Issue Date: November 2024

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

Summary

In response to climate change, energy-related equipment has recently become increasingly high-capacity. For example, commercial PV inverters have been expanding their capacity from 25 kW to 30-33 kW. In addition, EV chargers in the U.S. and European markets are required to be single-phase up to 12kW class in line with the demand for higher output, and in the Japanese market as well, there is a movement to increase capacity (from 6 kW to 10 kW) against the backdrop of mitigation of standards and other factors. Furthermore, the trend towards higher capacity in energy storage systems and industrial inverters is driving demand for PCB power relays that can safely interrupt 50A-class large currents. However, because PCB power relays that control large currents are relatively larger in size than other electronic components, the size of equipment becomes larger, resulting in a larger footprint for the equipment.

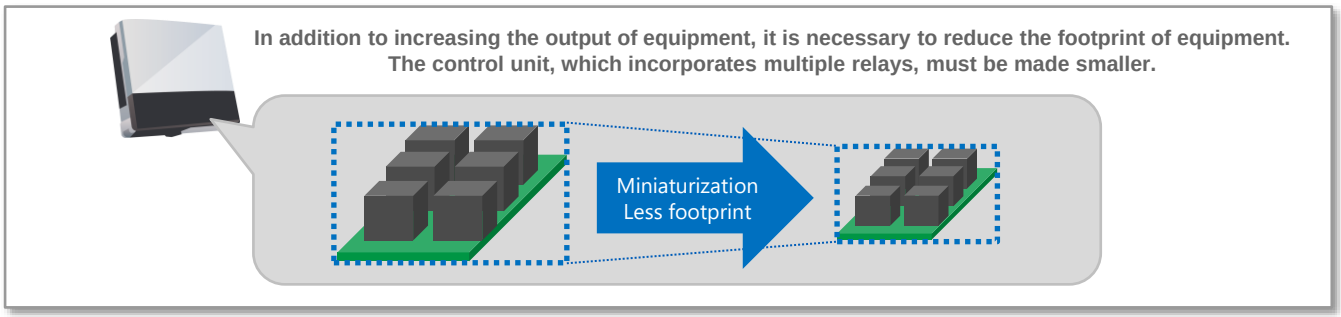
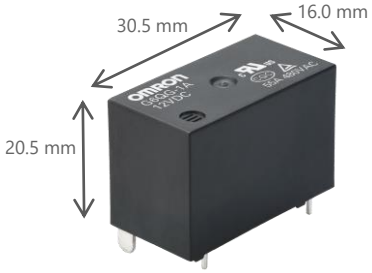


Figure 1: Miniaturization of PV inverter and control unit

The G6QG is the industry's smallest*1 PCB power relay capable of large current control of 480VAC/55A. The G6QG achieves both large-current control of energy-related equipment and miniaturization of equipment, thereby contributing to the development of the energy market.

Product outline



Contact mechanism	Single (1a)
Contact material	Ag alloy (Cd-free material)
Rated load (Resistive load)	480VAC, 55A 480VAC, Input: 20A, Energizing: 55A, Interrupting: 20A
Rated flowing current	55 A
Maximum contact voltage	480 VAC
Maximum contact current	55 A
Weight	Approx. 18g

Value provided

- **Industry's smallest class*1, contributing to miniaturization of equipment and reduction of footprint**
- **Compatible with three-phase power supply at rated 480VAC/55A**
- **Complies with PV inverter application standards*2 by having a contact gap of 2 mm or more**

*1 According to OMRON's research in September 2024
*2 Compliant with IEC 62109

Main applications


PV inverter (33kW class)


EV charger (mode 3 single-phase 12kW class, mode 4 3-phase 3-wire 200kW class)

Energy storage system (single-phase 3-wire, 10kW class)


Industrial inverter (3-phase power supply)

Figure 2: Specification overview, value provided, and major applications

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

Energy-related equipment market trends

(1) PV inverter

There is a trend towards higher capacity in commercial PV inverters, with output increasing from 25 kW to 30 kW. Furthermore, as shown in Figure 3, the market share is high in the capacity range up to 40 kW among commercial PV inverters, and the market production volume is expected to grow. The G6QG has a contact gap of 2 mm or more in accordance with the IEC 62109 standard required for PV inverter applications, so you can use it with confidence. It can also be used for grid connection applications of PV inverters. (See Figure 4)

