**Autonics**

# Multi-channel Power Controllers



# SPRM Series
## PRODUCT MANUAL

**For your safety, read and follow the considerations written in the instruction manual, other manuals and Autonics website.**
The specifications, dimensions, etc. are subject to change without notice for product improvement. Some models may be discontinued without notice.

## Features

- Single-phase control / three-phase control
- Supports a wide range of rated voltages from 220 to 440 VAC∼
- Various rated current models of 25 / 40 / 55 / 70 / 90 / 110 / 160 A
- Improved visibility with 4-line LCD display
- Monitoring load current / voltage / output / resistance / heatsink temperature / power
- Detachable display module can be installed on a separate panel
- Supports various alarms, heater brake, partial heater brake, fuse break, heatsink over heat, overcurrent, FAN error, etc. and saving alarm history
- Improved fuse replacement convenience with open/close structure
- Supports RS485, EtherCAT communication

CE c(UL)us LISTED KC

## Safety Considerations

- Observe all 'Safety Considerations' for safe and proper operation to avoid hazards.
- ⚠ symbol indicates caution due to special circumstances in which hazards may occur.

⚠ **Warning**  Failure to follow instructions may result in serious injury or death.

01. **Fail-safe device must be installed when using the unit with machinery that may cause serious injury or substantial economic loss.(e.g. nuclear power control, medical equipment, ships, vehicles, railways, aircraft, combustion apparatus, safety equipment, crime / disaster prevention devices, etc.)**
Failure to follow this instruction may result in personal injury, economic loss or fire.
02. **Do not use the unit in the place where flammable / explosive / corrosive gas, high humidity, direct sunlight, radiant heat, vibration, impact or salinity may be present.**
Failure to follow this instruction may result in explosion or fire.
03. **Install on the device panel, and ground to the bolt for grounding separately.**
Failure to follow this instruction may result in fire or electric shock.
04. **Do not connect, repair, or inspect the unit while connected to a power source.**
Failure to follow this instruction may result in fire or electric shock.
05. **Check 'Connections' before wiring.**
Failure to follow this instruction may result in fire.
06. **Do not disassemble or modify the unit.**
Failure to follow this instruction may result in fire or electric shock.

⚠ **Caution**  Failure to follow instructions may result in injury or product damage.

01. **Use the unit within the rated specifications.**
Failure to follow this instruction may result in fire or product damage.
02. **Use a dry cloth to clean the unit, and do not use water or organic solvent.**
Failure to follow this instruction may result in fire or electric shock.
03. **Keep the product away from metal chip, dust, and wire residue which flow into the unit.**
Failure to follow this instruction may result in fire or product damage.
04. **Since leakage current still flows right after turning off the power or in the output OFF status, do not touch the load terminal.**
Failure to follow this instruction may result in electric shock.
05. **Be careful not to injure the edges of the heat sink.**

## Cautions during Use

- Follow instructions in 'Cautions during Use'. Otherwise, it may cause unexpected accidents.
- Power supply should be insulated and limited voltage / current or Class 2, SELV power supply device.
- Use the product, after 3 sec of supplying power.
- Before use, set the mode and function according to the specification. Since changing the mode / parameter during operation may result in malfunction, set the mode and function after disconnecting load output.
- Re-supply the power to the unit after 3 sec of turning off the power. Failure to follow this instruction may result in malfunction.
- To ensure the reliability of the product, install the product on the panel or metal surface vertically to the ground.
- Install the unit in the well ventilated place.
- While supplying power to the load or right after turning off the power of the load, do not touch the body and heat sink. Failure to follow this instruction may result in a burn due to the high temperature.
- Install a power switch or circuit breaker in the easily accessible place for supplying or disconnecting the power.
- Do not wire to terminals which are not used.
- Use twisted pair wire for communication line.
- When connecting the display module and the main body with a LAN cable (direct / cross cable), be careful not to generate excessive tension. Poor contact may cause malfunction of the display.
- Since inter element can be damaged when using with coil load, inductive load, etc., the inrush current must be under the rated load current.
- To prevent product malfunction due to noise, wire power, control input, communication, and load cables separately.
- When installing close to the load line, use a line filter for the power line and use a shield wire.

- For stable operation, use shield wire for control, alarm, and communication wires.
  Use a ferrite core on the shield wire to cope with EMC.
- Do not use near the equipment which generates strong magnetic force or high frequency noise.
- This unit may be used in the following environments.
  - Indoors (in the environment condition rated in 'Specifications')
  - Altitude max. 2,000 m
  - Pollution degree 2
  - Installation category III

## Ordering Information

This is only for reference, the actual product does not support all combinations.
For selecting the specified model, follow the Autonics website.

| SPRM | ❶ | - | ❷ | ❸ | ❹ |

❶ **Control phases**
3: 3-phase

❷ **Rated load voltage**
F: Free voltage

❸ **Rated load current**
Number: Rated load current (unit: A)

❹ **Communication**
R: RS485
EC: EtherCAT

## Product Components

- Product
- Instruction manual
- Display blank panel × 1
- RS485 communication connector × 1
- Control input connector × 1
- Power input / Alarm output connector × 1
- Feedback control connector × 1

## Manual

For proper use of the product, refer to the manuals and be sure to follow the safety considerations in the manuals.
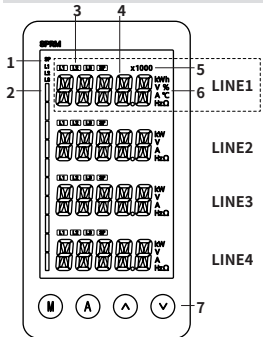Download the manuals from the Autonics website.

## Software

Download the installation file and the manuals from the Autonics website.
### ■ DAQMaster
It is the comprehensive device management program for Autonics' products, providing parameter setting, monitoring and data management.

## Display Module



**1. BAR output phase (orange)**
: Turns ON L1, L2, L3, or 3P phase of output BAR display.
**2. Output BAR (orange)**
: 10 bars for output percentage.
Turns ON from the bottom bar. About 10 % of output displays per one bar.
**3. Control / Monitor phase (green)**
: Turns ON L1, L2, L3, or 3P phase of control or monitor phase.
**4. PV / SV display part (white)**
: 0000.0 to 9999.9 (fixed decimal point)
LINE 1 to 4 are available to set the desired monitoring value for each line at the setting check mode.
**5. × 1000 indicator (green)** (only LINE1)
: Turns ON for over 6 digit accumulated power.
Multiply 1000 times for PV / SV display part value.
E.g.) PV/SV display part is 1, Unit indicator is kWh and ×1000 indicator turns ON, it means 1,000 kWh.
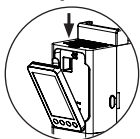
### 6. Unit indicator (green)

| Unit | kWh [01] | kW [02] | V | % [01] | A | °C [01] | Hz | Ω |
|------|----------|---------|---|--------|---|---------|-----|---|
| Load | Accumulated power | Power | Load voltage | Output | Load current | Heatsink temp. | Input power freq. | Load resistance |

01) Only LINE1
02) For LINE2 to 4

**7. Setting keys (M, A, ▲, ▼)**

### ■ Separate display module



- Press the display module removal button on the top of the unit.
- The separated display module is available to install on a remote panel for convenient load monitoring.
- Connect the RJ45 cable between the display module and main body. This cable should be within 5 m length for prevent noise.
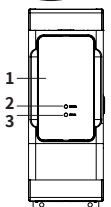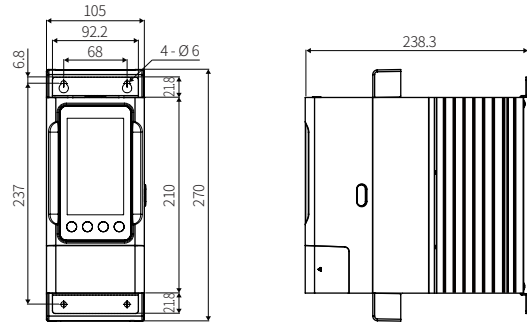
**1. Display blank panel**
: Attach this for prevent dust from entering the product.
**2. Power indicator (POWER, green)**
: Turns ON for stable operation after power input
**3. Alarm indicator (ERROR, red)**
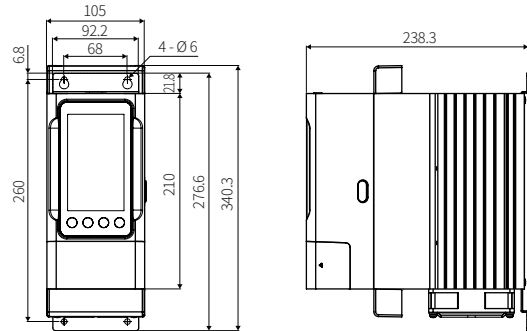: Flashes for alarm occur

**[Main body]**

## Dimensions

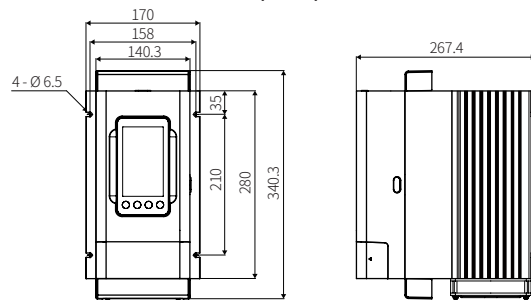- Unit: mm, For the detailed drawings, follow the Autonics website.

