



SINGLE-PHASE APR-V

TYPE	RPVE□020-□	RPVE□250-□
	RPVE□045-□	RPVE□350-□
	RPVE□060-□	RPVE□450-□
	RPVE□100-□	RPVE□600-□
	RPVE□150-□	

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Note: Please make sure that this instruction manual will be handed over to the final user who is responsible for the maintenance of this instrument.

Safety design of equipment (request)

Please take the following into consideration in designing and manufacturing equipment using the AC power regulator (hereafter called APR).

1. Scope of application of product

The APR described in this manual is designed as a general-purpose product for general industry. The application of APR is off the subject in the following usage. The nuclear power, the aerospace, the medical treatment, the traffic equipment, ship, the passenger car, and systems of special application that may considerably affect the human life and property.

2. Failure of product

The APR uses electronic parts that center on the semiconductor for a main circuit and the control circuit. These electronic parts break down at a certain probability. Please do the safe designs of a redundant design, fire spread preventive design, erratic operation preventive design, etc. where an accident resulting in injury or death, a fire accident, and social damage, etc. are not caused as a result of the breakdown of the device that uses APR.

3. Malfunctions of main circuit semiconductors

Thyristors are used in the main circuit of the instrument. As their failure, the short-circuit may rarely occur. Although some models of the series have a function of detecting the said failure, safety design must be respected as in 2 above so that any malfunction will not entail serious damages.

About the latest information

If system designing including the APR is in progress based on the contents of our general APR brochure, general D&C brochure, and related technical documents, we recommend you to obtain the latest information from our website at the following URL.

If maintenance is to be performed for the first time in a long time since the purchase of this instrument, various pieces of information is also available at the website.

<APR Web site>

<http://www.fujielectric.co.jp/technica/products/ac-power-regulators/index.html>

<Fe Library>

<https://felib.fujielectric.co.jp/download/index.htm>

Search word : RPVE

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INTRODUCTION

Thank you very much for purchasing Fuji's single-phase APR-V. Please be sure to read this manual carefully to ensure safety in handling the instrument, maintain intended functions and performance of the instrument, and operate the instrument properly.

This instrument should be handled (installed, wired, operated, and maintained/inspected) only by experts who have sufficient knowledge on this instrument.

1. SAFETY PRECAUTIONS

Be sure to read this instruction manual carefully before performing installation, wiring, operation, and maintenance/inspection.

Operate the instrument properly after obtaining knowledge on the devices, information on safety, and all the other precautions on this instrument.

This instruction manual classifies the level of safety precautions into "**WARNING**" and "**CAUTION.**"

Warning sign	Meaning
 WARNING	Improper handling may result in dangerous situations involving death or serious injury.
 CAUTION	Improper handling may result in dangerous situations involving medium or minor injury or property damage.

Even notes of CAUTIONS may involve a serious accident depending on situations. You must follow all of them because they contain very important information.

Application

 WARNING
<p>This instrument is not intended for use on devices or systems involving human lives. If you intend to use the instrument for special applications such as nuclear power control, aviation and space applications, medical treatment, traffic control, or ship and their systems, contact our sales representative. If you use the instrument for a system that may, if fails, expose human lives to danger or cause considerable loss, be sure to install a safety device.</p> <p>..... A fire or accident may result.</p>

Installation

WARNING

- Install the instrument to an incombustible object such as metal.
- Do not install the instrument near combustible objects.
..... **A fire may result.**

CAUTION

- Do not transport the instrument by holding the cover of the terminal block.
..... **The instrument may fall, thus resulting in injury.**
- Prevent foreign matter such as lint, paper, wood chips, and scrap metal from entering the APR or becoming attached to the cooling fan. After the installation, check that objects such as screws and tools are not left within the instrument.
..... **A fire or accident may result.**
- Install the instrument in the orientation shown by the dimensional outline drawing.
- Install the instrument in a place that satisfies the environmental conditions for installation (temperature, humidity, dust, installation gap, vibration, etc.).
- Do not transport or install the instrument with the screws and the cover kept removed to prevent deformation or break.
- Install the instrument in a place that endures the weight of the instrument, using specified screws and at specified torque.
- Do not install or operate the APR that has damaged or missing parts.
- Install the instrument within a panel that is not accessible to people.
..... **A fire, accident, or injury may result.**
- Do not step on the package of the instrument.
..... **Injury may result.**

Wiring

WARNING

- Wiring should be performed by qualified wiring experts.
- Before carrying out wiring, check that the power for the main circuit and the control power are turned off.
- Be sure to install this instrument first and then carry out wiring.
..... **Electric shock or injury may result.**
- To ensure safety, be sure to earthing the instrument to the  terminal.
- Install the APR main unit first, and then carry out wiring and fasten the screws of the main circuit. Check that the screws are fastened securely.
- Use the power wire and load wire that satisfy the operating conditions.
- Connect the instrument to the main circuit power supply and control power supply via a circuit breaker for circuit protection and a ground fault interrupter.
..... **Electric shock or fire may result.**

CAUTION

- Check that the rated input voltage of the product and the power supply voltage coincide.
- Pay attention not to reverse the input and output terminals.
- Check carefully that the wiring of the control circuit has been carried out properly.
- Fasten screws at the designated torque.
- The APR and wires generate electrical noise, thus causing sensors and other devices installed nearby to malfunction. To prevent this, take appropriate measures against electrical noise.
..... **An accident or injury may result.**

Operation

WARNING

- Check the installation and wiring carefully for improper wiring and poor connections.
- Do not operate switches with wet hand. Do not splash liquid such as water over the instrument.
- Before selecting functions or making adjustment, turn off the power, wait for 5 minutes or longer, check that the “DRIVE MONITOR” and “Alarm” lamps have gone off, and then check using a tester that there is no electric potential between the main circuit terminals L1 and U (L0 and N0 400V only), and power supply terminals L and N.
- If an alarm is issued, or any abnormality such as emission of abnormal odor is found, turn off the input power, and then perform inspection. If the alarm or abnormal state recurs and the cause cannot be found, be sure to contact your dealer and never leave the problem unsolved.
- Be sure to mount the cover of the terminal block first, and then set the power to ON (close). Do not remove the cover in energized state.
- Even if each input is set to 0%, or the “Run/Stop” signal is set to OFF (open), electric shock may result if you touch an output terminal. Do not touch the terminals.
..... **Electric shock or fire may result.**
- If the alarm is reset with the operation signal set to ON, the instrument starts promptly. Be sure to check in advance that the operation signal is set to OFF.
..... **An accident may result.**

CAUTION

- Do not touch the cooling fan because it becomes hot.
- Do not touch the rotating cooling fan.
..... **Injury or burns may result.**

Maintenance and inspection

WARNING

- Before performing inspections, turn off the power and wait for 5 minutes or longer. Check also that the “DRIVE MONITOR” and “Alarm” lamps have gone off, and then check using a tester that there is no electric potential between the main circuit terminals L1 and U, L0 and N0(400V only), and control power supply terminals L and N. (Before performing inspections, check the voltage between terminals as well as a terminal and the earthing with a tester, taking the entry of voltage from the output side into consideration.)
- Do not perform maintenance and inspection or replace parts unless you are authorized to do so.
- Be sure to replace parts with specified ones. (Use insulated tools and remove metallic objects such as watch and bracelet) when performing replacement work.
..... **Electric shock or injury may result.**
- Clean the cooler fan and the cooling fin after it checks.

Disposal

CAUTION

Dispose of the APR-V as an industrial waste.

Others

WARNING

- Never modify the instrument.
..... **Electric shock or injury may result.**

General precautions

The illustrations in this instruction manual may show the state of the instrument with the cover or safety shield removed in order to show details clearly. Before operating the instrument, be sure to mount the cover and protective shield back to the original position, and operate it according to the descriptions of the instruction manual.

Conformance to European standard

The APR with CE mark conforms to the European standard on condition that it is installed according to the following descriptions.

CAUTION

- [1] Conformable model is “RPVE□□□□-□-□□□/UL”. (Refer to Section 3 Code symbols.)
- [2] Conforming directives are RoHS directive (2011/65/EU+(EU) 2015/863), low voltage directive (2012/A11:2014 (EN62477-1)) and EMC directive (2014/30/EU (IEC60947-4-3:2014)).
- [3] This product bears the CE mark on condition that it satisfies specific conditions. Since various other devices are used for mechanical equipment in addition to our product, the machine manufacturer should arrange so the product satisfies specific conditions.
- [4] Install the APR and setting indicator under the conditions of overvoltage category II and pollution degree of 2 or clearer specified by EN62477-1. To use it in the degree of contamination of 2 or clearer, install the instrument within a control panel that does not allow water, oil, carbon, and dust to come in (IP54 or higher).
- [5] For the 400V system power supply, use a TN or TT power distribution system with the neutral point grounded.
- [6] Only authorized persons (experts) should operate the control panel.
- [7] The enclosure of the control panel should be opened or closed with a key or using a tool. Or ensure that the power can be turned on only when the enclosure is closed.
- [8] Be sure to ground the \oplus terminal of the APR, and do not attempt to protect operators from electric shock only with a ground fault interrupter. Uses a crimp contact plated with tin or an equivalent material for the earthing lead, and perform single wiring with the wire size required by the standard. (Do not install two or more wires together.)
- [9] To protect the instrument from short circuit and overload, use a circuit breaker for circuit protection, ground fault interrupter, or electromagnetic contactor (conforming to the EN or IEC standard) on the input side of the main circuit and that of the control power. (The main circuit input side: Select it from the ratings value of the load. Control power supply input side: 3A goods)
- [10] Use a wire of diameter and wire type specified in the attachment C of EN60204 for the main circuit terminal of the APR.
- [11] Connect the measures parts such as input EMI filter to the exterior of the input side of the main circuit power and the control power of the APR to maintain the specifications of the entire instrument within the limit specified by EN61000-6-4 and EN61000-6-2.
(On condition that the instrument is not used in a residential, commercial, or light industrial environment.) To ensure the noise prevention effect, handle the filter, following the description of its instruction manual. The following are the major precautions in handling the filter.
 - Use a filter of the specifications higher than the phase, rated voltage, and rated current of the APR, and that has damping property falling within the several 100 kHz to several MHz range.
 - Use a filter for each of the APR, if two or more APRs are to be used.
 - To improve the earthing resistance between the filter and the panel, peel off the coating around the mounting hole to expose the metal surface, thus ensuring sufficient contact between the metal surface and the mounting surface of the filter.
 - Connect the input power to the input terminal (IN) of the filter, and the earthing terminal to the earthing stud. Then connect the output terminal (OUT) of the filter to the main power of the APR and the control power input, using as short wire as possible.
 - Do not allow the input and output wire to come close to each other.
- [12] If the control circuit terminal is to be placed around a high-voltage live part such as a main circuit terminal, add a tube, or use double-insulated wire.
- [13] Use crimp contacts with insulated coating for wiring to the “L(R1), N(T1), Z1, Z2 and ZC (L0 and N0(400V only)) terminals of the control circuit.
- [14] If a variable resistor is to be mounted externally for manual setting or gradient setting, take appropriate measures against rotation of the main unit of the resistor.

Conformance to the UL standard and Canadian standard (cUL certification)

The APR marked with UL/cUL conforms the UL standard and Canadian standard by installing it, following the cautions shown below.

CAUTION

- [1] Conformable model is “RPVE□□□□-□-□□□/UL”. (Refer to Section 3 Code symbols.)
- [2] Use Class 2 power supply for input setting signals.
- [3] Use an UL certified copper wire with maximum permissible temperature of 75°C or higher for the main circuit.
- [4] Use an UL certified Class 1 wire for the control circuit wiring.
- [5] Use UL/CSA certified round crimp contacts. Crimp the contacts, using a crimping tool recommended by the manufacturer.
- [6] Use the standard recognition acquisition equipment for short-circuit or overload protection for the input side of the main circuit and the input side of the control power.
(The main circuit input side: Select it from the ratings value of the load. Control power supply input side: 3A goods)
- [7] Use it on the condition that is higher than pollution degree 2.

Measures against harmonics

All of the APRs (auxiliary power regulator) of any type (in the case of phase control system) used by specific customers are subject to “the guideline for measures against harmonics to be taken by customers that receive high voltage or special high voltage power.” Such customers must calculate equivalent capacity and harmonic leakage current, and if the calculated value exceeds the limit specified by the contract, they must take appropriate measures.

Refer to “JEAG 9702-2018 Technical guideline of measures against harmonics” for details.

Reference: Japan Electric Association

Conformance to RoHS directive

The RoHS directive is a regulation on toxic substances. The directive regulates the use of toxic substances for electric and electronic devices. The substances contained in such devices regulated by the directive are the following ten: lead (Pb), cadmium (Cd), hexavalent chromium (Cr6+), mercury (Hg), polybrominated biphenyls (PBBs), polybrominated diphenyl ethers (PBDEs), Di-2-ethylhexyl phthalate(DEHPs), Butyl benzyl phthalate(BBPs), Dibutyl phthalate(DBP), and Diisobutyl Phthalate (DIBP).

This APR conforms to the RoHS directive.

2. CHECKING THE PRODUCT

Check the following before installing the instrument.

- (1) Is the delivered instrument of specifications you ordered? Are all the accessories supplied?
(Check the type, voltage, current, outside dimensions, and accessories specified, if any.)
- (2) Is the instrument damaged due to an accident during transportation?
If you notice anything wrong, contact your dealer or our sales representative nearest to you.
- (3) A rating plate is attached to the main unit at the position shown on the next page. Check that the delivered item is the one you ordered.

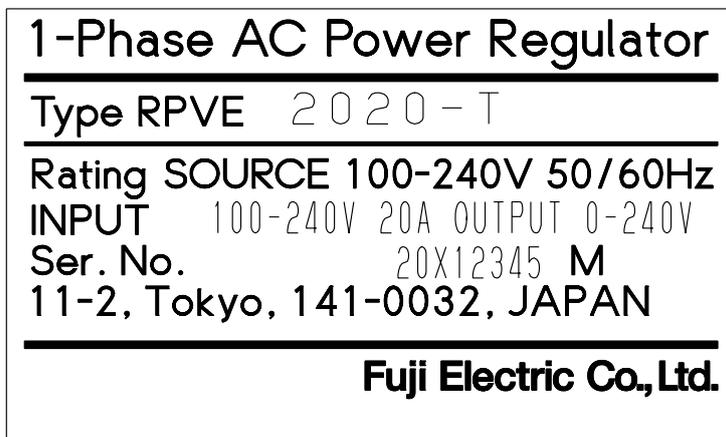
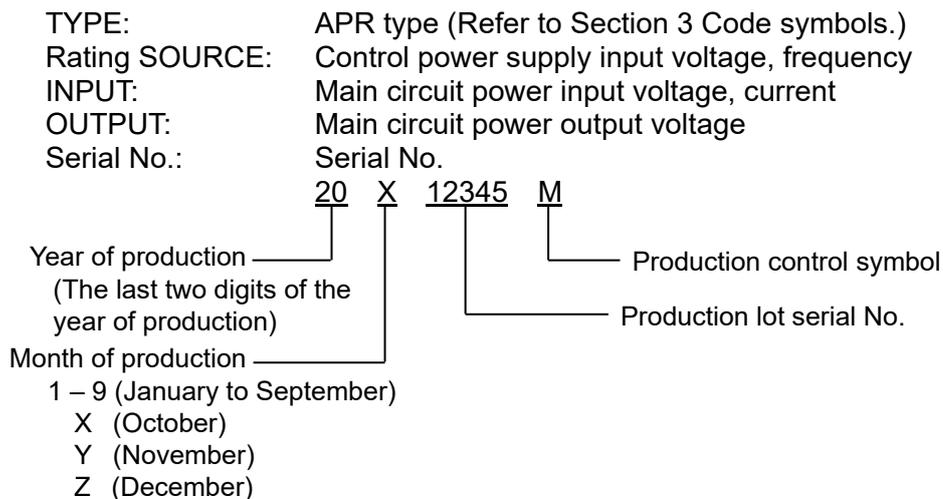


Fig. 2-1 Rating plate



- (4) There is no terminal (4A, MA, 4B, MB) for the parallel run with an old model (MX series and MX2 series). Nominate main body option No. 'ZAX' when you do an old model and parallel operation.
(Refer to P3-1 and P7-12)
- (5) Use setting indicator [APD3] when you use the heater disconnection detection function Type2 (single-functioning) or Type3 (high-functioning). CT-5S one is necessary for Type3 (high-functioning) outside.
(Refer to P7-5 figure 7-2)
- (6) From the following sentences, setting indicator is written as APD3.