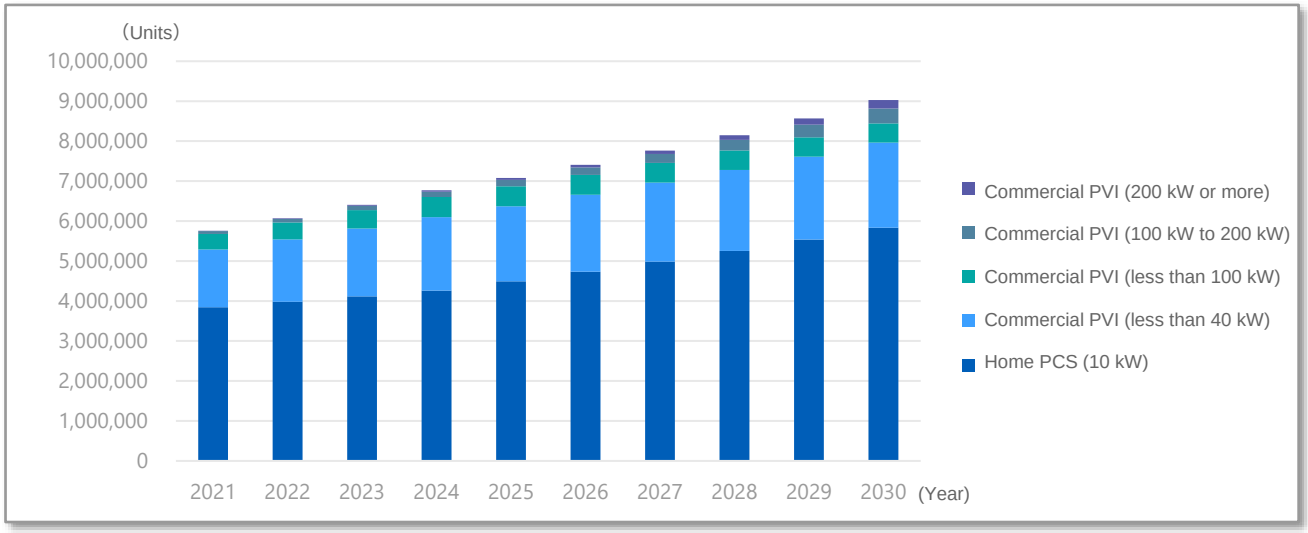


Figure 3: Trends in PV inverter production volume by capacity

(Source data) Edited by our company based on information from "Wood Mackenzie: The Global PV Inverter and MLPE Landscape, 2021" (as of October 2024)

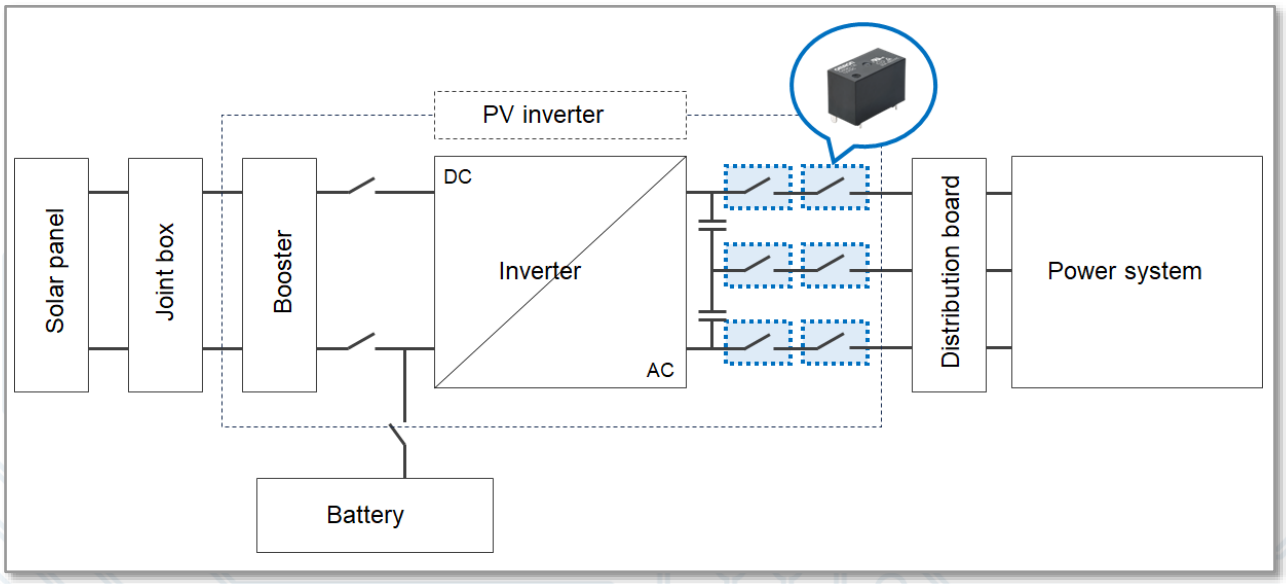


Figure 4: Block diagram (PV inverter) and G6QG installation location

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

Energy-related equipment market trends

(2) EV charger

With regard to EV chargers, output models in the capacity range from 7.4 kW to 12 kW single-phase are on the rise in the U.S. and European markets. While in the Japanese market, based on the rating increase* in JARI certification standards, consideration is being given to increasing the output to 10 kW and the upper current limit from 30 A to 50 A. Along with this specs improvement, demand for 50A-class PCB power relays is growing.