### ■ Rated load current 25 / 40 / 55 A



### ■ Rated load current 70 A



### ■ Rated load current 90 / 110 / 160 A



### ■ Display module
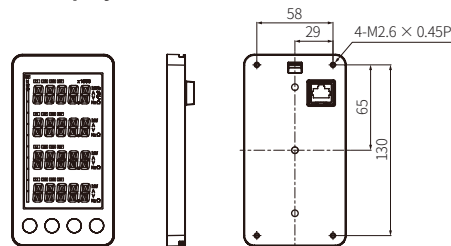


### ■ Panel cut-out of display module

- Panel flushing mounting
- Bolts fastening
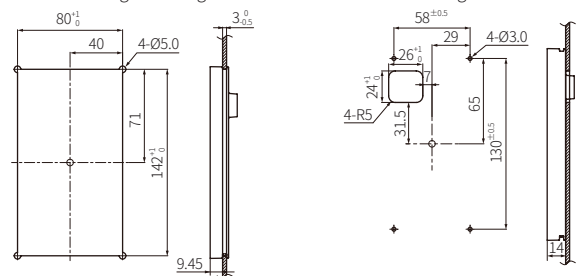


## Cautions during Installation

⚠ **High Temperature Caution**
While supplying power to the load or right after turning off the power of the load, do not touch the body and heatsink.
Failure to follow this instruction may result in a burn due to the high temperature.

### ■ Mount space
- When installing multiple power controllers, keep space between power controllers for heat radiation.
Horizontal: ≥ 80 mm, vertical: ≥ 100 mm

- Unit: mm
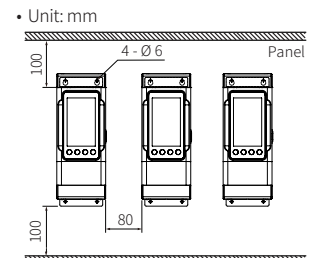
## Specifications

| Model | SPRM3-F□R | SPRM3-F□EC |
|---|---|---|
| Control phases | Single phase 3 Ch or 3-phase | |
| Rated load voltage | Free voltage 220 - 440 VAC∼ 50 / 60 Hz | |
| Rated load current [01] | 25 / 40 / 55 / 70 / 90 / 110 / 160 A | |
| Display method | 5 digit 11 segment LCD (white) × 4, Output BAR | |
| Auto control input | DC 4 - 20 mA × 3 Ch, 0 - 5 / 1 - 5 / 0 - 10 VDC⎓, External adjuster (10 kΩ), RS485, EtherCAT | |
| Manual control input | Parameter setting | |
| Digital input (DI) | RUN / STOP selectable, AUTO / MANU selectable, RESET | |
| Alarm output | 250 VAC∼ 2 A, 30 VDC⎓ 2 A, 1c resistance load | |
| Comm. output | RS485 | RS485, EtherCAT |
| Cooling method | Rated load current 25 / 40 / 55 A: natural cooling<br>Rated load current 70 / 90 / 110 / 160 A: forced air cooling (with cooling fan) | |
| Unit weight (packaged) | Rated load current 25 / 40 / 55 A: ≈ 4.75 kg (≈ 5.75 kg)<br>Rated load current 70 A: ≈ 4.8 kg (≈ 5.8 kg)<br>Rated load current 90 / 110 / 160 A: ≈ 9.42 kg (≈ 10.55 kg) | |
| Approval | CE , cULus LISTED , KC | |

01) It is the rated load current of each channel in single-phase operation.

| Control method | Phase control | Cycle control |
|---|---|---|
| Control mode | Normal /<br>Constant current feedback /<br>Constant voltage feedback /<br>Constant power feedback | Fixed cycle / Variable cycle |
| Applied load | Resistance load, inductive load | Resistance load |
| Output range | Resistance load: 0 to 98 %<br>Inductive load: 5 to 98 % | 0 to 100 % |
| Output accuracy | Varies by control mode | |
| Normal | Within ± 10 % F.S. of rated load voltage | - |
| Constant current / voltage / power feedback | Within ± 3 % F.S. of rated load current / voltage / power | - |

| Power supply | 24 VDC⎓ ± 10 % |
|---|---|
| Min. load current | 1 A |
| Power consumption | ≤ 15 W |
| Insulation resistance | ≥ 200 MΩ (500 VDC⎓ megger) |
| Dielectric strength | Between the charging part and the case: 3,000 VAC∼ 50 / 60 Hz for 1 min |
| Output leakage current | ≤ 10 mArms |
| Noise immunity | ± 500 V square wave noise (pulse width: 1 μs) by the noise simulator |
| Memory retention | ≈ 10 years<br>(when using non-volatile semiconductor memory type) |
| Vibration | 0.5 mm double amplitude at frequency of 5 to 55 Hz in each X, Y, Z direction for 2 hours |
| Vibration (malfunction) | 0.5 mm double amplitude at frequency of 5 to 55 Hz in each X, Y, Z direction for 10 min |
| Ambient temperature | -10 to 40 °C, storage: -20 to 80 °C (no freezing or condensation) |
| Ambient humidity | 35 to 85 %RH, storage: 35 to 85 %RH (no freezing or condensation) |

## Communication Interface

### ■ RS485

| Comm. protocol | Modbus RTU (16 bit CRC), Modbus ASCII |
|---|---|
| Application standard | Compliance with EIA RS485 |
| Max. connection | 31-unit (address: 1 to 99) |
| Comm. synchronous method | Asynchronous |
| Comm. method | 2-wire half duplex |
| Comm. distance | ≤ 800 m |
| Comm. speed | 2,400 / 4,800 / 9,600 (default) / 14,400 / 19,200 / 38,400 / 57,600 / 115,200 bps |
| Comm. response time | 0 to 9999 ms (default: 0 ms) |
| Start bit | - |
| Data bit | 8 bit (fixed) |
| Parity bit | None (default), Even, Odd |
| Stop bit | 1 bit (default), 2 bit |
| EEPROM life cycle | ≈ 50,000 operations (Erase / Write) |

### ■ EtherCAT

| Comm. specifications | EtherCAT |
|---|---|
| Association approval [01] | EtherCAT Conformance tested |
| Connection cable | CAT5e class or over (Shield type: SF/FTP, S/FTP, SF/UTP) |
| Max. comm. distance | Within 100 m distance between nodes |
| Max. baud rate | 10 / 100 Mbps |
| Topology | Star, Line, Tree |

01) EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

## Load Output Formula

| Type | Input | | Formula |
|---|---|---|---|
| Auto control (AUTO) | Current | DC 4 - 20 mA | Load output [%]<br>= (Control input [%] × Output slope [%])<br>+ Offset |
| | Voltage | 1 - 5 VDC⎓ | |
| | | 0 - 5 VDC⎓ | |
| | | 0 - 10 VDC⎓ | |
| | RS485 / EtherCAT | 0 to 100.0 % | |
| | External adjuster | 0 to 10 kΩ | |
| Manual control (MANU) | Parameter | 0 to 100.0 % | Load output [%] = Parameter SV [%] |

## Unit Descriptions

• The configuration of each model may differ depending on the supported specifications.