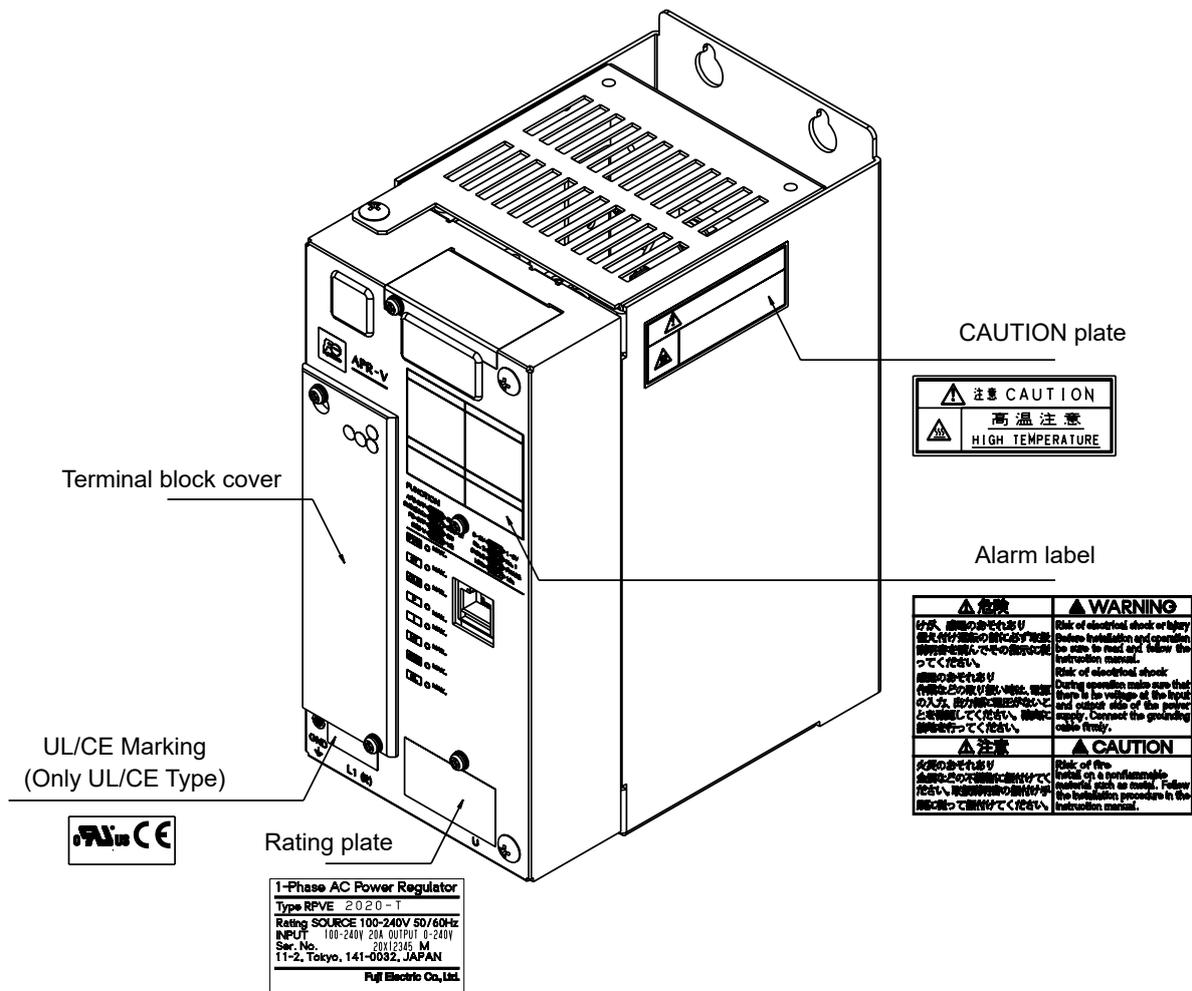


Fig. 2-2 Appearance of the product

⚠ 危険	⚠ WARNING
<p>けが、感電のおそれあり 備え付け運転の前に必ず取扱 説明書を読んでその指示に従 ってください。</p> <p>感電のおそれあり 作業などの取り扱い時は、電源 の入力、出力側に電圧がないこ とを確認してください。確実に 接地を行ってください。</p>	<p>Risk of electrical shock or injury Before installation and operation be sure to read and follow the instruction manual.</p> <p>Risk of electrical shock During operation make sure that there is no voltage at the input and output side of the power supply. Connect the grounding cable firmly.</p>
⚠ 注意	⚠ CAUTION
<p>火災のおそれあり 金属などの不燃物に据付けてく ださい。取扱説明書の据付け手 順に従って据付けてください。</p>	<p>Risk of fire Install on a nonflammable material such as metal. Follow the installation procedure in the instruction manual.</p>

Fig. 2-3 Alarm display (At the bottom of the front face)

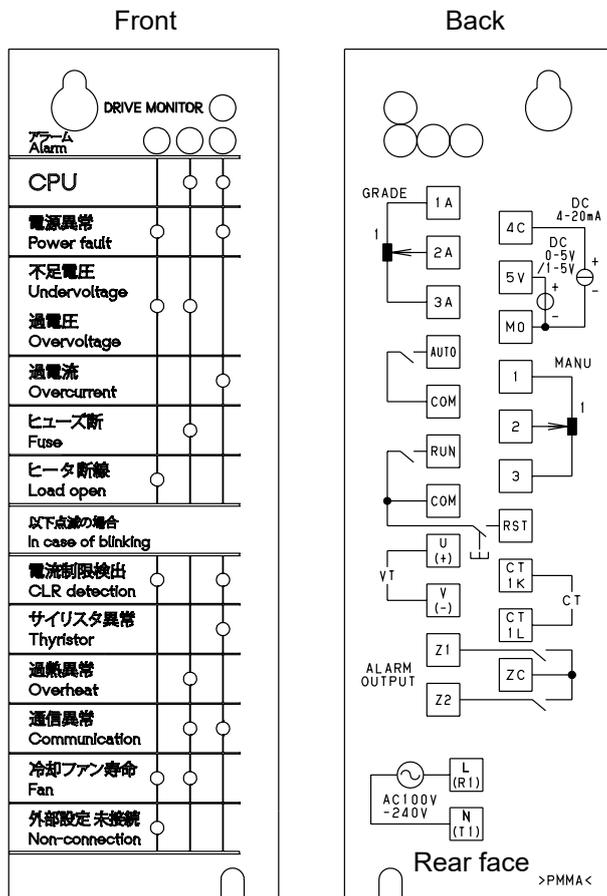


Fig. 2-4 Terminal block cover

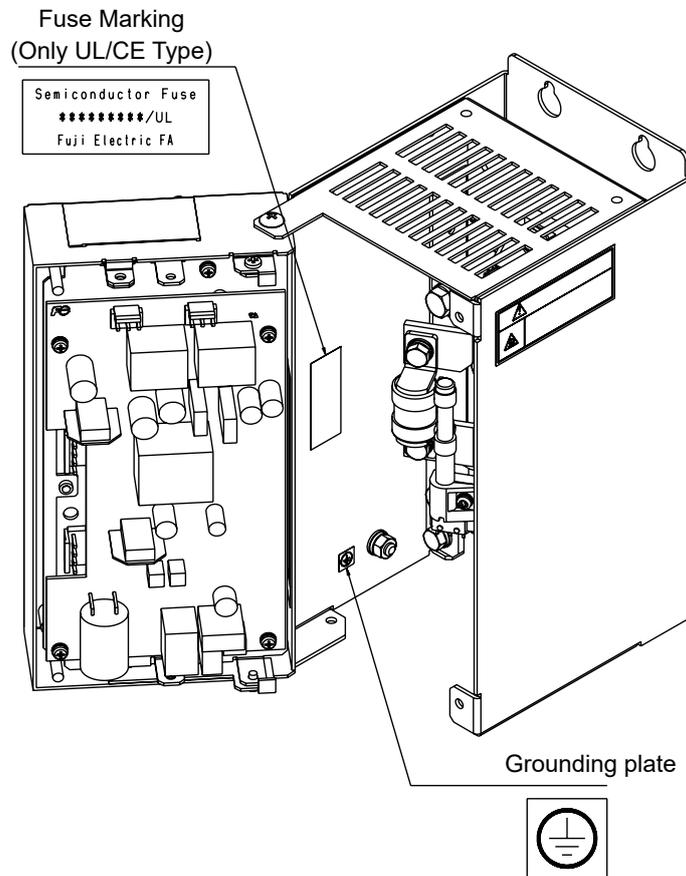
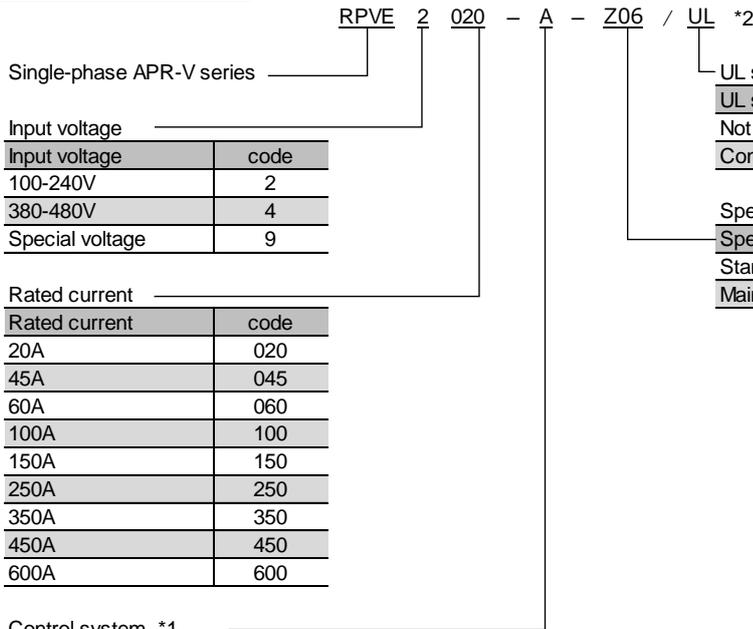


Fig. 2-5 Appearance of the product (with the front cover opened)

3. CODE SYMBOLS



Single-phase APR-V series

Input voltage	code
100-240V	2
380-480V	4
Special voltage	9

Rated current

Rated current	code
20A	020
45A	045
60A	060
100A	100
150A	150
250A	250
350A	350
450A	450
600A	600

Control system *1

Control system	External devices required (option)	code
Without feedback function	—	T
AC CLR	—	A
AC ACR + AC CLR	—	B
AC AVR + AC CLR	VT (Type : PT-5S)	C
AC AWR + AC CLR	VT (Type : PT-5S)	D
DC Feedback Control + AC CLR	Insulating converter(Fast-response)	E
Transformer primary control by cycle control	CT (Type: CT-5S. Accessory)	P

UL standard , Canadian standard and European standard

UL standard , Canadian standard and European standard	code
Not specified	Blank
Conforming to UL, cUL, CE marking	UL

Specifications *7

Specifications	code
Standard	Blank
Main unit: optional item	Z**

CLR=Current Limit Regulator
 ACR=Automatic Current Regulator
 AVR=Automatic Voltage Regulator
 AWR=Automatic Watt Regulator

- *1: VT and CT must use our special goods only for our company. If our goods are not used, safety might not be secured. Select control method A type when you select the rush current auto suppression function of cycle control.
- *2: Stuff including “-” or “/” when the order code is a blank.
- *3: Contact your sales representative for a test report.
- *4: The price of setter is not included in the main unit. The order form is "RPN001".
- *5: The SETTING INDICATOR (APD3) is sold separately. The order form is "APD3".
- *6: The price of cable to establish APD3 in the control panel surface is not included in the main unit. The order form is "RPN002-1" (for 1m), "RPN002-3" (for 3m), "RPN002-5" (for 5m) .
- *7: Optional items of the main unit (Example)

Name of optional specifications	Contents	Code symbol
Minimum soft start time (0.05 sec.)	Variable soft start time range: 0.05 to 10 sec./0.05 to 100 sec. (Control system : T or A)	RPVE□□□□-□-Z06
Built-in base load setting	Base load setting mounted to the printed board of the control circuit	RPVE□□□□-□-Z07
Built-in gradient setting	Gradient setting mounted to the printed board of the control circuit	RPVE□□□□-□-Z43
Printed wiring board coating processing	It is equipped with the circuit board which applied coating materials.	RPVE□□□□-□-Z70
Communication board: Parallel operation	Communication board mounted for master/slave system parallel operation *8	RPVE□□□□-□-ZAP
Communication board: Parallel operation	MX series and MX2 series interchangeability communication board *9	RPVE□□□□-□-ZAX
Communication board: Modbus RTU	Communication board mounted for Modbus RTU system network communications	RPVE□□□□-□-ZAM
Communication board: CC-Link	Communication board mounted for CC-Link system network communications	RPVE□□□□-□-ZAC
APD3 : For mounting	APD3 for installing the setting indicator to the main unit supplied	RPVE□□□□-□-ZB3
Input voltage : Special voltage	Special voltage other than rated voltage *10	RPVE9□□□-□-ZE□
AO board: Current signal	Output DC4-20mA *11	RPVE□□□□-□-ZAA
AO board: Voltage signal	Output DC0-10V *11	RPVE□□□□-□-ZAB

- *8: It is not compatible with the MX series and the MX2 series. It is compatible with the N series. The cycle control cannot be done by existing together to the three phase. The slave machine cannot use the heater disconnection detection function with APD3 at parallel operation.
- *9: It is compatible with the MX series and the MX2 series. The cycle control cannot be done by existing together to the three phase. The slave machine can use the heater disconnection detection function with APD3 at parallel operation.
- *10: Please contact us for available input voltage.
- *11: The content of the output signal can be changed by APD3.

4. SPECIFICATIONS

Item		Specification										
Type (Product code)		RPV□□□□-□										
Rated current [A] (At the ambient temperature of 50°C)		20	45	60	100	150	250	350	450	600		
Main circuit power supply	Power voltage	Single phase, 100 to 240V, 380 to 480V, voltage fluctuation ±10%										
	Frequency	50/60Hz ±2.5Hz (Frequency automatically judged and switched)										
Control circuit power supply (Note 1)	Power voltage	Single phase 100 to 240V ±10% (Only a sine wave is operation guaranteed. Make the same phase as main circuit power supply.)										
	Frequency	50/60Hz ±2.5Hz (Frequency automatically judged and switched)										
	Power capacity [VA]	36					40	45				
Internal heating value [W]		47	74	89	124	190	320	377	510	700		
Cooling system		Self-cooled					Air-cooled					
Applicable load	Phase control	Resistance load, inductive load, transformer primary control, rectifier primary control										
	Cycle control (Note 2)	Resistance load, inductive load, transformer primary control										
Control	Waveform control system	Phase control or cycle control (intermittent system) (Changed by the function select switch SW2)										
	Output voltage regulation range	0 to 100% of the power voltage of the main circuit (actual value) (excluding voltage drop of thyristor)										
	Input/output characteristics	Linear characteristics of actual value, Linearity ±2%FS or lower (In the case of resistance load, within the auto setting signal range of 10 to 90%)										
	Power voltage compensation (Applicable to control systems T and A)	Output fluctuation reduced to ±3%FS or lower for the power voltage fluctuation of ±10% (within the auto setting signal range of 10 to 90%)										
	Setting signal	Manual setting	Variable resistor to be mounted externally: 1 kΩ (B characteristics: 1/2 W or higher) HIGH-LOW (two-position control) contact signal: External wiring									
		Auto setting	Current signal: 4 to 20mA DC (Zin = 100 Ω) Voltage signal: 0 to 5V DC, 1 to 5V DC (Zin = 10 kΩ) (Changed by the function select switch SW4)									
	Gradient setting	For a setting signal, it is settable with size of the output optionally. Externally mounted variable resistor (1 kΩ) (B characteristics of 1/2 W or higher) (standard), built-in (option), or voltage signal setting by control circuit terminal "5V-M0" (The function select switch SW5 is turned OFF, only 1 to 5V DC supports.) Reverse gradient characteristics allowed by combination with base load setting										
	Base load setting	0 to 100% of output voltage (Option: built-in)										
	Soft start and soft up/down time (Note 3)	0.5 to 10 sec. or 5 to 100 sec. (Changed by the function select switch SW1) Soft up/down time can be fixed to 0.5 sec. (The function select switch SW7 is turned OFF.)										
	Feedback control system (phase control system only)	AC CLR					(Control system A)					
		AC ACR + AC CLR					(Control system B)					
		AC AVR + AC CLR					(Control system C)		Control systems B, C, D, and E: Operated with priority placed on AC CLR function.			
		AC AWR + AC CLR					(Control system D)					
		DC Feedback Control + AC CLR					(Control system E)					
	Rush current auto suppression (Cycle control system only) (Note 4)	At CLR setting 100%, current of 90% or more of the rated current is detected with the internal CT and reduced with phase angle changed. (Control systems A only. The function select switch SW6 is turned OFF.)										
	CPU memory error	Memory error is detected when CPU is started, disabling output.										
	Power supply abnormal	[1] Control power frequency that does not fall within the 45 to 65Hz range is detected. [2] Sudden change of control power frequency by ±2.5Hz or more is detected.										
Undervoltage (Note 5)	Undervoltage of control power supply voltage (110V system: 85V or lower, 220V system: 165V or lower, 440V system: 315V or lower) is detected.											
Overvoltage (Note 5)	Overvoltage of control power supply voltage (110V system: 140V or higher, 220V system: 265V or higher, 440V system: 535V or higher) is detected.											
Overcurrent	Approximately 120% or higher of rated current is detected with internal CT (Control systems A, B, C, D, E and P)											
Main fuse blow n	Output is stopped with internal main fuse to protect major element.											
Heater disconnection (Note 6)	APR output current value that falls below the disconnection judgment value is detected with internal CT. (Control systems A, B, C, D and E)											
CLR detection	Load current exceeding the CLR setting is detected and the value is reduced to fall within the permissible CLR setting range by changeover phase angle. (Control systems A, B, C, D, E and P)											
Thyristor failure	Thyristor short circuit is detected with internal CT. The firing pulse stops, but the output might not be stopped. (Control systems A, B, C, D, E and P)											
Overheat	Detection by temperature sensor.											
Communication error (Option)	Communication error between APRs operated in parallel is detected.											
End of life of cooling fan	Reduction of steady rotation speed to 70% (200 rpm) is detected.											
Failure detection/protection	Setting input disconnected (Note 7)	[1] Disconnection of current / voltage setting signal is detected [2] Disconnection of manual/gradient setter is detected										
	Load error (Control system P only)	[1] Detected when load is open. [2] When load current is delayed by 30° or more										
	Analog output current error (option)	Detects when the allowable load resistance is exceeded when using the current signal on the AO board.										
	Alarm contact output	Relay contact: Serious breakdown + minor breakdown [1a (ON/NC) + 1a (ON/NC) contact, 250V AC, 1A]										
	Surrounding Air Temperature	-5 to +50°C (If the ambient temperature exceeds +50°C and less than +55°C, the load current is reduced against the rated current.)										
Environment	Storage temperature	-20 to +60°C										
	Ambient humidity	30 to 90%RH (No condensation allowed.)										
	Others	Corrosive gas, dust, the one which promotes insulation degradation and vibration are not allowed. Indoor use at altitude of 1000 m or lower										
Insulation	Withstand voltage (between main circuit and earthing terminal) (Note 8)	2,000V AC for 1 minute (100 to 240V), 2,500V AC for 1 minute (380 to 440V, 380 to 480V)										
	Insulation resistance (to earthing terminal)	10 MΩ or higher with a 500V DC megger										

- Note 1: Operated at the rated voltage of 110V or 220V. If the instrument is used for the rated voltage of 230V or 240V, adjust the maximum output voltage by the power voltage compensation setting (PVC setting).
- Note 2: When a transformer of VT is connected to the output side, a phenomenon of magnetic deviation occurs, so please cut off a transformer of VT at the time of cycle control use. Primary control of the transformer based on cycle control is valid for control system P only.
- Note 3: The control systems B, C, D, and E type, even if it sets up soft start soft up/down time short, since priority is given to the speed of response of feedback control, it may not become short. It can set up for a long time.
- Note 4: In the rush current auto suppression, generation of overcurrent is suppressed by the compound control with the phase control. Do not connect a transformer such as VT to the output side to prevent a phenomenon of magnetic deviation. (Refer to P8-3 Note *4.)
- Note 5: The APR detects the control power supply voltage at the time of power supply injection automatically. Therefore, when the power supply voltage goes up and down slowly or a series of 110V power supply and a series of 220V power supply change, "overvoltage" or "under voltage" warning alarm are detected.
- Note 6: In the case of cycle control (control system A), it becomes the "load opening detection" warning alarm.
- Note 7: Does not operate when voltage signal is set to 0 to 5V DC (The function select switch SW4 is turned OFF.).
- Note 8: Cooler fan's DC power supply is supplied from the second side of the power supply circuit. Cooler fan's power supply connector need not be pulled out when you examine an insulation voltage.

