

**ONE-PORT SURGE PROTECTOR FOR  
POWER SUPPLY USE**

MODEL

**MAKF**

**BEFORE USE ....**

Thank you for choosing us. Before use, please check contents of the package you received as outlined below.

If you have any problems or questions with the product, please contact our sales office or representatives.

**■ PACKAGE INCLUDES:**

Surge protector.....(1)  
Marking label.....(1) sheet

**■ MODEL NO.**

Check that model No. described on specification label matches the operational line voltage and other specifications as shown in 'PERFORMANCE' below.

**■ INSTALLATION / INSTRUCTION MANUAL**

This manual describes necessary points of caution when you use this product, including installation, connection and basic maintenance procedures.

**LIMITATION APPLICABLE TO MAKF**

The MAKF will protect electronics equipment from damage caused by induced lightning by absorbing most of the surge voltages.

However, MAKF may not be effective against certain extremely high voltages exceeding its discharge current capacity (20kA @8/20µsec. waveform) caused by a direct or almost direct hit by lightning.

The MAKF must be installed according to this installation / instruction manual.

**PERFORMANCE**

**Response time:** ≤ 20 nanoseconds

**Maximum discharge current:** 20kA × twice (8/20 µsec.)

**Nominal discharge current:** 5kA (8/20 µsec.)

**Leakage current:** ≤ 1mA at the discharge voltages listed in the table below.

MODEL	Uc (AC) (V)	DISCHARGE VOLTAGE (Vmin)	Up	
			@1.0kA (8/20 µs) (Vmax)	@5kA (8/20 µs) (Vmax)
MAKF-120	150	250	600	800
MAKF-240	275	420	1000	1400
MAKF-280	320	460	1100	1500
MAKF-400	440	670	1500	2100
MAKF-480	530	820	1800	2500

Uc = Maximum continuous operational voltage

Up = Voltage protection level

Insulation resistance: ≥ 100MΩ with 500V DC  
(line to alarm output)

Dielectric strength: 2000V AC @1 minute  
(line to alarm output)

**POINTS OF CAUTION**

**■ INSTALLATION**

**• DANGER!**

DO NOT install the MAKF at the inlet of the power source wiring or close to it. DO NOT ground the MAKF at the point common to an external lightning protection device such as a lightning rod. In both cases, the MAKF will be subject to the danger of direct lightning.

**• DANGER!**

DO NOT perform an installation and wiring of the MAKF during thunder storms.

- Be sure to house the MAKF inside an metal enclosure for safety. Even though the MAKF is capable of withstanding an induced discharge current expected in normal conditions, it is entirely possible to be hit by a certain strong lightning exceeding its designed capacity. It is also subject to a direct hit by a lightning. The MAKF will be destroyed by such high lightning energy.
- We recommend to install the MAKF in a position where the check window is clearly visible to facilitate inspection and maintenance.
- DO NOT install the MAKF where it is subjected to continuous vibration. Do not apply physical impact to the MAKF.
- Environmental temperature must be within -5 to +55°C (23 to 131°F) and relative humidity within 30 to 90% RH in order to ensure adequate life span and operation.

**■ HIGH TEMPERATURE**

**• DANGER!**

The head element surface may be hot. DO NOT touch the sides of the head element module when you remove it from the base for maintenance. Hold instead the grips at the top and bottom of the module. When the MAKF's discharge element gradually degrades, its increased leakage current causes high temperature at the surface of the MAKF's head module, until the discharge element is finally separated from the power line by the thermal breaker. However, a part of the module may already be too hot to touch safely if the module is near the end of its life.

- Observe at least 20 mm (0.8 inch) between the MAKF and other devices in order to prevent the high temperature from affecting them.

**■ OPERATIONAL VOLTAGE**

- DO NOT connect a power source of which the nominal operational voltage exceeds the MAKF's maximum continuous operational voltage, Uc value indicated on the specification label at the front.
- Be sure that the peak voltage does not exceed 1.4 times the maximum continuous operational voltage. Distorted waveform may have extremely high peak voltage.

