruction value	o	100	%	Output instruction through APR internal calculation	○
2	Output current	A	20	A	AC output current detection value	○
3	Power frequency	H	60.0	Hz	Power frequency detection value	○
4	Output setting signal	r	100	%	Each setting signal detection value	○
5	Gradient setting signal	G	100	%	Gradient setting signal detection value	○
6	Auto/manual switching	t	At/m 1/m2	-	Auto/manual switching terminal status display	-
7	Alarm code	E	_SM	-	Display at the time of alarm occurrence	-

(Note) Monitor accuracy: ○ = ±5%

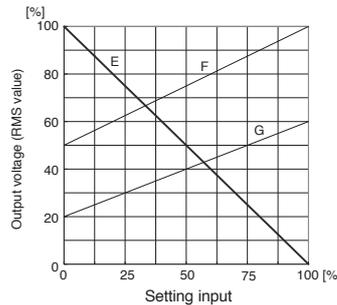
● Example of setting groups

Function code	Name	Function code data (Settable range)	Step size	Unit	Factory default setting
1b.01	Manual digital setting	0 to 100.0 [%]	0.1	%	0
1b.02	Gradient digital setting	0 to 200.0 [%]	0.1	%	100.0
1b.03	Base load setting	0 to 100.0 [%]	0.1	%	0
1b.04	Soft start time setting	T, A types: 0 to 100.0 [seconds]	0.1	seconds	0.5
1b.05	Soft up time setting	B type: 0.5 to 100.0 [seconds]	0.1	seconds	0.5
1b.06	Soft down time setting		0.1	seconds	0.5

● Gradient setting / base load setting



Gradient setting: Set an output value for when setting input is 100%. (Setting range: 0 to 200%)
(Note) The upper limit output value is up to 100% of input voltage.

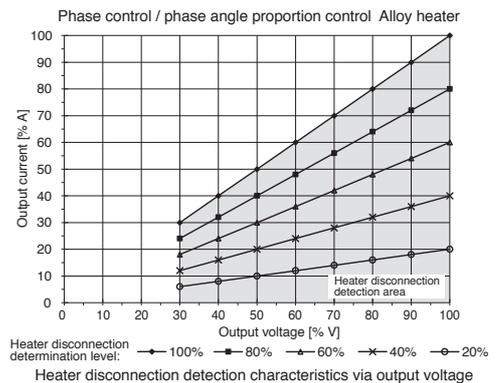


Base load: Set an output value for when setting input is 0%. (Setting range: 0 to 100%)
Actual output represents characteristics resulting from the connection between a base load setting value and gradient setting value using a straight line.

● Heater disconnection detection (Types with control methods A, B)

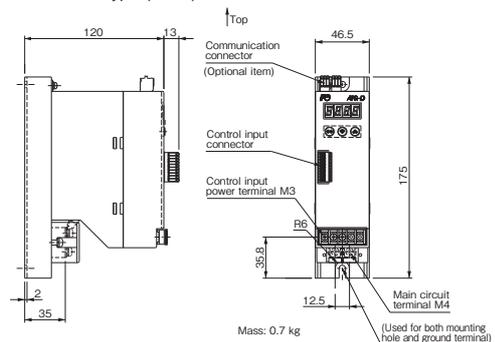
Heater disconnection is detected when the load current drops lower than the current value set with the heater disconnection determination level.

- Applied heater: Alloy heater (Load which flows 40 to 100% of the rated current when the output voltage is 100%)
- Number of parallel lines: 1 to 3 lines (The material and capacity must be identical.)
- For phase control / phase angle proportion control
 - When setting less than 5%: Disconnection determination invalid
 - When setting 5% or higher: Disconnection is detected when the output current is approximately 5 to 100% of the rated current.
- For cycle control
 - When setting less than 5%: Disconnection determination invalid
 - When setting 5% or higher: Load open is detected when the output current is less than approximately 5% of the rated current.
- Determination range: 30 to 100% of the output instruction value
- Determination accuracy: ±5% FS or less

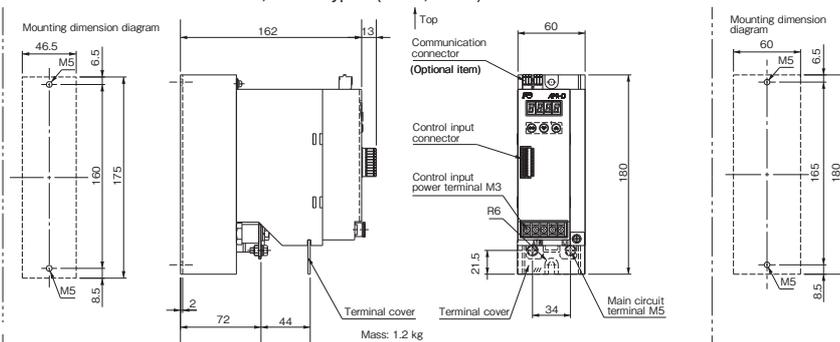


External dimension diagram [Unit: mm]

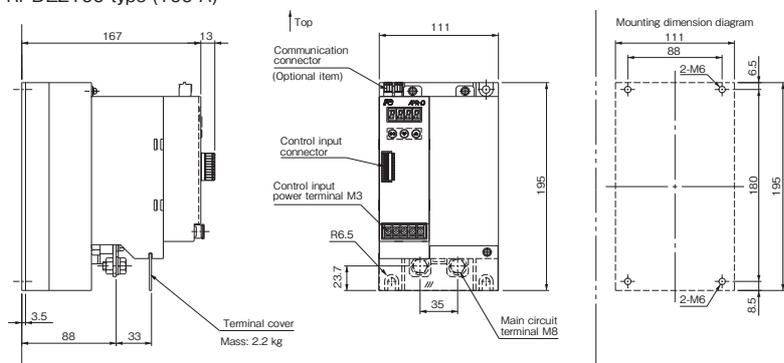
RPDE2020 type (20 A)



RPDE2045, 2060 types (45 A, 60 A)



RPDE2100 type (100 A)