5. INSTALLATION

Pay attention to the following when installing the instrument.



WARNING

- Install the instrument to an incombustible object such as metal.
- Do not install the instrument near combustible objects.
..... **A fire may result.**

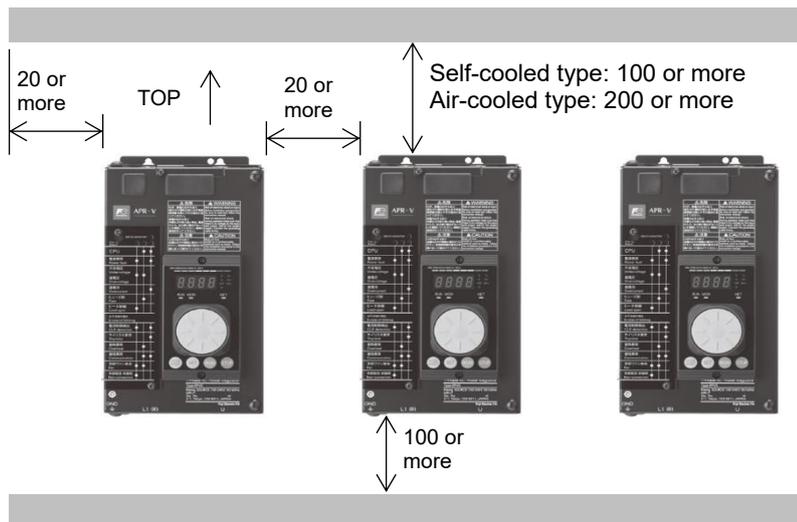


CAUTION

- Do not transport the instrument by holding the cover of the terminal block.
..... **The instrument may fall, thus resulting in injury.**
- Prevent foreign matter such as lint, paper, wood chips, and scrap metal from entering the APR or becoming attached to the cooling fan. After the installation, check that objects such as screws and tools are not left within the instrument.
..... **A fire or accident may result.**
- Install the instrument in the orientation shown by the dimensional outline drawing.
- Install the instrument in a place that endures the weight of the instrument using specified screws and at specified torque.
..... **A fire or accident may result.**

Notes

- (1) Install the instrument in a place not subject to dust and having high cooling effect.
To discharge the heat of the APR, install it on a metallic object on the vertical surface, observing the orientation shown by Fig. 5-1 and allowing sufficient space on the left, right, top, and bottom of the instrument.
- (2) The temperature within the panel increases due to the heating of the APR. Take appropriate cooling / ventilating measures, taking the increase of temperature into consideration. (The maximum allowable temperature within the panel is 55°C.)
- (3) If the APRs are used laid out close to each other, interference of heat occurs between APRs. Be sure to allow sufficient space shown by Fig. 5-1 or larger.
- (4) Allow sufficient space from adjacent objects for wiring of the main circuit terminal, control power terminal, and control circuit terminal as well as replacement of the main fuse (to be replaced by removing the two screws on the front panel) and cooling fan (to be replaced by removing the fan mounting screw at the top) using tools.



Note: The values on this figure do not include working space or option (Finger guard etc.). (Unit: mm)

Fig. 5-1

- (5) Rated current is the value specified on condition that the ambient temperature is 50°C. If the temperature exceeds 50°C, decrease the load current according to Fig. 5-2.

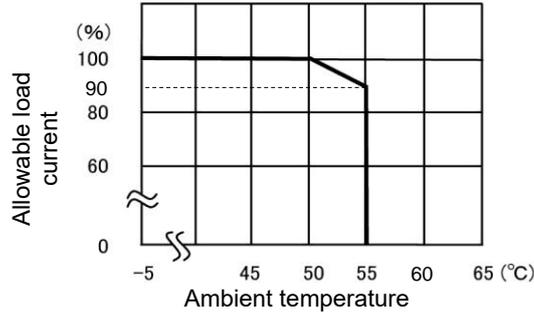


Fig. 5-2

- (6) The APR main unit has an opening on the top. Be careful not to drop an object into the opening.

6. EXTERNAL DIMENSIONS

* Tightening torques for mounting the main unit

Setscrew	Tightening torque (±10%)
M4	1.8N·m(18kgf·cm)
M5	3.5N·m(35kgf·cm)
M6	5.8N·m(58kgf·cm)

* Tightening torques for control circuit terminal

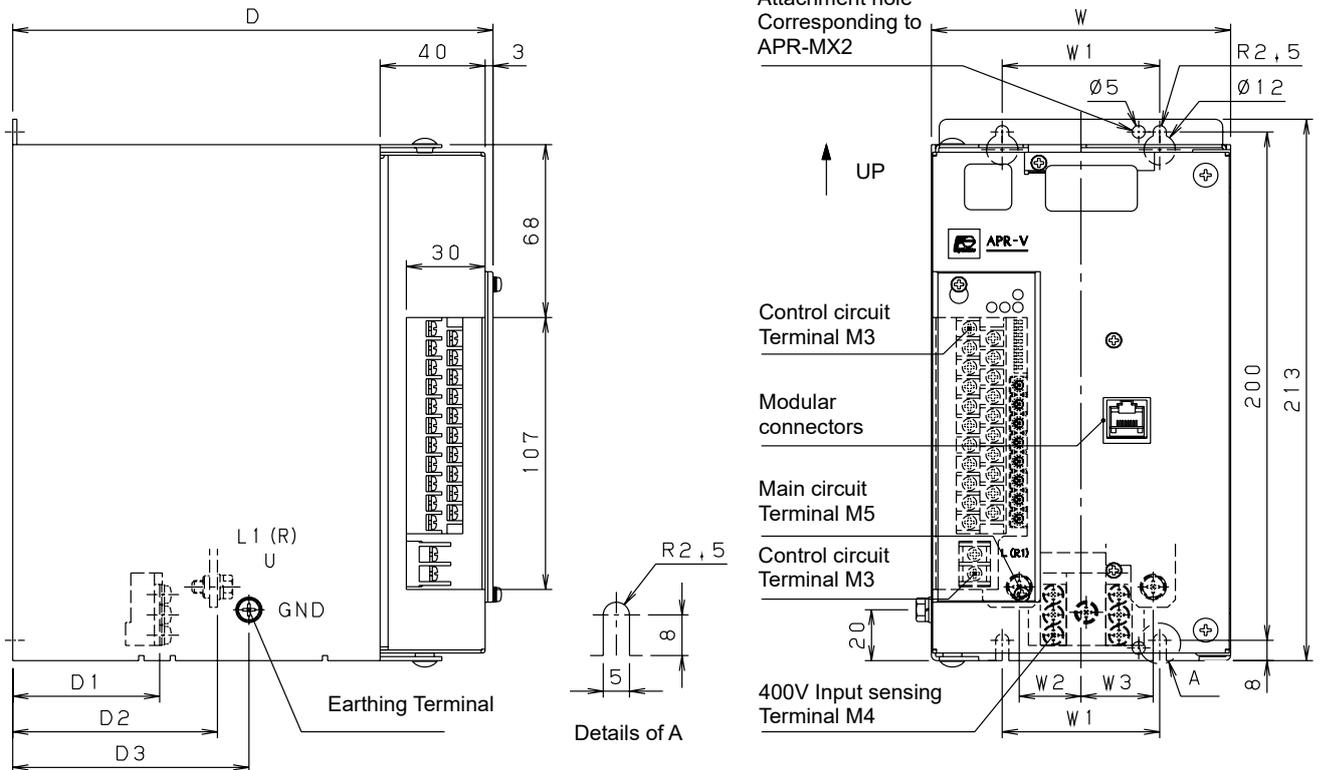
Setscrew	Tightening torque (±10%)
M3	0.55N·m(5.5kgf·cm)

* Tightening torques for terminals (conductors)

Setscrew	Tightening torque (±10%)
M5	2.7N·m(27kgf·cm)
M8	12.0N·m(120kgf·cm)
M10	24.0N·m(240kgf·cm)
M12	40.0N·m(400kgf·cm)

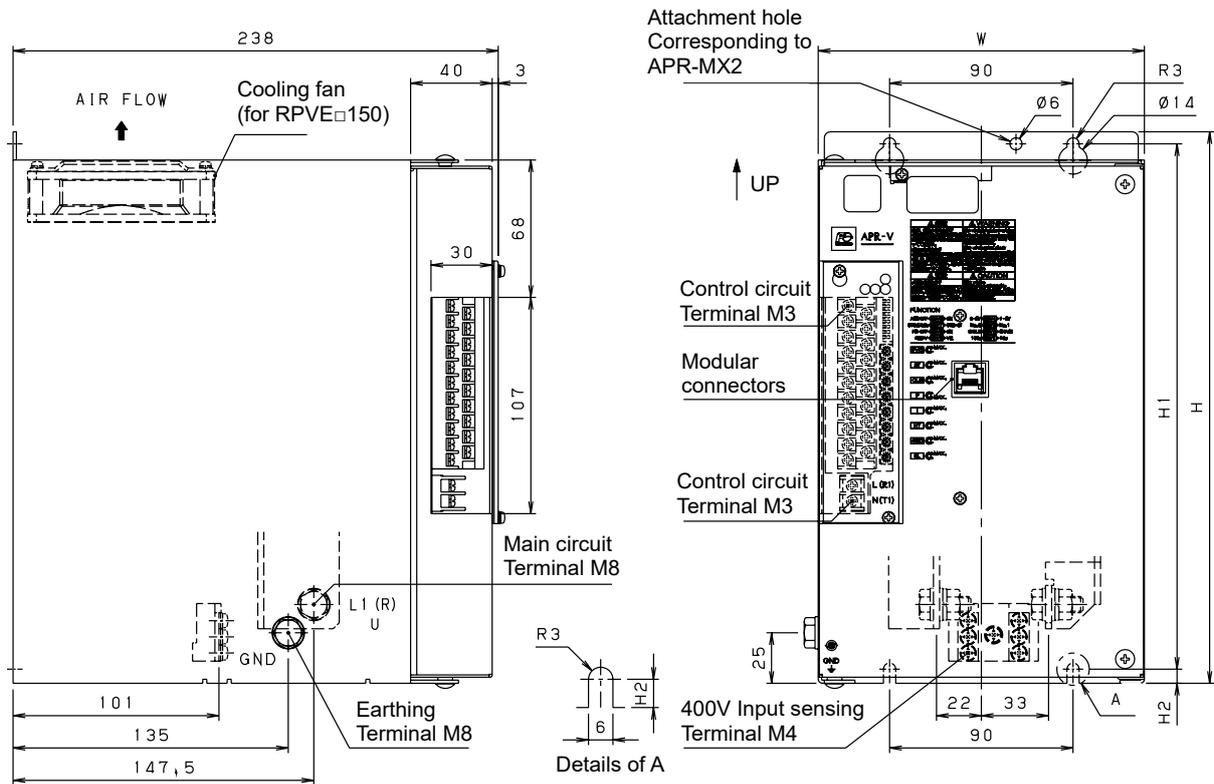
* Tightening torques for 400V Input sensing terminal

Setscrew	Tightening torque (±10%)
M4	1.8N·m(18kgf·cm)



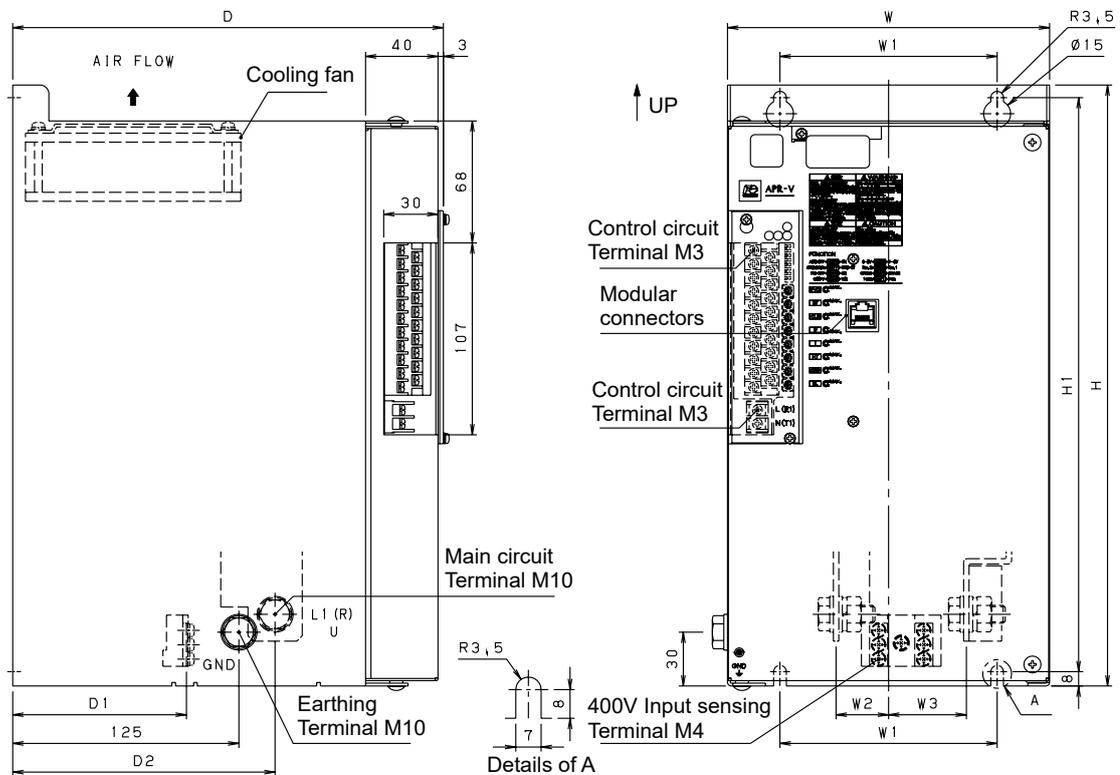
Type	W	W1	W2	W3	D	D1	D2	D3	Mass [kg]
RPVE□020	100	50	25.5	25.5	158	36	58	70	2.6
RPVE□045	114	60	23.5	27.5	183	56	78	90	3.6
RPVE□060									

图 6-1 RPVE□020、RPVE□045、RPVE□060



Type	W	H	H1	H2	Mass [kg]
RPVE□100	144	224	210	8	5.3
RPVE□150	160	273	260	7	6.4

図 6-2 RPVE□100、RPVE□150



Type	W	W1	W2	W3	H	H1	D	D1	D2	Mass [kg]
RPVE□250	178	120	29	43	335	320	238	96	145	9.0
RPVE□350	200	150	40	49	345	330	263	106	160	10.6
RPVE□450										

図 6-3 RPVE□250、RPVE□350、RPVE□450

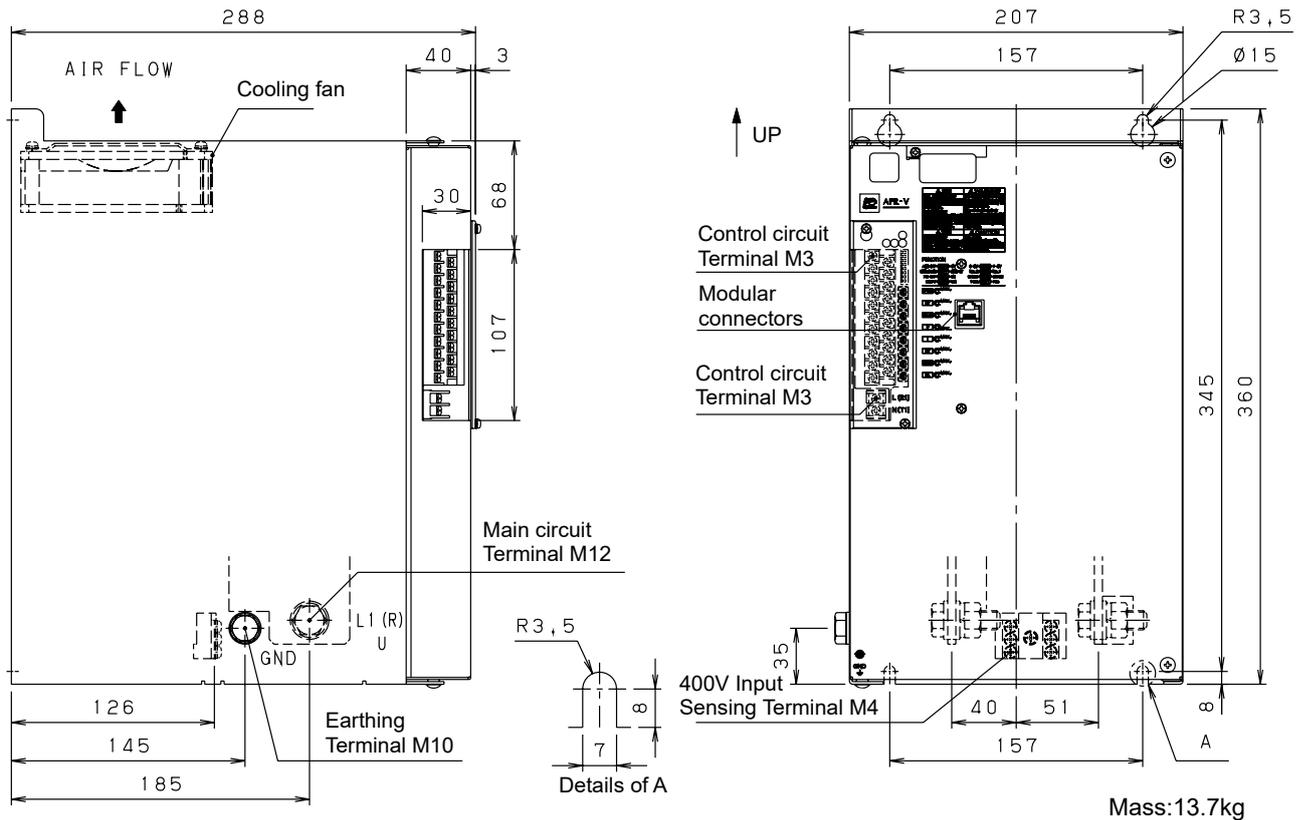


图 6-4 RPVE□600

7. CONNECTION OF TERMINALS

Pay attention to the following when performing wiring.

