

Control Panel Basics



Basic Information on Control Panel Design



Knowhow on Control Panel Design, from the Latest Information, Environmental Measures, Safety Standards, and Valuable Information.

Changes in the market require handling a wide variety of control panel issues.

Control Panel Basics describes OMRON's wealth of knowhow and information and provides easy-to-understand descriptions of the knowledge required to solve these issues through concrete examples.

Control Panel Basics

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Control Panel Efficiency Starts with the Terminals

Change from Tightening Screws to Inserting Wires
You Can Increase Production Efficiency by Rethinking Wiring Work

Wiring Work

Wiring work is essential to manufacturing control panels, and it accounts for the majority of the lead time for control panel manufacturing. Therefore, if you can make wiring work easier and faster, you can dramatically shorten the manufacturing lead time for control panels.

Current Issues

Normally when people hear about wire connection methods, many of them tend to think about securing wires by tightening screws. And in reality, many of the control devices used in control panels use screw terminals, and such devices have become common. Also, screw terminals have a long track record, are the method most recognized by customers, and are therefore considered reliable. However, screw terminals require that you loosen the screw, attach the wire (crimp terminal), and then tighten the screw, which is a lot of work.

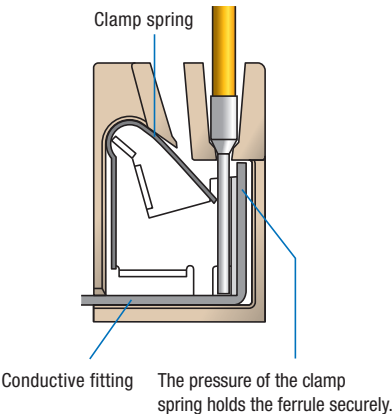
New Screwless Connections

Screwless connections, which have recently become common in Europe, eliminate the need to tighten screws to dramatically reduce the work required for wiring and they are gradually becoming popular in control panels around the world. The work of loosening and tightening screws has been replaced by merely inserting wires to complete wiring work, greatly reducing work time. First you need to learn about screwless connections and then experience how efficient this method is.

Push-in Terminals

Push-in terminals are one type of screwless terminal. Wiring is completed simply by inserting a wire with a crimped ferrule. The strength of a spring presses the ferrule against the terminal wall to connect the wire.

Mechanism



No Retightening Work

Note: Test conditions: IEC 60947-7-1

Differences in Wiring Work

	Wiring			
Screw terminals	(1) Loosen the screw.	(2) Remove the screw.	(3) Attach the terminal.	(4) Tighten the screw.
Round terminals				
	27 s *			
Forked terminals		Unnecessary		
	7 s *			
Push-in terminals				Insert.
Ferrules		2 s *		
	Not necessary	Not necessary	Not necessary	

* Based on OMRON demonstration test results.

What Are Push-In Plus Terminal Blocks?

Push-In Plus Terminal Blocks were independently developed by OMRON for easy wire insertion and firm wire holding ability. It's as easy as inserting an earphone jack: No tools are required for wiring.

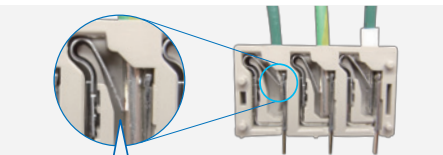
Easy to Insert

OMRON's Push-In Plus terminal blocks are as easy as inserting to an earphone jack. This reduces the load on worker fingers.



Held Firmly in Place

Even though less insertion force is required, the wires are held firmly in place. The advanced mechanism design technology and manufacturing technology produced a spring that ensures better workability and reliability.



IEC standard (cable diameter)	Push-In Plus terminal block	Screw terminal block
20 N min. (AWG20, 0.5mm ²)	125N	112N

* Information for Push-In Plus terminal blocks and Screw terminal blocks is based on OMRON's actual measurement value data for the XW2R.

Work with Both Hands

Optimized shape to hold the screwdriver was created by the resin parts and the spring. Work goes smoothly when connecting stranded wires directly to the terminal because it's easier to aim at the desired terminal.



Wiring Possible with Stranded Wires

You can insert wires with ferrules or you can also insert solid wires or stranded wires.



Recommended Products with Push-In Plus Terminals

Switch Mode Power Supplies
S8VK-S

Uninterruptible Power Supply (UPS)
S8BA

Power Monitors
KM-N2/KM-N3

Measuring and Monitoring Relays
K8DT

Solid-state Timers
H3DT

Solid-state Timers
H3Y(N)-B

Solid-state Timers
H3RN-B

Liquid Leakage Sensor Amplifiers
K7L-B

Sockets for Relays with Forcibly Guided Contacts (for G7SA)
P7SA-PU

Common Sockets (for MY/H3Y(N)-B)
PYF-PU(-L)

Common Sockets (for G2R-S/H3RN-B/K7L-B)
P2RF-PU

Slim I/O Relays
G2RV-SR

Slim I/O Relays
G3RV-SR

I/O Relay Terminals
G70V

Pushbutton Switches Push-In Plus Terminal Block Series
A22N-P/A30N-P/M22N-P

Solid State Relays for Heaters
G3PJ

DIN Track Terminal Block
XW5T

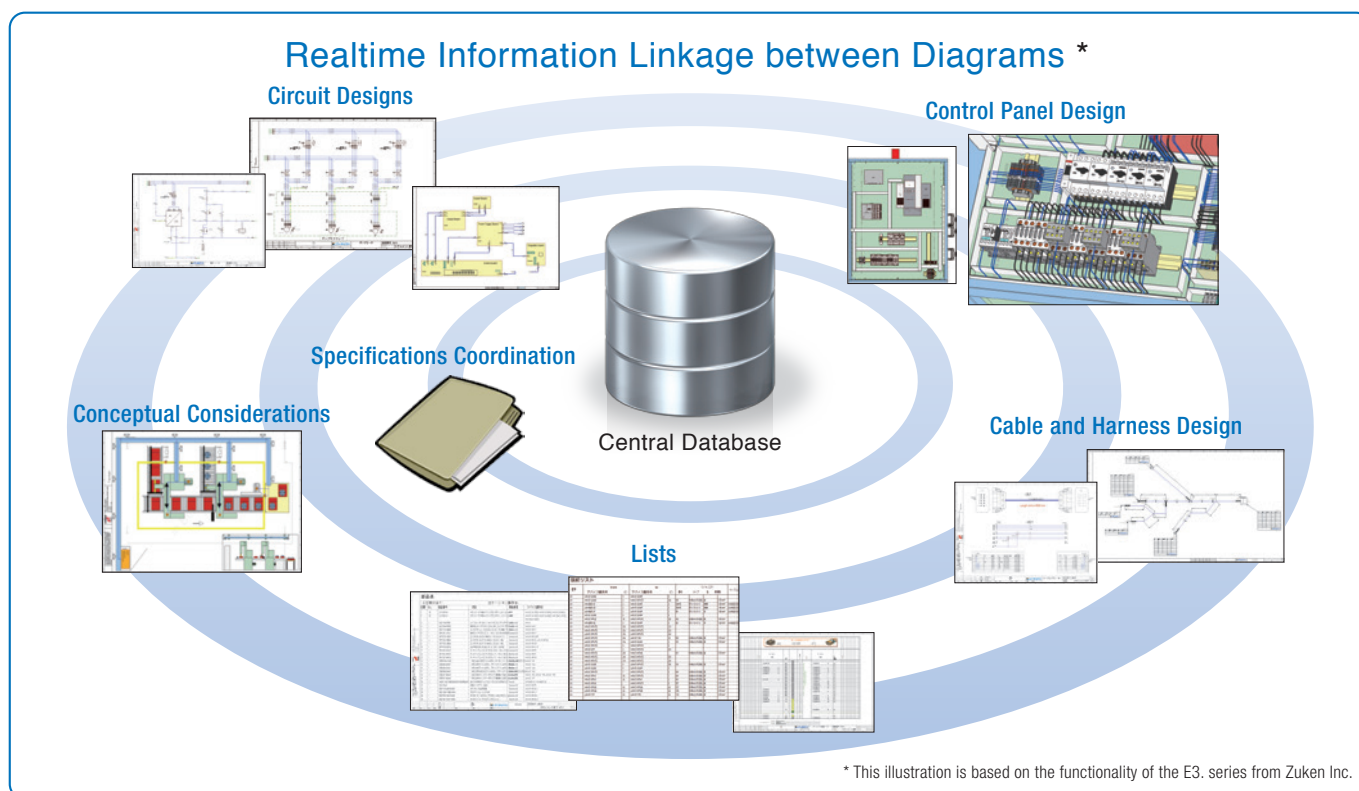
Digital Temperature Controllers
E5CC-B/E5EC-B

Application of Electrical Control CAD

Electrical Control CAD Significantly Increases the Efficiency and Quality of Electrical Control Designs

What Is an Electrical Control CAD?