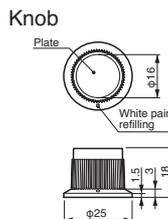
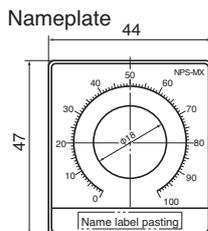
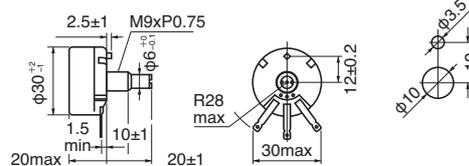


Supplied items (If specified in ordering information)

Setter type: RPD001	Used in setting method "variable resistor setting, two-position control, gradient setting," etc.
---------------------	--

Rating: 1 kΩJ 2.5 W Type: RA30Y20SB102J (Manufacturer: Tokyo Cosmos)

Variable resistor
Mounting hole machining diagram



Name label sheet
(Japanese and English, 8 types)

Manual setting	MANUAL SET.
Gradient setting	GRADE SET.
HIGH setting	HIGH SET.
LOW setting	LOW SET.

Important notes for installation

- (1) Install in a dust-free place with high cooling effect. To ensure heat radiation from APRs, mount the APR on a vertical metal surface, make sure the vertical mounting direction is as shown in the Figure 1, and provide sufficient space both vertically and horizontally. If placing APRs closely to one another, ensure sufficient space beyond the dimensions indicated in Figure 1 to reduce heat interference among the APRs.
- (2) Heat generation of an APR raises the temperature inside the panel. In consideration of expected temperature rises, implement measures such as cooling and ventilation. (The maximum temperature inside the panel is 55°C.) The reference ambient temperature for the rated current is 40°C. When it exceeds 40°C, reduce the load current.
- (3) Ensure sufficient space with nearby objects in consideration of the work space required for wiring tools at individual terminals.
- (4) The top of an APR has a partial opening. Be careful not to drop any object into the opening.

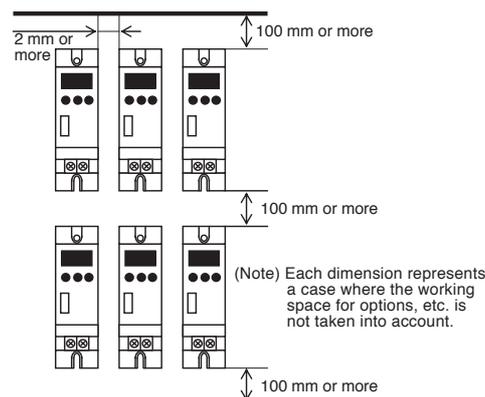
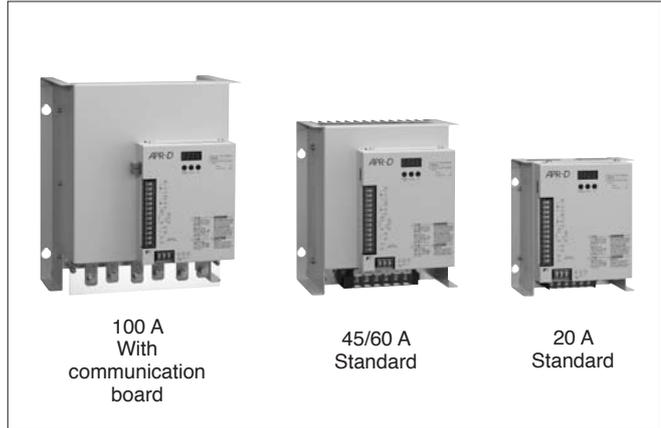


Fig. 1 Installation spacing



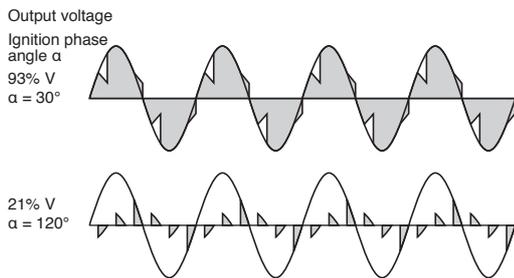
The three-phase APR-D Series is the successor to the APR-L. It is a space-saving, wiring-saving, low-cost APR with greatly improved functionality and performance thanks to its built-in CPU.



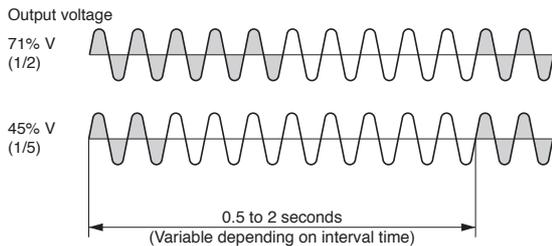
■ Features

- This is a thyristor pure anti-parallel system (six-arm).
- The output range is 0 to 100% of the main circuit power supply voltage.
Excluding the voltage drop portion due to thyristor-specific resistance
- Able to switch the waveform control method (phase control, cycle control, and phase angle proportion control).

Phase control method (0 to 100%)



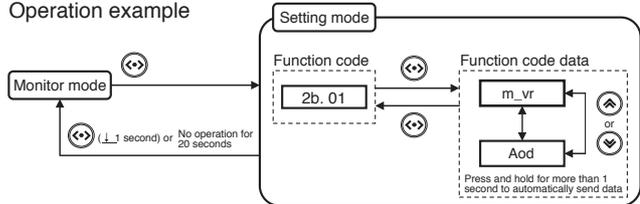
Cycle control method (continuous)



- The main circuit terminal block comes with a cover attached.
- The mounting pitch is the same as for APR-L.
However, this excludes 400 V, 45/60 A products.
- Output for various settings represent linear characteristics of RMS values.

- Base load setting, digital settings including gradient setting, and monitor functions are available as part of the standard configuration.