* (Reference) Rating increase of JARI certification standards (according to OMRON's research in October 2024)
https://www.meti.go.jp/shingikai/mono_info_service/charging_infrastructure/pdf/003_06_00.pdf

The G6QG can be considered for use in EV chargers (mode 3) for single-phase, 3-wire, 10kW-class safety shutdown applications (see Figure 5) and EV chargers (mode 4) for three-phase, 3-wire, up to 200kW-class AC pre-charging applications (see Figure 6).

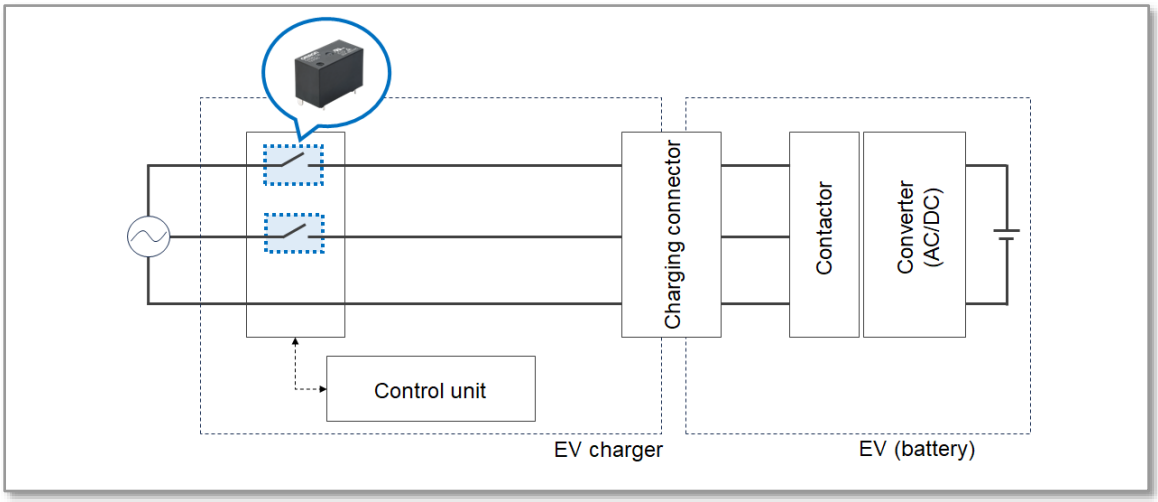


Figure 5: Block diagram (EV charger mode 3) and G6QG installation location

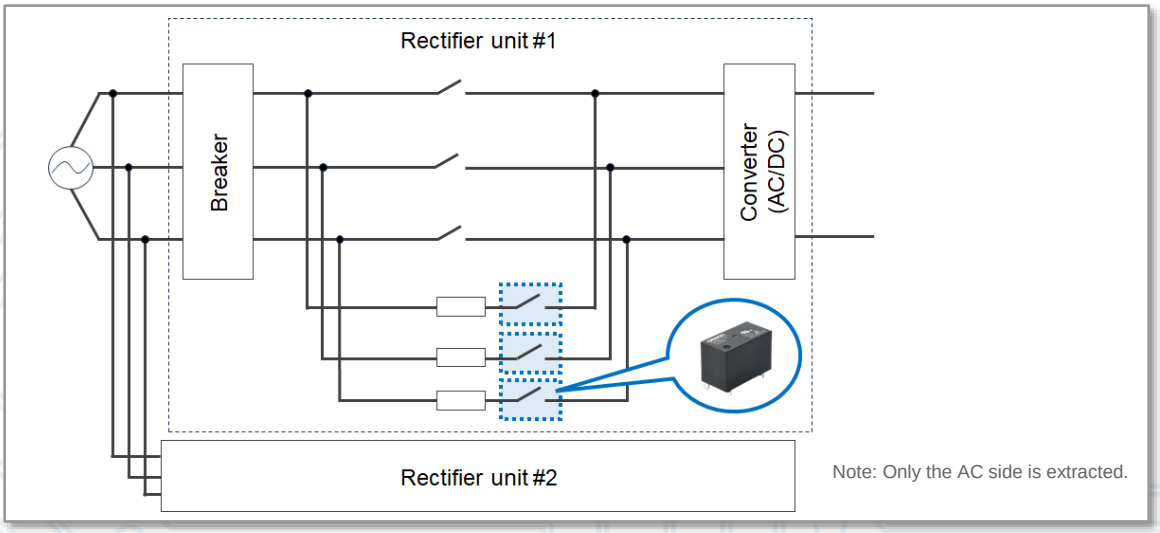


Figure 6: Block diagram (EV charger mode 4) and G6QG installation location

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

Energy-related equipment market trends

(3) Energy storage system

With the increase in natural disasters, strengthening the resilience function is being called for both domestically and internationally. There is demand for 50A-class relays for safety interruption of AC input/output sections in home energy storage systems, for which we can propose the G6QG.