[Top]  [Bottom]
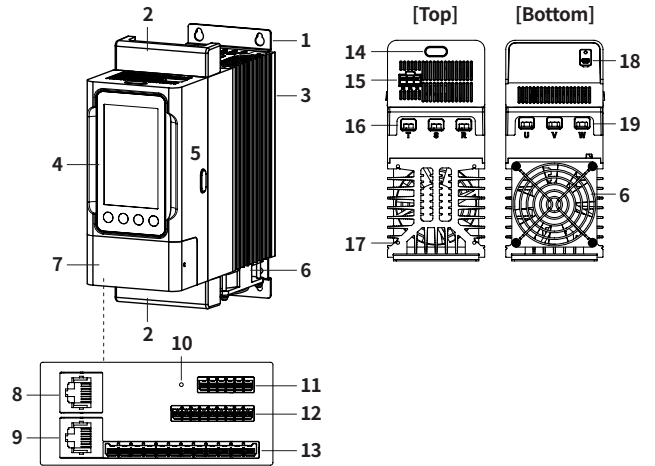
1. **Bracket** [Rated load current: 25 / 40 / 55 / 70 A model]
2. **Load power terminal protection cover**
3. **Heatsink**: Rated load current 90 / 110 / 160 A models have left / right mounting holes.
4. **Display module**: For more information, refer to Display Module.
5. **Case open button**
6. **Cooling fan** [Rated load current: 70 / 90 / 110 / 160 A model]
7. **I / O terminal cover**
8. **EtherCAT communication connector (IN)** [Communication: EtherCAT model]
9. **EtherCAT communication connector (OUT)** [Communication: EtherCAT model]
10. **RESET switch**: Reset for operation / alarm
11. **RS485 communication connector**
12. **Control input connector**
13. **Power input / Alarm output connector**
14. **Display module remove button**
15. **Feedback control connector**
16. **R, S, T load input terminal**
17. **Bolt for grounding (M4)**
18. **USB connector**
   : Do not use this connector. It may cause product failure. This connector is used for firmware upgrade, operation mode change, and A/S.
19. **U, V, W load output terminal**

## Cautions during Wiring

### ■ RS485 communication connector, Control input connector, Power input / Alarm output connector

Unit: mm, Unit: mm, Use ferrule terminal of size specified below.
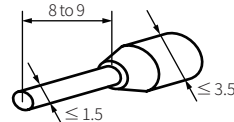


### ■ Load Input / Output Connector

• Unit: mm, Use crimp terminals of size specified below.
  Be sure to use crimp terminals with insulating sleeves (tubes).



| Rated load current | A | B |
|---|---|---|
| 25 / 40 / 55 / 70 A | ≥ 6.0 | ≤ 16.0 |
| 90 / 110 / 160 A | ≥ 8.0 | ≤ 26.0 |

• Cable / screw / tightening torque spec. is different depending on the load current. Be sure to the below before connection.

| Rated load current | Spec. | Power input / Alarm output | Control input / Comm. input | Feedback | Load input / output |
|---|---|---|---|---|---|
| 25 / 40 / 55 / 70 A | Wiring | AWG 24 to 16 | AWG 26 to 16 | AWG 30 to 8 | AWG 10 to 4 |
| | Screw | - | - | - | M6 |
| | Tightening torque | - | - | - | 5.5 to 6.0 N m |
| 90 / 110 / 160 A | Wiring | AWG 24 to 16 | AWG 26 to 16 | AWG 30 to 8 | AWG 3 to 2 / 0 |
| | Screw | - | - | - | M8 |
| | Tightening torque | - | - | - | 6.5 to 7.0 N m |

## Derating Curve
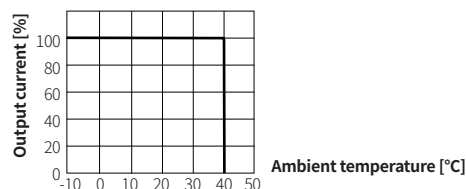
## Connections

- The configuration of each model may differ depending on the supported specifications.

### ■ EtherCAT communication connector

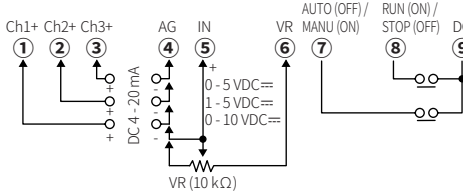| Pin layout | Pin | Function | Pin | Function |
|---|---|---|---|---|
| LED1 LED2 (IN) LED1 LED2 (OUT) | 1 | TD + | 5 | - |
| | 2 | TD - | 6 | RD - |
| | 3 | RD + | 7 | - |
| | 4 | - | 8 | - |

- LED1 (green): Turns ON for data input, LED2 (yellow): Turns ON for data output

### ■ RS485 communication connector

N.C  N.C  N.C  N.C  B (-)  A (+)
① ② ③ ④ ⑤ ⑥
RS485

### ■ Control input Connector

- Select one among 1, 2, or 3 terminal for 3-phase DC 4 - 20 mA input.

Ch1+ Ch2+ Ch3+     AG   IN        VR   AUTO (OFF) / MANU (ON)   RUN (ON) / STOP (OFF)   DG
① ② ③            ④ ⑤        ⑥   ⑦                          ⑧                      ⑨

DC 4 - 20 mA
0 - 5 VDC
1 - 5 VDC
0 - 10 VDC
VR (10 kΩ)

### ■ Power input / Alarm output connector

Alarm output 1 to 6
250 VAC~ 2A 1a, 30 VDC⎓ 3A 1a
Resistive Load

COM1 AL1  AL2 COM2 AL3  AL4 COM3 AL5  AL6
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫
N.O. N.O. N.O. N.O.    24 VDC⎓
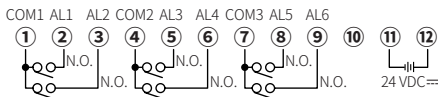
### ■ Feedback control connector

| Pin layout | Pin | Function |
|---|---|---|
| L3 L2 L1 | L1 | R input feedback |
| | L2 | S input feedback |
| | L3 | T input feedback |

This is the connection for measuring the load voltage and controlling (constant voltage / constant power) feedback.
If it is not connected, it is impossible to measure the load voltage, and the feedback control and alarm related to the load voltage may be limited.

### ■ Load input / output, feedback terminal connection

- A, B, C = R, S, T = U, V, W = L1, L2, L3 3-phase line
  N = neutral line
  The voltage is applied by combining the 3-phase line, and the neutral line.
- Single-phase connection: Three-channel operation or each phase input power can be applied with one input power.
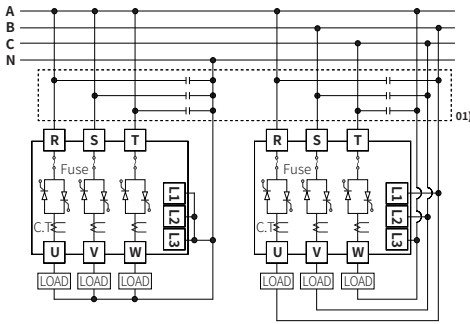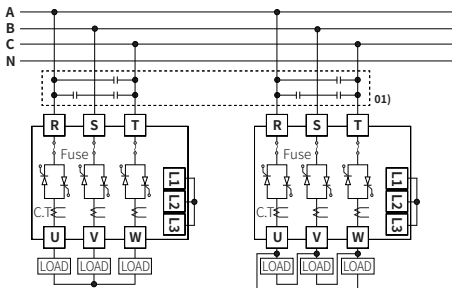
**[Phase voltage]**   **[Line voltage]**
01) Connect the CAP (capacitor) and it conforms to EMC standards.
  - FILM CAPACITOR: ≥ 1μF / 500 VAC~

- 3-phase connection: Set the parameter by Star / Delta connection.

**[Star]**   **[Delta]**
01) Connect the CAP (capacitor) and it conforms to EMC standards.
  - FILM CAPACITOR: ≥ 1μF / 500 VAC~

### ■ Suitable specifications

- The following connectors can be used with equivalent or substitute.

| Connector | Connector specifications | Manufacture |
|---|---|---|
| EtherCAT communication | RJ45 connector [01] | - |
| RS485 communication | 0225-0806 | Dinkle |
| Control input | 0225-0809 | |
| Power input / Alarm output | 0226-0812 | |
| Feedback control | EC762HV-03P-BK | |

01) EtherCAT dedicated cable must be used and the performance can not be guaranteed when using other cables.