Operation example



- Allows soft start time, soft up time, and soft down time to be individually set between 0 to 100.0 seconds.
- When power to the main circuit is turned ON, soft start is always activated.
- The power supply voltage ranges are 200 to 240 V AC and 380 to 480 V AC.
(Note) An operational transformer is provided with 380 to 440 V AC products.
An operational transformer for 380 to 480 V AC products is a separately sold option.
- Allows communication control as an optional function.
Main unit option type:
ZAP: Up to 50 units can be operated in parallel.
For cycle control, a flicker prevention function is available.
ZAM: Various settings and monitors are possible by means of RS485 (Modbus RTU).

- All models of the APR units are compliant with the CE marking / Compliant with the EU RoHS Directive (2011/65/EU + (EU)2015/863)
For 400 V products, the operational transformer needs to be modified to comply with the CE marking.



Compliant with the new EMC Directive (2014/30/EU)
Compliant with the new Low Voltage Directive (2014/35/EU)

- Complies with revised Chinese RoHS
All three-phase APR-D Series models are supported as standard.



Order specifications (explanation of order types)

RPDW2060-T1-ZAP-02 (Note 1)

(1) Model classification

Model	Code
APR- D Series	RPD

(2) Phase number

Phase number	Code
Three-phase	W

(3) Input voltage

Input voltage	Code
200 to 240 V	2
380 to 440 V, 380 to 480 V	4 (Note 5)

The main unit supports 380 to 480 V.

(4) Rated current

Rated current	Code
20 A	020
45 A	045
60 A	060
100 A	100

(8) Others

Others	Code
None specified	Blank
No operational transformer	01
Test report (in Japanese and English) attached	02
No operational transformer + test report attached	03

The test report is generated in Fuji Electric's standard format. Special specifications (Z) are also available upon request by customers. It is not shown on the main unit type.

(7) Specifications

Specifications	Code
Standard	Blank
Optional accessories for main unit	Z** (Note 3)

(6) Setter (Note 2)

Setter	Code
None	Blank
Setter: 1 set	1
Setter: 2 sets	2
Setter: 3 sets	3

(5) Control method

Control method	Code
No feedback function	T

(Note 1) For the order codes which are blank, please fill it in with a hyphen "-".

(Note 2) One set of setters is composed of a variable resistor, nameplate, control knob, and attachment sheet.

The format of the separate order is "RPD001". It is not shown on the main unit type.

(Note 3) Optional accessories for main unit (example)

Option specification name	Content	Type
Communication board) Supports parallel run	Parallel run communication board mounting with anti-flicker function (Note 4)	RPDW□□□□-T□-ZAP
Communication board) Supports network connections	Modbus RTU communication board mounting	RPDW□□□□-T□-ZAM

(Note 4) The parallel run function provided by this communication board is not compatible with models other than the APR-D series. Does not support cycle control in combination with single-phase products.

(Note 5) For input voltage code "4", an operational transformer (ML3C2954) is supplied as part of the standard configuration.

For products which support 480 V or CE marking, add "-01" to the main unit's type and separately order "TR3-300R/UL".

Order format example) RPDW4020-T1-01

Name	Transformer type	Rating (Primary voltage/ secondary voltage, capacity)
Operational transformer (standard)	ML3C2954	380, 400, 440 V/210 V 20 VA
Operational transformer (480 V compatible)	TR3-300R/UL	380, 400, 440, 480 V/220 V 300 VA

Rating, type / product code

Phase number	Input voltage	Output current [A]	Type (= product code)
Three-phase	200 to 240 V	20	RPDW2020-T
		45	RPDW2045-T
		60	RPDW2060-T
		100	RPDW2100-T
	380 to 440 V	20	RPDW4020-T
		45	RPDW4045-T
		60	RPDW4060-T
		100	RPDW4100-T

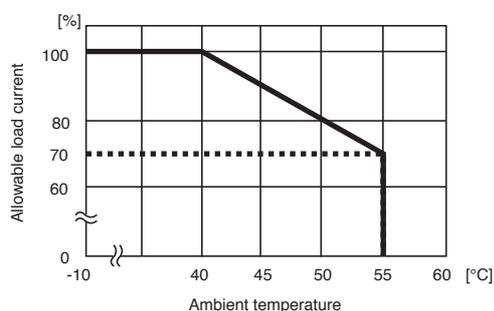
(Note) The price does not include a setter set and the main unit's options.

Important notes in selecting products

Allowable load current - ambient temperature characteristics

The reference ambient temperature for the rated current is 40°C.

When it exceeds 40°C, reduce the load current as below:



Main unit options

After delivery, addition and modification are not allowed for the type (= product code). Please remember this when placing an order.

Fast-acting fuse

The main circuit does not contain a fuse. Use a fast-acting fuse depending on the capacity.

Important notes for power cycle life expectancy

If RUN and STOP are repeated at short-period cycles (for example, 30-minute RUN and 30-minute STOP), a large difference in temperature will occur in the thyristor element, significantly shorting its life expectancy through thermal fatigue. If such operations are needed, try to minimize the temperature fluctuation. Specifically, reduce the use rate of rated current to less than 80%. Or, choose an APR whose rated current is one level higher, so that the use rate of rated current is less than 80%.



Fuji AC Power Regulator [APR]

APR-D Series (Three-phase)