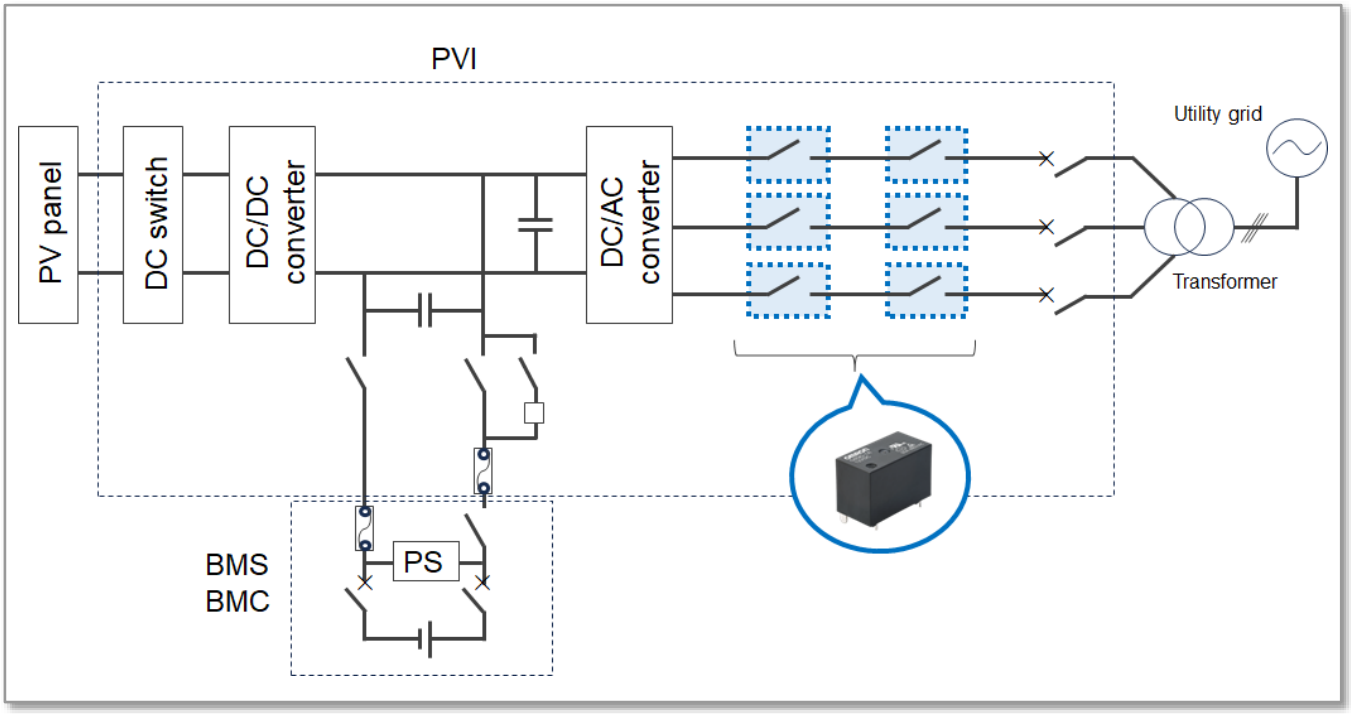


Figure 7: Block diagram (energy storage system) and G6QG installation location

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

Product value and test data of G6QG

The G6QG is the industry's smallest class*1, yet it can control large currents in the 480VAC/55A class. The G6QG can also achieve low heat generation, which contributes to improved energy efficiency. Please see below for details.

(1) Industry's smallest class*1 yet capable of controlling large currents and high voltages (480VAC/55A)

The G6QG is capable of interrupting currents up to 480VAC/55A. Some customers may be finding it difficult to suppress the rise in temperature of components that control large currents during product operation.
The G6QG is a product with enhanced heat dissipation by utilizing OMRON's heat dissipation design know-how. For example, it reduces the resistance of the current-carrying path using OMRON's material technology and suppresses the rise in terminal temperature during energization by widening the terminal width and improving heat dissipation (see Figure 8). Furthermore, the G6QG is capable of interrupting loads of 480VAC/55A, making it suitable not only for single-phase power supply applications, but also for various three-phase power supply applications. Conditions for soldering to the board are also described later. Please refer to “Soldering Conditions” on Page 11.

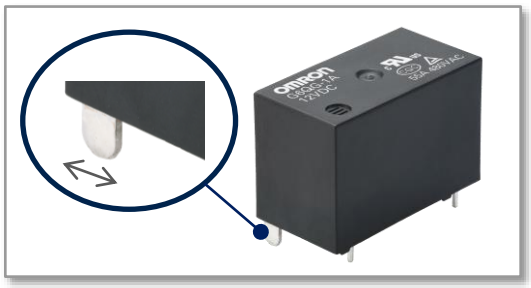


Figure 8: Coil-side terminal part

(2) Contact gap of 2 mm or more (compliant with IEC 62109)

As mentioned above, relays installed in PV inverters must have a contact gap of 1.8 mm or more in compliance with IEC 62109*2. The contact gap of 2 mm or more is secured although it ranks among the smallest in the industry, making it possible to consider applying it to various applications (such as PV inverters) where insulation performance is required by safety standards.