Electrical control CAD is specialized software to design circuit diagrams (elementary wiring diagrams), cable production diagrams, and control panel layout diagrams. Specialized electrical CAD previously existed, but CAD that unifies management of design data have recently received a lot of attention.



The use of high-quality electrical control CAD libraries is important to maximizing the functionality of electrical control CAD.

Partners for electrical control CAD:

Zuken Inc.



EPLAN

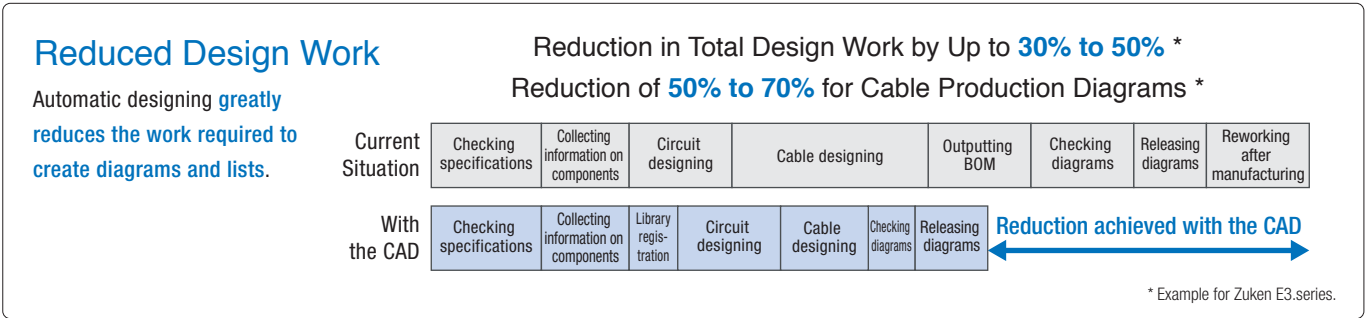


E3.series is a product name of Zuken Inc. for their Electrical and Control Cable Design Solution.
EPLAN is a registered trademark of EPLAN Software & Service GmbH & Co. KG.

Benefits of Introducing Electrical Control CAD

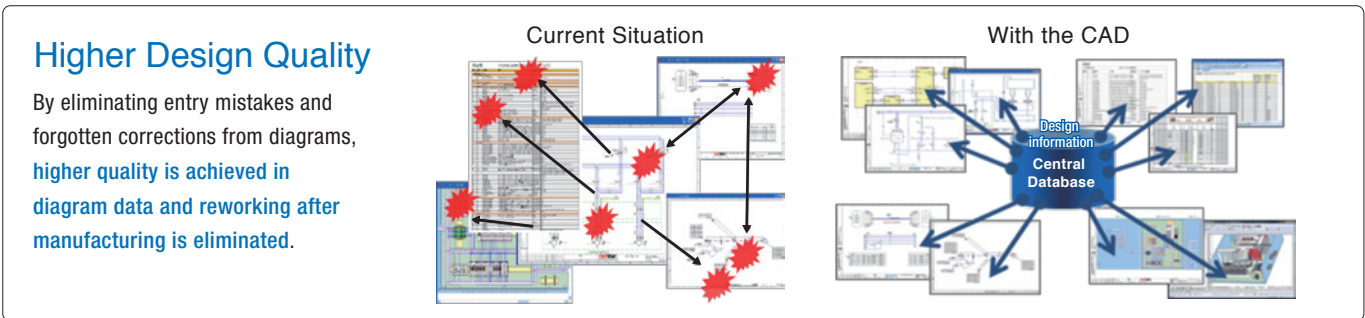
Automatic Creation of Diagrams and Lists

The unified management of design information in a database makes it easy to automatically create diagrams, such as cable production diagrams, as well as many different types of lists.



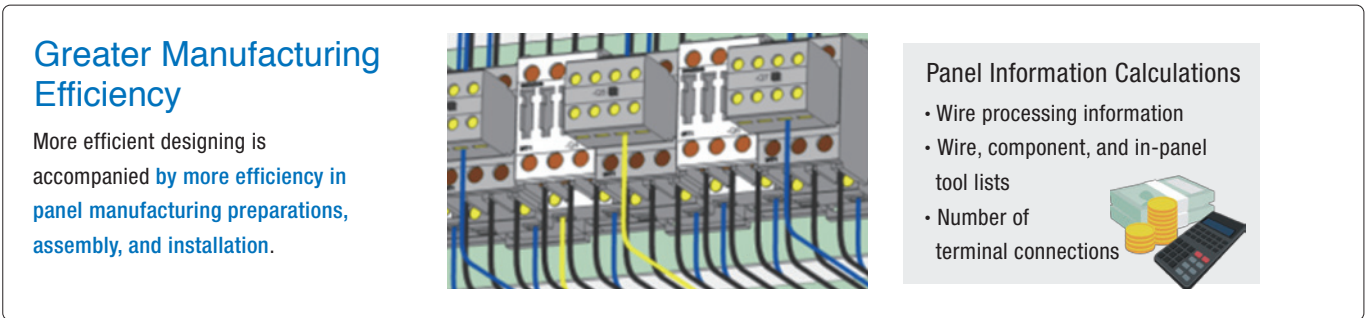
Achieve Consistency between Diagrams in Realtime

The results of designing work (circuit diagrams, cable production diagrams, control panel layout diagrams, terminal block layout diagrams, connector lists, etc.) can be edited from any diagram and the changes will be reflected in all the related diagrams and lists in real time. This helps eliminate entry mistakes and forgotten corrections to greatly increase design quality.



Flexible Panel Design, Including Wiring, Interference Checks, and Wire Processing

Simplified 3D designing allows you to consider interference checks and prohibited areas in designs. Wire length measurement function allows wires to be prepared in advance.



Note: The example of the results of CAD introduction on this page is based on the functionality of the E3. series from Zuken Inc.



Panel Assist Web

Simplify and Accelerate Panel Designing.

Information to Solve Your Control Panel Manufacturing Issues

Panel Assist Web

New Value For Control Panels

The Panel Assist Web is a new website for our customers that work with control panels. You can select products and search for documents. Or you can find solutions for the issues you face in control panel manufacturing and you can manage BOM. Use this website to more efficiently design control panels.

Take a Look Now!

► www.ia.omron.com/solution/panel/



Easy Product Selection: No Registration Required



Find Information to
**Help Solve
Issues**

You can find information to help you solve control panel issues, such as downsizing or work reduction issues.
(e.g., explanatory videos for Push-In Plus Terminal Blocks are available.)

Sample: Specifications Search

Narrow down items by specs.

Reset the conditions

Class: ☒ Analog Timer ☐ Digital Timer ☐ Time switch

Value Design for Panel: ☒ Compliant (Unified dim size, Close mountable at 55 °C, Push-in plus terminal block, Wire front-release release, Conforms to C-BAUCSA)

Mounting method: ☒ DIN rack mounting ☐ Panel mounting ☐ PCB mounting ☐ Socket

Wiring method: ☐ Screw terminal block ☐ PCB terminals ☐ Socket ☒ Push-in terminal block/Screwless clamping terminal block

Width: 20 mm max.

Operation surface size: ☐ 12.8 x 31.2 ☐ 17.5 x 80 ☐ 17.5 x 90 ☐ 17.75 x 23.3 ☐ 21.5 x 28 ☐ 22.5 x 79 ☐ DIN48x45 ☐ DIN96 x 96

Power supply voltage: ☐ 24 VAC ☐ 48 VAC ☐ 100/110 VAC ☐ 120 VAC ☐ 200/220/230 VAC ☐ 240 VAC ☐ 6 VDC max. ☐ 12 VDC ☐ 24 VDC ☐ 48 VDC ☐ 100 VDC ☐ 110 VDC ☐ 125 VDC

Control output: ☐ Transistor Output ☐ Contact output (1 point) ☐ Contact output (2 points)



Find Information without
Getting Lost

Just the right products and documents will be recommended in response to operations. You can find the information you need quickly and select the optimum products.