■ Specifications

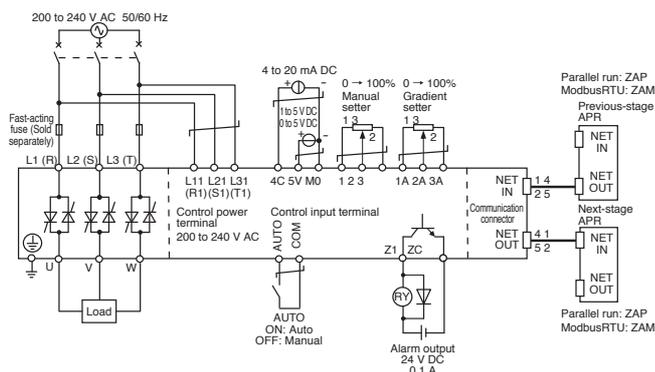
Item		Specifications			
Type (product code)		RPDW□020-T	RPDW□045-T	RPDW□060-T	RPDW□100-T
Input	Phase number	Three-phase			
	Main circuit	Rated voltage	200 to 240 V AC ±10% (Performance guarantee), ±15% (Operation guarantee) (Note 1) 380 to 480 V AC ±10% (Performance guarantee), ±15% (Operation guarantee) (Note 1)		
		Frequency	50 Hz/ 60 Hz ±2.5 Hz (Must be the same as that of the control circuit.)		
	Control circuit	Rated voltage	200 to 240 V AC ±10% (Performance guarantee), ±15% (Operation guarantee) (Note 1)		
		Frequency	50 Hz/60 Hz ±2.5 Hz (auto identification)		
Power capacity		15 VA or less			
Output	Rated current (ambient temperature 40°C)	20 A	45 A	60 A	100 A
	Cooling system	Self-cooled			
	Applied load	Resistive load			
	Minimum load current	0.5 A (However, at 100% output at the rated input voltage)			
	Generated loss	75 W	155 W	196 W	317 W
Control functions	Waveform control method	Phase control / cycle control (continuous) / phase angle proportion control			
	Output voltage adjustment range	0 to 100% of main circuit power supply voltage (RMS value) (Except thyristor voltage drop)			
	Input-output characteristics		Linear characteristic of RMS value, linearity: ±3% FS or less (phase control) Linearity: ±5%FS or less (cycle control) (However, at resistive load / setting signal 10 to 90%)		
	Setting signal	Manual setting	Digital setting: Setting with front keys External variable resistor: 1 kΩ (B characteristic 1/2 W or higher) HIGH/LOW (two-position control) contact signal: Digital setting through external wiring or front keys		
		Auto setting	Current signal: 4 to 20 mA DC (Zin = 100 Ω) Voltage signal: 0 to 5 V DC (SSC signal: 0/12 V DC), 1 to 5 V DC (Zin = 11 kΩ) (Setting change with front keys)		
	Gradient setting	Setting range	0 to 100% of output voltage		
		Setter	Digital setting: Setting with front keys External variable resistor: 1 kΩ (B characteristic 1/2 W or higher) Control input terminal "5V-M0" voltage signal: 1 to 5 V DC		
	Base load setting	Setting range	0 to 100% of output voltage		
		Setter	Digital setting: Setting with front keys		
	Soft start, up/down time	Setting range	0 to 100 seconds		
Setter		Digital setting: Setting with front keys			
Scanning interval setting	Setting range	0.5 to 2.0 seconds			
	Setter	Digital setting: Setting with front keys			
Alarm function	CPU memory error	CPU memory error detection at startup			
	Power frequency abnormality	Detects control power frequencies other than 45 to 65 Hz			
	Auto setting input not connected (Note 2)	Detection of non-connection of current and voltage signals (Only with auto setting chosen for setting signals)			
	Manual setting input not connected	Detection of non-connection of a manual setter (Only with external variable resistor chosen for manual setting)			
	Gradient setting input not connected	Detection of non-connection of a gradient setter (Only with external variable resistor or 1 to 5 V DC chosen for gradient setting)			
	Open phase / phase sequence failure	Detection of open phase or phase sequence failure regarding the main circuit power and control power			
	Data writing/reading failure	Detection of read/write errors from/to EEPROM			
	Communication error (Note 3)	Detection of data transmission failure when in parallel run or network communications			
Alarm output	Open collector 24 V DC/ 0.1 A 1 circuit				
Operating environment	Ambient temperature	-10°C to +55°C (When +40°C is exceeded, the load current needs to be reduced.)			
	Storage temperature	-20°C to +60°C			
	Ambient humidity	+5 to +95% RH (no condensation)			
	Others	No corrosive gases (sulfide gas, ammonia gas, etc.), dust, substances and actions that promote insulation deterioration Use indoors at an altitude of 1000 m or less			
Insulation	Dielectric strength (Main circuit to ground)	2 kV AC, 1 minute (200 to 240 V); 2.5 kV AC, 1 minute (380 to 480 V)			
	Insulation resistance (To ground)	10 MΩ or higher, measured with 500 V DC megger tester			

(Note 1) Performance guarantee refers to satisfying specifications and assuring proper run of the product. Operation guarantee refers to assurance of damage-free parts and proper run of the product.

(Note 2) It does not operate when the voltage signal 0 to 5 V DC (0/12 V) is set.

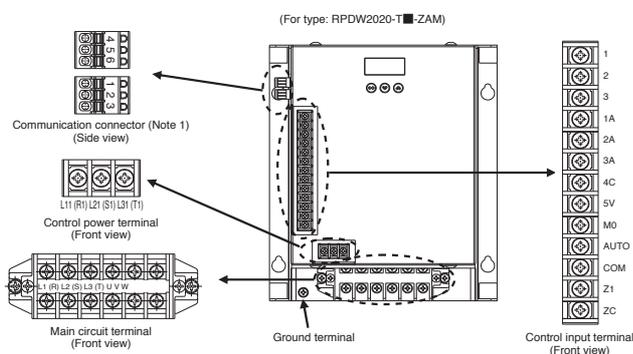
(Note 3) Option type: ZAP or ZAM only

■ Connection diagram



Three-phase APR-D External connection diagram (Full connection)

● Positions and functions of connection terminals



(Note 1) It is provided when the main unit option (ZAM) is specified.