## Initial Display When Power is ON

When power is supplied, after all display will flash for 1 sec, model specification is displayed sequentially. After this, enter into RUN mode.
- Model specification: rated current, communication type, firmware version
- Example of SPRM3-F160EC model,

| | 1. All displays | 2. Model spec. | 3. Run mode |
|---|---|---|---|
| LINE1 | 8888.8 | ModEL | 0.0 |
| LINE2 | 8888.8 | 160EC (rated current + comm. type) | 0.0 |
| LINE3 | 8888.8 | FW | 0.0 |
| LINE4 | 8888.8 | V01 (firmware version) | 0.0 |

## Alarm

- Parameter setting is available to set alarm usage, alarm delay time, relay output, auto release,etc.

| Alarm | Display | Operation | | Alarm release [01] |
|---|---|---|---|---|
| | | Alarm | Output (default) | |
| Overcurrent | oC | | Stop (SCR OFF) | • Re-supply power. |
| Overvoltage | oV | | | • Press [RESET]. [02] |
| Heatsink over heat | otW | | Maintain (normal operation) | • Press [▼] for over 2 sec. |
| Heatsink over heat protection | otP | Error display flashes at LINE1 | Stop (SCR OFF) | • Set parameter A-RCY as ON by each alarm |
| Heater break | Ht-bk | | | |
| Partial heater break | dLF-A | | Maintain (normal operation) | |
| Load unbalance | UL | | | |
| SCR error | SCR-A | | Stop (SCR OFF) | |
| Fuse break | FUSE | | | |
| FAN error | FAN | | Maintain (normal operation) | |
| Frequency error | FRQY | | Stop (SCR OFF) | |

01) If the alarm occurrence condition is not removed, the alarm is re-occur even if the alarm release method is applied.
02) The power is reapplied.

## Replacement of Fuse

- Open the case by pressing the case open button on the right side of the product.
- The performance of the product is guaranteed only when using the fuse provided by us. For replacing the fuse, use the recommended fuse.

Case open button
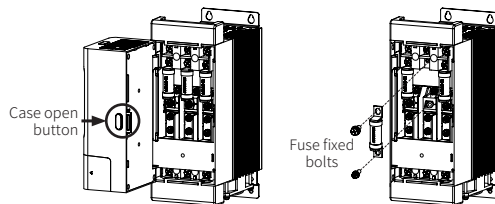
Fuse fixed bolts

| Rated load current | Recommended fuse | Manufacturer |
|---|---|---|
| 25 A | 50FE | BUSSMANN |
| 40 A | 63ET | |
| 55 A | 80ET | |
| 70 A | 100FE | |
| 90 / 110 A | 660GH-160 | HINODE |
| 160 A | 660GH-200 | |

### ■ Bolt specification

| Rated load current | Fuse fixed bolt |
|---|---|
| 25 / 40 / 55 / 70 A | M6 |
| 90 / 110 A | Top: M8 Bottom: M6 |
| 160 A | M8 |

## Mode Setting

| | | | | | |
|---|---|---|---|---|---|
| | [M + ▲] 2 sec | → | **Setting check mode** | [M] 2 sec | → |
| | [M] 2 sec | → | **Program setting mode** | [M] 2 sec | → |
| | [A + ▼] 2 sec | → | **Manual control input** [01] | [M] 2 sec | → |
| | [M + A] 2 sec | → | **Alarm setting mode** | [M] 2 sec | → |
| | [M] [02] | → | **BAR output phase setting** | Auto | → |
| RUN | [A] [02] | → | **LINE1 control / monitor phase setting** | Auto | → | RUN |
| | [▲] | → | **LINE1 load type setting** [03] | Auto | → |
| | [▼] | → | **Input amount check** [04] | Auto | → |
| | [M + ▼] 2 sec | → | **EtherCAT status monitoring mode** | [M] 2 sec | → |
| | 7-9 terminal external contact of control input connector | → | **RUN / STOP** | Auto | → |
| | 8-9 terminal external contact of control input connector | → | **Auto / Manual control** | Auto | → |
| | [▼] 2 sec | → | **Alarm reset** | Auto | → |
| | Reset switch of I/O terminal | → | **Operation reset** [05] | Auto | → |

01) This parameter is in program setting mode. It operates when manual control mode.
02) It is available when 3-phase setting as OFF at single-phase / 3-phase parameter setting of Program setting mode.
03) Load type of LINE1 is selectable by the [▲] key in RUN mode or at setting check mode.
    Load type of LINE 2 to 4 is selectable at setting check mode.
04) Press the [▼] key when LINE1 displays output and the input amount check is displayed with flashing.
05) In the event of system anomalies and alarms, RESET input restarts the power controller. (parameters are not reset.)

## Parameter Setting

- Some parameters are activated / deactivated depending on the model or setting of other parameters.
- For more information, refer to the manuals.

### ■ Setting check mode

| Parameter | LINE1 |
|---|---|
| LINE1 monitor setting | LINE1 |
| LINE2 monitor setting | LINE2 |
| LINE3 monitor setting | LINE3 |
| LINE4 monitor setting | LINE4 |
| Parameter copy | PCoPY |
| Current time check | tIM-C |
| Alarm history | ALM-d |

### ■ Program setting mode

| Parameter | LINE1 |
|---|---|
| Single-phase / 3-phase | oP-S |
| Control input | INPUt |
| Load type | LoAd |
| Control mode | oPER |
| Feedback control | Fb-S |
| Soft start / up / down | SoF-t |
| Output high / low limit | oUt-L |
| Output current limit | C-LM |
| Input slope correction | SLoPE |
| Input offset | oFSEt |
| Partial heater break | dLF |
| Power distribution control | PdC |
| RS485 communication | RS485 |
| Parameter reset | RSt-P |
| Reset check | RSt |
| Lock | LoCk |
| Manual control input | MANU |

### ■ Alarm setting mode

| Parameter | LINE1 |
|---|---|
| Overcurrent alarm | oC |
| Overvoltage alarm | oV |
| Heatsink over heat alarm | otW |
| Heatsink over heat protection alarm | otP |
| Heater break alarm | Ht-bk |
| Partial heater break alarm | dLF-A |
| Load unbalance alarm | UL |
| SCR error alarm | SCR-A |
| Fuse break alarm | FUSE |
| FAN error alarm | FAN |
| Frequency error alarm | FRQY |
| Alarm save | ALM-S |
| Time setting | t-SEt |

## Alarm

By setting parameters, you can set whether to use each alarm and relay output.

### ■ Overcurrent alarm
It can protect the load/fuse from overcurrent.
During alarm operation, OC in LINE1 flashes every 0.5 sec and the output stops (SCR OFF).
- Operation condition: If the current higher than the LMT-C set value of the 2-1 overcurrent alarm is applied during the DLY-T time of the 2-1 overcurrent alarm, an alarm occurs. The set value is based on the RMS value.

### ■ Overvoltage alarm
It can protect the load from overvoltage.
During alarm operation, OV on LINE1 flashes every 0.5 sec and the output stops (SCR OFF).
- Operation condition: If the voltage higher than the LMT-V set value of the 2-2 overvoltage alarm is applied during the DLY-T set time of the 2-2 overvoltage alarm, an alarm occurs. The set value is based on the RMS value.

### ■ Heatsink over heat alarm
During alarm operation, OTW on LINE1 flashes every 0.5 sec and the output maintains.
- Operation condition: If the temperature of the heatsink maintains the temperature above the TEMP set value of the 2-3 heatsink over heat alarm during the DLY-T set time of the 2-3 heatsink over heat alarm, an alarm occurs.

### ■ Heatsink over heat protection alarm
During alarm operation, OTP on LINE1 flashes every 0.5 sec and the output stops (SCR OFF).
- Operation condition: If the temperature of the heatsink maintains the temperature above the TEMP set value of the 2-4 heatsink over heat protection alarm during the DLY-T set time of the 2-4 heatsink over heat protection alarm, an alarm occurs.

### ■ Heater break alarm
During alarm operation, HT-BK on LINE1 flashes every 0.5 sec and the output stops (SCR OFF).
- Operation condition: If the current below the LMT-C set value of the 2-5 heater break alarm is over the LMT-O set output of the 2-5 heater break alarm during the DLY-T set time of the 2-5 heater break alarm, an alarm occurs.

### ■ Partial heater break alarm
Partial heater break alarm is available for single phase control.
During alarm operation, DLF-A on LINE1 flashes every 0.5 sec and the output maintains.
- Operation condition: When using up to 6 parallel loads based on single-phase 1 channel, an alarm occurs if some loads (heaters) are disconnected.
  An alarm occurs when the average current value of the load generated by scanning the heater (load) is different from the currently measured average current value.