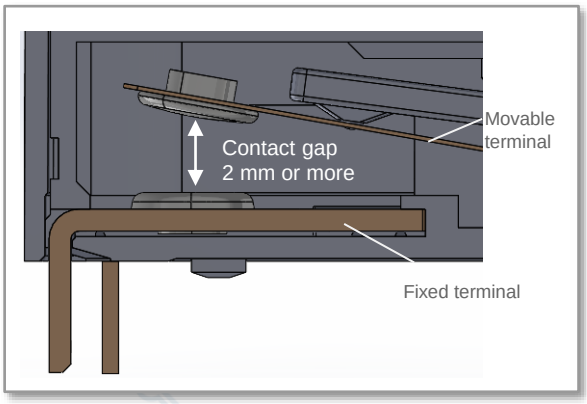


Figure 9: Internal structure (contact area)

*1 According to OMRON's research in September 2024
*2 The insulation distance required for the contact gap is determined by the overvoltage category, pollution degree, elevation, and other factors. Please check the distance by yourself.

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

Product value and test data of G6QG

(3) Low heat generation (low initial contact resistance)

In general, if the coil power is the same, the smaller the relay, the greater the internal temperature rise tends to be. The initial contact resistance of the G6QG is defined as 100 mΩ or less, but this is only guaranteed value. As shown in Figure 10, the actual initial contact resistance value is 10 mΩ or less. Despite its compact structure, the G6QG achieves low initial contact resistance, making it ideal for customers who want to downsize their equipment and increase board density, but are concerned about the degradation of equipment performance caused by heat generation. Please see Figure 11 for terminal temperature rise values.