● Screw size and tightening torque

Terminal	Screw size	Tightening torque [N·m] ±10%
Main circuit terminal L1 (R), U L2 (S), V L3 (T), W	20 A product M4	1.8 (18 kgf·cm)
	45 A product M5	3.5 (35 kgf·cm)
	60 A product M6	5.8 (58 kgf·cm)
	100 A product M8	13.5 (135 kgf·cm)
Ground terminal	20 A product M4	1.8 (18 kgf·cm)
	45, 60 A products M5	3.5 (35 kgf·cm)
	100 A product M6	5.8 (58 kgf·cm)
Control power terminal L11 (R1), L21 (S1), L31 (T1)	20 to 100 A products M3	0.5 (5 kgf·cm)
Control input terminal 1 to ZC	M3	0.5 (5 kgf·cm)
Communication connector	NET IN, NET OUT	-
Main unit mounting screws	20 A product M4	1.8 (18 kgf·cm)
	45, 60 A products M5	3.5 (35 kgf·cm)
	100 A product M6	5.8 (58 kgf·cm)

■ Other options (sold separately)

● Fast-acting fuse application table

APR type	Rated Current	Voltage series	Fast-acting fuse type	Fast-acting fuse holder
RPDW2020	20 A	200 V	CR2LS-30 (30 A)	CM-1A (for 3-pole products)
RPDW4020		400 V	CR6L-30 (30 A)	CMS-4 (for 1-pole products)
RPDW2045	45 A	200 V	CR2LS-75 (75 A)	CM-1A (for 3-pole products)
RPDW4045		400 V	CR6L-75 (75 A)	CMS-5 (for 1-pole products)
RPDW2060	60 A	200 V	CR2LS-100 (100 A)	CM-1A (for 3-pole products)
RPDW4060		400 V	CR6L-100 (100 A)	CMS-5 (for 1-pole products)
RPDW2100	100 A	200 V	CR2L-150 (150 A)	CM-2A (for 3-pole products)
RPDW4100		400 V	CR6L-150 (150 A)	CMS-5 (for 1-pole products)

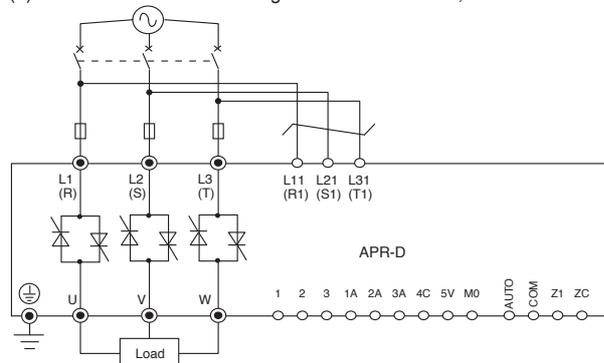
● Replacement adapter for APR-L (RPD002-W□□)

Type	Content
RPD002-W06	For RPDW4045-□, RPDW4060-□

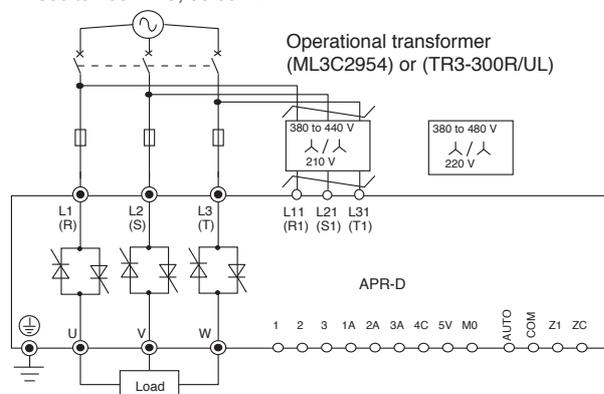
(Note) Attach the adapter to the mounting holes (for APR-L) on the panel surface, and then attach the APR-D to the adapter.

● Wiring of the main circuit terminals and control power terminals

(1) When the main circuit voltage is 200 to 240 V AC, 50/60 Hz



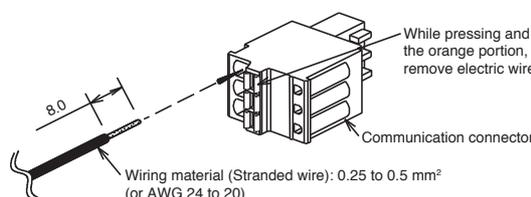
(2) When the main circuit voltage is 380 to 440 V AC or 380 to 480 V AC, 50/60 Hz



● Terminal function

Terminal	Pin	Symbol	Name	Function description
Main circuit Terminal	-	L1 (R), L2 (S), L3 (T)	Main circuit input terminal	Three-phase power input for the main circuit
	-	U, V, W	Main circuit output terminal	APR output. Connection of three-phase load
Ground terminal	-	⊕	Ground terminal	Main body grounding terminal
Control power supply Terminal	-	L11 (R1), L21 (S1), L31 (T1)	Control power terminal	Control circuit power supply Three-phase 200 V to 240 V AC input
Control input Terminal	-	1, 2, 3	Manual setting input	Manual setting input through a variable resistor
	-	1A, 2A, 3A	Gradient setting input	Gradient setting input through a variable resistor
	-	4C, M0	Auto setting input	Auto setting input through 4 to 20 mA DC
	-	5V, M0	Auto setting input or gradient setting input through 1 to 5 V DC	Auto setting input (SSC signal input) through 0 to 5 V DC (0/12 V)
Communication connector	-	AUTO, COM	Auto/manual switchover input	External contact Closed: Auto setting Open: Manual setting
	-	Z1, ZC	Alarm output terminal	When an alarm occurs, the internal open collector turns ON. Operation selection is possible with function code 5A (alarm function).
	Network	1-2	NET IN	RS-485 input
4-5		NET OUT	RS-485 output	Connection with slave unit or connection of a terminating resistor
Parallel RUN	1-2	NET IN	Parallel run input	Data reception from the previous-stage APR
	4-5	NET OUT	Parallel run output	Data transmission from the next-stage APR

● Communication connector wiring example





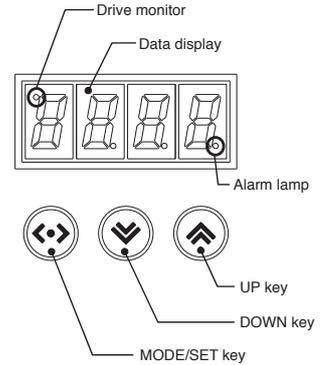
Fuji AC Power Regulator [APR]

APR-D Series (Three-phase)

■ The standard configuration of the APR-D Series contains display/operation units for various monitors and settings.