Solution Display Examples

Panel Solutions
We are offering practices and solutions to miscellaneous problems for control panels.

Innovation in Creating Control Panels | Space-saving/Downsizing | Workload Reduction | Thermal Countermeasures | Development of New Personnel

Innovation in Control Panel Building
Control Panel Building that Goes One Step Ahead Bring New Value to Control Panels
OMRON promotes an approach to Control Panels, Processes, and People for control panel building that creates new value in order to achieve control panels that go one step ahead.

Work Reduction
Push-In Plus Terminal Blocks
1 Push-In Terminals for Greatly Reduced Wiring Work Have you ever thought that reducing wiring work would greatly reduce the overall work for control panel manufacture?



Easy Selection
of In-panel Devices

It can be added to BOM

You can greatly reduce model selection work.
You can filter selection by model and then compare product specifications for easy selection.

Sample: Recommendation Display

Accessories

Recommended Items

Products that are selected together: Multifunction Power Counter RTCA-A

Unified Value Design products: SINK-S (R01202E3480/R) SINK-S

Reducing Wiring Work in terminal blocks: DIN Track Push-in Terminal Blocks XWST-P

See the product details | Narrow down items by specs

Related Articles
Innovation in Control Panel Building



Even More Convenient Functions with Member Registration (Free Registration)



Create BOM Easily

You can create and save BOM of OMRON and non-OMRON products. Convenient tools are provided for more-advanced designing.



BOM to Reduce Design Work

You can use the tool and various kinds of convenient functions starting from BOM.

Reduce Work with the Terminal Block Support Tool

The electrical specifications and applicable wires are automatically displayed for the selected devices. You can easily select the Terminal Blocks required to wire devices without wasting time.

Replacement with the Latest Products

You can import an existing BOM to check product manufacturing status and stock status, and to replace products with the most suitable up-to-date products.

BOM Example

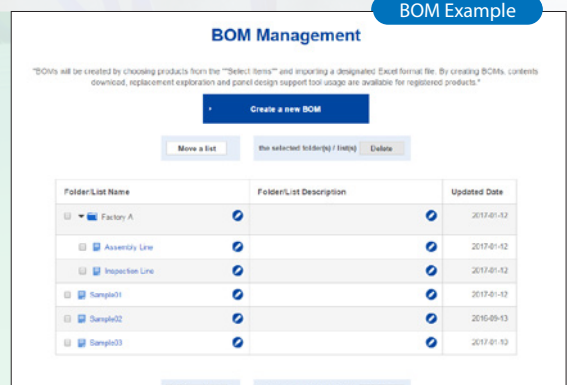
	Model number	Product Category	Manufacturer	Production status
☐	E5CC-RX2ABM-000	Temperature Controllers	omron	
☐	E5CC-RX2ASM-000	Temperature Controllers	omron	
☐	H3DT-A1 AC/DC24-20	Timers/Time Switches	omron	
☐	QRV-SR500 AC/DC 24	General Purpose Relays/Power Relays	omron	
☐	XWST-P1.5-1.1	Terminal Blocks	omron	

Checking in Advance with Thermal Simulation Tool

Just input basic control panel information in addition to the selected device information to understand heat risks and thereby reduce the need of working later.

Download Documents as Soon as You Select Parts

You can download CAD data or catalogs in multiple languages.





Heat Measures

The correct Fan must be selected to suppress temperature rise inside the panel.

If the temperature inside the panel increases, the lives of devices and parts inside the panel will be reduced and malfunctions could result. Particularly devices and parts that generate heat are greatly affected by heat. Panel cooling and Fan selection are extremely important to long-term usage of the panel and parts inside the panel.

Selecting Fans

- 1

Check the heating values of devices and the panel (kW).

Check the heating value of each device located in the control panel and then find the total heating value. Generally speaking, the heating value indicates the power consumption, so you can assume that the power consumption equals the heating value.

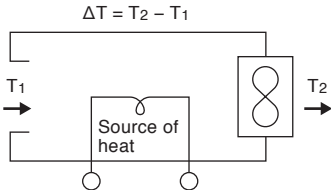
$$\begin{aligned} \text{Heating value (W)} &= \text{Input power} - \text{Output power} \\ &= \frac{\text{Output power}}{\text{Efficiency}} - \text{Output power} \end{aligned}$$
- 2

ΔT of devices and panel: Allowable temperature rise (°C)

ΔT can be obtained by subtracting the device ambient temperature, T1 from the allowable internal temperature, T2.

Note: As a guideline, you can make the calculation with a value of 10°C.
(Use the more severe condition.)

$$\Delta T = 10^{\circ}\text{C} \text{ (guideline)}$$


- 3

Calculate Q, the required flow rate (m³/min).

$$Q = \frac{50 \times W}{\Delta T} \text{ m}^3/\text{min}$$

Q = Flow rate (m³/min)
ΔT = Allowable temperature rise (°C)
W = Heating value (kW)
- 4

Select the size of the required Fan based on the maximum flow rate.

Normally, select a Fan with a maximum flow rate of 1.3 to 2 times the calculated required flow rate (Q). As the flow rate increases, noise increases. If the Fan is used in an environment where noise is a problem, select a Fan with a lower flow rate.
- 5

Selecting Options

If fine foreign matter may enter the Fan, select a Filter.

If slender objects such as fingers may enter the Fan, select a Finger Guard.

Note: Actually results may vary from calculations, so measurement and confirmation in the actual panel are required.

Calculation Example for a Control Panel with Two 100-W Power Supplies

Note: The S8JX-N10024C (output voltage: 24 VDC, output current: 4.5 A, efficiency: 83% min.) is used for the 100-W Power Supplies.

First, the heating value (power consumption) is calculated.

$$\begin{aligned} \text{Heating value (W)} &= \frac{24 \text{ (V)} \times 4.5 \text{ (A)}}{83 \text{ (\%)}} - 24 \text{ (V)} \times 4.5 \text{ (A)} \\ &= \frac{108 \text{ (W)}}{0.83} - 108 \text{ (W)} = 22.120 \dots \text{ (W)} \end{aligned}$$

Two Power Supplies are used, therefore,

$$22.12 \text{ (W)} \times 2 \approx 44.2 \text{ (W)} \approx 0.04 \text{ (kW)}$$

$$Q: \text{ Required flow rate} = \frac{50 \times 0.04 \text{ (kW)}}{\Delta T: 10^{\circ}\text{C}} \approx 0.2 \text{ [m}^3/\text{min]}$$

Maximum flow rate calculation: $Q \times 2 \quad 0.2 \times 2 = 0.4 \text{ [m}^3/\text{min]}$

Therefore, one R87F-A□A83H is required according to the maximum flow rate of the table on the right.

Note: This calculation example assumes that the control panel contains only two Power Supplies.

Models and Maximum Flow rate

Model	Size (mm)	Maximum flow rate (m³/min)	
		50 Hz	60 Hz
R87F-A□A15HP	120 × 120 × t 38	2.7	3.1
R87F-A□A13HP	120 × 120 × t 25	1.9	2.2
R87F-A□A93HP	92 × 92 × t 25	0.9	1.0
R87F-A□A85HP	80 × 80 × t 38	0.8	0.9
R87F-A□A83H	80 × 80 × t 25	0.6	0.7



Point!

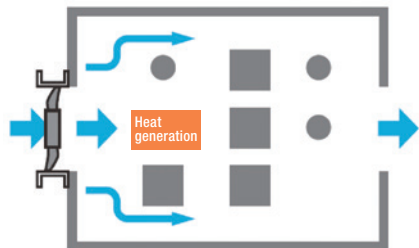
If the flow rate is insufficient, two Fans can be operated in parallel for approximately twice the maximum flow rate.

$Q1 \times 2 \approx Q2$

Q1: Flow rate of one Fan
Q2: Flow rate for parallel operation

Airflow Direction and Inlet/Outlet Cooling Effect Differences

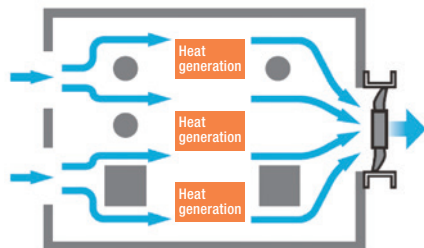
When the Heat-generating Portions Are Concentrated at One Location



Advantages of Inlet Installation

- You can concentrate cooling on the heat-generating portions.
- The pressure inside the box increases, which reduces dust entry from other openings.