## ■ DIELECTRIC STRENGTH TESTING

- Remove the head element from the base before conducting a dielectric strength test. The MAKF will start discharging at the described discharge voltage if a test voltage is applied with the head module connected to the base. It will result in an insulation failure.
- Be sure to return the head element and fasten securely after the test.

## ■ AND ....

- We recommend that you keep spare MAKFs so that you can replace them quickly when necessary.

## APPLICATIONS

- Protects electric devices such as isolation transformers, heaters, electromagnetic contactors, motors.
- Protects electric devices of high load current.
- Provides primary protection of a power supply system in a distribution switchboard.

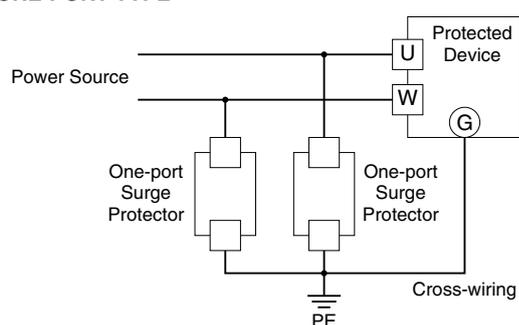
Low-voltage equipment such as computers, measuring instruments, transmission devices, which generally incorporate semiconductor circuitries, is especially vulnerable against lightning surges. We recommend to use combination type surge protectors incorporating serial impedance (model examples: MAX, MMA, MAH), or to set up a double protection by MAKFs (Refer to 'PROTECTING LOW-VOLTAGE EQUIPMENT' under 'WIRING' section).

### • One-Port and Combination Type SPD

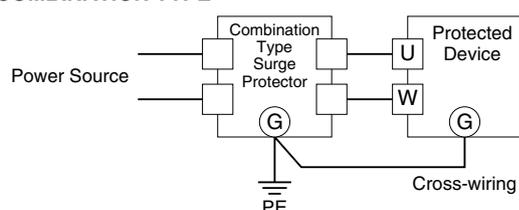
A one-port SPD is connected in parallel between the power and ground lines. In this configuration, electric current does not pass through the SPD, thus the load current may be disregarded.

A combination type SPD is inserted in serial on the power line. The impedance of the SPD inserted in the line suppresses the surge voltage to a low level regardless of the strength of lightning surges.

### ■ ONE-PORT TYPE



### ■ COMBINATION TYPE



## FEATURES

### ■ CURRENT CAPACITY

- The one-port SPD can be used regardless of the load current.

### ■ HIGH PERFORMANCE & RESPONSE TIME

- The varistor discharge element does not disturb the power line with follow current normally observed by a spark gap after a discharge. The response time is also very high.

### ■ HIGH DISCHARGE CURRENT CAPACITY

- The MAKF is designed to withstand 20 kA surges twice (test waveform 8/20  $\mu$ sec.). High design standard compared to normally induced surge current level of 1 kA.

### ■ THERMAL BREAKER

- The power supply voltage is continuously applied to the incorporated discharge element. Degraded element is automatically separated from the power lines for safety to prevent overheating caused by leakage current.
- The failure is notified visually by the check window color change and remotely by an alarm contact.

### ■ PREVENTING ELECTRIC SHOCK

- The MAKF's terminal section covered with an insulation enclosure has IP20 protection level to protect from an electric shock.
- The MAKF is designed for use with ring shape solderless terminals for a wide range of wire sizes from 2 to 14 mm<sup>2</sup>.

### ■ KEYED PIN CONNECTION

- The connection of the head element and the base is keyed for exact matching of line voltage, i.e. the MAKF-120 head element (120V rating) cannot be inserted by mistake to a base connected to 240V AC line.

### ■ EASY MAINTENANCE

- The pin-mounted head element can be easily separated from the base for easy regular inspection, replacement and insulation tester testing.
- The power line is not interrupted when the head element is removed.