WARNING

- Be sure to connect a ground lead to the \oplus terminal to ensure safety.
 - Be sure to check that the input power is set to OFF before performing wiring.
 - Install the APR main unit first, and then carry out wiring and fasten screws for the main circuit. Check that the screws are fastened securely.
 - Use the power wire and load wire that satisfy the operating conditions.
 - Connect the instrument to the main circuit power supply and control power supply via a circuit breaker for circuit protection and a ground fault interrupter.
- **Electric shock or fire may result.**

CAUTION

- Check that the rated input voltage of the product and the power supply voltage coincide.
 - Pay attention not to reverse the input and output terminals.
 - Check carefully that the wiring of the control circuit has been carried out properly.
 - Fasten screws at the designated torque.
- **A fire or injury may result.**

(1) Notes on wiring

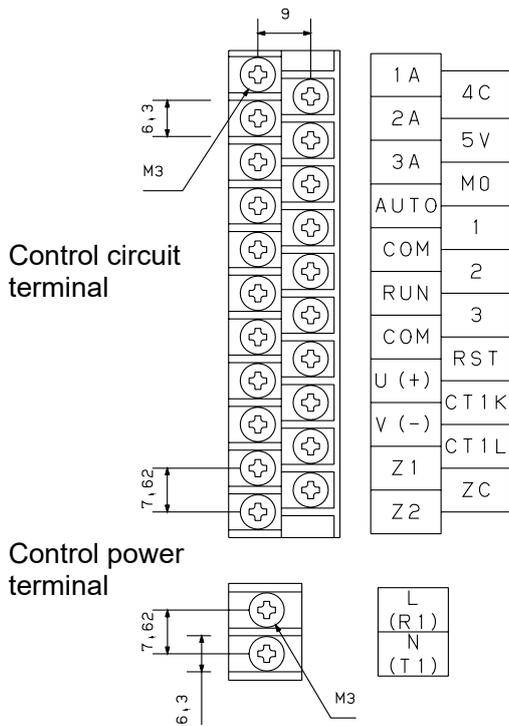
- Use the supplied screws (bolts) for main circuit terminals [L1(R), U, L0 and N0 (400V only)]. If screws (bolts) larger than the specified size are used, insufficient insulation from surrounding parts may result. Use an insulation cap for crimp contacts.
- Use crimp contacts with insulation coating when performing wiring to terminals L(R1), N(T1), Z1, Z2, ZC, L0 and N0 (400V only) within the control circuit terminal block, and ensure sufficient insulation from adjacent terminals.

- (c) To prevent noise, perform wiring to control circuit terminals, allowing sufficient distance from the main circuit terminal [L1(R), U] and the control power terminals [L(R1), N(T1)]. Do not place them in the same duct. If wires are to be crossed, place them so they cross at right angles.
Twist wires by signal group (4 to 7 turns/10 cm). If a shielded wire is to be used, connect the shield casing to the earthing terminal, and keep the other end open.
- (d) If a breaker for circuit protection is to be used on the input side of the control power, we recommend you to install it at the position shown by Figs. 7-2, 7-3, and 7-4.
- (e) Use crimp contact R1.25-3S (small diameter contact for M3 screw) for the control circuit terminal block.
- (f) For the electric wire used for the input sensing terminal terminal, select an electric wire that meets the required safety standards. Also, use AWG16-14 (1.25-2mm²) with a rated voltage of 600V and a maximum allowable temperature of 75 ° C or higher.
- (g) After the wiring is completed, return the terminal block cover back to the original position to ensure safety.
- (h) Voltage is generated at the output terminals through the internal snubber circuit even if output is not made from the APR. To prevent electric shock during maintenance and inspection, install a breaker or equivalent devices in the former stage of the APR.
- (i) **When performing primary control with a transformer (to be connected between the APR and the load), observe the following to prevent overcurrent, blowing of main fuse, and burns of the transformer due to magnetic deviation of the transformer.**
 - [1] Allow sufficient magnetic flux density of the transformer(1.0-1.2T or lower).
 - [2] If there is a possibility that no load is applied to the transformer, connect a resistance that feeds the current of approximately 0.5A to the primary winding in parallel.
- (j) Wire the control circuit terminal in the same board. When extend to the board outside, insert signal amplifiers midway, and do noise measures.

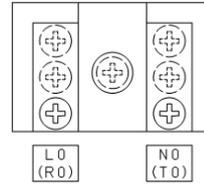
(2) Functions of terminals

Caution: The COM terminal is connected in the printed circuit board inside.

Name	Symbol	Description	When not used
Main circuit terminal	L1 (R), U	Connects the APR input and main power supply. Connects the APR output and single-phase load.	--
Earthing terminal	⊕	Earthing terminal of the main unit Connect to the ground.	
Control power terminal	L (R1), N (T1)	Input of single-phase 100 to 240 V power for control circuit	
Input sensing terminal (400V only)	L0(R0), N0(T0)	Input power is detected by input in phase and voltage with main circuit power	
Auto/manual changeover input	AUTO, COM	Set to Auto by closing the external contact. Set to Manual by opening the external contact. Close the external contact of the slave APR in parallel operation.	
Gradient setting input	1A, 2A, 3A	Input of gradient setting allowed by connecting a variable resistor Set to LOW in HIGH-LOW setting	2A-3A short circuit
Run/stop input	RUN, COM	Run by closing the external contact. Output is set to OFF (stop) by opening the external contact.	Short circuit
Auto setting input	4C, M0	Input of 4 to 20 mA DC current signals from temperature regulator, etc.	Open
	5V, M0	Input of 0 to 5V or 1 to 5V DC voltage signals from temperature regulator, etc. Input of 1 to 5V DC voltage signals can be allocated to the inclination setting input. (Refer to P9-1 Note *5.)	
Manual setting input	1, 2, 3	Input of manual setting allowed by connecting a variable resistor Set to HIGH in HIGH-LOW setting	
Alarm reset input	RST, COM	Alarm display and alarm contact output are reset by closing the external contact.	
External CT input	CT1K, CT1L	Connect the external CT (CT-5S) for control system P. Connect the external CT for high performance heater disconnection detection function (option).	
External VT input	U (+), V (-)	Connect VT and DC converter of various insulation types to perform feedback detection.	
Alarm contact output	Z1, ZC	The internal contact is set to ON when an alarm is issued (serious breakdown).	
	Z2, ZC	The internal contact is set to ON when an alarm is issued (minor breakdown).	
APD3 input / output	APD	Various settings and displayed values are sent / received when APD3 is connected.	
		Parallel operation signals from the APR in the previous stage (NET OUT) are received in parallel operation (Option code: ZAP).	
Parallel operation input/output	NET IN, NET OUT	Various settings and displayed values are sent to and received from the host at network communications (Option code: ZAM).	
	4A, MA	Parallel operation signals are received to the APR in the previous stage in parallel operation (Option code: ZAX).	
	4B, MB	Parallel operation signals are sent to the APR in the later stage in parallel operation (Option code: ZAX).	



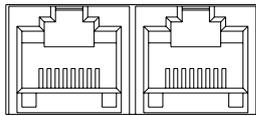
(b) Input sensing terminal (400V only)



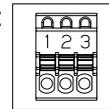
Note: The COM terminal is connected inside the board.

(a) Control circuit terminal and Control power Terminal

Option code:
ZAP



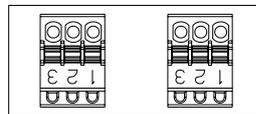
Option code:
ZAA
ZAB



1: AO_V Analog Current (ZAA)
2: AO_C Analog Voltage (ZAB)
3: COM

Note: Use either current or voltage.

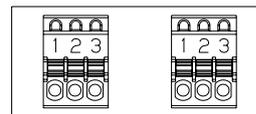
Option code:
ZAM



1: DXA(+)
2: DXB(-)
3: SG(N.C)

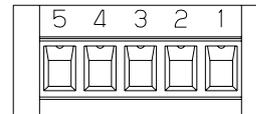
(d) Analog output connector

Option code:
ZAX



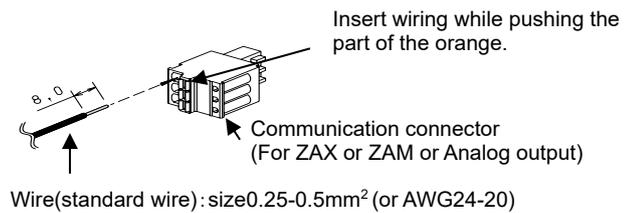
1: 4A, 4B
2: NC
3: MA, MB

Option code:
ZAC



1: DA
2: DB
3: DG(SG)
4: SLD
5: FG

(c) Communication board connectors



(e) Connection method

Fig. 7-1. Control circuit terminal, Control power Terminal and Communication board connectors

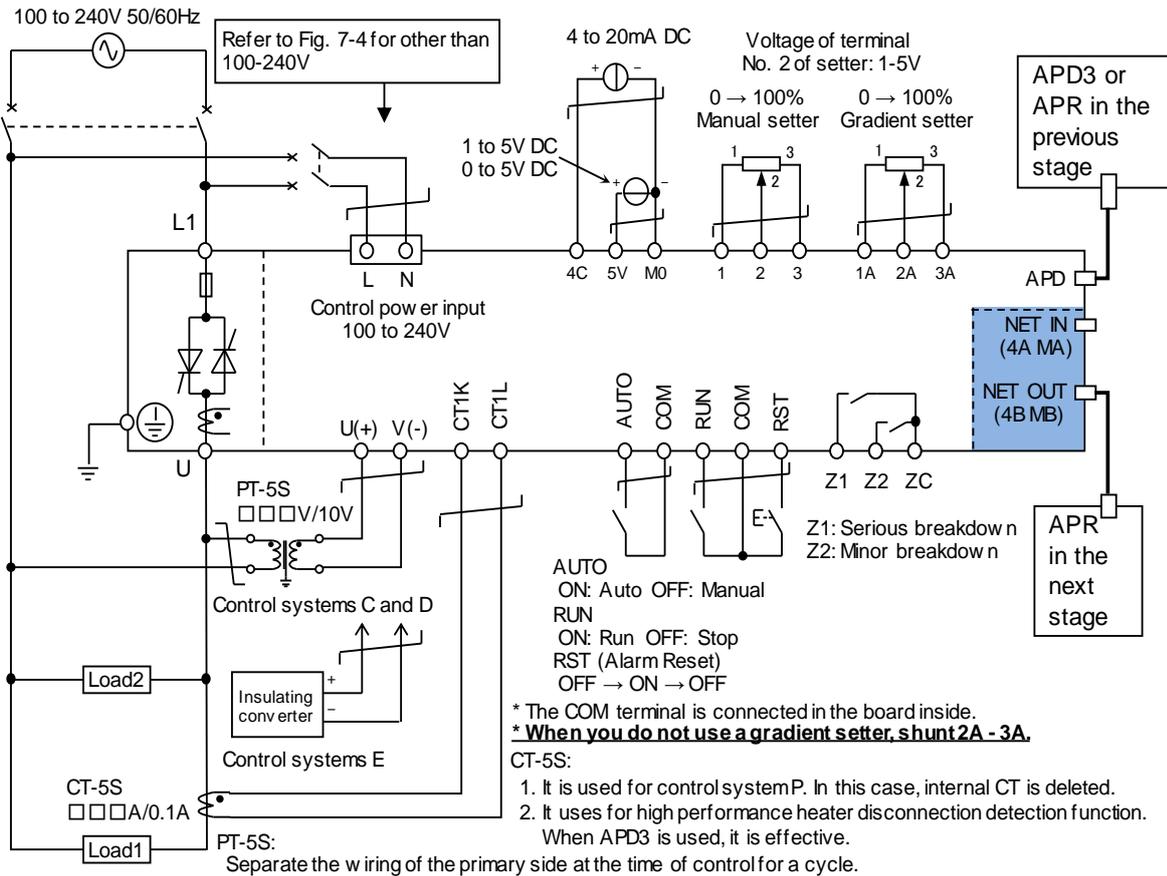


Fig. 7-2 External connection diagram
(Full connection and, the function allocation of the terminal stand don't change.)

(3) Main circuit power supply and control power supply

(a) 100 to 240V (Refer to Fig. 7-3.)

The L and N terminals are used for control power input. If the control power is in separate line from the main circuit power supply, **be sure to check that they are in the same phase.**

(b) Voltages other than 100 to 240V (Refer to Fig. 7-4.)

Control power terminals: Connect 100-240V power supply to L and N.

Input power supply detection terminals: Connect L0 and N0 so that they are in phase with the main circuit power supply

There is no problem even if a circuit protection circuit breaker is installed before the input power detection terminal L0 and N0. Output starts with soft start after checking the power supply voltage and frequency between L0 and N0.

* Check that the phase of the main circuit power and that of the control power are the same. If not, output cannot be made properly.

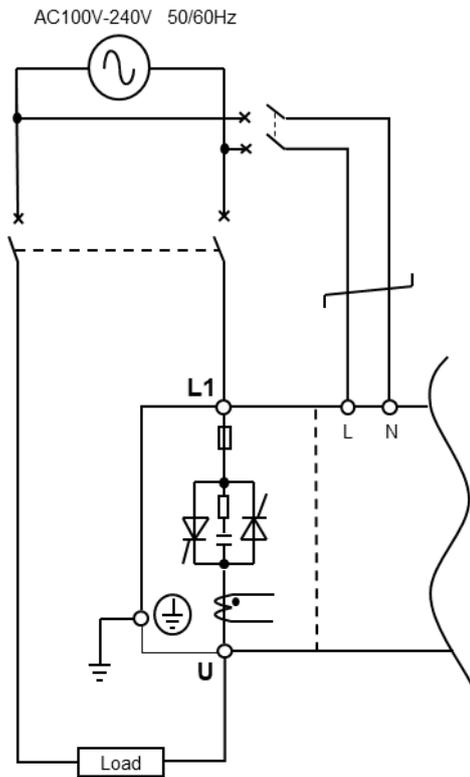


Fig. 7-3 AC100V-240V (Ex.)

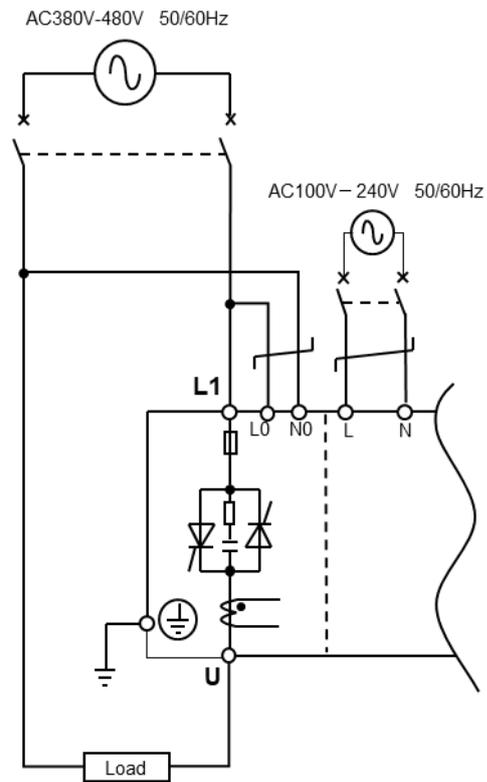
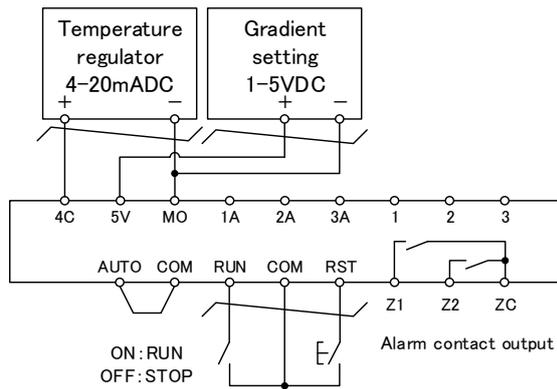


Fig. 7-4 AC380V-480V(Ex.)

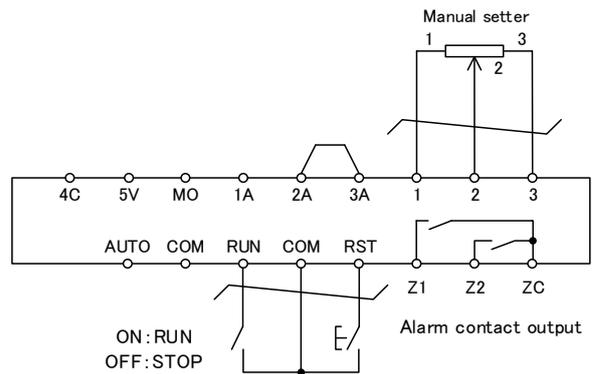
(c) Earthing terminal (Refer to Fig.7-2, 7-3, 7-4)

Be sure to ground earthing terminal, in purpose of safety and a noise countermeasure.