When the Heat-generating Portions Are at Many Locations

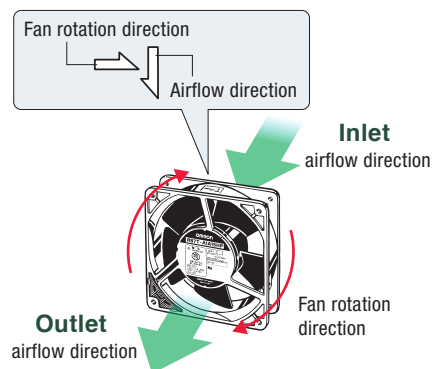


Advantages of Outlet Installation

- A wide area can be cooled.

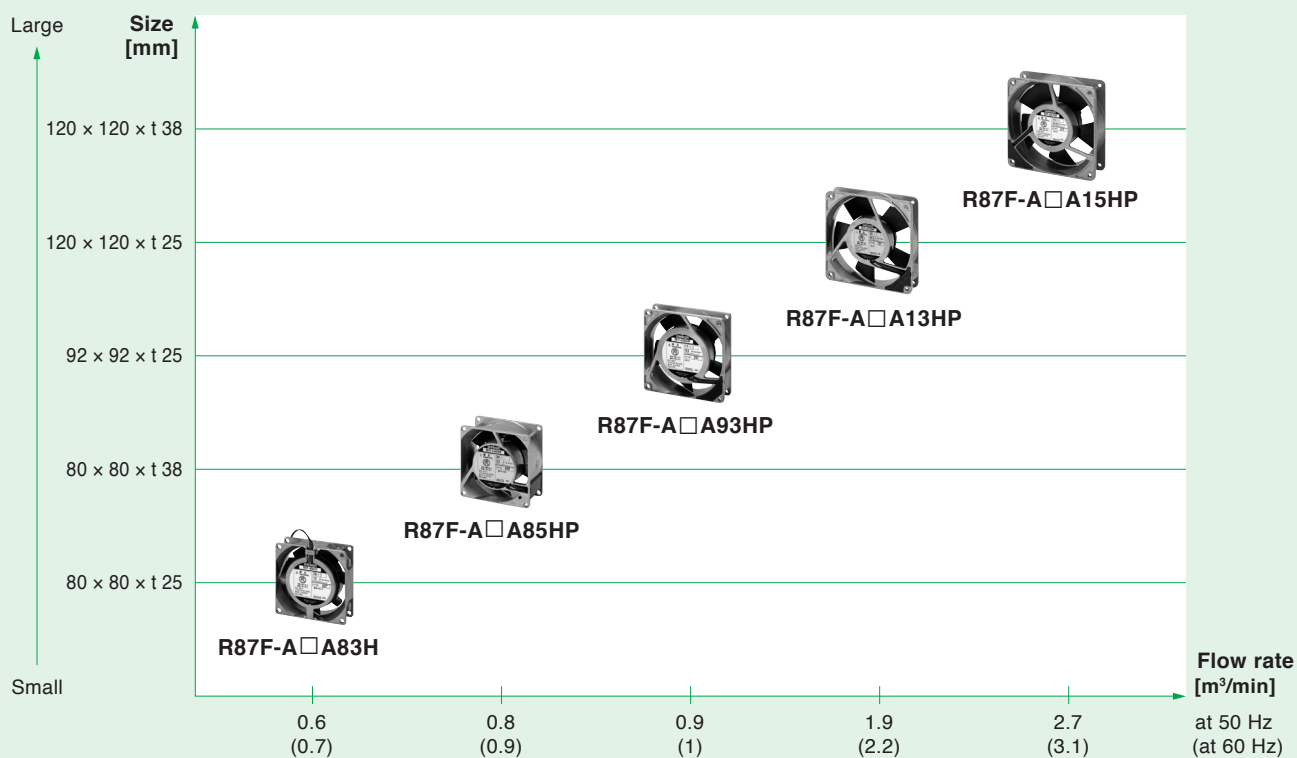
Reference Information:

The Fan airflow is in one direction, which is indicated on the top of the Fan.

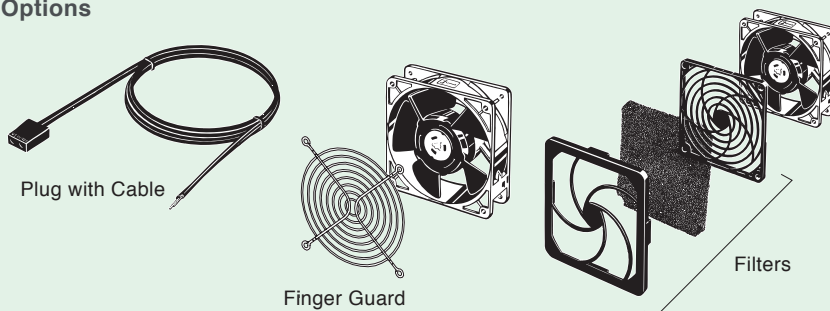


Recommended Axial Fans

R87F AC Axial Fans



Options



Models	
Plug with Cable *	R87F-PC(JT)
Finger Guards	R87F-FG□
Filters	R87F-FL□(S)

* Required for models with terminals (models ending with "P").

Search for OMRON R87F for details.



High Humidity Measures

If a control panel is installed in a location with high humidity, measures against short-circuits are required.

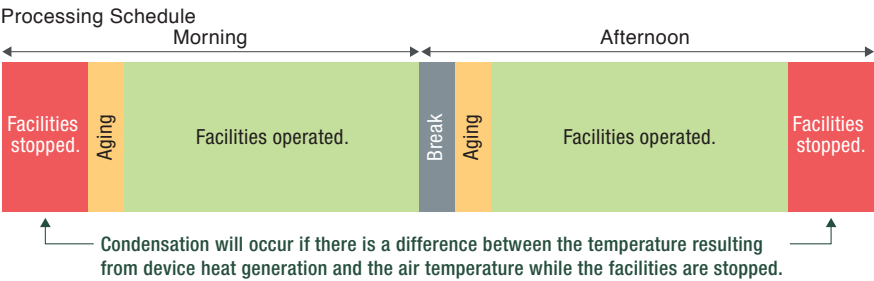
Condensation will occur in the control panel as the result of a difference in the device temperature and external air temperature. This condensation may adhere to a PCB and if condensation and dust repeatedly collect on the PCB, short-circuits will occur.

Examples of Short-circuits Caused by Condensation

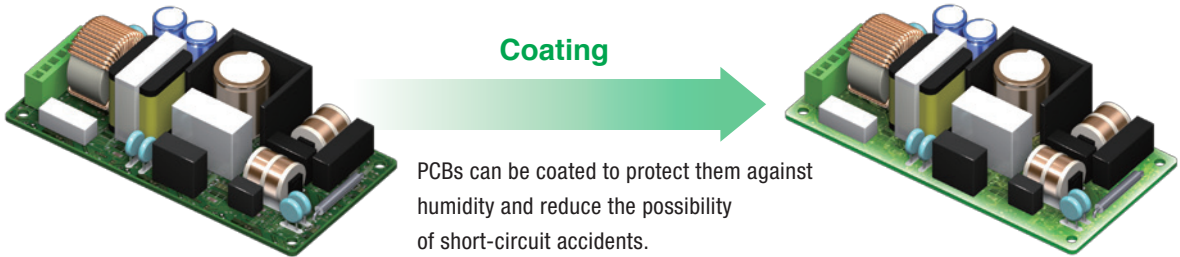


Case 1: **Short-circuit** from Water Drops Generated by Condensation

Case 2: **Short-circuit** Caused by Repeated Condensation and Dust Collection



Preventing Short-circuits with Products with Coated PCBs or Modifications



Recommended Products with Coated PCBs

Ask your OMRON representative for more information on coating.