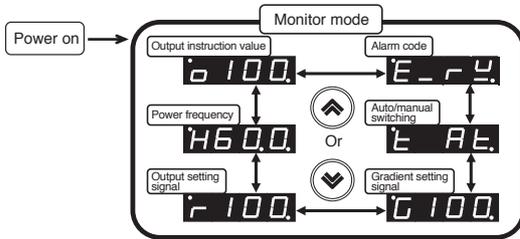
• Names and functions of the individual parts

Name	Function	Name	Function
Drive monitor	Data display unit 4th digit DP Run output Presence (light up) / absence (turn off)	UP key DOWN key	Use to select run information shown on the data display unit and to change the function code data. *Press and hold for one second or longer to perform auto switch of the data display.
Data display	4-digit 7-segment LED monitor Displays the following information for each operation mode. • During MON (monitor) mode Run information (Output instruction value, input signal, etc.) Displays the alarm code when an alarm occurs. The 4th digit shows items for various types of run information. • During SET mode Displays function code and function code data, etc.	MODE/SET key	Use to switch the operation mode. • During MON (monitor) mode Press and release to switch to the setting mode. • When selecting a function code in setting mode Press and release to switch to function code data display. Press and hold for 1 second or longer to switch to the monitor mode. • When setting function code data in setting mode • Press and release to confirm data. • Press and hold for 1 second or longer to cancel the setting and return to the monitor mode.
Alarm lamp	Data display unit 1st digit DP Alarm Presence (blink) / absence (turn off)		



• Monitor mode

Operating the UP and DOWN keys causes the monitor items below to be shown. (The alarm code is shown only when a failure occurs.)



No.	Monitor item	Function item display	Display	Unit	Display description
1	Output instruction value	o	100	%	Output instruction through APR internal calculation
2	Power frequency	H	60.0	Hz	Power frequency detection value
3	Output setting signal	r	100	%	Each setting signal detection value
4	Gradient setting signal	G	100	%	Gradient setting signal detection value
5	Auto/manual switching	t	At/m1	-	Auto/manual switching terminal status display At ... Auto setting m1 ... Manual setting
			Hi/Lo	-	Two-position control status indication Hi ... HIGH setting Lo ... LOW setting
6	Alarm code	E	_Sm	-	Indication when an alarm occurs (Example: Manual setting input non-connection)

• Setting mode

It is possible to set and confirm the data below for each item:

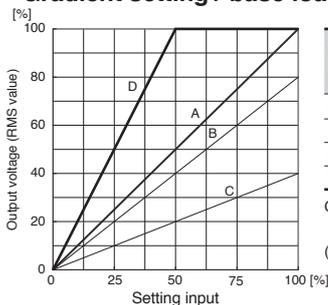
Category	Display	Setting item	Description of the main functions
Data setting	1b._ _	Basic function 1 b code (1b.01 to 1b.07)	Setting to be used for basic APR operations Mainly replacing external volume
	2b._ _	Basic function 2 b code (2b.01 to 2b.07)	Setting to be used for basic APR operations Mainly function selection
	4n._ _	Network function n code (4n.01 to 4n.08)	Communication settings
	5A._ _	Alarm function A code (5A.02 to 5A.09)	Alarm output setting
Setting option	6o._ _	Setting option function o code (6o.01 to 6o.04)	Utility function setting (Display of function codes changed from factory defaults and restriction of operations of the setting indicator)
Initial setting	0i._ _	Initial setting function i code (0i.04 to 0i.05)	Communication protocol settings, ROM version check

Setting item	Setting signal	Function code	Function code data
Auto setting	Current signal	4 to 20 mA DC	-
	Voltage signal	1 to 5 V DC 0 to 5 V DC	2b.03 (Auto setting Voltage signal Selection) 1 to 5v (1 to 5 V DC) 0 to 5v (0 to 5 V DC (0/12 V))
Manual setting	Setting indicator	2b.01 (Manual setter selection)	Aod (Setting indicator)
	External variable resistor	1-2-3	m-vr (external variable resistor)
Gradient setting	Setting indicator	2b.02 (Gradient setter selection)	Aod (Setting indicator)
	External variable resistor	1A-2A-3A	G-vr (external variable resistor)
	Voltage signal		5vm0 (Voltage setting signal)
Slave unit (ZAP)	-	4n.01 (Master/slave selection)	no. 2- (Slave)

• Example of setting groups

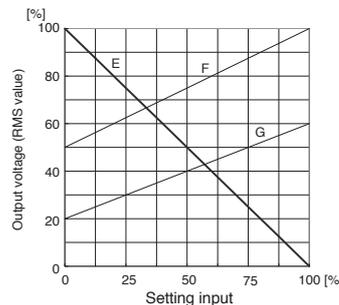
Function code	Name	Function code data (Settable range)	Step size	Unit	Factory default setting
1b.01	Manual digital setting	0 to 100.0 [%]	0.1	%	0
1b.02	Gradient digital setting	0 to 200.0 [%]	0.1	%	100.0
1b.03	Base load setting	0 to 100.0 [%]	0.1	%	0
1b.04	Soft start time setting	0 to 100.0 [seconds]	0.1	seconds	0.5
1b.05	Soft up time setting		0.1	seconds	0.5
1b.06	Soft down time setting		0.1	seconds	0.5

• Gradient setting / base load setting



Characteristic	Output adjustment range [%]	Base load setting [%]	Gradient setting [%]
A	0 to 100	0	100
B	0 to 80	0	80
C	0 to 40	0	40
D	0 to 100	0	200

Gradient setting: Set an output value for when setting input is 100%. (Setting range: 0 to 200%)
(Note) The upper limit output value is up to 100% of input voltage.



Characteristic	Output adjustment range [%]	Base load setting [%]	Gradient setting [%]
E	100-0	100	0
F	50-100	50	100
G	20-60	20	60

Base load: Set an output value for when setting input is 0%. (Setting range: 0 to 100%)
Actual output represents characteristics resulting from the connection between a base load setting value and gradient setting value using a straight line.