### ■ Load unbalance alarm
During alarm operation, UL on LINE1 flashes every 0.5 sec and the output maintains.
- Operation condition: If the unbalance rate over the LMT-P set value of the 2-7 load unbalance alarm continues during the DLY-T set time of the 2-7 load imbalance alarm, an alarm occurs.
- Unbalance rate (%) = $\dfrac{(\text{Max. line current} - \text{Min. line current}) \times 100}{\text{Average line current}}$

  E.g.) R-phase line current: 100 A, S-phase line current: 90 A, T-phase line current: 80 A,

  Unbalance rate (%) = $\dfrac{(100 - 80) \times 100}{90}$ = 22.22 %

### ■ SCR error alarm
During alarm operation, SCR-A on LINE1 flashes every 0.5 sec and the output stops (SCR OFF).
- Operation condition: If the current over the LMT-C set value of the 2-8 SCR error alarm is applied over the LMT-O set output of the 2-8 SCR error alarm during the DLY-T set time of the 2-8 SCR error alarm, an alarm occurs.

### ■ Fuse break alarm
During alarm operation, FUSE on LINE1 flashes every 0.5 sec and the output stops (SCR OFF).
- Operation condition: If the fuse break, load no-power, or load disconnection continues during the DLY-T set time of the 2-9 fuse break alarm, an alarm occurs.

### ■ FAN error alarm
During alarm operation, FAN on LINE1 flashes every 0.5 sec and the output maintains.
- Operation condition: If the fan does not operate under the condition that the fan should operate during the DLY-T set time of the 2-10 FAN error alarm, an alarm occurs.
- FAN operation condition: ON at heatsink (inner temperature) 40 °C, OFF at 35 °C

### ■ Frequency error alarm
During alarm operation, FRQY on LINE1 flashes every 0.5 sec and the output stops (SCR OFF).
- Operation condition: If the power frequency of the load input remains out of 45 to 65 Hz during the DLY-T set time of the 2-11 frequency error alarm, an alarm occurs.

## Parameter Setting

- Some parameters are activated / deactivated depending on the model or setting of other parameters. Refer to the description of each parameter.
- Do not change parameters during output.
- If any key is not entered for 60 sec in each parameter, it returns to RUN mode.
- [M], [▲], [▼] key: Changes LINE.
- [A] key: When LINE1 flashes, saves current set value and moves to the next parameter.
       Changes set values.
       Changes setting digits.
- [▲], [▼] key: Changes number when numerical set value is changed
- **Bold** specifications for each parameter setting range are factory default.

### ■ Setting check mode

**0-1. LINE1 monitor setting**

Select the parameter to be checked in LINE1 of the RUN mode.

| LINE1 | **LINE1** |
|---|---|
| LINE2 | **OUT**: Output<br>KWH-1: Accumulated power<br>TMP-H: Heatsink temperature<br>OPER: Control mode<br>IN-CH: Control input<br>FRQY: Input power frequency<br>AMP: Load current<br>VOLT: Load voltage |
| LINE3 | |
| LINE4 | |

**0-2. LINE2 monitor setting**

Select the parameter to be checked in LINE2 of the RUN mode.

| LINE1 | **LINE2** | | |
|---|---|---|---|
| LINE2 | U-VOL: U-phase voltage<br>U-V: U-V lines voltage<br>**U-AMP**: U-phase current<br>U-WAT: U-phase power<br>U-HZ: U-phase frequency<br>U-RES: U-phase resistance | V-VOL: V-phase voltage<br>V-W: V-W lines voltage<br>V-AMP: V-phase current<br>V-WAT: V-phase power<br>V-HZ: V-phase frequency<br>V-RES: V-phase resistance | W-VOL: W-phase voltage<br>W-U: W-U lines voltage<br>W-AMP: W-phase current<br>W-WAT: W-phase power<br>W-HZ: W-phase frequency<br>W-RES: W-phase resistance |
| LINE3 | | | |
| LINE4 | | | |

**0-3. LINE3 monitor setting**

Select the parameter to be checked in LINE3 of the RUN mode.

| LINE1 | **LINE3** |
|---|---|
| LINE2 | Same as 0-2. LINE2 monitor setting<br>(default: **V-AMP**) |
| LINE3 | |
| LINE4 | |

**0-4. LINE4 monitor setting**

Select the parameter to be checked in LINE4 of the RUN mode.

| LINE1 | **LINE4** |
|---|---|
| LINE2 | Same as 0-2. LINE2 monitor setting<br>(default: **W-AMP**) |
| LINE3 | |
| LINE4 | |

**0-5. Parameter copy**

| LINE1 | **PCOPY** |
|---|---|
| LINE2 | **UP**: Save parameter transfer<br>　　(Body → Display module)<br>DOWN: Save parameter reception<br>　　(Display module → Body) |
| LINE3 | **NONE**<br>START: After flashing WAIT, NONE is<br>　　ON. |
| LINE4 | |

**0-6. Current time check**

The time of the 0-6. Current time check is displayed based on the time set in the 2-13. Time setting.

| LINE1 | **TIM-C** | | | | |
|---|---|---|---|---|---|
| LINE2 | **YEAR** | MONTH | DAY | HOUR | MIN |
| LINE3 | Current year | Current month | Current day | Current hour | Current minute |
| LINE4 | | | | | |

**0-7. Alarm history**

Displays the alarm phase on the control / monitor phase of LINE4.

| LINE1 | **ALM-D** | |
|---|---|---|
| LINE2 | **EMPTY**: No saved alarms | ALM00 to 09<br>: Alarm stored in 00 to 09 |
| LINE3 | | YEAR / MONTH_DAY / HOUR-MIN<br>: Cross check with [A] key |
| LINE4 | | OC: 2-1. Overcurrent alarm<br>OV: 2-2. Overvoltage alarm<br>OTW: 2-3. Heatsink over heat alarm<br>OTP: 2-4. Heatsink over heat<br>　　protection alarm<br>HT-BK: 2-5. Heater break alarm<br>DLF-A: 2-6. Partial heater break<br>　　alarm<br>UL: 2-7. Load unbalance alarm<br>SCR-A: 2-8. SCR error alarm<br>FUSE: 2-9. Fuse break alarm<br>FAN: 2-10. FAN error alarm<br>FRQY: 2-11. Frequency error alarm |

## ■ Program setting mode

**1-1. Single-phase / 3-phase**

According to 3PH ON / OFF of single-phase / 3-phase, LINE2 of the following parameters is displayed as 3PH / L1, L2, L3, ALL.
• ALL = L1 + L2 + L3 + 3PH

| LINE1 | OP-S | |
|---|---|---|
| LINE2 | **3PH**: 3-phase | L1: R-phase (U-phase) <br> L2: S-phase (V-phase) <br> L3: T-phase (W-phase) |
| LINE3 | **ON**: 3-phase operation <br> OFF: Single-phase operation, <br>     L1, L2, L3 displayed on LINE2 | **ON** <br> OFF |
| LINE4 | **STAR**: Star connection <br> DELTA: Delta connection | |

**1-2. Control input**

| LINE1 | INPUT |
|---|---|
| LINE2 | According to 1-1. Single-phase / <br> 3-phase setting (default: **3PH**) |
| LINE3 | **CH1_A**: 4 - 20 mA at Channel 1 <br> CH2_A: 4 - 20 mA at Channel 2 <br> CH3_A: 4 - 20 mA at Channel 3 <br> 1-5V: 1 - 5 VDC⎓ <br> 0-5V: 0 - 5 VDC⎓ <br> 0-10V: 0 - 10 VDC⎓ <br> EC: EtherCAT communication <br> RS485: RS485 communication <br> EX-R: External volume 10 kΩ <br> NONE: Not used |
| LINE4 | |

**1-3. Load type**

| LINE1 | LOAD |
|---|---|
| LINE2 | According to 1-1. Single-phase / <br> 3-phase setting (default: **3PH**) |
| LINE3 | **RESIS**: Resistive load <br> TRANS[01]: Transformer load |
| LINE4 | |

01) When set as a transformer load, operation stops when cycle control is set due to the risk of fuse breakage.