Switch Mode Power Supplies

S8VK-S
S8FS-G

Timers

H3CR
H3DT
H3Y-B
H5CX

Digital Temperature Controllers

E5□C/E5□C-B
E5CB

Micro PLCs

CP1E
CP1L
CP1H
CP1W

Counters

H7CX
H7E□-N

Single-phase Power Controller

G3PW

MEMO

[illegible]

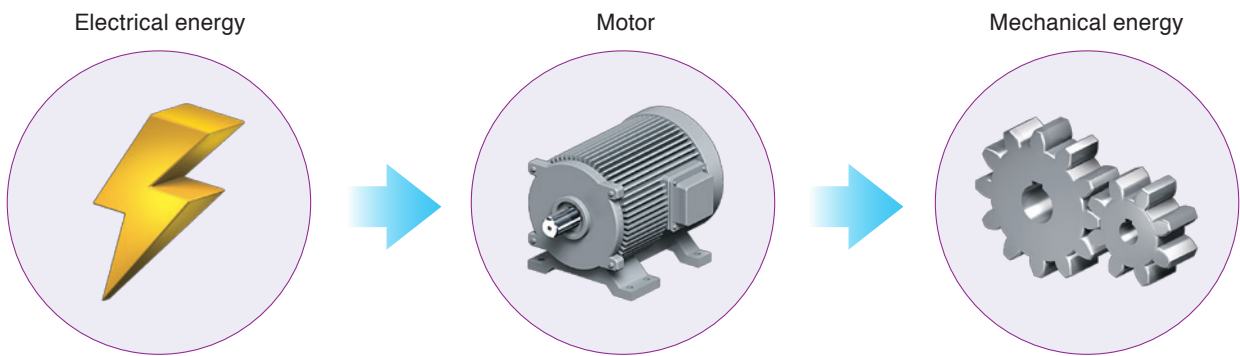
Examples of and Measures to Prevent Motor Failures

Implementing Protective Measures for Failures of Important Devices

In general, when devices are used for a long period of time, they deteriorate over that time, and ultimately fail. To minimize the effects of device failure, we recommend that you implement protective measures in advance for important devices. This section discusses motors, which are important devices.

Motors

A motor converts electrical energy to mechanical energy. Due to its characteristics, a motor has both an electrical structure and a mechanical structure , and it fulfills very important roles.



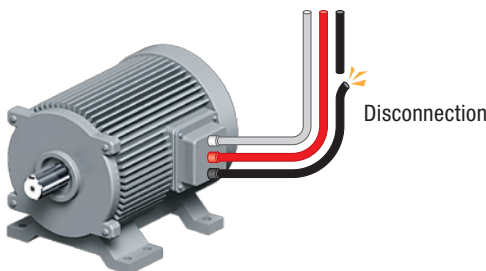
There are various failure types that lead to motor failure. By detecting abnormal signals and using them to stop the motor, motor failure and damage to the motor's load can be avoided. Major examples of motor failures and products that can be used to detect motor abnormalities are introduced on the right-hand page.

One Point !

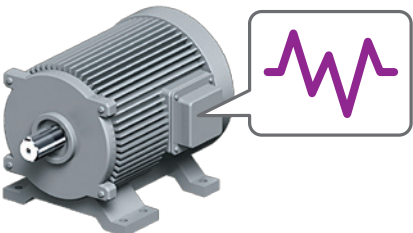
Are just breakers and thermal relays insufficient as protective measures?

Not all types of motors and operation can be protected with just breakers and thermal relays.

Example:
Breakers can not detect phase loss.



General thermal relays can not detect phase loss during operation, so operation may not be stable.

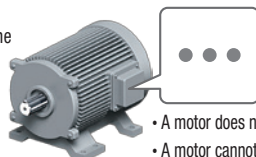


Motor Failure Examples (Phenomena)

Phase-loss Errors

Example:
Disconnection of a power line

Failure to start



Burning due to phase-loss operation



Unstable operation

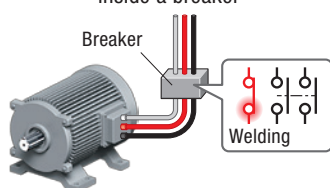


Phase loss when starting

Phase loss during operation

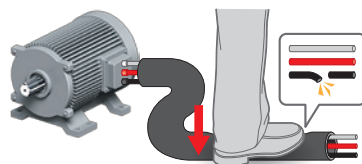
Causes

Welded contacts inside a breaker

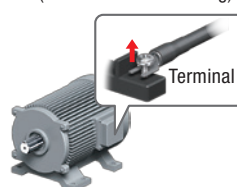


Disconnection

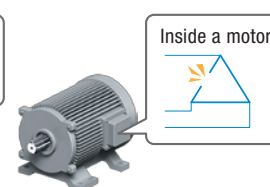
- Wheels rolling over or people stepping on lines
- Cables bent too far, etc.



Loose screws (contact failure in wiring)

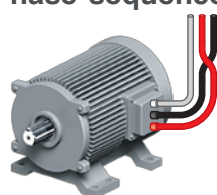


Phase loss inside a motor



Reversed-phase (Phase-sequence) Errors

Incorrect wiring causes reverse rotation of the motor.

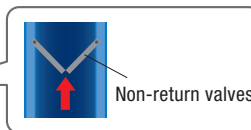


Incorrect wiring

- Movable equipment
- Incorrect phase on power line side

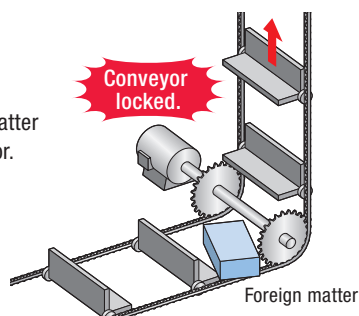


Reverse rotation of motor will damage valves in pumps.



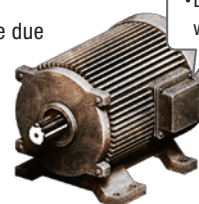
Overloads

Caught foreign matter locks up the motor.



Current Leakage

Current leakage due to insulation deterioration



- Aged deterioration
- Deterioration due to water or oil intrusion

Recommended Protective Relays

Detect Phase loss and Phase sequence
Models added with transistor outputs for stable operation with PLC.

Phase-sequence
Phase-loss Relays
K8DT-PH





Relay Selection:

“Better Too Big Than Too Small” Does Not Apply

Circuit Reliability will be Increased by Selecting a Suitable Relay for the Load.

With a computer or smartphone, you may want to select a hard disk or memory with extra capacity. In general, something larger often works well to substitute for something smaller, as in the saying "better too big than too small". However, that does not work with relays. The structural conditions required in a control relay to carry a large current as opposed to a minute current are different, so a suitable relay must be selected. Selecting a suitable relay will help increase the reliability of the relay circuit. You need to understand relay characteristics and correctly select relays to increase the quality of control circuits.

Relay Selection Methods

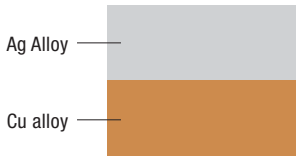
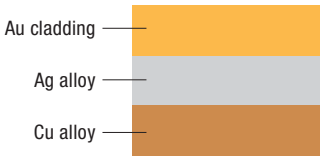
Switching High-capacity Loads

An important thing that determines the contact breaking capacity is the size of the gap between contacts of the same pole. Double-break contacts (see right-hand page) with a wide gap are effective. An Ag alloy with high conductivity is generally used for the contact material. However, Ag alloys are not suitable to switch minute loads that do not generate arcs when switching because organic films easily forms on the contact surfaces.

Switching Minute Loads

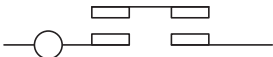
To reduce the probability of contact failure, using bifurcated contacts (see right-hand page) with two contact points is more effective than using single contacts with one contact point. Also, the arcs that are generated when switching minute loads are small, so they do not remove oxide and other films. Therefore, Au or Au alloys that resist corrosion are used for the contact material. However, they are not suitable to switch large currents due to the smaller contacts and lower conductivity in comparison with Ag alloys.

Differences and Trends in Contact Materials

Ag alloy	Au-clad Contacts
Ag alloys have high conductivity and are effective in switching large loads. Some corrosion occurs, but the switching arcs have a cleaning effect that removes organic films that form on contact surfaces.  Ag Alloy Cu alloy	The contact surfaces are clad with Au, which has a high resistance to corrosion, to increase resistance to corrosion. The formation of a resistive film will be suppressed, and arcing will be also reduced to make these contacts effective for minute loads.  Au cladding Ag alloy Cu alloy
High	Low
Low	High

Note: Au: Gold, Ag: Silver, Cu: Copper.