External dimension diagram [Unit: mm]

(1) External dimensions and mass

External dimensions

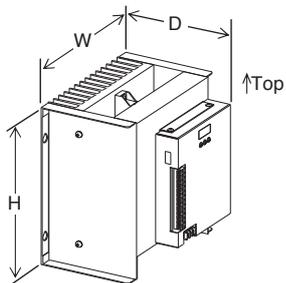
	20 A	45 A/60 A	100 A
W	185	240	291
H	215	265	345
D	135	170	215

Note) The external dimensions of the 200 V series and 400 V series are identical.

Mass

20 A	45 A/60 A	100 A
2.6 kg	6.8 kg	10.0 kg

Note) The mass of the 200 V series and 400 V series is identical.

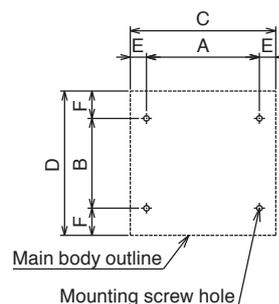


(2) Mounting pitch (drilling)

Mounting pitch

	20 A	45 A/60 A	100 A
A	170	222	270
B	145	165	245
C	185	240	291
D	215	265	345
E	7.5	9	10.5
F	35	50	50
Mounting screw	M4	M5	M6

Note) The external dimensions of the 200 V series and 400 V series are identical.



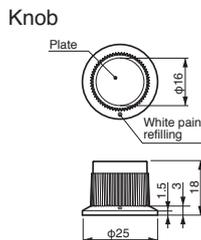
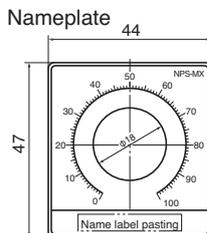
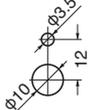
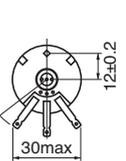
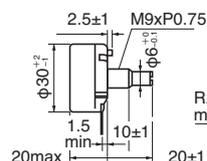
Supplied items (If specified in ordering information)

Setting type: RPD001

Used in setting method "variable resistor setting, two-position control, gradient setting," etc.

Rating: 1 kΩ 2.5 W Type: RA30YN20SB102J (Manufacturer: Tokyo Cosmos)

Variable resistor Mounting hole machining diagram

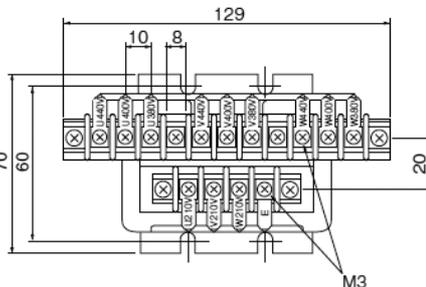
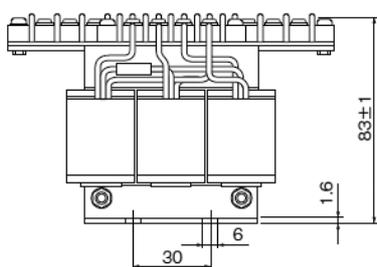


Name label sheet (Japanese and English, 8 types)

Manual setting	MANUAL SET.
Gradient setting	GRADE SET.
HIGH setting	HIGH SET.
LOW setting	LOW SET.

Operating transformer Type: ML3C2954

Provided when the input voltage code is 4; Note: CE marking not supported

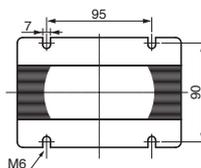
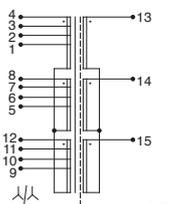
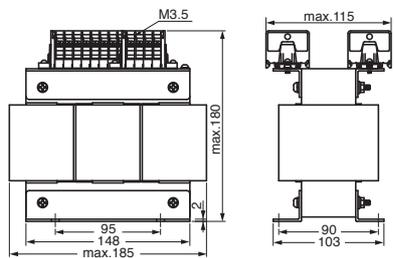


Output current	For 20 to 100 A
Rated	3φ, 380, 400, 440 V/210 V 20 VA
Type	ML3C2954

Mass: 1.7 kg

Operating transformer (three-phase) Type: TR3-300R/UL

Provided when the input voltage code is 4



Output current	For 20 to 600 A
Rated	3φ, 380, 400, 440, 480 V/220 V 300 VA
Type	TR3-300R/UL

Primary voltage	Terminal number (R-S-T)
380 V	1-5-9
400 V	2-6-10
440 V	3-7-11
480 V (Note 1)	4-8-12

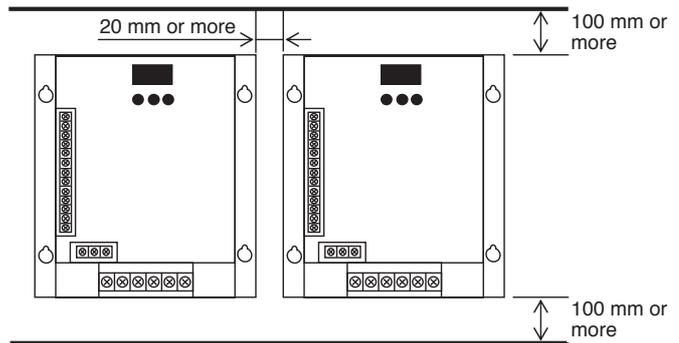
Mass: 8.5 kg

(Note 1) Do not use it at 460 V or 480 V when the main unit is of the standard voltage specification.



■ Important notes for installation

- (1) Install in a dust-free place with high cooling effect. To ensure heat radiation from APRs, mount the APR on a vertical metal surface, make sure the vertical mounting direction is as shown in the figure on the right, and provide sufficient space both vertically and horizontally. If placing APRs closely to one another, ensure sufficient space beyond the dimensions indicated in the figure on the right to reduce heat interference among the APRs.
- (2) Heat generation of an APR raises the temperature inside the panel. In consideration of expected temperature rises, implement measures such as cooling and ventilation. (The maximum temperature inside the panel is 55°C.) The reference ambient temperature for the rated current is 40°C. When it exceeds 40°C, reduce the load current.
- (3) Ensure sufficient space with nearby objects in consideration of the work space required for wiring tools at individual terminals.
- (4) The top of an APR has a partial opening. Be careful not to drop any object into the opening.