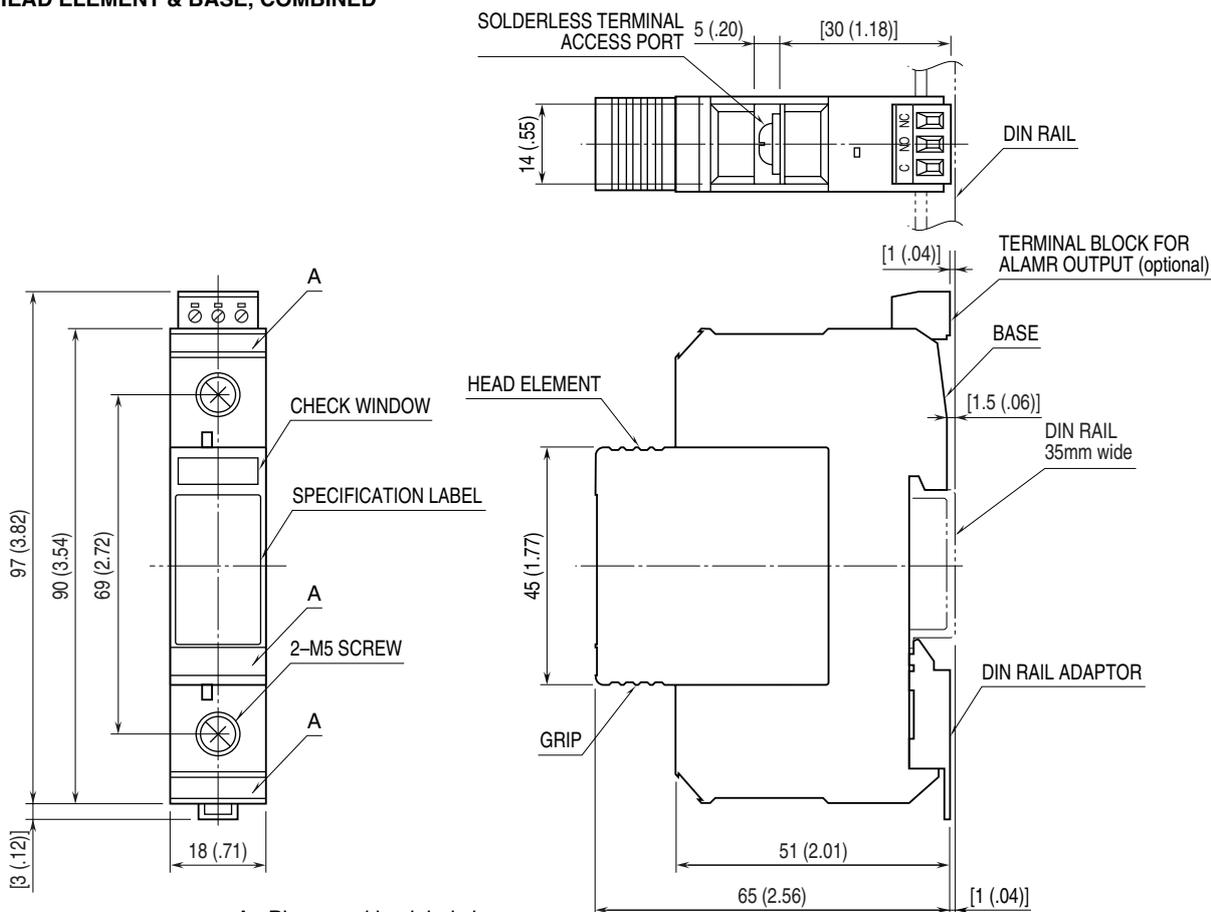
### ■ COMPACT DESIGN

- The thin and compact modules can be mounted side by side in high density on a DIN rail.
- Wiring bridge (model: CNB) is available to easily cross-wire multiple modules to the ground.
- Single mount adaptor (model: MBS) to install the MAKF on the wall is available.

# COMPONENT IDENTIFICATION & DIMENSIONS

Unit: mm (inch)