Differences in Contact Configuration and Application Examples

Contact Configuration	Common Loads	Application Examples
Double-break contacts 	High-capacity loads Guideline: Loads over 15 A Note: For relays, 40 A for AC and 10 A for DC.	Switching compressors and heaters Control applications for switching motors
Single contacts 	General loads Guideline: 0.05 to 15 A	General sequence circuits
Bifurcated contacts 	Minute loads Guideline: Less than 0.05 A	PLC inputs, signal applications, and self-holding circuits
Crossbar Bifurcated Contacts 	Minute loads Guideline: Less than 0.01 A Note: Contact reliability is increased because nearly line contact is achieved and the weight per surface area is larger.	Alarm applications (Infrequent applications)

High capacity

Low capacity

Major Examples of Relay Models, Contact Configuration, and Contact Materials

Relays for Control Circuits (For Relay Sequences)	Higher Load Capacity (2) MK	Even Higher Load Capacity (3) MM	Model	Contact configuration	Contact materials
Circuit Operation Confirmation (4) MY(S)			(1) MY	Single	2-pole: Ag alloy 3-pole: Ag alloy 4-pole: Au cladding + Ag alloy
Greater Contact Reliability (Minute Loads) (6) MY4Z			(2) MK	Single	Ag alloy
Greater Resistance to Environments (8) MYQ			(3) MM	Single	Ag alloy
Holding Circuits (10) MY2K			(4) MY(S)	Single	2-pole: Ag alloy 4-pole: Au cladding + Ag alloy
High-capacity DC Load Switching (14) MK-S(X)			(5) MK-S	Single	Ag alloy
Slim Relays (16) G2R-□-S			(6) MY4Z	Bifurcated	Au cladding + Ag alloy
			(7) MY4Z-CBG	Crossbar bifurcated	Au cladding + Ag alloy
			(8) MYQ	Bifurcated	Au plating + Ag alloy
			(9) MY4H	Bifurcated	Au plating + Ag alloy
			(10) MY2K	Single	Au plating + Ag alloy
			(11) G7K	Single	Au plating + Ag alloy
			(12) MKK	Single	Ag alloy
			(13) MMK	Single	Ag alloy
			(14) MK-S(X)	Double break	Ag alloy
			(15) MMX	Single	Ag alloy
			(16) G2R-□-S	Single	Ag alloy
			(17) G2R-□-S	Single	Ag alloy
			(18) LY	Single	Ag alloy
			(19) G7J	Double break	Ag alloy
			(20) G7Z	Double break	Ag alloy
			(21) MMX	Single	Ag alloy
			(22) MK-S(X)	Double break	Ag alloy
			(23) G2RV-□-AP	Single	Au plating + Ag alloy
			(24) G7T for input	Crossbar bifurcated	Au cladding + Ag alloy
			(25) G7T for output	Single	Ag alloy
			(26) G2RV_SR	Single	Ag alloy
			(27) G6B-4BND	Single	Ag alloy
			(28) G6B-4CB	Single	Ag alloy
			(29) G70V-SI Series	Single	Au plating + Ag alloy
			(30) G70V-SO Series	Single	Ag alloy
			(31) G7TC-I□ Series	Crossbar bifurcated	Au cladding + Ag alloy
			(32) G7TC-O□ Series	Single	Ag alloy

Note: Mainly Two-pole Relays are used in control circuits.

Relays for I/O Applications

High AC Capacity (18) LY	Even Higher Capacity (19) G7J	Even Higher Capacity (20) G7Z
High DC Capacity (21) MMX	Even Higher Capacity (22) MK-S(X)	
Minute Loads (23) G2RV-□-AP	Even Higher Reliability (24) G7T	
Slim Design (25) G7T	Even Slimmer Design (26) G2RV	

Note: Mainly One-pole Relays are used for I/O applications.

Types of Terminal Relays

Terminal Relays (4 Points)	I/O Blocks (8 or 16 Points)
(27) G6B-4BND/4CB	(29) G70V-SI Series
(28) G6D-F4B	(30) G70V-SO Series
	(31) G7TC-I□ Series
	(32) G7TC-O□ Series

Types of UL Certification

There are UL Listing and UL Component Recognition for UL certification.

UL certification is required for control panels used in the USA.

Here we describe the difference between certification as a UL listed component (listing) and certification for a UL recognized component (R/C).

Actions Required for New or Revised Components Used in Control Panels for the USA

Industrial control panels used in the USA are required to comply with UL508A.

Of the components used in control panels that comply with UL 508A, there are differences in the requirements depending on the UL certification (UL listed components or UL recognized components).

UL 508A Compliance

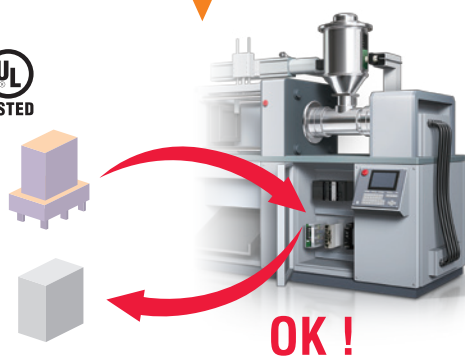


Using UL Listed Components

Application to the UL is **not required**.

- New or upgraded components can be used at any time.
- If urgent changes to components become necessary for adjustments or to handle problems, they can be made immediately.

Changes are possible at any time.

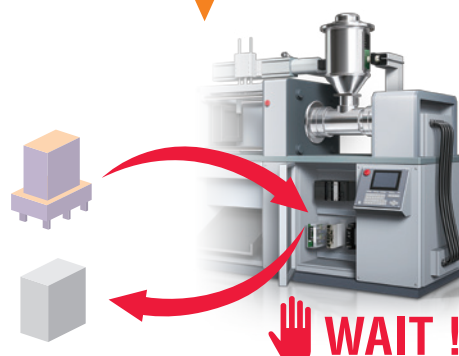


Using UL Recognized Components

Application to the UL is **required**.

- These components must be registered. The documents and data required for registration must be prepared and an application must be made to the UL.
- The UL will check the certification conditions and process the changes, so time will be required to use new or upgraded components.

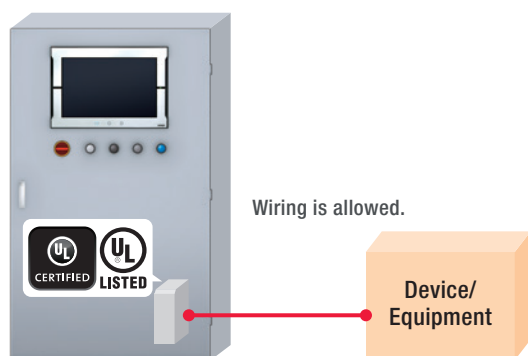
Component registration is required, which delays application.



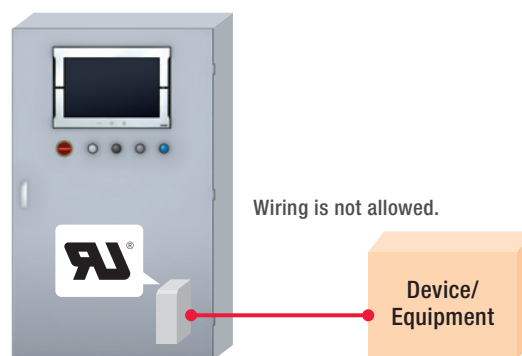
There are also differences based on whether the component is directly connected to devices or equipment outside of the control panel.

Example in Final Installation Site of Control Panel

Using UL Listed Components



Using UL Recognized Components



Note: There are some exceptions.

Point ! For People Who Want to Know More

UL Listing

- In general, this certification applies to end products that are operated by general users, such as machine tools, robots, and other equipment that are directly controlled by an operator.
- Because it is assumed that the equipment will be used by an operator or a general user, there are many restrictions and evaluation tests for designs and configuration components.

UL Component Recognition

- This certification applies to components that are built into end products that do not function by themselves or have limited functionality (molded products, wires, PWB, and general-purpose Automation Systems).
- Components for which UL Listing is not required fall under UL Component Recognition.

Recommended UL Listed Components

A Perfect Fit for Small Control Panels
Coated PCBs for Better Resistance
to Environment Connections for
Easy Wiring

Switch Mode Power Supplies
(60-W, 120-W, 240-W, 480-W)

S8VK-S



Search for "OMRON S8VK-S" for details.

Reliable and Easy Operation-
Worldwide Power Supply
Resistant in tough environments
Easy and fast installation
The most compact class on
the market

Switch Mode Power Supplies
(15-W, 30-W, 60-W, 120-W,
240-W, and 480-W models)

S8VK-G



Search for "OMRON S8VK-G" for details.