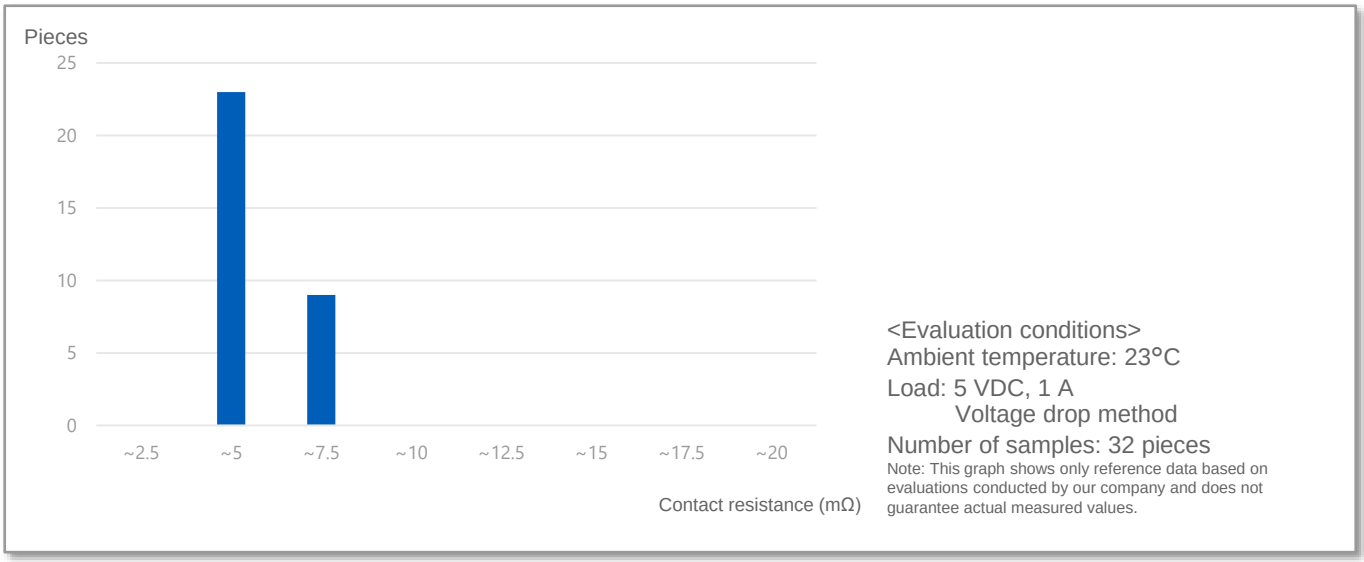


Figure 10: Initial contact resistance

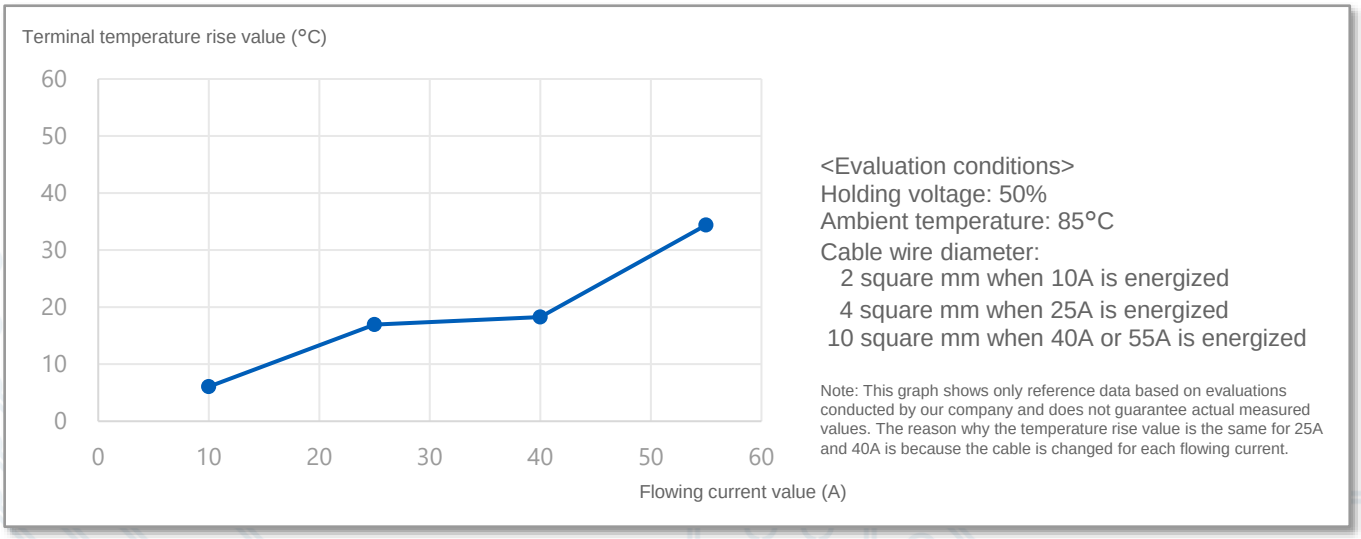


Figure 11: Terminal temperature rise by current flow

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

Acquired G6QG safety standards

The G6QG has acquired various safety standards. Please refer to the table below.

The approval rating values for overseas standards are different from the performance values determined individually confirm the values before use.

UL/C-UL (CSA) Recognized (File No.E41515)

Model	Coil ratings	Contact ratings	Number of test operations
G6QG-1A	12 VDC, 24 VDC	480 VAC 55 A (Resistive) 85°C	10
		Making 20 A, carrying 55 A, breaking 20 A, 480 VAC (Resistive) 85°C	30,000

TÜV Certified for EN/IEC Standards (EN61810-1) (Certification No.R50623877)

Model	Coil ratings	Contact ratings	Number of test operations
G6QG-1A	12 VDC, 24 VDC	480 VAC 55 A (Resistive) 85°C	10
		Making 20 A, carrying 55 A, breaking 20 A, 480 VAC (Resistive) 85°C	30,000

CQC Certified (Certification No.CQC24002427192)

Model	Coil ratings	Contact ratings	Number of test operations
G6QG-1A	12 VDC, 24 VDC	480 VAC 55 A (Resistive) 85°C	10
		Making 20 A, carrying 55 A, breaking 20 A, 480 VAC (Resistive) 85°C	30,000

Figure 12: Overseas standard certification ratings

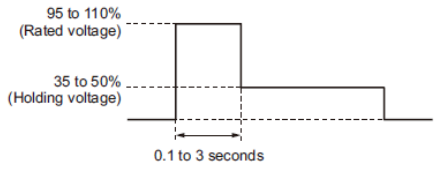
How to use G6QG

(1) Holding voltage control

● Holding voltage

Be sure to use the G6QG at the holding voltage. First apply the rated coil voltage for 0.1 to 3 seconds to reduce the actual coil power dissipation.
Set the rated coil voltage range to 95% to 110% and the allowable holding voltage to 35% to 50% (Figure 13).

Three specific circuit diagram examples for realizing holding voltage are presented on the following pages.



	Applied coil voltage	Coil resistance ✻	Coil power consumption
Rated voltage	100%	103 Ω (12 VDC) 411 Ω (24 VDC)	Approx. 1,400 mW
Holding voltage	35%		Approx. 172 mW

✻ The coil resistances were measured at a coil temperature of 23°C with tolerances of ± 10%.

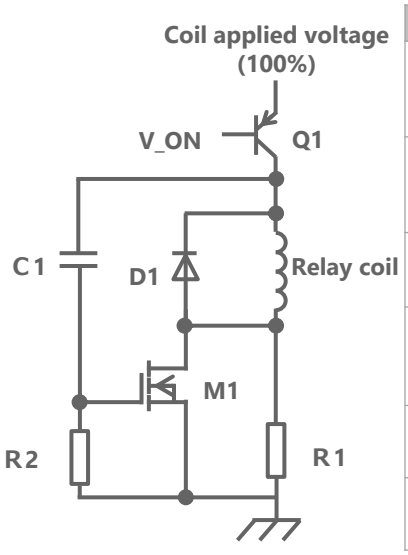
Figure 13: Holding voltage control conditions