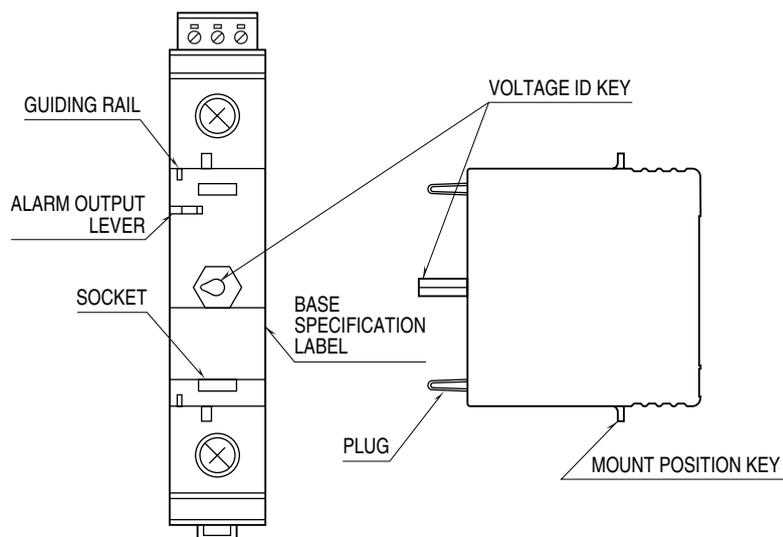
## ■ HEAD ELEMENT & BASE, COMBINED



A : Place marking labels here.

•When mounting, no extra space is needed between units.

## ■ HEAD ELEMENT & BASE, SEPARATED

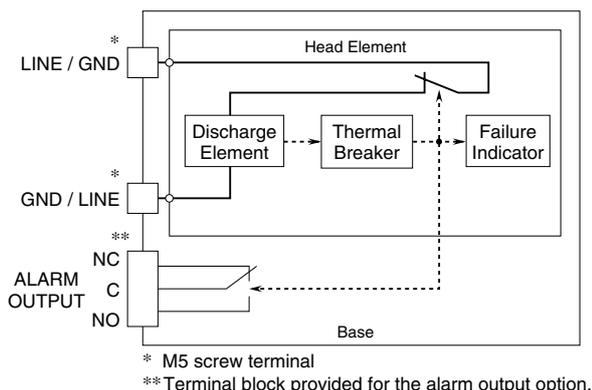


## ■ MARKING LABELS

(terminal identifiers, tag name labels)

L1	L2	L3
N	E	G

## CIRCUIT & CONNECTION DIAGRAM



## INSTALLATION

### ■ DIN RAIL MOUNTING

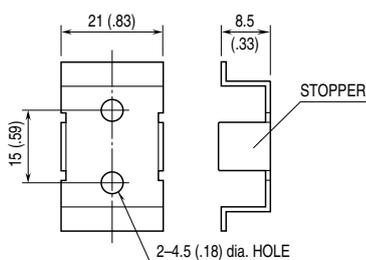
The MAKF is mounted on a 35-mm-wide DIN rail, closely side by side. Set the base so that its DIN rail adaptor is at the bottom. Position the upper hook at the rear side of base on the DIN rail and push in the lower.

If the terminal block for alarm output at the top hits the wall and blocks the upper hook to reach the DIN rail, mount the MAKF without the terminal block and then replace it. When removing the base, push down the DIN rail adaptor utilizing a minus screwdriver and pull.

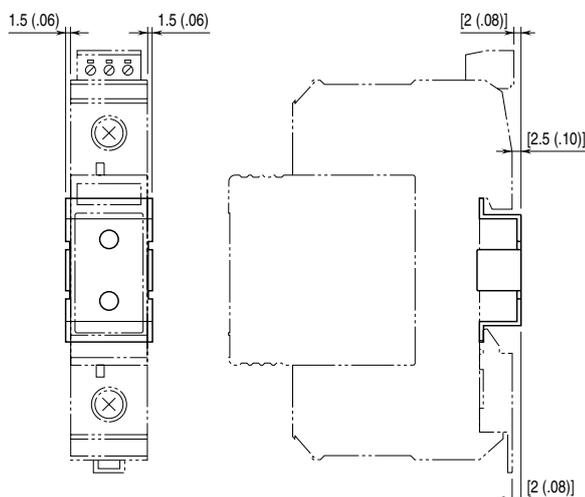
### ■ WALL MOUNTING

Wall mounting is available using the Single Mount Adaptor (model: MBS). The MAKF can be mounted to the adaptor in the same manner as to the DIN rail. Refer to the drawings below (Unit: mm (inch)) when mounting the MBS to the wall.