Worldwide 3-phase Power Supply
Resistant in tough environments
Easy and fast installation
The most compact class on
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Switch Mode Power Supplies
(120-W, 240-W, 480-W,
and 960-W models)

S8VK-T



Search for "OMRON S8VK-T" for details.

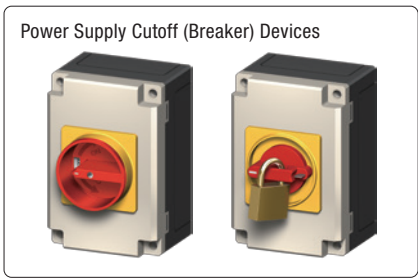
Control Panel Design Considering Electrical Safety Standards

The IEC 60204-1 electrical safety standards related to machine control panels must be considered.

The power supply breakers, device locations, and electric-shock prevention for control panel design are described from the viewpoint of safety standards.

Power Supply Cutoff (Breaker) Devices

- ON “|” and OFF “○” must be indicated.
- There must be an external operation means (e.g., handle).
- There must be a means to lock the device in the OFF position.
- There must be a suitable cutoff capacity. Etc.



Device Locations

- (1) Power supply cutoff devices: 0.6 to 1.9 m, recommended max.: 1.7 m
- (2) Manual operation devices: 0.6 m or higher
- (3) Terminals: 0.2 m or higher
- (4) Devices that must be approached for periodic maintenance or adjustments: 0.4 to 2.0 m

Enclosure Degree of Protection: IP22 or Better

Electric Shock Prevention

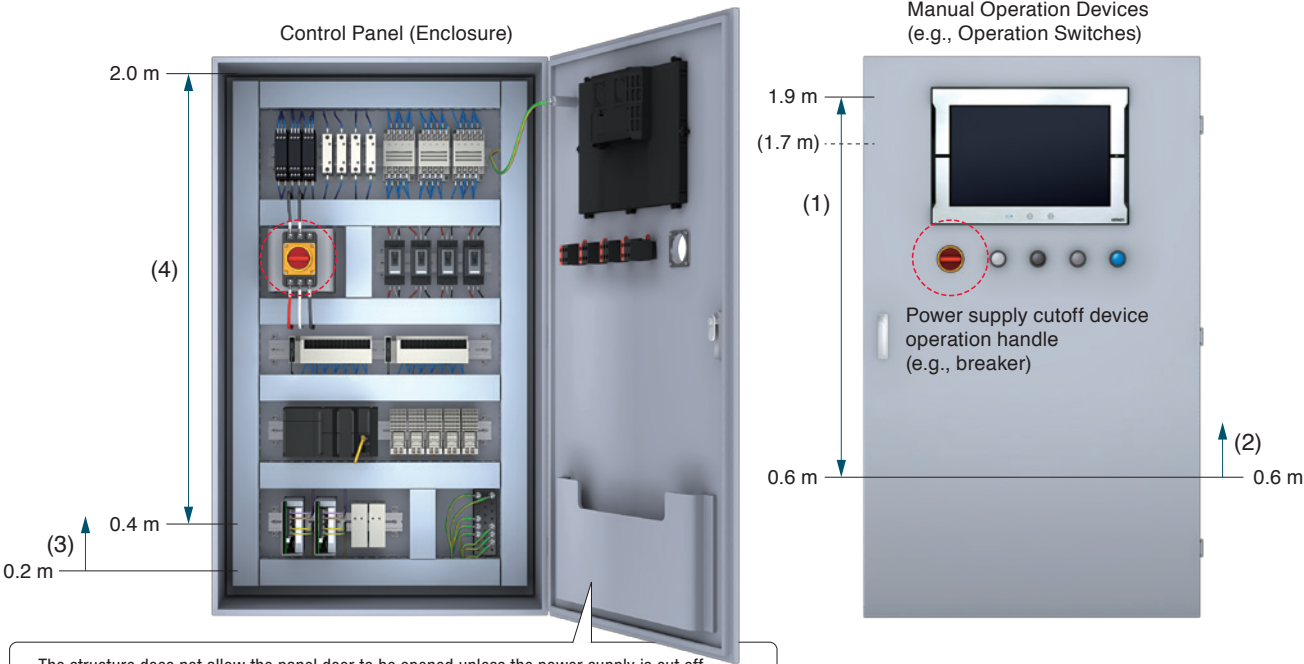
- When Enclosure Is Opened:
- It must be possible to open the enclosure when charged sections are cut off.
 - If the enclosure can be opened without cutting off a charged section, all charged sections must have IP2X or IPXXB protection.
If a barrier is provided, a tool must be required to remove it or the charged section must be automatically cut off when it is removed.

Additional Information

- IP2X: Protection against foreign objects with a diameter of 12.5 mm or larger (equivalent to a finger)
- IPX2: Protection against vertically falling water drops when enclosure tilted up to 15°
- IPXXB: Protection against an approaching finger

Reference Illustration

(Numbers 1 to 4 correspond to items 1 to 4 under Device Locations.)



- The structure does not allow the panel door to be opened unless the power supply is cut off.
- If the door can be opened without cutting off the power supply, charged sections must be protected, e.g., with covers, so that they cannot be touched with fingers or similar objects.

Note: The values are the heights from the working surface.

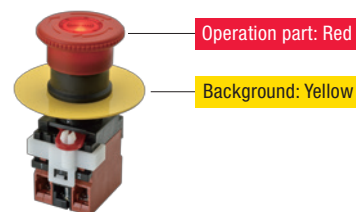
Control Panel Component Colors

It is important to correctly understand the meaning of the colors of indicators, operation parts, and wires.

Machine status indicated by indicator color		General meaning of operation device (operation part) color		General rules	
Color	Meaning	Description	Operator action	Description	Application example
Red	Emergency	Hazardous situation	Immediate action for the hazardous situation	Actuate in the event of a hazardous situation or emergency	●Emergency stop ●Stopping or turning OFF for emergency stop ●Initiation of emergency function
Yellow	Caution	Abnormal situation An impending critical situation	Monitoring and/or intervention	Actuate in the event of an abnormal condition	●Intervention to suppress abnormal condition ●Intervention to restart an interrupted automatic cycle
Green	Normal	Normal situation	No specific action required	Actuate to initiate normal conditions	●White is the most suitable color for a device (operation part) for starting or turning ON something, but green is also acceptable.
Blue	Mandatory	Indication of situation requiring operator action	Required action	Actuate for a condition requiring mandatory action	●Reset function
White	Neutral	Other situations Situation in which the use of red, yellow, green, or blue does not seem appropriate	Monitoring	Initiation of functions	●White can be used for any function other than an emergency stop.
				Human or environmental safety	Process status
				Hazard	Emergency
				Caution	Abnormality
				Safe	Normal
				Mandatory	
				—	



Color Requirements for Emergency Stop Switches



Wire Colors (IEC 60204-1)

Applicable conductor	Color
Ground (earth) circuit	Green-yellow spiral 
Power neutral circuits	Light blue 
Primary power circuits	Black 
DC control circuits	Blue 
AC control circuits	Red 
Excepted circuits (e.g., interlock circuits)	Orange 

Note: Excerpt from IEC 60204-1

Recommended Operation Devices

Globally applicable switches conceived for compactness, simplicity, and safety.

Pushbutton Switches A22N

Search for OMRON A22N for details.



Emergency Stop Switches
That Conform to Various Standards

Emergency Stop Switches A22E

Search for OMRON A22E for details.