Auto setting
Current signal (4 to 20 mA DC) with gradient setting by voltage signals (1 to 5V DC)

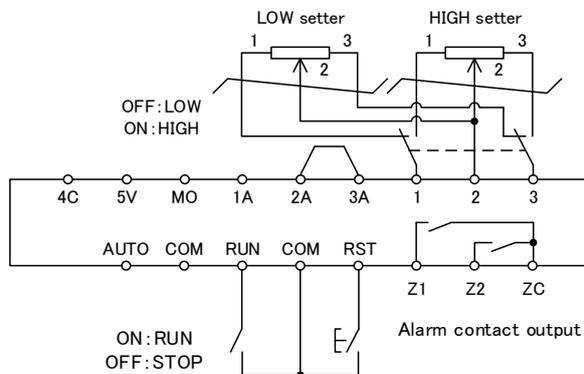


Manual setting

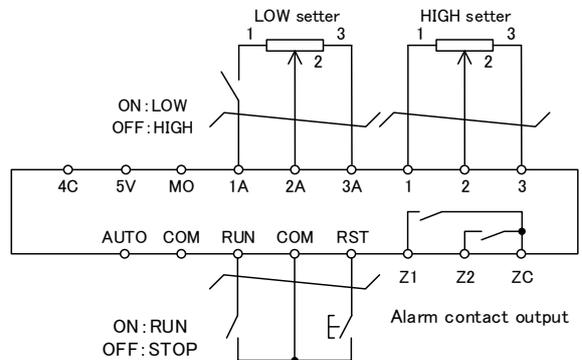


Manual setting
HIGH-LOW setting (2-position control)

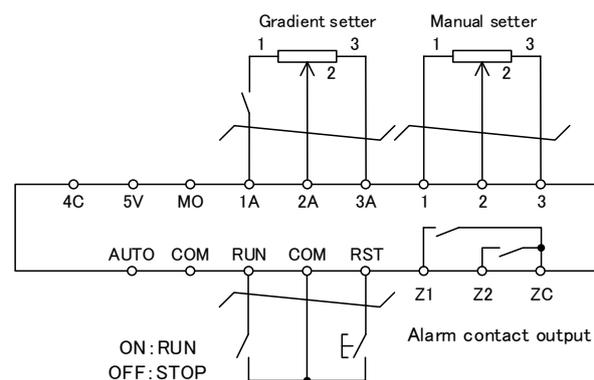
Method 1: HIGH and LOW settable separately



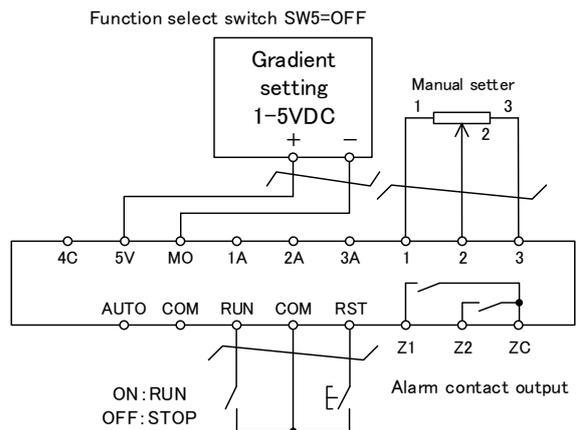
Method 2: Output at LOW = HIGH setter × LOW setter
Output at HIGH = HIGH setter



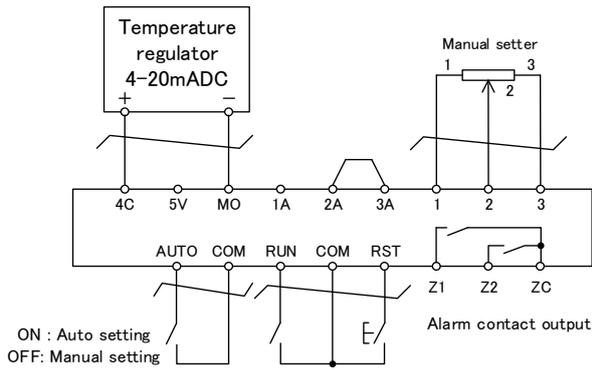
Manual setting with Gradient setter



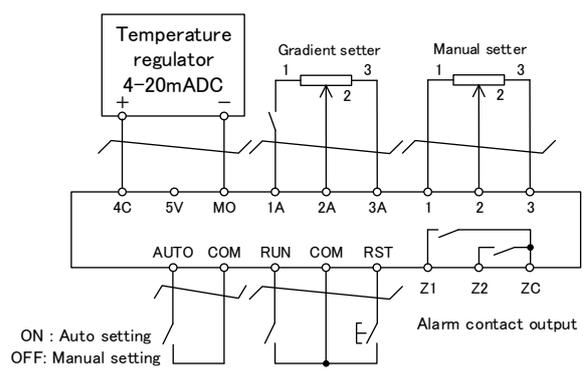
Manual setting
Voltage signal (1 to 5V DC) with gradient setting



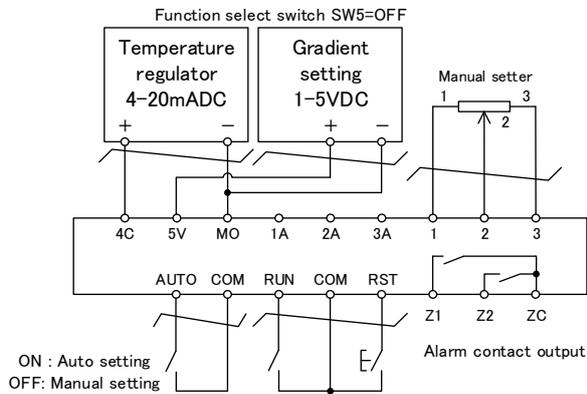
Auto/Manual changeover setting



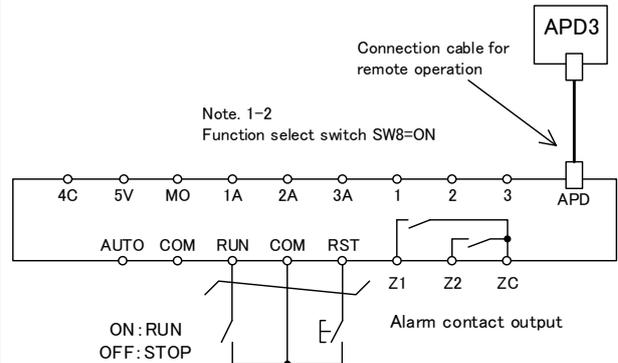
Auto/Manual changeover setting with Gradient setter



Auto/Manual changeover setting with gradient setting by voltage signals (1 to 5V DC)



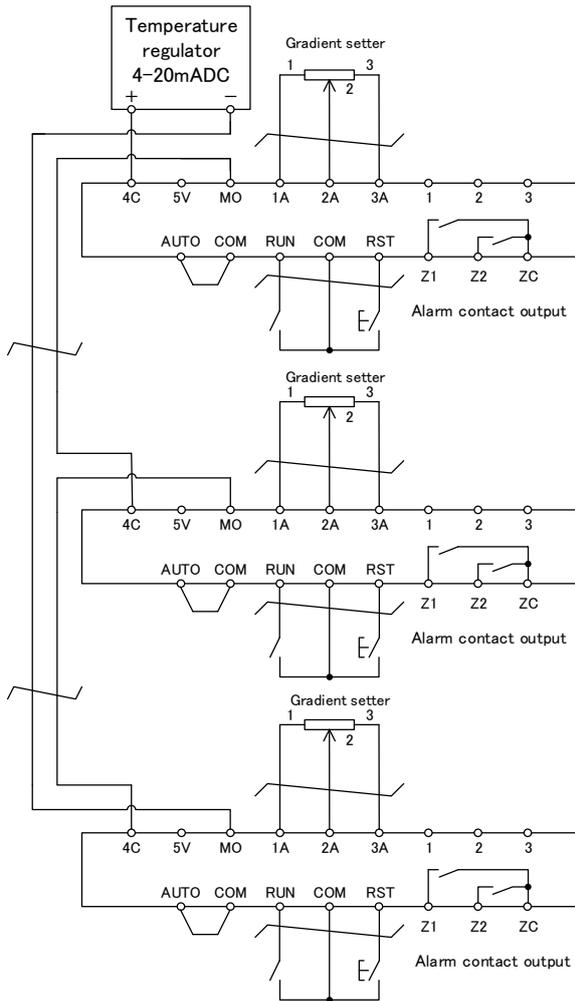
APD setting with built-in communication board



Note 1: The connection cable for remote operation is necessary when connecting APR and APD3.
 Form: RPN002-□ 1, 3, and □=5: Length (m)
 Use a straight cable (within 20m) for 10BASE-T/100BASE Control circuit terminal stand, control power supply terminal stand, and connector for communication -TX that meets the standard of United States ANSI/TIA/EIA-568A category 5 or category 5e when you use LAN cable on the market.

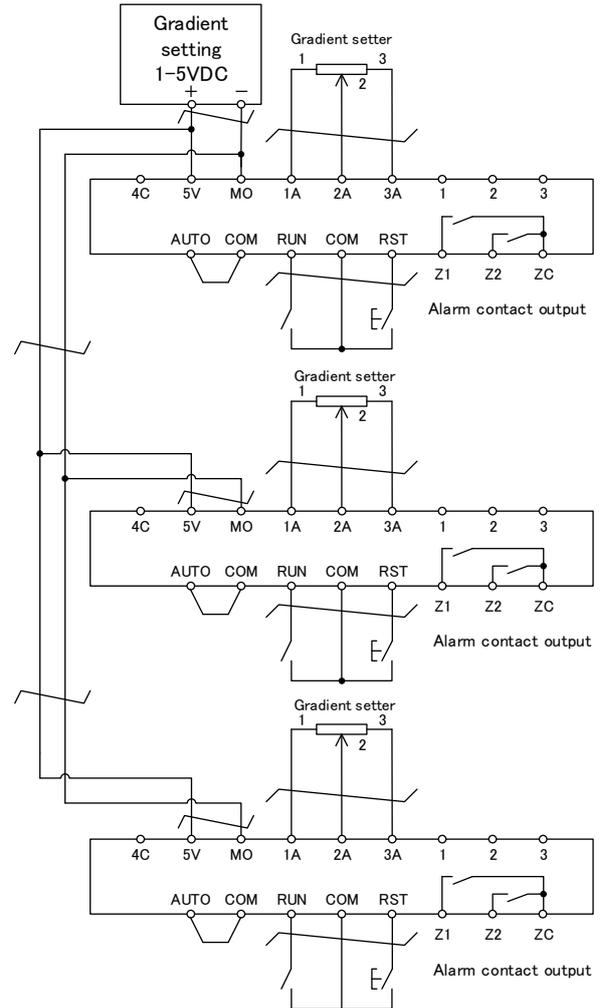
Note 2: APD3 = setting indicator (another goods for sale)

Direct parallel operation of 2 or more units by current signals (4 to 20 mA DC) with Gradient setter for each.



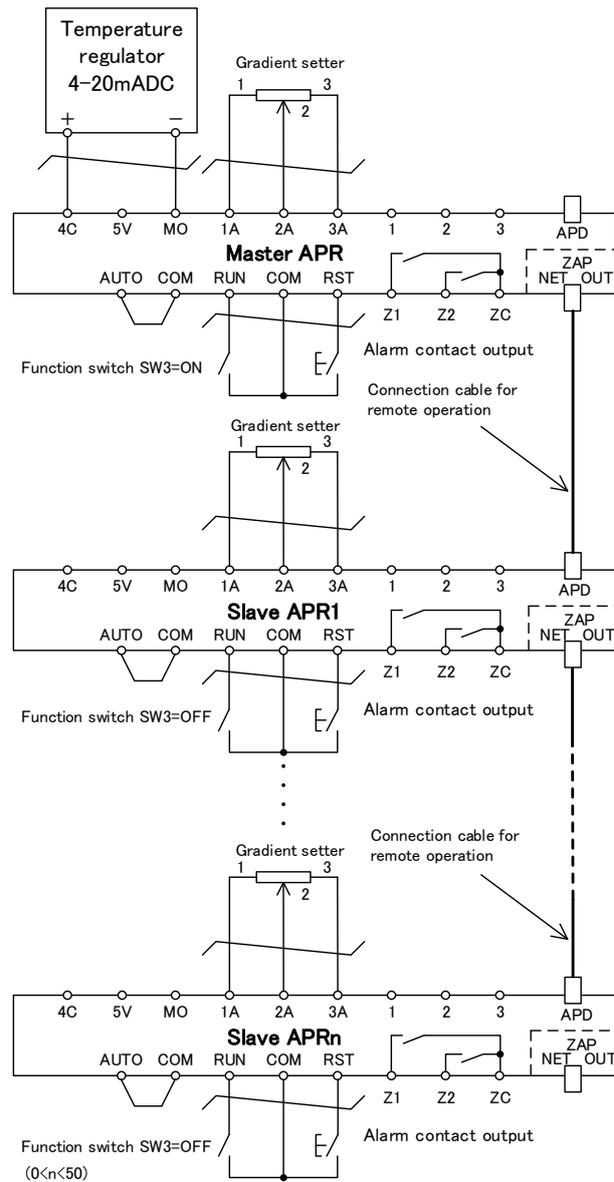
Note:
Do not connect between COM terminals of each APR.
Do not make the COM terminal common by an outside relay point of contact etc.
Set the number of APR so that the total of internal resistance(100Ω) of APR should not exceed the temperature adjustment meter.

Direct parallel operation of 2 or more units by voltage signals (0 to 5V, 1 to 5V DC) with Gradient setter for each.

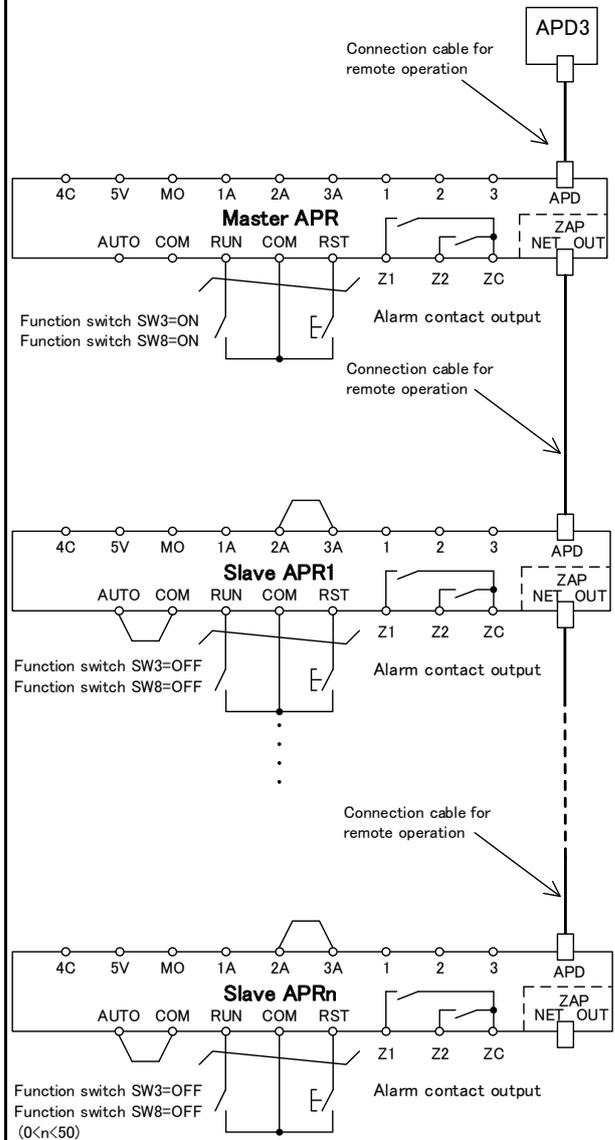


Note:
Internal resistance of APR is 10kΩ.

Parallel operation of 2 or more units by current signals
(4 to 20 mA DC) with Gradient setter for each.
(Option code: ZAP)



Parallel operation of 2 or more units by APD3
(Option code: ZAP)



Note 1: It becomes goods equipped with "For communication board parallel operation"
(Main body option goods. Option code: ZAP) (Refer to P3-1.)

Note 2: The connecting cable for remote control is necessary when connecting each APR and APD3.

Form: RPN002-□ 1, 3, and □=5: Length (m)

Use a straight cable (within 20m) for 10BASE-T/100BASE-TX that meets the standard of United States ANSI/TIA/EIA-568A category 5 or category 5e when you use LAN cable on the market.

Note 3: APD3 = setting indicator (another goods for sale)

Note 4: In the case of the phase control, gradient setting, base load setting, and power supply voltage compensation function of each slave APR are valid. They are invalid in case of cycle control.
(The flicker prevention function works in cycle control.)

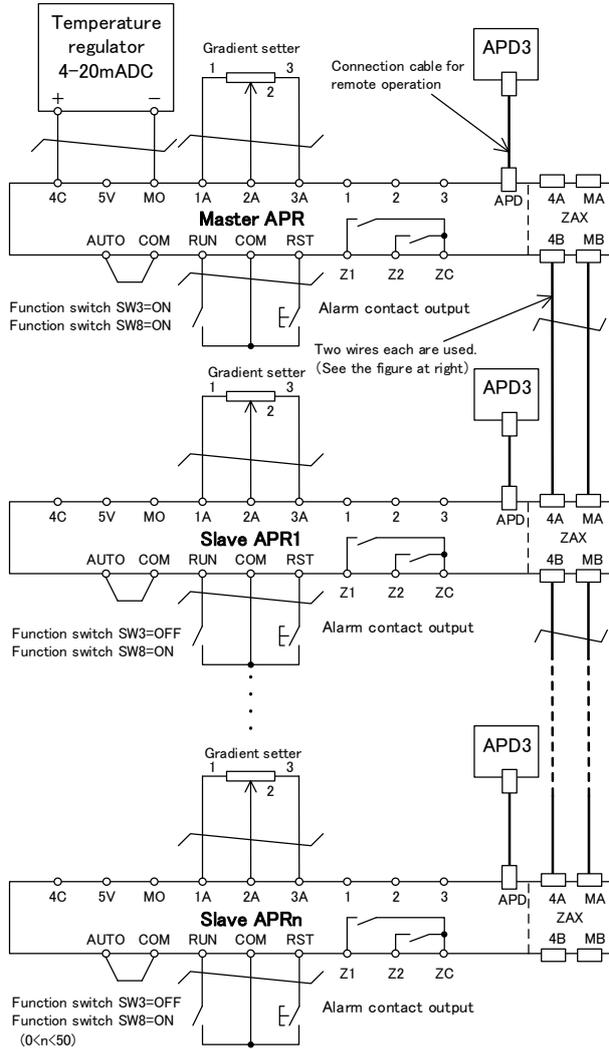
Note 5: If manual setting is selected for a slave APR (by opening AUTO-COM), isolated manual operation of that unit can be made. The subsequent APRs are operated in parallel by the Master APR.

Note 6: The turning on procedure of the power supply: the first slave machine and second machine from the mastering machine ... Or, turn on all machines simultaneously.

Note 7: It is not possible to control by making single phase APR and three-phase APR exist together at the cycle control. The phase control is possible.

Note 8: The slave machine of the APD3 cannot use the heater disconnection detection function.