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

How to use G6QG

● **CR method**

The CR system consists of a holding voltage circuit that passes current through a capacitor to operate a relay. The feature of this method is that it is relatively easy to control, as it is automatically shifted to a holding voltage state by simply applying the rated coil voltage to the drive circuit as usual. The coil current is reduced by the resistor (R1), resulting in reduced power consumption. Determine the resistance value (R1) so that the coil voltage is 45 to 60% or more. Note that if the same resistor as the coil resistor is used for R1, the coil current will be halved, and the power consumption of the entire circuit can be halved. (See Figures 14 and 15)



Symbol	Component	Selection method
Q1	Relay drive transistor	"Vce" is more than the coil voltage plus Vf of D1. "Ic" is more than the sum of the coil current and R2 current.
D1	Surge absorbing diode	"If" is equal to or more than the rated coil current. "Vr" is 2 to 3 times the coil voltage.
M1	Current switching MOS FET	Select at "Vds" more than the coil voltage plus Vf of D1 voltage. Select "Ids" more than the coil current.
R1	Coil current limiting resistor	Resistance value: Determined according to the holding voltage (%) Power consumption: More than resistance multiplied by the square of the holding current
R2	Time constant resistor	When applying the rated voltage to the coil for 100 ms, the time constant C x R should be approximately 70ms to 80ms. Note: Adjust to suit the gate sensitivity and capacitance of the MOS FET.
C1	Time constant capacitor	

Figure 14: Recommended holding voltage CR circuit example and peripheral component selection method

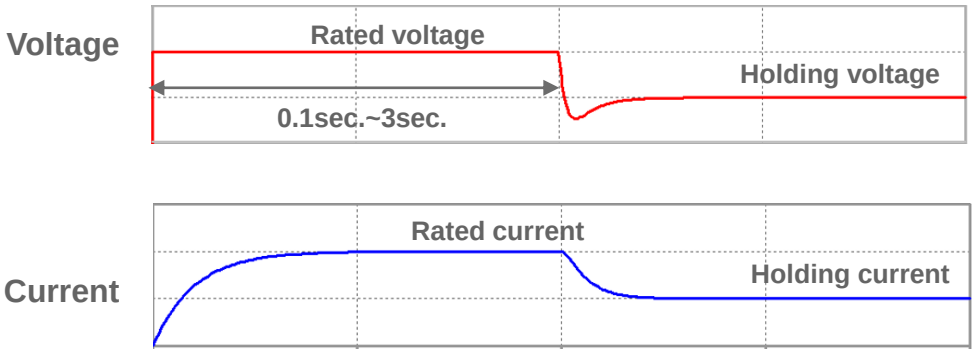


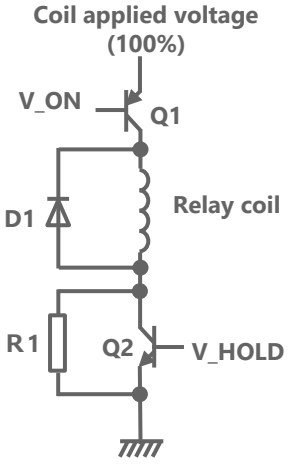
Figure 15: Example of coil voltage and current waveforms in CR circuit

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

How to use G6QG

● **Switching method (1)**

A holding voltage circuit can be configured simply by adding a current-limiting resistor (R1) and a switching element (Q2). The coil current is reduced by turning off the switch (Q2) after the rated voltage is applied to the coil. By making R1 the same as the coil resistance, the power consumption of the entire circuit can be reduced by half. (See Figures 16 and 17)



Symbol	Component	Selection method
Q1	Relay drive transistor	"Vce" is more than the coil voltage plus Vf of D1. "Ic" is more than the rated coil current.
Q2	Holding voltage switching transistor	"Vce" is more than the coil voltage plus Vf of D1. "Ic" is more than the rated coil current.
D1	Surge absorbing diode	"If" is equal to or more than the rated coil current. "Vr" is 2 to 3 times the coil voltage.
R1	Coil current limiting resistor	Resistance value: Determined according to the holding voltage (%) Power consumption: More than resistance multiplied by the square of the holding current

Figure 16: Recommended holding voltage circuit example with switch, and peripheral component selection method