#### ■ MBS



#### ■ MBS ATTACHED TO THE MAKx



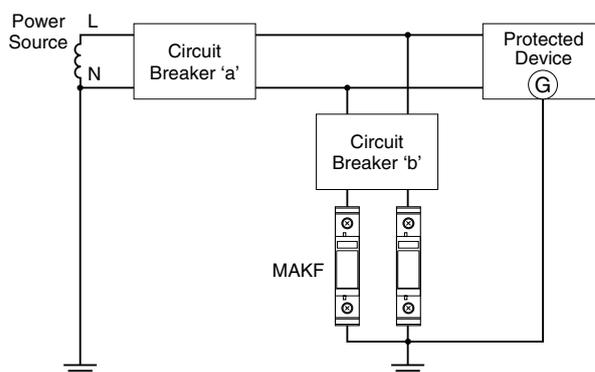
## CONNECTION PROCEDURE

### ■ INSTALLING CIRCUIT BREAKERS

The MAKF incorporates a thermal breaker which separates the discharge element from the power line upon detecting the increased leakage current by the element's gradual degradation.

However, in rare cases, when the MAKF is hit by an extremely strong lightning which exceeds the MAKF's designed induced surge capacity, the discharge element may be burned out and short-circuited at a burst without the thermal breaker being able to separate it safely from the line.

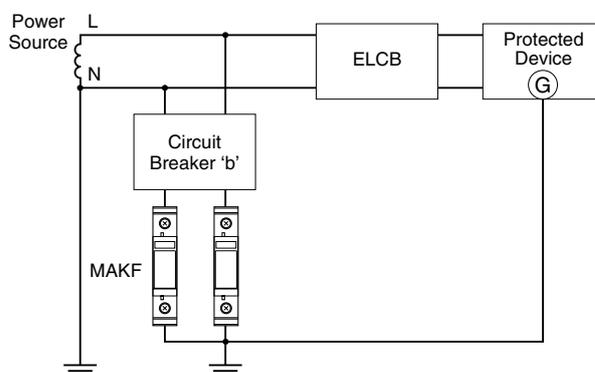
Install a circuit breaker at the power source side of the surge protector as a backup protection. The example below shows a single-phase/two-wire configuration. Molded-case circuit breakers (MCCB), earth leakage circuit breakers (ELCB) or current-limiting fuses (slow-blow type only) can be used. Install the MAKF at the secondary of the circuit breaker 'a' as shown in the figure. If the rated current of the circuit breaker 'a' exceeds 30A, or if the loss of power supply to the protected device should be prevented when the circuit breaker 'a' blows due to a surge protector failure, install the circuit breaker 'b' (rated current 20 to 30 A) at the branch circuit.



### ■ USING AN EARTH LEAKAGE CIRCUIT BREAKER

Time-delay type ELCB is recommended for use with surge protectors. You may need to reset other types of ELCB too often due to it tripping unnecessarily by lightning.

If the circuit breaker 'a' in the above figure should not be time delayed in order to coordinate with other breakers, add a branch at the primary side of the ELCB and install a MCCB and the surge protectors.



**■ CIRCUIT BREAKER REQUIREMENTS**

Additional requirements are listed below:

- The circuit breaker must have elements at both poles.
- The rated interrupting capacity of the circuit breaker must be greater than the highest amount of current that could be available in the circuit.
- Recommended sensitivity current rating: 30mA
- When the alarm output of the MAKF should be used, choose also a circuit breaker with an alarm output. Configure a logical addition sequence so that the alarm trips when both or either of the MAKF or the breaker alarm trips.
- Recommended rating of a current-limiting fuse: Rated current 30A, I<sup>2</sup>t value 5000A<sup>2</sup>s minimum. Current-limiting fuses have no alarm and thus are not recommended when the MAKF is with the alarm output.

**■ INSTALLATION ON THE LINES**

In general, lightning surges hit electric devices in common mode to the ground. As a result, transient voltage appears between the power line and the ground. The basic use of the MAKF is an installation between the power line and the ground.

However, if there is an imbalance of the power source impedance, transient voltage may appear also between the power lines. In this case, the MAKF installed between the line and the ground suppresses the transient voltage to the maximum of two times the maximum surge voltage of the device.