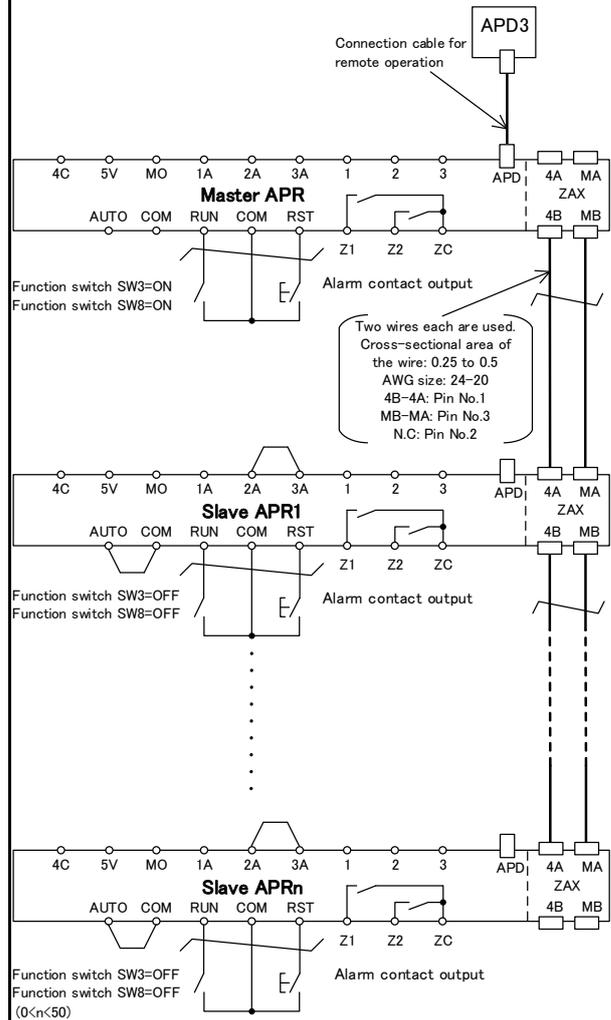
Parallel operation of 2 or more units by current signals
(4 to 20 mA DC) with Gradient setter for each.
(Option code: ZAX)



●Function code setting.

- 2.b02(Selection of output setting 2): Grd (Gradient setting)
- 4.n01(Selection of communication system): PAR(A(ZAX))
- 4.n11(Selection of parallel operation Master / Slave): no.2-(Slave) (Slave APR only)

Parallel operation of 2 or more units by APD3
(Option code: ZAX)



Notice:

If manual setting is selected for a slave APR (by opening AUTO-COM), isolated manual operation of that unit can be made. The subsequent APRs are operated in parallel by the Master APR.

Note 1: It becomes goods equipped with "For communication board parallel operation"

(Main body option goods. Option No. ZAX) (Refer to P3-1.)

Note 2: This connection method is compatible with MX series and MX2 series.

Note 3: APD3 = setting indicator (another goods for sale)

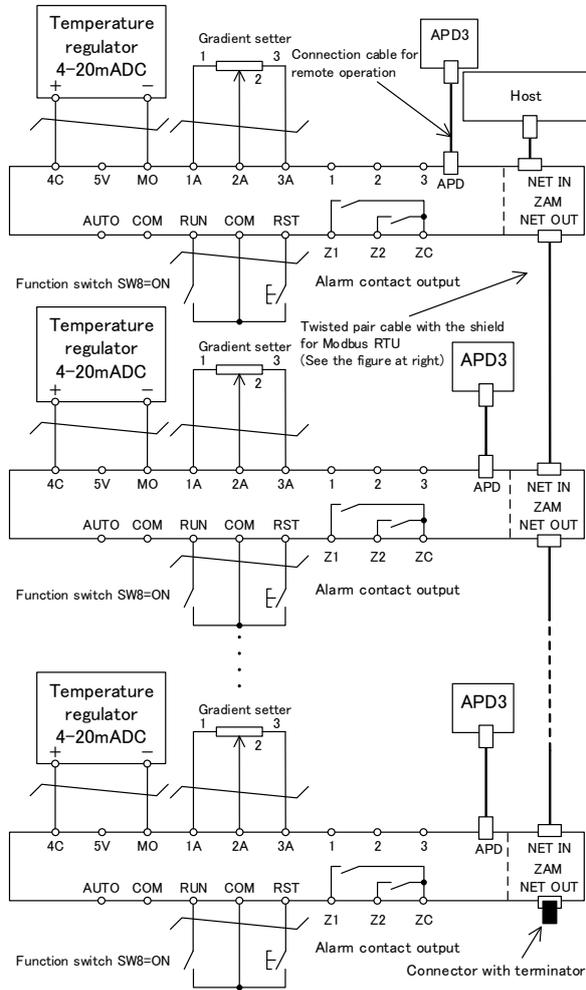
Note 4: In the case of the phase control, gradient setting, base load setting, and power supply voltage compensation function of each slave APR are valid. They are invalid in case of cycle control. (The flicker prevention function works in cycle control.)

Note 5: The turning on procedure of the power supply: the first slave machine and second machine from the mastering machine ... Or, turn on all machines (MAX.50) simultaneously.

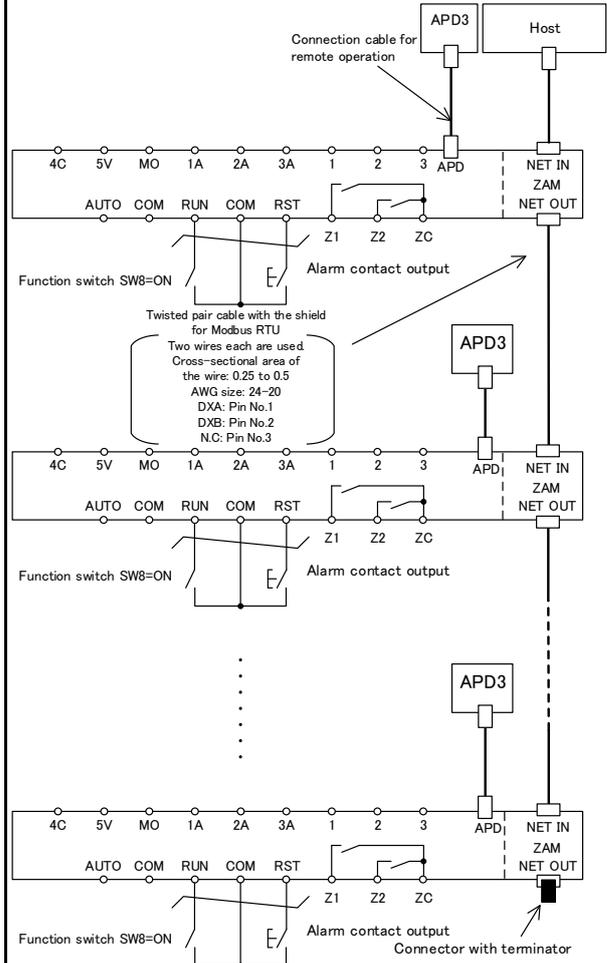
Note 6: It is not possible to control by making single phase APR and three-phase APR exist together at the cycle control. The phase control is possible.

Note 7: The slave machine of the APD3 can use the heater disconnection detection function.

Network communication (Modbus RTU)
with current signals (4 to 20 mA DC) and Gradient setter



Network communication (Modbus RTU)



- Function code setting.
- 2.b02(Selection of output setting 2): Grd (Gradient setting)
- 4.n01(Selection of communication system): PArA(ZAX)
- 4.n02(Selection of network mode): on.n
- 4.n03-4.n13: Customer network communication settings

- Function code setting.
- 4.n01(Selection of communication system): PArA(ZAX)
- 4.n02(Selection of network mode): on.n
- 4.n03-4.n13: Customer network communication settings

Note 1: It becomes goods equipped with "For communication board Modbus RTU operation"

(Main body option goods. Option No. ZAM) (Refer to P3-1.)

Note 2: Driving continues though warning is generated if APD3 is detached (Yellow LED and Red LED blink).

When you want to stop warning LED indication, make function cord 6.013 [APD3: Selection of communication open circuit detection valid / invalid] "oFF"(invalid).

Note 3: Make function select switch SW8 of all APR on (factory setting).

Note 4: Insert a connector with the terminal resistance that is attached to a terminal [NET OUT] of end APR.

Note 5: APD3 = setting indicator (another goods for sale)

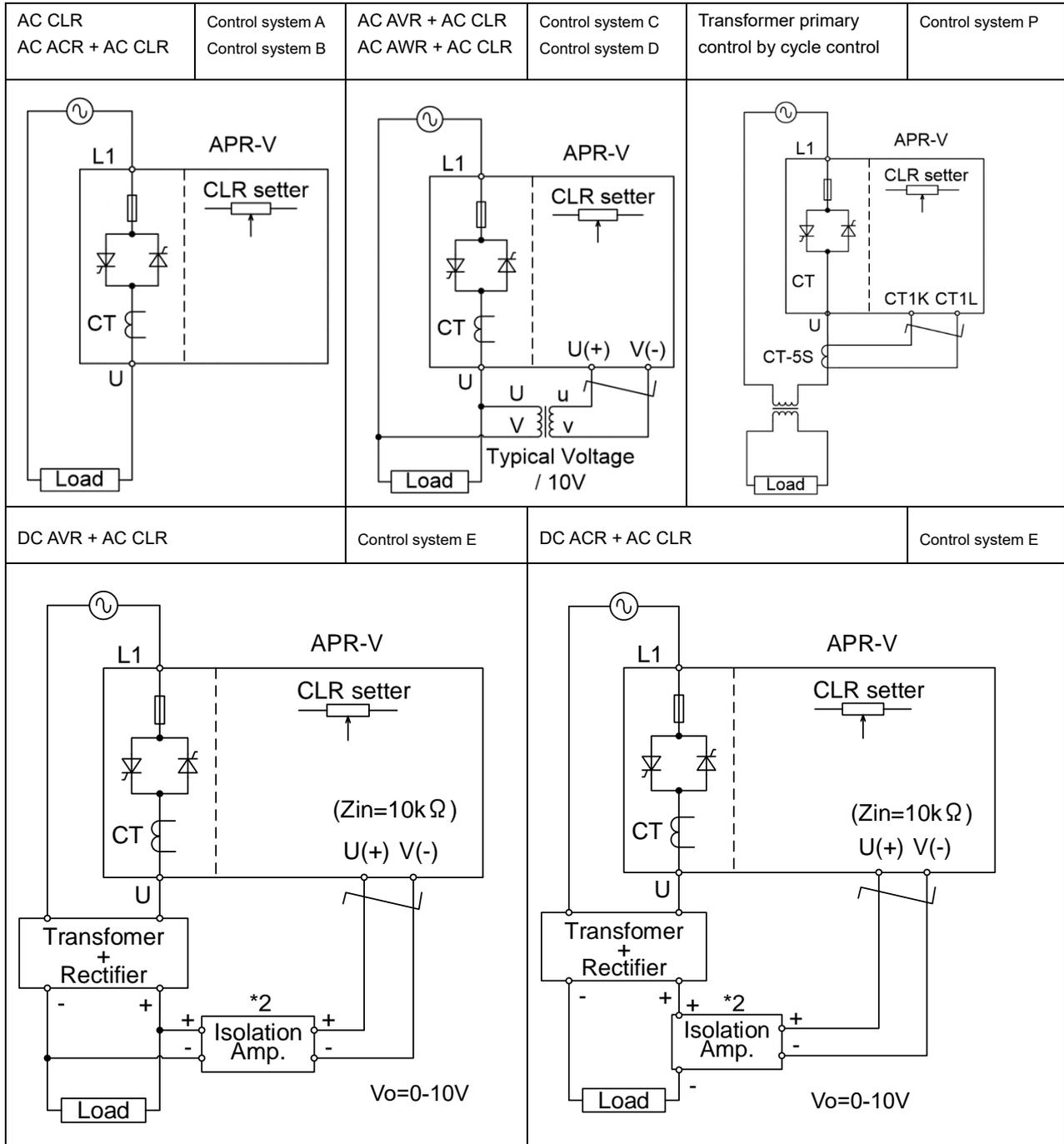
Network communication (CC-Link) with current signals (4 to 20 mA DC) and Gradient setter	Network communication (CC-Link)
<p>●Function code setting.</p> <ul style="list-style-type: none"> 2.b02(Selection of output setting 2): Grd (Gradient setting) 4.n01(Selection of communication system): cc_L(CC-Link) 4.n02(Selection of network mode): on.n 4.n03-4.n10: Customer network communication settings 	<p>●Function code setting.</p> <ul style="list-style-type: none"> 4.n01(Selection of communication system): cc_L(CC-Link) 4.n02(Selection of network mode): on.n 4.n03-4.n10: Customer network communication settings
<p>Note 1: It becomes goods equipped with "For communication board CC-Link operation" (Main body option goods. Option No. ZAC) (Refer to P3-1.)</p> <p>Note 2: Driving continues through warning is generated if APD3 is detached (Yellow LED and Red LED blink). When you want to stop warning LED indication, make function cord 6.013 [APD3: Selection of communication open circuit detection valid / invalid] "oFF"(invalid).</p> <p>Note 3: Make function select switch SW8 of all APR on (factory setting).</p> <p>Note 4: For details on wiring methods, refer to the "Installation Manual" issued by the CC-Link Partner Association.</p> <p>Note 5: APD3 = setting indicator (another goods for sale)</p>	

(5) Example of connection by feedback control system

Note 1: The following are examples of connection for feedback control. The terminal connection related to AWR setting input is not displayed. Refer to “Example of connection by setting method.” The CLR setting is built-in. (External CLR setting is optionally available.)

Note 2: Feedback control is not performed if cycle control is selected. Note, however, that rush current auto suppression is valid in this case.

Example of connection by feedback control system



1: (1) Resistance load (power factor: 0.8 to 1) can be used for the secondary side of the single-phase transformer. [Refer to Section 8 (1) (i) Notes on control system P.]

(2) Place the external CT adjacent to the APR main unit.

*2: Use a fast-response insulating converter (Our supply outside).

8. OPERATION

Observe the following during operation.

WARNING

- Check the installation and wiring carefully for incorrect wiring and disconnection.
- Do not operate switches with wet hand. Do not splash liquid such as water over the instrument.
- Before selecting functions or making adjustment, turn off the power, wait for 5 minutes or longer, check that the "DRIVE MONITOR" and "Alarm" lamps have gone off, and then check using a tester that there is no electric potential between the main circuit terminals L1 and U, and power supply terminals L and N.
- If an alarm is issued, or any abnormality such as emission of abnormal odor is found, turn off the input power, and then perform inspection. If the alarm or abnormal state recurs and the cause cannot be found, be sure to contact your dealer and never leave the problem unsolved.
- Be sure to mount the cover of the terminal block first, and then set the power to ON (close). Do not remove the cover in energized state.
- Even if each input is set to 0%, or the "Run/Stop" signal is set to OFF (open), electric shock may result if you touch an output terminal. Do not touch the terminals.
..... **Electric shock or fire may result.**

CAUTION

- Do not touch the cooling fan because it becomes hot.
- Do not touch the rotating cooling fan.
..... **Injury may result.**

(1) Note

After installation and wiring are completed, perform the following to prepare for operation.

- (a) Check the installation and wiring carefully for improper wiring and poor connections.
(Otherwise malfunction or failure may result. Pay special attentions to the phase sequence of the control power supply and input sensing terminal (400V only). Operation run/stop control and auto/manual changeover circuit.)
- (b) The function select switch or setter for adjustment need not be operated in normal cases.
If they are to be operated, refer to Fig. 8-1.
- (c) Check carefully that the input voltage and load are appropriate for the rating of the APR.
If the load is less than 1/4 of the rated current of the APR, refer to (g) and (h).
- (d) Do not remove any parts of the main unit, or operate internal control knobs and setting switches to avoid failure or malfunction.
- (e) If a transformer is connected to the load of the APR, set the transformer so that the magnetic flux density has enough capacity (80 to 90% of maximum), to prevent rush current because of saturation.
If the transformer should be kept in a state with no load, connect in parallel a resistance that ensures 0.5A or larger on the primary side.
- (f) The APR is equipped with a power supply voltage compensation function. This function reduces the fluctuation of output voltage if the power supply voltage fluctuates. However, if induction load and the fluctuation of control voltage waveform (around the peak in particular) are too large, this function may not produce sufficient effect. Check the power supply voltage and waveforms carefully.
- (g) **The APR cannot be operated normally unless a load is connected. Output voltage is generated through the CR for thyristor protection when the load is opened, which can be measured with a meter.**
- (h) Set the minimum value for setter for adjustment "HT" to invalidate the detection of heater disconnection.
- (i) **Cautions on control system P**
 - [1] Applicable single-phase transformer is as follows:
 - Applicable single-phase transformer: Insulating transformer (two-winding transformer)
 - Not applicable single-phase transformer: Auto transformer (such as slide transformer)Note that the secondary side of the applicable single-phase transformer should be resistance load (power factor: 0.8 to 1.0).
The load whose resistance value on the secondary side fluctuates by 20% or more is not applicable.
 - [2] Make sure that load current of sine waves that are symmetrical on positive and negative sides are fed on the primary and the secondary sides of the single-phase transformer. Specifically, the primary control by a transformer is not applicable.

- [3] Select a single-phase transformer whose load capacity (the current fed to the APR during one voltage cycle) is 30% or higher of the rated capacity of the single-phase transformer. If the operation is carried out at less than 30% of the rated capacity of the APR, an alarm "control system P load error" is issued.
- [4] Turn off the power before changing the tap of the single-phase transformer. **If the power supply voltage is 220 V, for example, select 220 V or higher for the tap voltage on the primary side. If the tap voltage is lower than the power supply voltage, magnetic deviation may occur.**
- [5] Do not connect other devices between the APR and the single-phase transformer.
- [6] The control system P carries out integrated control at the time of soft start and when eliminating magnetic deviation of the single-phase transformer during operation.
- [7] The control system P may output current waveforms that are asymmetrical on the positive and negative sides to minimize magnetic deviation.
- [8] Alarm display "CLR detection" (Red/Green LED blinking) may be issued, which means that the load current is the same as the CLR setting. At this time, decrease the output voltage to prevent it from exceeding the CLR setting.
- [9] The control system P is switched to control system A if the function select switch SW2 is set to "phase control." In this case, the heater disconnection detection function is disabled.
- (j) The load current detection is necessary for control system B type (ACR), control system D type (AWR), and control system E type (DC Feedback) goods. If APR doesn't connect a real load, correct operation cannot be done. Turn off and examine the function select switch SW6 when you do performance test by a temporary load with these APR. Return the function select switch SW6 to former state after it examines it.
- (k) If the APR is operated and stopped in short cycles (operated for 30 minutes and then suspended for 30 minutes, for example) repeatedly, large temperature difference arises within the interior of the thyristor element, and consequently the life of the thyristor element is shortened significantly due to thermal fatigue. If the APR is used in such cycles, the temperature fluctuation range should be minimized. **Specifically, reduce the duty cycle of the rated current to less than 80%. Or select an APR whose rated current is one stage higher to keep the duty ratio to less than 80% of the rated current.**
- (ℓ) Lengthen the smallest off space time (ON⇒OFF⇒ON) for driving signal (RUN - COM) than power supply 1 cycle.