**1-4. Control mode**

| LINE1 | OPER |
|---|---|
| LINE2 | According to 1-1. Single-phase / <br> 3-phase setting (default: **3PH**) |
| LINE3 | **PA**: Phase control <br> F-CY: Fixed cycle control <br> V-CY: Variable cycle control |
| LINE4 | |

**1-5. Feedback control**

Feedback control is available when 1-4. Control mode is set to PA. If set to F-CY, V-CY, set the 1-5. Feedback control to UNUSE.
When 1-1. Single-phase / 3-phase 3PH is set to ON, the average value of U, V, W phases is feedback controlled.

| LINE1 | FB-S | | | |
|---|---|---|---|---|
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) | | | |
| LINE3 | **UNUSE**: Not used | FB-V: Constant voltage feedback | FB-C: Constant current feedback | FB-W: Constant power feedback |
| LINE4 | | 3-phase: 110.0 to **380.0** to 480.0 [V] <br> Single-phase: 110.0 to **220.0** to 480.0 [V] | 1 to **Rated current** to <br> 110 % of rated current [A] | 440 V × 10 % of rated current to <br> **440 V × Rated current** to <br> 440 V × 110 % of rated current[kW] |

**1-6. Soft start / up / down**

Soft start time: Time to get the output which is applied into the load is 100 %
Soft up time: Time to reach rise when changing control value during operation
Soft down time: Time to reach the descent when changing the control value during operation

| LINE1 | SOF-T | | |
|---|---|---|---|
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) | | |
| LINE3 | **ST_T**: Soft start time | UP_T: Soft up time | DN_T: Soft down time |
| LINE4 | [Normal, Cycle control model] <br> 0 to **3** to 999 [sec] <br><br> [Feedback control model] <br> 0 (reach target output value quickly) <br> to **3** to <br> 999 (reach target output value slowly) | [Normal, Cycle control model] <br> 0 to **3** to 999 [sec] <br><br> [Feedback control model] <br> 0 (reach target output value quickly) <br> to **3** to <br> 999 (reach target output value slowly) | [Normal, Cycle control model] <br> 0 to **3** to 999 [sec] <br><br> [Feedback control model] <br> 0 (reach target output value quickly) <br> to **3** to <br> 999 (reach target output value slowly) |

**1-7. Output high / low limit**

This function is to high / low limit output range to protect load.
If the low-limit value is set larger than the high-limit value, the output is based on the low-limit value.
E.g.) If the output high-limit is set to 50 %, the output is 50 % above the control input 50 %.
    If the output low-limit is set to 20 %, the output is 20 % below the control input 20 %.

| LINE1 | OUT-L | |
|---|---|---|
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) | |
| LINE3 | **HIGH**: Output high-limit value | LOW: Output low-limit value |
| LINE4 | 0.0 to **100.0** [%] | **0.0** to 100.0 [%] |

**1-8. Output current limit**

When the output current limit is over, the output turns OFF.

| | |
|---|---|
| LINE1 | **C-LM** |
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) |
| LINE3 | 1.0 to **110.0 % of rated current** [A] |
| LINE4 | |

**1-9. Input slope correction**

It prevents load damage by limiting 100% of the power supplied to the load.

| | |
|---|---|
| LINE1 | **SLOPE** |
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) |
| LINE3 | -99.9 to **0.0** to 99.9 [%] |
| LINE4 | |

**1-10. Input offset**

Sets the offset value as much as the measured value (%) displayed on the display module from the lowest value of the input signal.
E.g.) the measured value = 5 %, offset = -5.0 %

| | |
|---|---|
| LINE1 | **OFSET** |
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) |
| LINE3 | -99.9 to **0.0** to 99.9 [%] |
| LINE4 | |

**1-11. Partial heater break**

Displayed when 1-1. Single-phase / 3-phase 3PH is set to OFF.

| | | | | | |
|---|---|---|---|---|---|
| LINE1 | **DLF** | | | | |
| LINE2 | **L1**, L2, L3, ALL | | | | |
| LINE3 | **START**: Start scan | LO_C: Number of multi load | LIM-O: Scan output limit value | UP_T: Output increase scan time | DN_T: Output decrease scan time |
| LINE4 | **OFF**: No scan<br>ST_ON: Starts scan | **2** to 6 | 25.0, 50.0, 75.0, **100.0** [%] | 0 to **1** to 10 [time]<br>(1 time: ≈160 sec) | **0** to 10 [time]<br>(1 time: ≈160 sec) |

**1-12. Power distribution control**

Displayed when 1-1. Single-phase / 3-phase 3PH is set to OFF.
One control input distributes and controls L1, L2, and L3 at variable cycle.
Operation stops when a problem occurs on L1.

| | |
|---|---|
| LINE1 | **PDC** |
| LINE2 | **OFF**, ON |
| LINE3 | **F-CY**: Fixed cycle control<br>V-CY: Variable cycle control |
| LINE4 | |

**1-13. RS485 comm.**

RS485 communication parameters take effect immediately after change.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LINE1 | **RS485** | | | | | | |
| LINE2 | **PROTO**: Protocol | ADDR: Address | BPS: Comm. speed | P-BIT: Parity bit | S-BIT: Stop bit | RS-T: Comm. response time | COPY: Write settings |
| LINE3 | **RTU**: Modbus RTU<br>ASCII: Modbus ASCII | **1** to 99 | 24: 2,400 [bps]<br>48: 4,800 [bps]<br>**96**: 9,600 [bps]<br>144: 14,400 [bps]<br>192: 19,200 [bps]<br>384: 38,400 [bps]<br>576: 57,600 [bps]<br>1152: 115,200 [bps] | **NONE**: Not used<br>EVEN<br>ODD | **1**, 2 [bit] | **0** to 9999 [ms] | **ON**, OFF |
| LINE4 | | | | | | | |

**1-14. Parameter reset**

| | |
|---|---|
| LINE1 | **RST-P** |
| LINE2 | **NONE**, START |
| LINE3 | |
| LINE4 | |

**1-15. Reset check**

Displayed when 1-14. Parameter reset set to START.
As soon as YES is selected, the parameters are reset.

| | |
|---|---|
| LINE1 | **RST** |
| LINE2 | **NO**, YES |
| LINE3 | |
| LINE4 | |

**1-16. Lock**

| | |
|---|---|
| LINE1 | **LOCK** |
| LINE2 | **OFF**: Not used<br>LOCK1: Locks program setting mode<br>LOCK2: Locks alarm setting mode |
| LINE3 | |
| LINE4 | |

**1-17. Manual control input**

Sets the output for manual control mode.

| | |
|---|---|
| LINE1 | **MANU** |
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) |
| LINE3 | **0.0** to 100.0 [%] |
| LINE4 | |

## ■ Alarm setting mode

Sets whether to use an alarm for each situation, delay time, relay output, and whether to use automatic recovery.

### 2-1. Overcurrent alarm

| LINE1 | OC | | | | |
|---|---|---|---|---|---|
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) | | | | |
| LINE3 | **ENABL**: Enable / Disable | LMT-C: Limit output current value | DLY-T: Alarm delay time | RLY-O: Relay output | A-RCY: Auto-recovery |
| LINE4 | **ON**, OFF | 1 to **110 % of rated current** [A] | 0 to **3** to 100 sec | **DISAL**, AL1, AL2, AL3, AL4, AL5, AL6 | ON, **OFF** |

### 2-2. Overvoltage alarm

| LINE1 | OV | | | | |
|---|---|---|---|---|---|
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) | | | | |
| LINE3 | **ENABL**: Enable / Disable | LMT-V: Limit output voltage | DLY-T: Alarm delay time | RLY-O: Relay output | A-RCY: Auto-recovery |
| LINE4 | **ON**, OFF | 10.0 to **500.0** V | 0 to **3** to 100 sec | **DISAL**, AL1, AL2, AL3, AL4, AL5, AL6 | ON, **OFF** |

### 2-3. Heatsink over heat alarm

If a temperature above the TEMP set value is detected, a heatsink over heat alarm occurrs.
Even if an alarm occurs, the device operates normally.

| LINE1 | OTW | | | |
|---|---|---|---|---|
| LINE2 | **ENABL**: Enable / Disable | TEMP: Heatsink alarm temperature | DLY-T: Alarm delay time | RLY-O: Relay output |
| LINE3 | **ON**, OFF | 40 to **60** to 65 °C | 0 to **3** to 100 sec | **DISAL**, AL1, AL2, AL3, AL4, AL5, AL6 |
| LINE4 | | | | |