If further protection is needed, the MAKF can be installed between the power lines as explained below:

- The MAKF's maximum continuous operational voltage must be within the maximum limit of line voltage variations.
- The MAKF has two terminals. Each terminal must be connected to each line. There is no polarity.

**■ CONNECTION EXAMPLES BY POWER SYSTEMS**

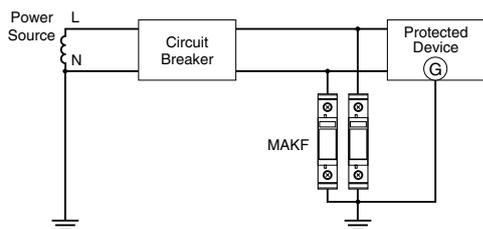
For circuit breakers in the figures, refer to 'INSTALLING THE CIRCUIT BREAKERS.'

Abnormal voltages appearing in case of a light load or a ground loop must be within the maximum continuous operational voltage when selecting the MAKF models.

For example, the IEC 60364-5-534 (Electrical installations of building; devices for protection against overvoltages) requires margins determined by the equations below:

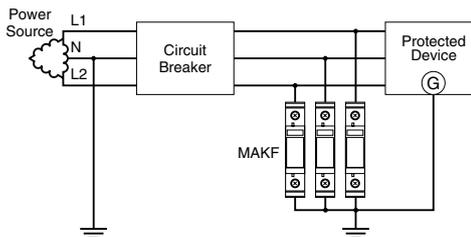
POWER SYSTEM	Uc (Max. Continuous Operational Voltage)
3ph/4w, Y connec, TT system	$Uc \geq 1.5 \times \text{Phase Voltage}$
3ph/4w, Y connec, TN system	$Uc \geq 1.1 \times \text{Phase Voltage}$
3ph/4w, Y connec, IT system	$Uc \geq \text{Line Voltage}$

**• Single-phase/2-wire connection**



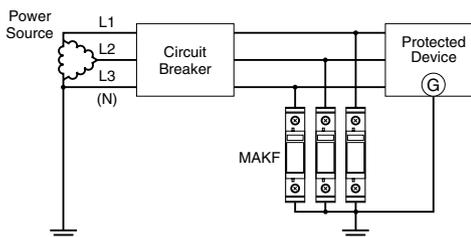
POWER SYSTEM	MODEL NO.
1-phase/2-wire, 100V AC	MAK-120x
1-phase/2-wire, 200V AC	MAK-240x
1-phase/2-wire, 250V AC	MAK-240x

**• Single-phase/2-wire (three-phase delta connection grounded in the middle of phases) or single-phase/3-wire connection**



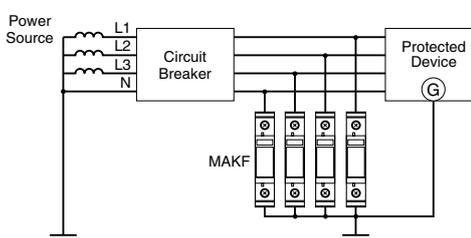
POWER SYSTEM	MODEL NO.
1-phase/2-wire, 100V AC	MAK-240x
1-phase/2-wire, 200V AC	MAK-400x
1-phase/3-wire, 200/100V AC	MAK-240x
1-phase/3-wire, 400/200V AC	MAK-400x

**• Three-phase/3-wire (delta connection)**



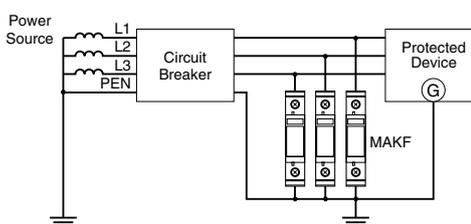
POWER SYSTEM	MODEL NO.
3-phase/3-wire, 200V AC	MAK-240x
3-phase/3-wire, 220V AC	MAK-240x
3-phase/3-wire, 400V AC	MAK-400x
3-phase/3-wire, 440V AC	MAK-480x

**• Three-phase/4-wire (star connection, TT system)**



POWER SYSTEM	MODEL NO.
3-phase/4-wire, 200/115V AC	MAK-240x
3-phase/4-wire, 220/127V AC	MAK-240x
3-phase/4-wire, 380/220V AC	MAK-400x
3-phase/4-wire, 415/240V AC	MAK-480x