(2) Selection of functions and adjustment

⚠ WARNING

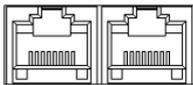
About function select switch switches, turn off the power, wait for 5 minutes or longer, check that the "DRIVE MONITOR" and "Alarm" lamps have gone off, and then check using a tester that there is no electric potential between the main circuit terminals L1, U, L0 and N0 (400V only) and power supply terminals L and N.

..... **Electric shock may result.**

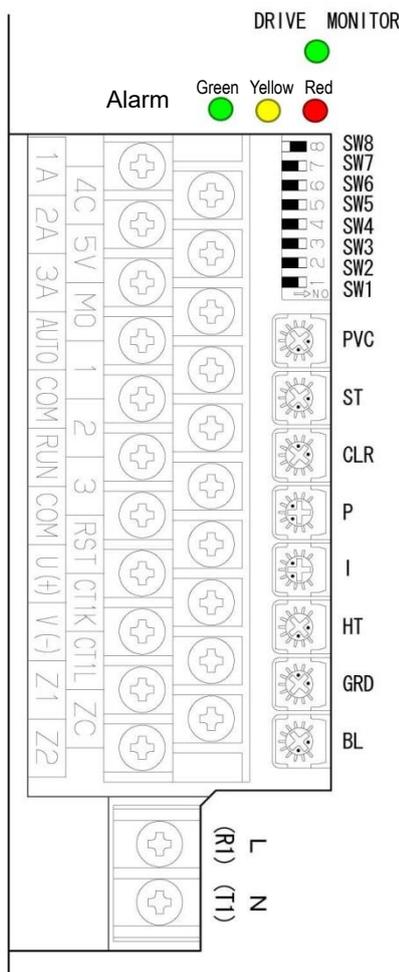
Remove the terminal block cover on the front panel, and various functions can be selected and various built-in setters can be adjusted.

The "DRIVE MONITOR" and "Alarm" displays can be checked without removing the terminal block cover.

*9
Communication board (Option)



Display	Function
DRIVE MONITOR	Thyristor firing pulse monitor display (Green LED)
Alarm	Red LED alarm display
	Yellow LED alarm display
	Green LED alarm display



Function select switch (FUNCTION SELECT)		Left (OFF)	Right (ON)	Factory setting
SW8	APD3 selection *1	No	Yes	Left (Off)
SW7	Soft up/down time selection *2	Fixed to 0.5 sec.	Soft start time	Right (On)
SW6	Control systems B, C, D, E: Valid/invalid *3	Invalid	Valid	
	Cycle control rush current auto suppression *4	Valid	Invalid	
SW5	Gradient setting selection *5	Voltage signal selection	External volume setting	
SW4	Voltage signal setting	0 to 5V	1 to 5V	
SW3	Parallel operation master/slave selection *6	Slave APR	Master APR	
SW2	Waveform control system changeover	Cycle control	Phase control	
SW1	Soft start time range selection	5 to 100 sec.	0.5 to 10 sec.	

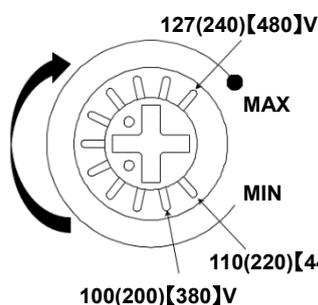
Setter for adjustment (ADJUST)		Function	Factory setting
PVC	Power supply voltage compensation setting (Types T, A, and P only) *7	Sets the output voltage at 100% setting signal within the 220 to 240V range.	Minimum value (Turn fully counter-clockwise.)
ST	Soft start time setting	Sets the soft start time from 0.5 to 10 or 5 to 100 sec. range.	
CLR	CLR setting (Excluding type T)	Sets the current limit value in the range from 0 to 100% of the rated current.	Maximum value (Turn fully clockwise.)
P	P adjustment (Excluding type T)	P adjustment with CLR, ACR, AVR, and AWR	Intermediate value
I	I adjustment (Excluding type T)	I adjustment with CLR, ACR, AVR, and AWR	
HT	Heater disconnection judgment setting (Excluding type T and P) *8	Sets the heater disconnection level in the range from 3 to 100% of the rated current.	Minimum value (Turn fully counter-clockwise.)
GRD	Built-in gradient setting (Option: Z43)	Sets in the range from 0 to 100% of the output. External setter is not required.	Maximum value (Turn fully clockwise.)
BL	Base load setting (Option: Z07)	Sets the base load in the 0 to 100% range.	Minimum value (Turn fully counter-clockwise.)

Fig. 8-1 Setter for adjustment and Function select switch layout

Note: Set the main power supply and control power supply to OFF before operating the function select switch.

- *1: Set the SW8 to ON when optional APD3 is to be connected. Various settings, operations, and displays can be made on the APD3. (Refer to the instruction manual of the APD3.) Please note that the output may change rapidly depending on the setting state by switching SW8.
- *2: Soft up/down time after soft start time can be selected between the same as the soft start time and 0.5 sec by switching SW7.
- *3: Output can be made by control system A with feedback control suspended for test run and other cases.

- *4: The cycle control rush current auto suppression function (SW2 and SW6 set to OFF) maintains the load current to 90% or lower of the rated current (at 100% CLR setting) by PI control to cope with the temperature characteristics of pure metal series resistance load (10 times the rated current may be fed). Control system T is not equipped with this function. Remove the VT for output detection to prevent occurrence of magnetic deviation.
- *5: The voltage of 1 to 5V DC can be allocated to gradient setting of 0 to 100% by using the control circuit terminal "5V-M0." At this time, voltage setting in the auto setting input cannot be used. Use current setting "4C-M0," manual setting input "1-2-3," or APD3. Even if 0 to 5V (SW4 set to OFF) is selected for "voltage signal selection," the gradient for 0 to 1V range is kept at 0%.
When the voltage signal keeps maintaining 0 to 1V DC for ten seconds, APR is an alarm (Green LED blinking).
- *6: Master APR in parallel operation: The APR that is operated by inputting settings
Slave APRs in parallel operation: The second and subsequent APRs that are operated by parallel operation signals from the APR of the previous stage.
Special specification No. (ZAP or ZAX) is displayed in the code symbols of the main unit (Refer to Section 3 Code symbols).
Parallel operation possibility number: To up to 50 (Refer to Section 7-11, 7-12).
- *7: 200V products: 100V The maximum output voltage can be set to 100V-127V according to the setting.
200V The maximum output voltage can be set to 200V-240V according to the setting.
400V products: The maximum output voltage can be set to 380V-480V according to the setting.
However, it cannot output a voltage higher than the power supply voltage.



Adjustment setting volume「PVC」

Ex.: Input 50%

200V products: 100V PVC 110V

200V PVC 220V

100V and 200V system is automatic detection

400V products: 400V PVC 430V

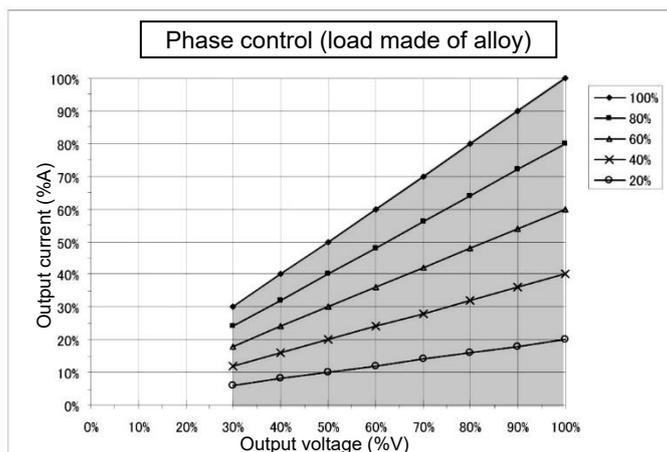
():200V products, []:400V products

- *8: Select the minimum value to invalidate the heater disconnection detection function. The control system P is equipped with a setter for adjusting phase angle to prevent magnetic deviation. It is not necessary to set it because it had set it when it shipped it.
- *9: The main unit of the standard items is equipped with a closing cover, and a communication board is not built-in.

9. HEATER DISCONNECTION

- (1) Heater disconnection alarm
 - (a) Applicable control system: Types A, B, C, D, and E
 - (b) Applicable load: Heaters made of alloy (Load that feeds 40 to 100% of the rated current at 100% output voltage)
 - (c) Number of units connected in parallel: 1 to 3 (Materials and capacity must be the same.)
 - (d) Judgment conditions: Detected when the output current value falls under the judgment setting.
 - (e) Judgment setting value range
 - Phase control: Approximately 3 to 100% of the rated current (Set with the setter for adjustment "HT.")
Less than 3% of "HT": disconnection judgment invalid
3% of "HT" or higher: Heater disconnection is detected when the output current falls within 3 to 100% range of the rated current.
 - Cycle control: Approximately 10% of the rated current
0% of "HT": disconnection judgment invalid
100% of "HT" : Load release detection when the output current is less than about 10% of the rated current.
 - (f) Judgment range: 30 to 100% of the output setting range (including the gradient setting).
30 to 100% of the rated voltage.
 - (g) Judgment accuracy: $\pm 5\%$ FS or lower
 - (h) Judgment time
 - Phase control: When disconnection is detected continuously for 1 sec.
 - Cycle control: When disconnection is detected for 4 energization cycles or longer
 - (i) Alarm output: Green LED for alarm is lit. Alarm contact (minor breakdown) comes on.
 - (j) Operation after detection: Operation is continued.

- (k) Alarm reset: Short circuit the alarm reset terminal or turn off the control power supply.
- (l) Heater disconnection detection characteristics



Standard specifications: Heater disconnection detection characteristics by output

(2) Judgment setting method (phase control)

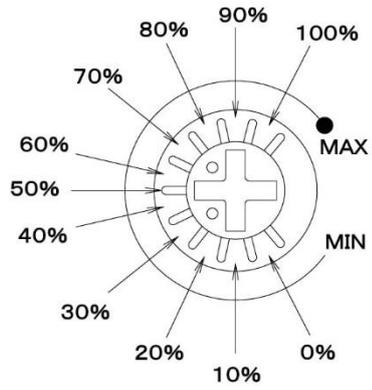
$$\text{Setting (\%)} = \frac{\text{Actual measurement of power supply voltage(V)}}{\text{Rated current of APR (A)}} \times \text{Heater disconnection coefficient}$$

* The heater disconnection coefficient is the basic level for detecting a disconnection in one heater against the number of heaters connected in parallel.

Number of heaters connected in parallel	Heater disconnection coefficient
1	50.00
2	75.00
3	83.33

(3) When setting is made using an actual unit

- [1] Setting can be made on condition that the output current in normal time is 60 to 100% of the rating and that the fluctuation of current at the time of disconnection is 30% or higher of the rating.
- [2] Operate the instrument at the output voltage of 50% or higher in a state in which all the heaters are connected in parallel. Turn the HT clockwise from the 0% position to locate the range where heater disconnection alarm is output (Example: 80%).
- [3] Operate the instrument at the output voltage of 50% or higher in a state where one of the heaters connected in parallel is disconnected. Turn the HT clockwise from the 0% position to locate the range where heater disconnection alarm is issued (Example: 40%).
- [4] Note that a heater disconnection alarm is not output unless state of heater disconnection continues for 1 second or longer.
Turn the HT and wait for 1 second or longer to check whether a heater disconnection alarm is output.
- [5] Set the HT to the center of the HT range found in sections [2] and [3] above (Example: set to 60%, which is the center of 40 and 80%).
- [6] Change the output voltage in the range from 0 to 100% in a state in which all the heaters are connected in parallel to make sure that no improper detection is made.
- [7] Operate the instrument at the output voltage of 50% in a state in which one of the heaters connected in parallel is disconnected to make sure that a heater disconnection alarm is output.
Reference: Refer to the following figure as the guideline of percentage of "HT" setting.



Setter for adjustment "HT"
(Example: 50%)

(4) Notes

- Heater disconnection judgment is valid during soft start time, soft ups and soft downs time.
- The setter for adjustment "HT" is factory-set at 0%. (Heater disconnection judgment is invalid.)
- If the distortion of power supply waveforms is large, the heater disconnection judgment setting calculation formulae may not be applicable. In such cases, use APD3 and external CT-5S in combination, or "heater disconnection alarm LA-3AR," which is optionally available.

10. MAINTENANCE AND INSPECTION

Pay attention to the following when performing maintenance/inspection and replacing parts.

WARNING

- Before performing inspections, turn off the power and wait for 5 minutes or longer. Check also that the “DRIVE MONITOR” and “Alarm” lamps have gone off, and then check using a tester that there is no electric potential between the main circuit terminals L1 and U, L0 and N0 (400V only), and power supply terminals L and N. (Before performing inspections, check the voltage between terminals as well as a terminal and the earthing with a tester, taking the entry of voltage from the output side into consideration.)
- Do not perform maintenance and inspection or replace parts unless you are authorized to do so.
- Be sure to replace parts with specified ones. (Use insulated tools and remove metallic objects such as watch and bracelet) when performing replacement work.
..... **Electric shock or injury may result.**
- Clean the cooler fan and the cooling fin after it checks.

(1) Notes

- Check with the LED of the DRIVE MONITOR whether the control circuit of the APR is operating normally. It lights when thyristor drive pulses occur.**
- Avoid humidity, overheating, and vibration to prevent performance degradation or failure.
- Check each terminal periodically for contact failure.
- Check the insulation resistance of the APR and the loads periodically.
- Blow the cooling fin and cooling fan with compressed air periodically to avoid accumulation of dust. Otherwise cooling effect deteriorates, thus causing a failure.

(2) Alarm display and remedy

If any abnormality is detected, the LED for alarm display on the front panel is lit or starts blinking, and the alarm contact is set to ON (closed).

LED: display ●: lights ★: blinks □: Flashing alternately

Alarm	Description	LED display	Alarm contact	Operation after detection	Alarm resetting method	
Thyristor error (2)	Short circuit of thyristor element is detected by internal CT.	– – Red ★	Serious breakdown contact (Z1) ON (Closed)	Drive pulse stop	[1]	
Overcurrent (1)	Detected by internal CT when the output current exceeds the rating for several cycles.	– – Red ●		Output stop		[1] or [2]
Overheating (4)	Detection by temperature sensor	– Yellow – ★				
CPU error (5)	CPU memory error	– Yellow Red ●				
Main fuse blown (3)	In case abnormal current such as insufficient insulation and short circuit should occur, the current is interrupted within half cycle to protect the main element.	– Yellow – ●				
Communication error (Option) (6)	[1] Communication error and/or transmission error of the master APR in master/slave system	– Yellow Red ★	Minor breakdown contact (Z2) ON (Closed)	Output continued	[1] or [2] or When changed to manual setting, reset command is received, and normal communication is restored.	
	[2] Communication error with the setter / network or transmission error with the host (setter)					
Heater disconnection (7)	Heater disconnection				[1] or [2]	
Control system P load error (8)	With control system P, • External CT is removed. • External CT is connected with reverse polarity. • Load current is delayed by 30° or more. • Detected when load is open.	Green ● – –			[1]	
Setting input disconnected (9)	[1] Detects disconnection of current/voltage setting signals [2] Detects disconnection of manual / gradient setter	Green ★ – –	None	Output stop	[1] or return automatic after normal return.	
Power supply abnormal (10)	When power supply frequency falls within the 45 to 65 Hz range	Green ● – Red ●			[1] or frequency returns back to the 45 to 65 Hz range.	
Power supply abnormal (12)	Undervoltage (detects decrease of control power supply voltage)	Green ● Yellow ● –			Output continued	
	Overtoltage (detects increase of control power supply voltage)	Green ● Yellow ● –				
CLR detection (11)	Detects load current that exceeds the CLR setting.	Green ★ – Red ★			Set the load current within the CLR setting range.	

Alarm	Description	LED display	Alarm contact	Operation after detection	Alarm resetting method
End of life of cooling fan (13)	Detects the end of life of cooling fan (decrease of speed) (Air-cooled type only)	Green ★ Yellow ★ –	None	Output continued	[1] (Replace cooling fan)
Analog output current error (option) (14)	Detects when the allowable load resistance is exceeded when using the current signal on the AO board.	Green ■ – Red ■			[1] Reduce load resistance to 400Ω or less

Note: How to reset alarms:

[1] Turn off the control power supply, **eliminate the cause**, and then turn on the power again.

[2] Short-circuits the alarm reset terminal.

If two or more alarms are issued simultaneously, alarm LED of higher priority is displayed.

Parenthesis () in the alarm column shows the priority level.

*1: **All the three LEDs are lit instantly when the power is turned on or off. (This is not a failure.)** If they do not, the internal control circuit of the APR may be faulty. We recommend you to allow us to perform inspection/repair in such cases.

*2: If thyristor error occurs, the thyristor element is short-circuited. Contact us in this case.

*3: If overcurrent should occur, check the loads for any failures. Overcurrent may occur at the time of start (cold start) depending on heater materials. To prevent this from occurring, increase the soft start time or decrease the current limit (CLR) value.

*4: When an abnormal overheating is generated, confirm whether the temperature in the board exceeds 50°C.

*5: If CPU error (memory error) should occur, contact us.

*6: If blowing of main fuse occurs, check the loads for any failures. If the main fuse is found to have blown, check the thyristor element for short circuit using a tester.

*7: If any abnormality is found during parallel operation, check the following.

- Symptom: An alarm is issued although parallel operation is not performed.

Cause: The function select switch SW3 set to "Slave APR (left side)".

Measures: Set it to "Master APR (right side)."

- Check the cable for remote operation for disconnection.

- Check the control power supply of the APR on the previous stage for break.

- When next APR continues transmission data of previous APR for approximately one second and cannot receive it, it becomes the alarm.

*8: **When the following contents continue the condition that "Setting input disconnected" produces for 10 seconds.**

[1] **At the time of auto setting (4 to 20mA DC, 1 to 5V DC, 0 to 5V DC) select, control circuit terminal "AUTO-COM" is an opening state.**

[2] **At the time of 4 to 20mA DC use, it is less than 4mA DC.**

[3] **At the time of 1 to 5V DC use, it is less than 1V DC.**

[4] **At the time of manual setting select, control circuit terminal "AUTO-COM" is a short state.**

[5] **The gradient setter or control circuit terminal "2A - 3A" is in a disconnected state.**

[6] **Function select switch SW5= left (OFF), a control circuit terminal "5V(+)-M0(-)" is less than 1V DC.**

*9: The above table is APR initialized at the factory. However, exclude special specification No. ZC□.

(3) Service parts

(a) Main fuse

The main fuse is required to protect the main element (thyristor) when short circuit occurs to the load.

Be sure to replace it with a specified one. We recommend you to stock some as spare parts.