Installation spacing

MEMO



Fuji AC Power Regulator [APR]

Option CT, VT

CT Used for high-function heater disconnection detection, etc.

Rated primary current	Product name	Type	Primary through-hole turns	Rated secondary output, etc.	Dimensions					Mass [kg]
					A	B	C	D	E	
20 A	CT	CT-5S	5T	Rated secondary: 0.1 A	20	71	39.5	60	95	0.8
45 A			3T		26	71	39.5	60	95	
60 A		2T	Rated load: 5 VA Accuracy class: Class 1	20	71	39.5	60	95		
100 A		1T		26	71	39.5	60	95		
150 A		1T		26	71	39.5	60	95		
250 A		1T		26	71	39.5	60	95		
350 A		1T	40	82	43	65	106	0.9		
450 A		1T	40	82	43	65	106			
600 A		1T	40	82	43	65	106			

(Note) Includes a secondary terminal cover.

VT (PT) Used for AVR, AWR, etc.

Voltage	Product name	Type	Rated primary input	Rated secondary output, etc.
For 100 V	VT	PT-5S 100 V/10 V	100, 110 V	Rated secondary: 10 V
For 200 V		PT-5S 200 V/10 V	200, 220 V	
For 230 V		PT-5S 230 V/10 V	230, 254 V	Rated load: 5 VA
For 380 V		PT-5S 380 V/10 V	380 V	
For 400 V		PT-5S 400 V/10 V	400, 440 V	Accuracy class: Class 1
For 415 V		PT-5S 415 V/10 V	415 V	
For 420 V		PT-5S 420 V/10 V	420, 460 V	
For 440 V		PT-5S 440 V/10 V	440, 480 V	

Mass: 0.8 kg



Selection of Instruments (Voltmeter, Ammeter, etc.)

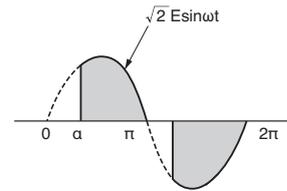
■ Phase control method

The voltage and current of AC circuits are generally expressed in RMS values, while moving-iron instruments are usually used as measuring instruments. However, some AC instruments, such as rectifier meters, digital meters, and testers, operate, in principle, by converting sine waveforms into average DC values. This can result

in incorrect RMS values being shown for APR phase-controlled waveforms. A supplementary explanation of this is given below. In other words, the ratio of the RMS value to the average value of the phase-controlled AC waveform will depend on the phase angle, as shown in the following equation.

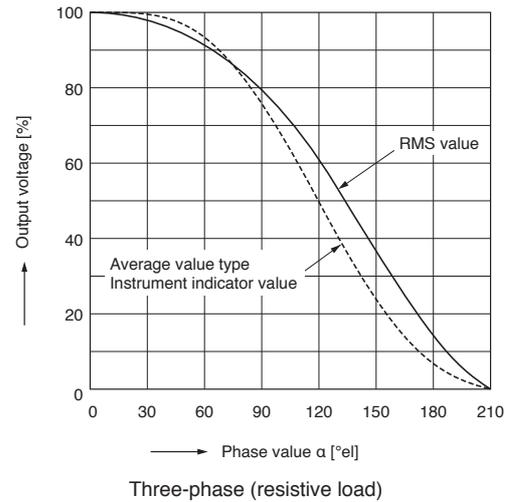
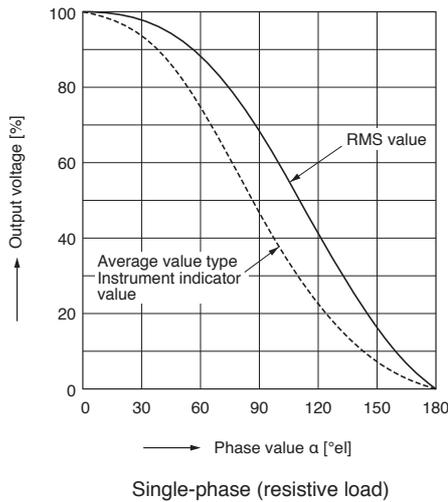
$$\text{RMS value: } E_e = \sqrt{\frac{1}{\pi} \int_{\alpha}^{\pi} (\sqrt{2} E \sin \omega t)^2 \cdot d(\omega t)} \dots\dots\dots (1)$$

$$\text{Average value: } E_m = \frac{1}{\pi} \int_{\alpha}^{\pi} \sqrt{2} E \sin \omega t \cdot d(\omega t) \dots\dots\dots (2)$$



E : Input voltage RMS value
 E_e : Output voltage RMS value
 E_m : Output voltage average value
 α : Phase control angle

The following figure shows the calculation results of the above equation for single-phase and three-phase APRs.



The following table summarizes the suitability of instruments.

Instrument operating principle and suitability for APR

Application	Instrument operating principle	Symbol	Suitability	Category
Voltmeter	RMS value calculation digital type	(RMS)	Best	RMS value type
Ammeter	Moving-iron type		Suitable	
	Rectifier type		Unsuitable	Average value type
	Tester		Unsuitable	
	Digital tester		Unsuitable	
Wattmeter	Ammeter / wattmeter type		Suitable	—



Safety Considerations

- For safe operation, before using the product, read the instruction manual or user manual that comes with the product carefully or consult your dealer from which you purchased the product or our sales office.
- For safe operation, wiring should be conducted only by qualified engineers who have sufficient technical knowledge about electrical work or wiring.
- Customers, who want to use the products introduced in this catalog for special systems or devices such as for atomic-energy control, aerospace use, medical use, passenger vehicle, and traffic control, are requested to consult with our sales office.
- Customers are requested to prepare safety measures when they apply the products introduced in this catalog to such systems or facilities that will affect human lives or cause severe damage to property if the products become faulty.

Before purchasing this product

- Please note that for product improvement, the appearance and specifications may be subject to change without prior notice.
- Please note in advance that printed and actual colors may differ slightly.
- For the details of the products included in this catalog, contact your dealer or our sales office.

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