### 2-4. Heatsink over heat protection alarm

If a temperature above the TEMP set value is detected, a heatsink over heat protection alarm occurrs.
Operation stops immediately after the alarm occurs.

| LINE1 | OTP | | | | |
|---|---|---|---|---|---|
| LINE2 | **ENABL**: Enable / Disable | TEMP: Heatsink alarm protection temperature | DLY-T: Alarm delay time | RLY-O: Relay output | A-RCY: Auto-recovery |
| LINE3 | **ON**, OFF | 65 to **80** to 90 °C | 0 to **3** to 100 sec | **DISAL**, AL1, AL2, AL3, AL4, AL5, AL6 | ON, **OFF** |
| LINE4 | | | | | |

### 2-5. Heater break alarm

| LINE1 | HT-BK | | | | | |
|---|---|---|---|---|---|---|
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) | | | | | |
| LINE3 | **ENABL**: Enable / Disable | LMT-C: Limit current output | LMT-O: Limit output | DLY-T: Alarm delay time | RLY-O: Relay output | A-RCY: Auto-recovery |
| LINE4 | **ON**, OFF | 1 to **110 % of rated current** [A] | 0.0 to **100.0** % | 0 to **3** to 100 sec | **DISAL**, AL1, AL2, AL3, AL4, AL5, AL6 | ON, **OFF** |

### 2-6. Partial heater break alarm

Displayed when 1-1. Single-phase / 3-phase 3PH is set to OFF.

| LINE1 | DLF-A | | |
|---|---|---|---|
| LINE2 | **L1**, L2, L3, ALL | | |
| LINE3 | **ENABL**: Enable / Disable | DLY-T: Alarm delay time | RLY-O: Relay output |
| LINE4 | **ON**, OFF | 0 to **3** to 100 sec | **DISAL**, AL1, AL2, AL3, AL4, AL5, AL6 |

### 2-7. Load unbalance alarm

Displayed when 1-1. Single-phase / 3-phase 3PH is set to ON.

| LINE1 | UL | | | | |
|---|---|---|---|---|---|
| LINE2 | 3PH | | | | |
| LINE3 | **ENABL**: Enable / Disable | LMT-P: Unbalance rate | DLY-T: Alarm delay time | RLY-O: Relay output | A-RCY: Auto-recovery |
| LINE4 | **ON**, OFF | 5 to **30** to 100 % | 0 to **3** to 100 sec | **DISAL**, AL1, AL2, AL3, AL4, AL5, AL6 | ON, **OFF** |

### 2-8. SCR error alarm

| LINE1 | SCR-A | | | | | |
|---|---|---|---|---|---|---|
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) | | | | | |
| LINE3 | **ENABL**: Enable / Disable | LMT-C: Limit current output | LMT-O: Limit output | DLY-T: Alarm delay time | RLY-O: Relay output | A-RCY: Auto-recovery |
| LINE4 | **ON**, OFF | 1 to **5** to **110 % of rated current** [A] | **0.0** to 100.0 % | 0 to **3** to 100 sec | **DISAL**, AL1, AL2, AL3, AL4, AL5, AL6 | ON, **OFF** |

### 2-9. Fuse break alarm

If a fuse break alarm occurs during single-phase operation, also check whether a 2-5. Heater break alarm occurs. If the load is open, a fuse break alarm occurs.

| LINE1 | FUSE | | | |
|---|---|---|---|---|
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) | | | |
| LINE3 | **ENABL**: Enable / Disable | DLY-T: Alarm delay time | RLY-O: Relay output | A-RCY: Auto-recovery |
| LINE4 | **ON**, OFF | 0 to **3** to 100 sec | **DISAL**, AL1, AL2, AL3, AL4, AL5, AL6 | ON, **OFF** |

### 2-10. FAN error alarm

| LINE1 | FAN | | |
|---|---|---|---|
| LINE2 | **ENABL**: Enable / Disable | DLY-T: Alarm delay time | RLY-O: Relay output |
| LINE3 | **ON**, OFF | 0 to **3** to 100 sec | **DISAL**, AL1, AL2, AL3, AL4, AL5, AL6 |
| LINE4 | | | |

### 2-11. Frequency error alarm

| LINE1 | FRQY | | | |
|---|---|---|---|---|
| LINE2 | According to 1-1. Single-phase / 3-phase setting (default: **3PH**) | | | |
| LINE3 | **ENABL**: Enable / Disable | DLY-T: Alarm delay time | RLY-O: Relay output | A-RCY: Auto-recovery |
| LINE4 | **ON**, OFF | 0 to **3** to 100 sec | **DISAL**, AL1, AL2, AL3, AL4, AL5, AL6 | ON, **OFF** |

### 2-12. Alarm save

If ENABL is set to ON, the contents of the alarm are saved if it continues for more than 30 seconds after the alarm occurs.
The saved alarm history can be checked in the 0-7. Alarm history.

| LINE1 | ALM-S | |
|---|---|---|
| LINE2 | **ENABL**: Enable / Disable | CLEAN: Alarm save clear |
| LINE3 | **ON**, OFF | **NONE**, START |
| LINE4 | | |

### 2-13. Time setting

| LINE1 | T-SET | | | | | |
|---|---|---|---|---|---|---|
| LINE2 | **YEAR** | MONTH | DAY | HOUR | MIN | SAVE |
| LINE3 | 2000 to **2020** to 2099 | 1 to **7** to 12 | 1 to **13** to 31 | 0 to **12** to 23 | **0** to 59 | **NONE** START: Saves the time of the START moment as the set time. |
| LINE4 | | | | | | |

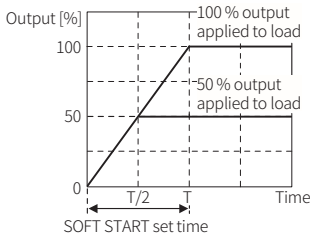## Function

### ■ Output high / low-limit value

This function is to limit output range to protect load.
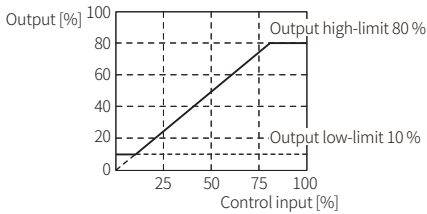


### ■ SOFT START

This function protects the load in cases that the set temperature is high, such as controlling the load (platinum. molybdenum, tungsten, infrared lamp, etc.) in which inrush current flows when power is supplied, or showing large width of temperature rise during initial operation.
If the input is changed before the end of the SOFT START function, T increases or decreases by the changed difference (%).



• T: SOFT START set time.
  Time to get the output which is applied into the load is 100 %.
• T/2: Time to get the output which is applied into the load is 50 %.

### ■ SOFT UP / DOWN

Unlike SOFT START which operates only once at supplying power, this function protects load from the inrush current in the RUN mode. When reached to the target output value, operation stops.
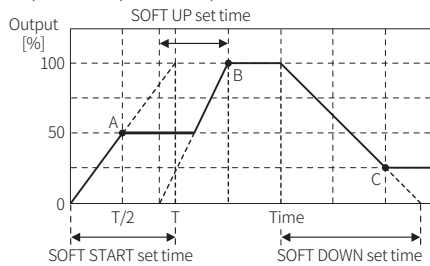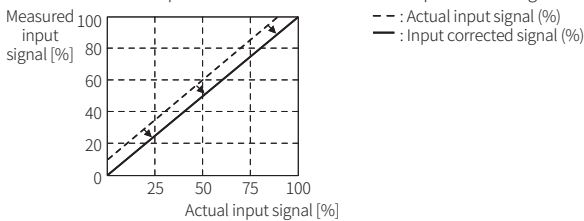


• A: SOFT START function finished
• B: SOFT UP function finished
• C: SOFT DOWN function finished

### ■ Input OFFSET

It compensates the offset between actual input value and measured input value.
• E.g.) When input monitoring value is 5 % at 4 mA in DC4 - 20 mA control input, setting LINE3 of 1-10 Input offset = -5.0 % calibrates the input monitoring value to 0 %.
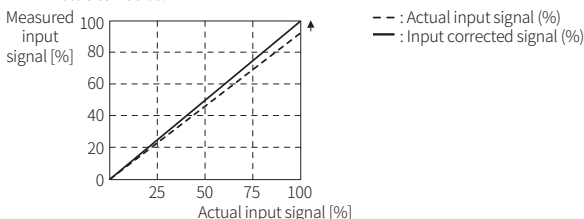