**• Three-phase/4-wire (star connection, TN system)**



POWER SYSTEM	MODEL NO.
3-phase/4-wire, 200/115V AC	MAK-120x
3-phase/4-wire, 400/230V AC	MAK-240x
3-phase/4-wire, 480/277V AC	MAK-280x
3-phase/4-wire, 690/400V AC	MAK-400x

## WIRING

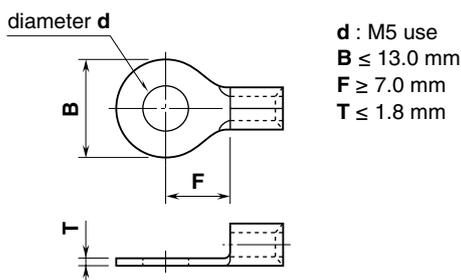
### LEADWIRES

Conductor cross-section area: 5.5 mm<sup>2</sup> minimum for both the power and the ground lines. However, a local industrial standard requirement for wiring should take precedence.

### SOLDERLESS TERMINAL

Applicable ring tongue terminal is as indicated below. Spade tongue terminal must conform with the ring type size. In order to ensure IP20 protection (IEC 50529) with a solderless terminal without insulation sleeve, cover the terminal with a marking tube to prevent direct touching by a hand.

#### Applicable Solderless Terminal Size



### POLARITY

Two screw terminals are provided. Connect either side to the power source side or the ground side.

### TORQUE

Tighten the screw terminals securely. Maximum allowable torque is of 2.5 N·m.

### MARKING LABEL

Use the marking labels included in the product package to identify power lines. The labels are appropriate in size to be placed close to each terminal as designated in the external dimensions.

Six labels are printed with typical markings, and three are blank for your own markings.

Blank labels may be used to identify the head element.

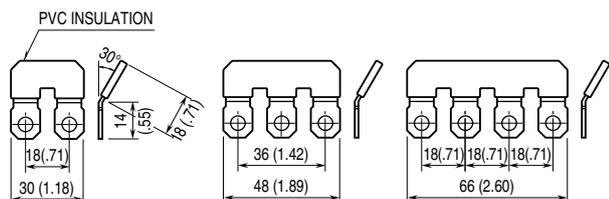
L1	L2	L3
N	E	G
PE		

### WIRING BRIDGE

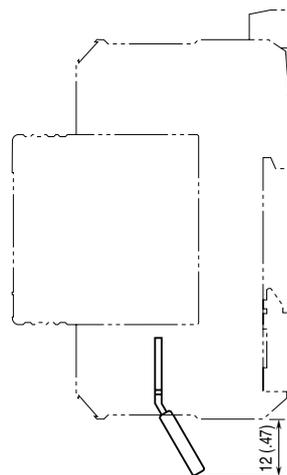
Wiring bridges for two poles (model: CNB-2), for three poles (model: CNB-3) and for four poles (model: CNB-4) are available for easy cross-wiring to the ground.

External dimensions are as shown below (Unit: mm (inch)).

#### CNB-2      CNB-3      CNB-4



### CNB ATTACHED TO THE MAKx



### WIRE LENGTH

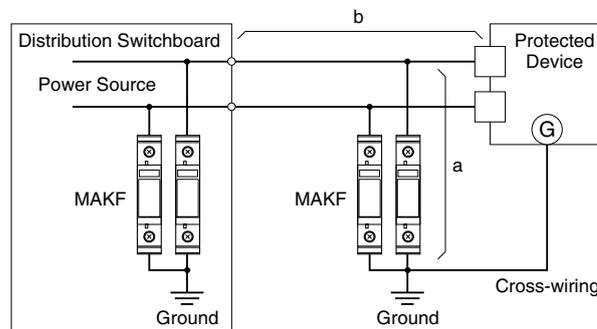
Keep the wire length to the minimum for both the power source side and the ground side. An example with single-phase/two-wire configuration is shown below. The wire length between the branch point and the ground ('a' in the figure) should ideally be less than 0.5 meters. Extra long wires should not be bundled in coils, but be cut to the minimum required length.