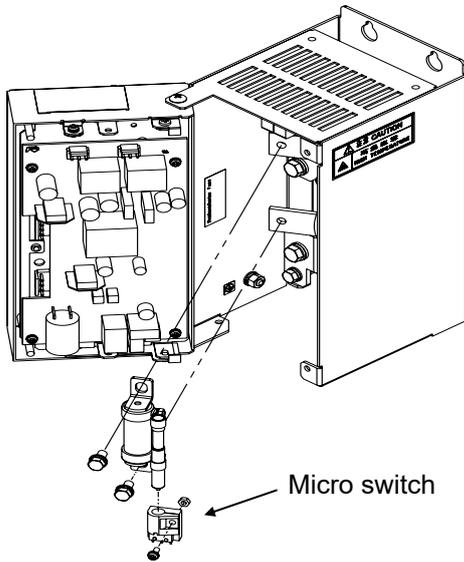
[1] Type of replacement fuse

Rated current of APR	100 to 240 V, 380 to 480 V common	Quantity required
20A	CR6L-30G/UL	1 piece / unit
45A	CR6L-75G/UL	
60A	CR6L-100G/UL	
100A	CR6L-150G/UL	
150A	CR6L-200G/UL	
250A	6,9URD30TTF0350	
350A	6,9URD31TTF0500	
450A	6,9URD31TTF0630	
600A	600A CS5F-800/UL	

Note1: When a CR6L type includes "S" ("not G"), it is with micro-switch (type: CRX-1).

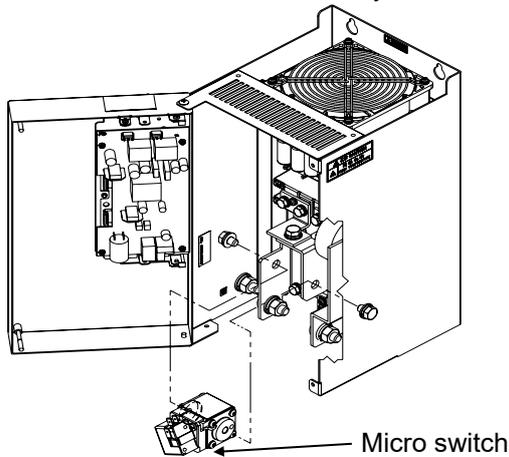
[2] Replacement procedure

- ◆ 20A-150A and 600A type
- (1) Loosen the screws on the front cover (at 2 positions), and open the front cover.
- (2) Remove the micro switch (20 to 150 A type) or contact block (600 A type).
 - * Be careful not to drop the screws and nuts of the micro switch or contact block.
 - * Do not remove the solder or crimp contact of the wire.
- (3) Remove the screw (bolt) that is mounting the main fuse and remove the main fuse.
- (4) Mount the replacement fuse.
- (5) Mount a micro switch or contact block to the specified replacement fuse.
- (6) Close the front cover, and fasten the screws on the front cover (at 2 positions).



Applicable type
 RPVE□020
 RPVE□045
 RPVE□060

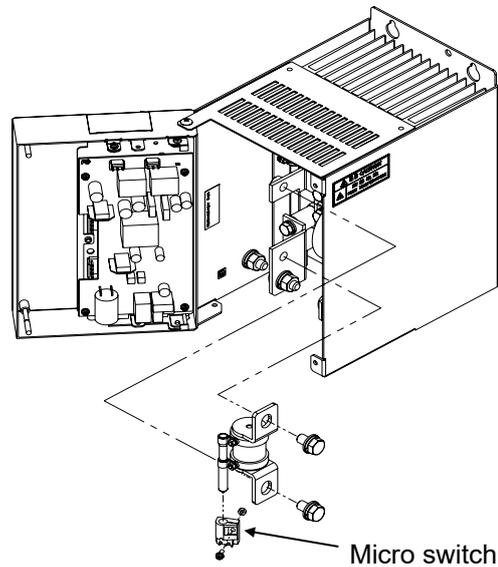
*Common to standard and overseas safety standard items



Applicable type
 RPVE□250
 RPVE□350
 RPVE□450

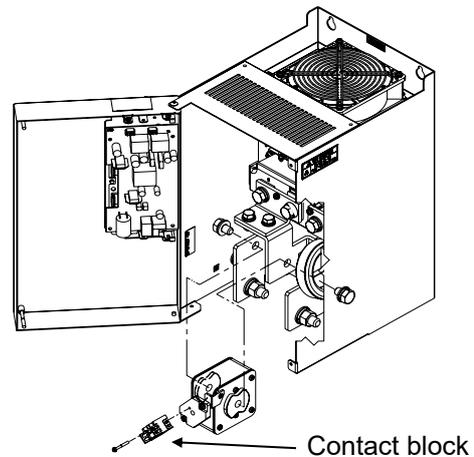
*Common to standard and overseas safety standard items
 This figure is RPVE□250

- ◆ 250A-450A type
- (1) Loosen the screws on the front cover (at 2 positions), and open the front cover.
- (2) Flat crimp terminal 1 and 4 of the micro switch remove the terminal.
- (3) Remove the screws (bolts) for attaching the main fuse, and remove the main fuse. Remove the switch and the micro-switch together.
- (4) Install the replacement fuse with the micro switch installed.
 - * Mount the replacement fuse and micro switch without removing the polyester film (insulating tape) attached to the micro switch.
- (5) Attach the flat crimp terminals to terminals 1 and 4 of the micro switch.
- (6) Close the front cover, and fasten the screws on the front cover (at 2 positions).



Applicable type
 RPVE□100
 RPVE□150

*Common to standard and overseas safety standard items
 This figure is RPVE□100



Applicable type
 RPVE□600

*Common to standard and overseas safety standard items

(b) Cooling fan

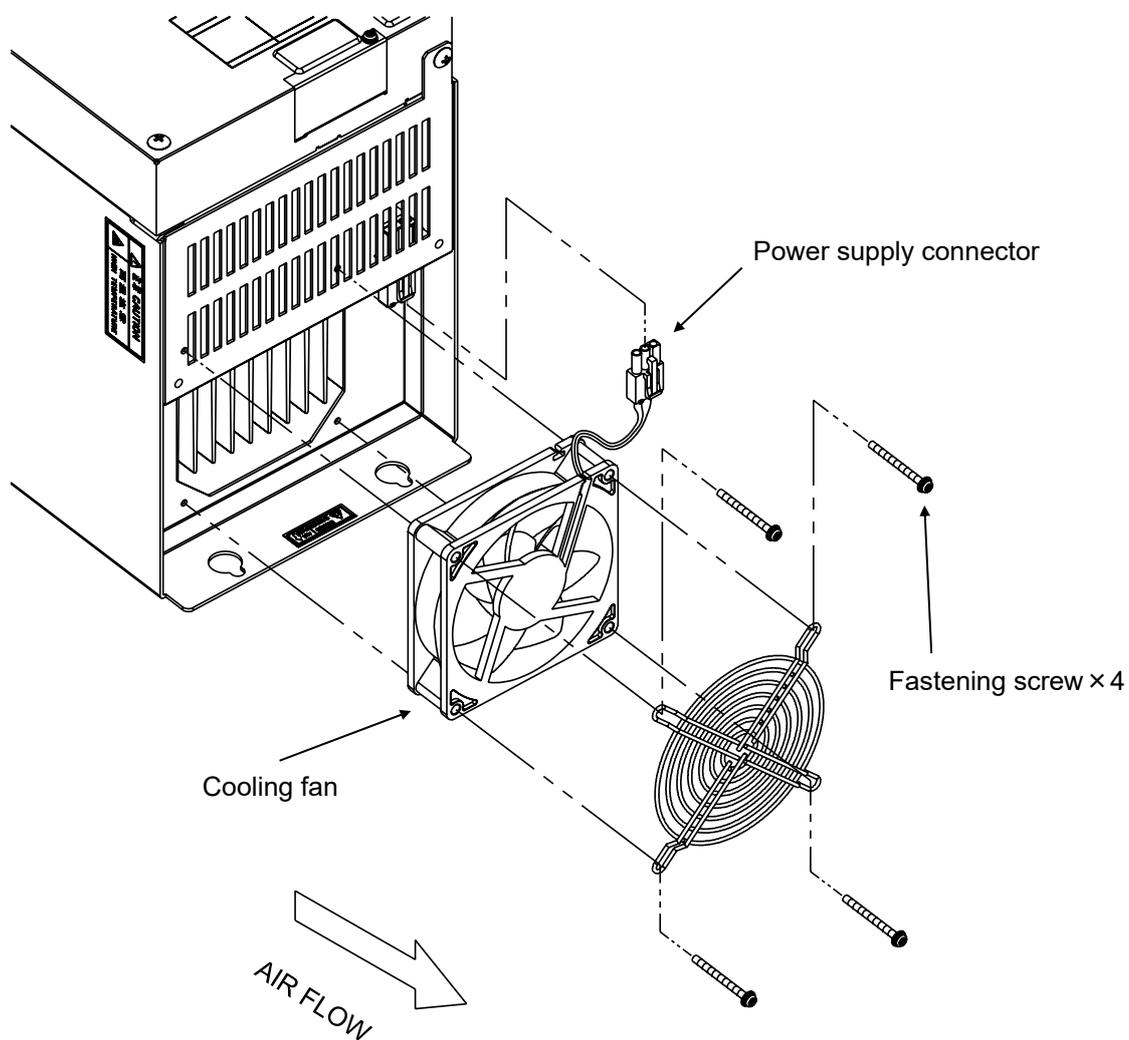
The average life of the cooling fan is approximately 40,000 hours (at the ambient temperature of 50°C. for the output 100%. 600A are about 23,000 hours.). Replace it with a new one in an early stage, taking this lifetime into consideration. If the lifetime comes to the cooling fan, the alarm is generated. (Green and yellow LED blinks. Refer to Section 10 (2).)

[1] Type of cooling fan for ordering

Rated current of APR	Type of cooling fan for ordering	Quantity required
150A	RPVE 150 Fan motor	1 piece / unit
250A	RPVE 250 Fan motor	
350A	RPVE 350 Fan motor	
450A	RPVE 450 Fan motor	
600A	RPVE 600 Fan motor	

[2] Replacement procedure

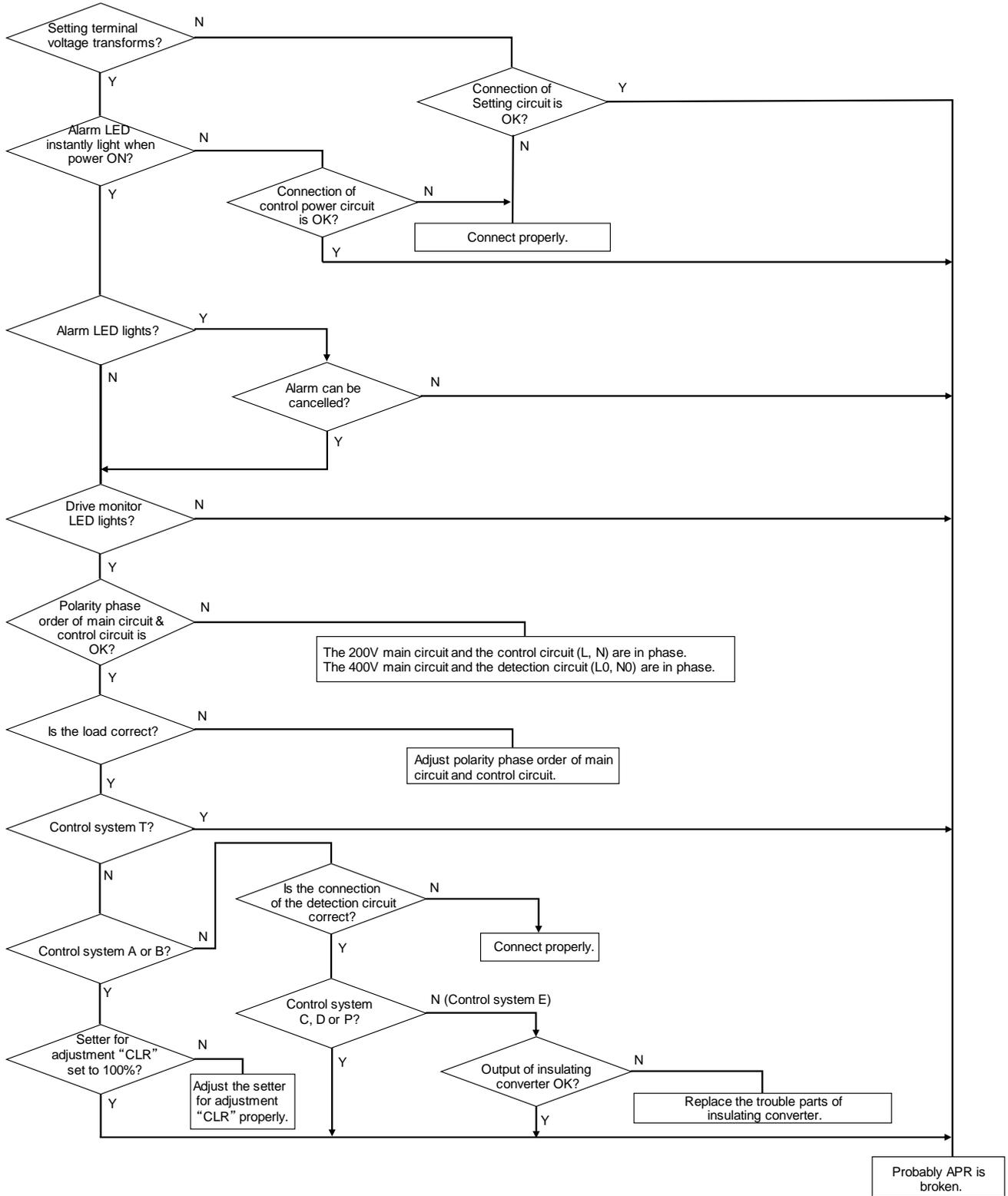
- (1) Remove the power supply connector of the cooling fan.
- (2) Loosen the fastening screws at 4 positions, and remove them from the APR main unit.
- (3) Mount the cooling fan on the side of the APR main unit from which the air from the cooling fan is discharged.



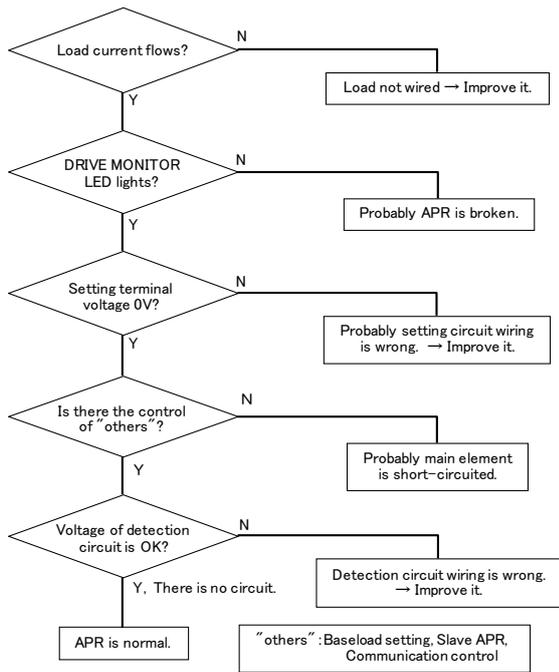
Replacement of fan for 150 to 600 A unit

11. TROUBLESHOOTING

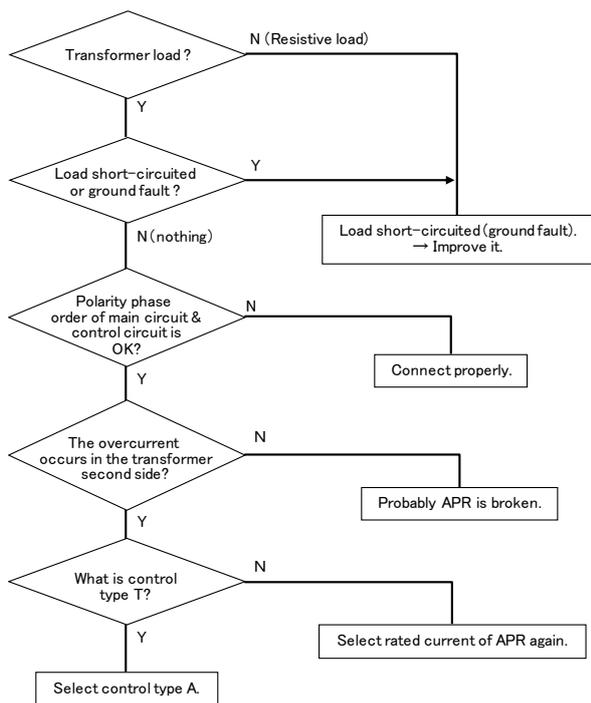
(1) No output



(2) Output does not stop



(3) Main fuse has broken.
(Replace main fuse after detecting the cause of trouble.)



12. GUARANTEE PERIOD

The APR undergoes strict test and inspection processes before delivery, but if any defects should be found, contacts your dealer or our sales representative.

The guaranteed term of the product becomes a period until either of "One year after it purchases it" or "18 months from the manufacturing years described in the plaque" passes early. However, it becomes an investigation for a fee and a repair in the following cases in the guaranteed term it.

- (1) Caused by the mistake in use and an improper repair and remodeling.
- (2) When using it within the range to have exceeded the standard specification value.
- (3) Caused by damage and the damage when it falls and it is transporting after it purchases it.
- (4) Caused by an earthquake, a fire, damage from storm and flood, lightning, an abnormal voltage, other natural disasters, and the second disasters.
- (5) When the customer has the responsibility origin.

13. DISPOSAL

Dispose of the instrument as industrial waste by consigning the disposal to an expert waste disposal service.

14. CONTACT

If failure, damage, and other problems should be found, contact your dealer or our sales representative nearest to you, providing the following information:

- (1) Type of APR (RPVE~)
- (2) Serial No. (Product number)
- (3) State of alarm LED (At and after power ON)
- (4) State of DRIVE MONITOR
- (5) State of the function select switch (SW1 to SW8)
- (6) Change in function code data (When APD3 is connected)
- (7) ROM version (When APD3 is connected)
- (8) Time of purchase
- (9) Details of inquiry (such as position and degree of damage, questionable points, faulty phenomenon, situations, etc.)

Note: Contact your dealer or our sales representative nearest to you if you find any unclear points or have questions.

The contents of this manual are subject to change without prior notice.

We are not responsible for the result of operation of the instrument despite the foregoing descriptions.