- - - : Actual input signal (%)
—— : Input corrected signal (%)

### ■ Input slope correction

It prevents load damage by limiting 100% of the power supplied to the load. It compensates the gain of the measured 100 % input for actual 100 % input value.
Calibrated monitoring value =

Monitoring value +

$$\frac{\text{Monitoring value}}{100 - \text{input slope correction value}} \times \text{Input slope correction value}$$

• E.g.) When the input monitoring value is 99 % at 20 mA in DC 4 - 20 mA control input, setting LINE3 of 1-9 Input slope correction = 1 % calibrates the input monitoring value to 100 %.
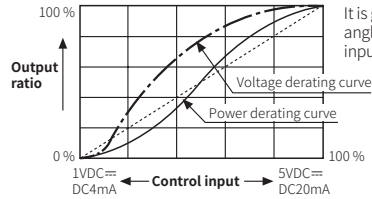


- - - : Actual input signal (%)
—— : Input corrected signal (%)

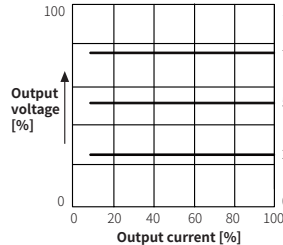## Control Method

### ■ Phase control

Phase control method is to control output by dividing AC phase by control input signal.

**• Normal = Phase equal division method by control input**



It is general output method to divide control angle proportionally according to control input signal and to output it.

**• Constant voltage feedback control mode**



It outputs a constant voltage proportional to the control input so that the output voltage does not fluctuate against fluctuations in power voltage and load resistance fluctuations of loads (iron, chromium, nichrome, etc.) with a small electrical resistance temperature coefficient.

**• Constant current feedback control mode**
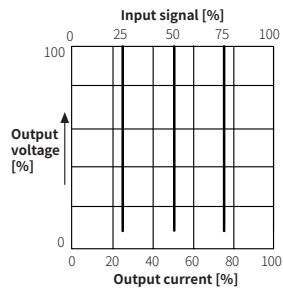


It outputs a constant current proportional to the control input so that the output current does not fluctuate against fluctuations in power voltage and load resistance fluctuations of loads (platinum, molybdenum, tungsten, etc.) in which the temperature coefficient of electrical resistance varies significantly from 6 to 12 times the normal temperature.

**• Constant power feedback control mode**
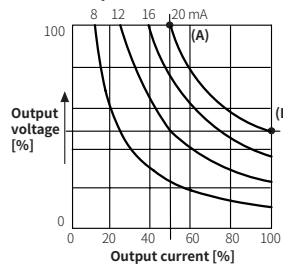


It is proper control method for a heater which resistance value variation by silicon carbide (SiC) heating is big.
It outputs constant power which is proportion to control input even though load variation and power supply variation.
• (A): [output voltage 100 % × output current 50 %]
  (B): [output voltage 50 % × output current 100 %]
• Output characteristics is proper 50 % of the curve which connects the point (A) and the point (B). The current output capacity of this unit should be over two times of load capacity.

### ■ Cycle control, zero cross turn-on

Compared to the phase control method, the load control linearity is better.
Since it is always ON or OFF at the zero point of AC, no noise is generated during ON / OFF, so it is a suitable control method for an environment where noise is not affected or an electric furnace with a large heat capacity.
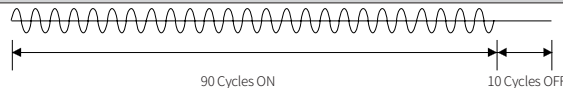
**• Fixed cycle control mode**

During fixed cycle (100 cycles) of load power, it repeats ON / OFF cycle as constant ratio according to control input signal and controls the power supplies on the load.
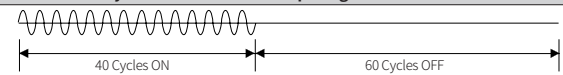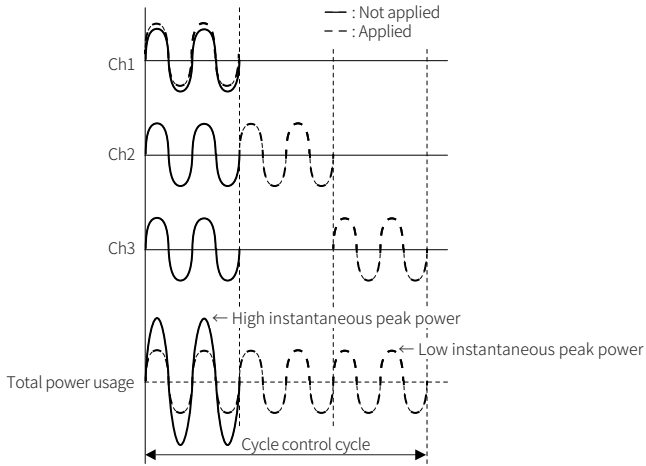


**• Variable cycle control mode**

By optimizing the number of cycles of the load power, it controls the power applied to the load by operating ON / OFF at a ratio proportional to the control input signal.
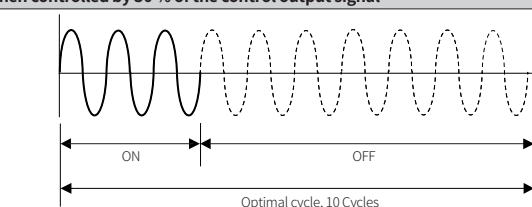
## ■ Power distribution control

In case of single-phase 2-channel or 3-channel cycle control, sequential distribution control is performed so that outputs do not overlap at the same time through internal algorithm operation between channels.

—— : Not applied
– – : Applied

Ch1

Ch2

Ch3

← High instantaneous peak power

← Low instantaneous peak power

Total power usage

Cycle control cycle

## Segment Table

The segments displayed on the product indicate the following meanings. It may differ depending on the product.

| 7 segment | | | | 11 segment | | | | 12 segment | | | | 16 segment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | ı | I | 0 | 0 | ı | I | 0 | 0 | ı | I | 0 | 0 | I | I |
| I | 1 | ப | J | I | 1 | ப | J | I | 1 | ப | J | I | 1 | ᴜ | J |
| 2 | 2 | ʁ | K | 2 | 2 | ʁ | K | 2 | 2 | ʁ | K | 2 | 2 | ʁ | K |
| 3 | 3 | ʟ | L | 3 | 3 | ʟ | L | 3 | 3 | ʟ | L | 3 | 3 | ʟ | L |
| 4 | 4 | ᴍ | M | 4 | 4 | ᴍ | M | 4 | 4 | ᴍ | M | 4 | 4 | ᴍ | M |
| 5 | 5 | � | N | 5 | 5 | ɴ | N | 5 | 5 | ɴ | N | 5 | 5 | ɴ | N |
| 6 | 6 | o | O | 6 | 6 | o | O | 6 | 6 | o | O | 6 | 6 | 0 | O |
| 7 | 7 | ᴘ | P | 7 | 7 | ᴘ | P | 7 | 7 | ᴘ | P | 7 | 7 | ᴘ | P |
| 8 | 8 | � | Q | 8 | 8 | �𐤒 | Q | 8 | 8 | ᴒ | Q | 8 | 8 | ᴒ | Q |
| 9 | 9 | ᴦ | R | 9 | 9 | ᴘ | R | 9 | 9 | ᴘ | R | 9 | 9 | ᴘ | R |
| A | A | ꜱ | S | A | A | ꜱ | S | A | A | ꜱ | S | A | A | ꜱ | S |
| b | B | ᴇ | T | b | B | ᴇ | T | b | B | ᴇ | T | Ƀ | B | ᴛ | T |
| C | C | ᴜ | U | C | C | ᴜ | U | C | C | ᴜ | U | C | C | ᴜ | U |
| d | D | ᴜ | V | d | D | ᴠ | V | d | D | ᴠ | V | Ꝺ | D | ᴠ | V |
| E | E | ᴜ | W | E | E | ᴡ | W | E | E | ᴡ | W | E | E | ᴡ | W |
| F | F | ꜱ | X | F | F | ˣ | X | F | F | ˣ | X | F | F | ˣ | X |
| G | G | ᴜ | Y | G | G | ᴜ | Y | G | G | ᴜ | Y | G | G | ˇ | Y |
| H | H | ᴣ | Z | H | H | ᴣ | Z | H | H | ᴣ | Z | H | H | ᴣ | Z |