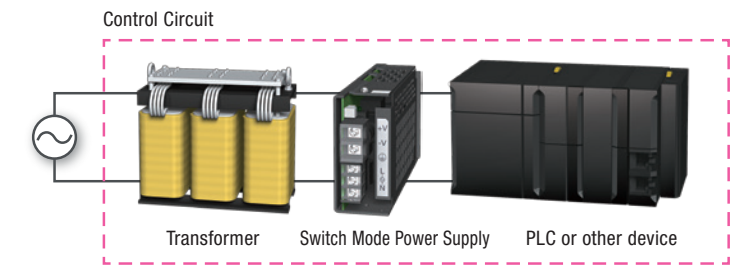


Reference

Saving Space in Control Panels with No Transformers

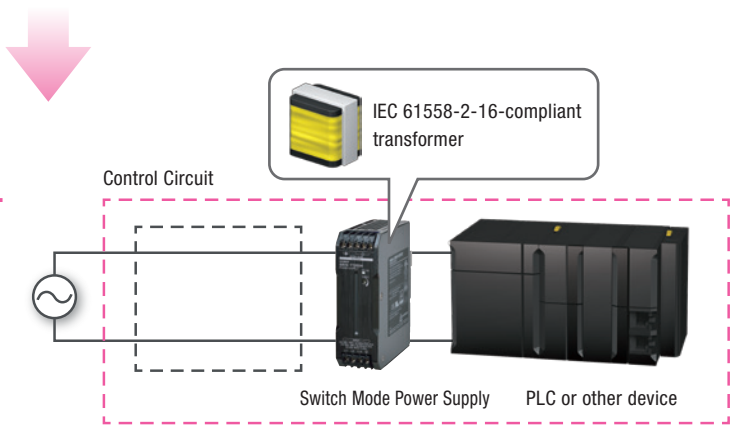
Eliminating Transformers for Control Circuits (Using a Switch Mode Power Supply with a Transformer Conforming to IEC 61558-2-16)

IEC 60204-1 in the Machinery Directive specifies that, if AC power is supplied to a control circuit, a transformer must be used in the control circuit and the transformer must have separate (compound) windings.



The transformer can sometimes be eliminated.

IEC 61558-2-16 also states that a switch mode power supply that uses a transformer with separate (compound) windings satisfies the above condition. That means that a transformer in a control circuit can be eliminated by using this type of switch mode power supply.



Recommended Power Supplies

For 380 to 480 VAC

Worldwide 3-phase Power Supply
Resistant in tough environments
Easy and fast installation
The most compact class on the market

Switch Mode Power Supplies
(120-W, 240-W, 480-W,
and 960-W models)

S8VK-T

Search for "OMRON S8VK-T" for details.



For 100 to 240 VAC

A Perfect Fit for Small Control
Panels Coated PCBs for Better
Resistance to
EnvironmentConnections for
Easy Wiring

Switch Mode Power Supplies
(60-W, 120-W, 240-W, 480W)

S8VK-S

Search for "OMRON S8VK-S" for details.



For 100 to 240 VAC

Reliable and Easy Operation-Worldwide
Power Supply
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Switch Mode Power Supplies
(15-W, 30-W, 60-W, 120-W, 240-W,
and 480-W models)

S8VK-G

Search for "OMRON S8VK-G" for details.



One Point ! The industrial power supply voltage in the world is often 380 to 480 VAC.

Area	Industrial power supply voltage	Area	Industrial power supply voltage
USA	Three-phase, 460 or 480 V	China	Three-phase, 380 V
Europe	Three-phase, 380, 400, or 415 V	India	Three-phase, 400 or 415 V
Thailand	Three-phase, 380 V	Japan	Three-phase, 200 V

MEMO

[illegible]



Color Universal Design

Adding Kindness to Manufacturing

What Is Color Universal Design?

Color universal design was developed to provide products, facilities, buildings, environments, services, and information to as many individuals as possible in consideration of people with color weakness.

Percentage of People with Color Weakness

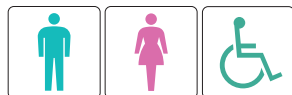
In Japan, one man in 20 and one woman in 500, and over 3.2 million people across Japan are assumed to have color weakness. The percentage of people with color weakness is even higher in Europe and the United States, and it is 8% to 10% in the West and 2% to 4% in Africa among men. Over 200 million people are assumed to have color weakness in the world.

The Value of Color Universal Design

Designing for people with color weakness will benefit people with normal color vision because it will produce well-organized, easy-to-understand designs. Therefore, color universal design is valuable to all people. Pushbutton switches and other operation switches are used not only on production lines in factories, but in public facilities, transportation, other infrastructure applications, food machines, and medical equipment, as just a few examples. At a medical site, an operating mistake can end up in life-threatening accidents. In the infrastructure, fatal accidents, traffic accidents, fires, and other accidents can be the result of a single operating mistake. Let us build a kinder working environment by improving the social color environment to make it easier to use by people with various types of color vision.

Simulations of How People with Non-standard Color Vision See Colors

People with Normal Color Vision (Type C)

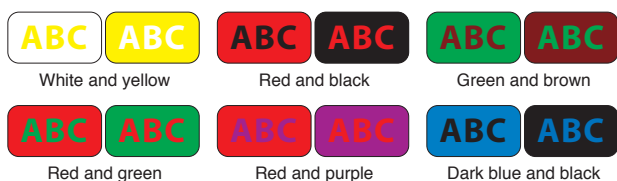


Simulation of People with Color Weakness (Type P)



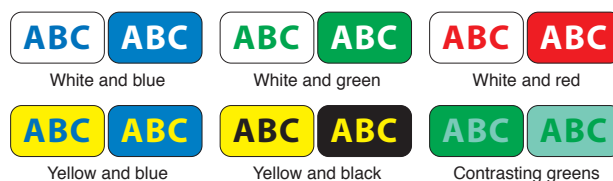
We need to provide a clear contrast in the use of colors on nameplates and in text displayed on touch panels and other devices.

Examples of Colors That Are Difficult to Distinguish



There is insufficient contrast between the colors of the text and background, so the text is hard to read or it is even possible that the presence of the text will not be noticed.

Examples of Colors That Are Easy to Distinguish



There is a clear contrast between the colors of the text and background. A bright text color is used on a dark background, or a dark text color is used on a bright background.

The information on this page is based on information, estimation results, concepts, and examples from the Color Universal Design Organization (NPO).

Recommended Operation Devices

Conforms to Color Universal Design *

Push-button Switches
(Push-in terminals)

A22N-P

Push-button Switches
A22N



* The yellow-blue-white and red-blue-white color combinations conform to color universal design.

Display Innovations for On-panel Devices

Increase Visibility by Using White Characters on Black Backgrounds

Control panels always include control amounts (e.g., temperatures or pressures).

The control amounts are important parameters that affect workpiece quality, and displays of the control amounts are generally provided on the fronts of control panels. Although touch panels are becoming popular display methods for high-end models, the cost involved results in many control panels using controllers with displays.

Control panels are installed in various lighting environments, from well-lit to dimly-lit locations. You need on-panel devices with good visibility.

The visibility of displays increases with the difference in the brightness of the colors used, so displays with a large difference in color brightness are easily recognized from a distance or in bright or dark locations.

If the background is black, white offers the largest difference in brightness, but the chromatic color yellow draws attention better.

Visibility of Various Colors on Black



Example: White characters on a black background are used in many types of locations.



Creating Panels with a Good Sense of Design and Good Visibility

By incorporating large display devices with white or yellow characters on a black background into panels, not only is visibility improved, but also panels with a high sense of design are made possible.

Also, control panels are not always viewed from directly in front of them, so viewing angles are also important.

Consider the visibility from an angle when you select components.



The display remains easy to read even from wide viewing angles.

Recommended Controllers with Displays

- Large, white PV displays that are easy to read and provide better visibility.
- Easy to use from model selection to setup and operation.
- A complete range of I/O capacities, functions, and performance.
- Handles more applications.

Digital Temperature Controllers
E5□C/E5□C-Bseries

Search for "OMRON E5_C" for details.



Product Catalogs for Control Panels

Sockets, Slim I/O Relays,
I/O Relay Terminals
Push-In Plus Terminal
Block Series
PYF-PU, P2RF-PU,
G2RV-SR/G3RV-SR, G70V/P75A-PU



Cat. No. J213

Switch Mode
Power Supplies
S8VK-S



Cat. No. T206

Measuring and
Monitoring Relays
K8DT



Cat. No. N210

Solid-state
Timers
H3DT



Cat. No. M091

Digital Temperature
Controllers
E5_C series



Cat. No. H220

Solid State Relays
for Heaters
G3PJ



Cat. No. J211

DIN Track
Terminal Blocks
XW5T



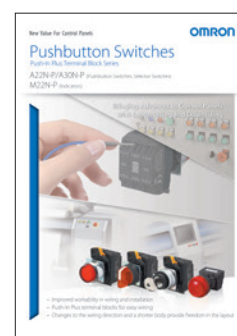
Cat. No. G123

Power Monitors
KM-N2/KM-N3



Cat. No. N212

Push-In Plus
Terminal Blocks Series
Pushbutton Switches
A22N-P/A30N-P/M22N-P



Cat. No. A253

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