### PROTECTING LOW-VOLTAGE EQUIPMENT

The MAKF, one-port surge protector, is most suitable to protect electric devices such as isolation transformers, heaters, electromagnetic contactors, motors. On the other hand, combination type surge protectors incorporating serial impedance (model examples: MAX, MMA, MAH) are suitable to protect low-voltage electric devices such as computers, measuring instruments, transmission devices.

However, when the distance between the distribution switchboard and the protected device ('b' in the figure) is longer than 20 or 30 meters, the reactance of the wires would function as serial impedance in the combination type surge protectors. In this case, the overall protection performance should be augmented by one-port surge protectors installed inside the switchboard and next to the protected device, protected device side cross-wired to the ground.

#### Single-phase/2-wire connection



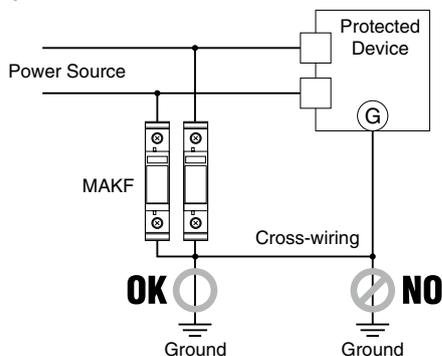
## GROUNDING

### ■ COMMON GROUNDING WITH CROSS-OVER WIRE

Basically a common grounding with cross-wiring between the MAKF and the protected device is recommended for adequate protection. Grounding resistance should be less than 100 ohms. If the protected device has no ground terminal, ground only the MAKF.

The ground point should be close to the MAKF side as shown below.

#### •Single-phase/2-wire connection



### ■ INDEPENDENT GROUNDING

The MAKF installed inside a distribution switchboard is often located far from the protected device, thus an independent grounding is needed. In such cases, keep the grounding resistance as low as possible (several ohms), or add another MAKF for local protection next to the protected device.

## ALARM OUTPUT

Optional SPDT relay output is available to alert when the thermal breaker has separated the discharge element from the power supply circuit.

If the alarm output should be transmitted remotely via outdoor cables, a surge protector for signal line is required.

Choose a circuit breaker with an alarm output. Configure a logical addition sequence so that the alarm trips when booth or either of the MAKF or the breaker alarm trips.

### ■ RELAY SPECIFICATIONS

Alarm output: The SPDT relay trips when the thermal breaker operates and/or the head element is removed.

Rated load: 250V AC @0.5A (resistive load)  
125V DC @0.2A (resistive load)

Minimum switching load: 5V DC, 1mA

### ■ CONNECTION

Terminal: Terminal block

Applicable wire size: 0.14 to 1.5 mm<sup>2</sup>

Stripped length: 7 mm

Torque: 0.25 N·m

## CHECKING

### ■ WIRING

- Make sure that wiring is done as instructed in the connection diagram.
- Make sure that the Ground terminal (G) is connected to the metallic housing of protected equipment.
- Make sure that the Ground terminal (G) is grounded to earth.

### ■ ELEMENT-BASE CONNECTION

- Make sure that the head element is pushed into the bottom of the base and that the mount position keys are entirely inserted into the key holes.
- The alarm output will not function appropriately if the head element is not connected firmly.

## MAINTENANCE

Even lightning in remote locations could induce surges without our knowledge. Regular checking of the surge protector is important to find degradations in early stage, before and after the storm seasons, and whenever you experience a strong lightning storm.

DO NOT attempt checking or replacing the surge protector during a thunder storm for safety.

Checking procedure is as explained below:

### ■ CHECK WINDOW

Green color is normal, indicating the surge protector is functioning properly. Black indicator means that the protector is in failure. Replace with a new one immediately.

### ■ DISCHARGE ELEMENT MODULE

Pull out the head element from the base.

Connect the probes of a multimeter in high-resistance range across the plugs on the head element and confirm no conduction (The meter should indicate 10 MΩ or greater).

Then connect the probes of a 1000 V DC/1000 MΩ insulation tester across the plugs and confirm discharging (The meter should indicate 20 MΩ or less).

If any of above testing proves an abnormality, replace the head element with a new one immediately.