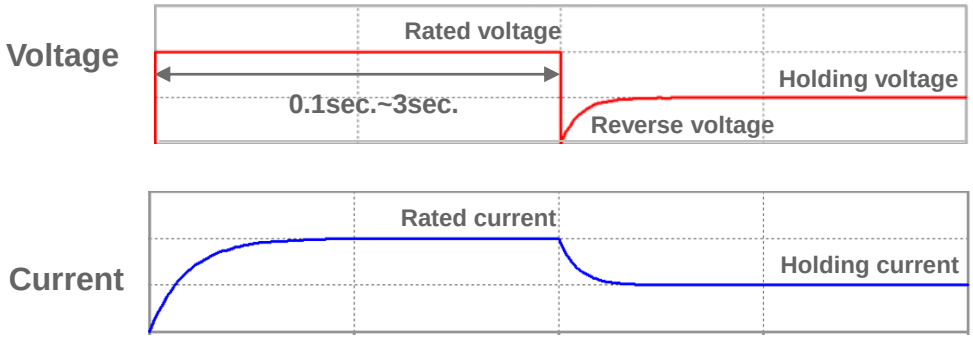


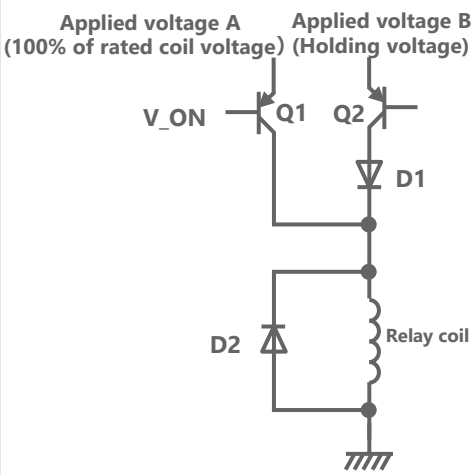
Figure 17: Example of coil voltage and current waveforms in holding circuit

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

How to use G6QG

● **Switching method (2)**

If a low voltage (B) for holding the coil is available in addition to the rated coil voltage (A), it can be switched to the holding voltage by means of a switch. Switching to 50% voltage will reduce the current to 50%, thus greatly reducing the power consumption of the entire circuit to 1/4 of the rated value. (See Figs. 18 and 19).



Symbol	Component	Selection method
Q1	Relay drive transistor	"Vce" is more than the coil voltage plus Vf of D1. "Ic" is more than the rated coil current.
Q2	Holding current transistor	"Vce" is more than the coil voltage plus Vf of D1. "Ic" is more than 50% of the rated coil current.
D1	Backflow prevention diode	"Vr" is more than the rated coil voltage. "If" is more than 50% of the rated coil current.
D2	Surge absorbing diode	"If" is equal to or more than the rated coil current. "Vr" is 2 to 3 times the coil voltage.

Figure 18: Recommended holding voltage circuit example with switch, and peripheral component selection method

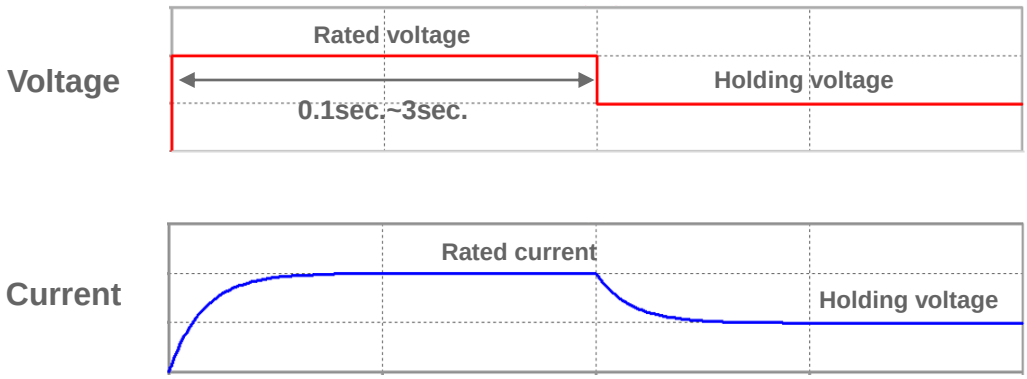


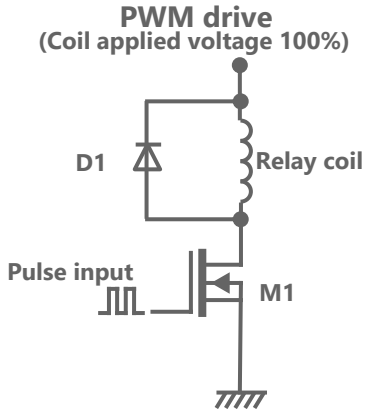
Figure 19: Example of coil voltage and current waveforms in holding circuit with switch

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

How to use G6QG

PWM (Pulse Width Modulation) control

When PWM output is available, the coil current can be reduced without adding any special components by turning the MOS FET for relay drive ON/OFF at high speed (recommended frequency 10 kHz or higher). When the ON/OFF ratio is set to 50%, the coil current is reduced to approximately 50% and the time during which power is consumed is also halved, thus greatly reducing the power consumption of the entire circuit to 1/4 of the rated value. (See Figure 20).



Symbol	Component	Selection method
D1	Surge absorbing diode	"If" is equal to or more than the rated coil current. "Vr" is 2 to 3 times the coil voltage.
M1	PWM control MOS FET	Select at "Vds" more than the coil voltage plus Vf of D1. Select "Ids" more than the coil current.

Figure 20: Recommended PWM control circuit example and peripheral component selection method

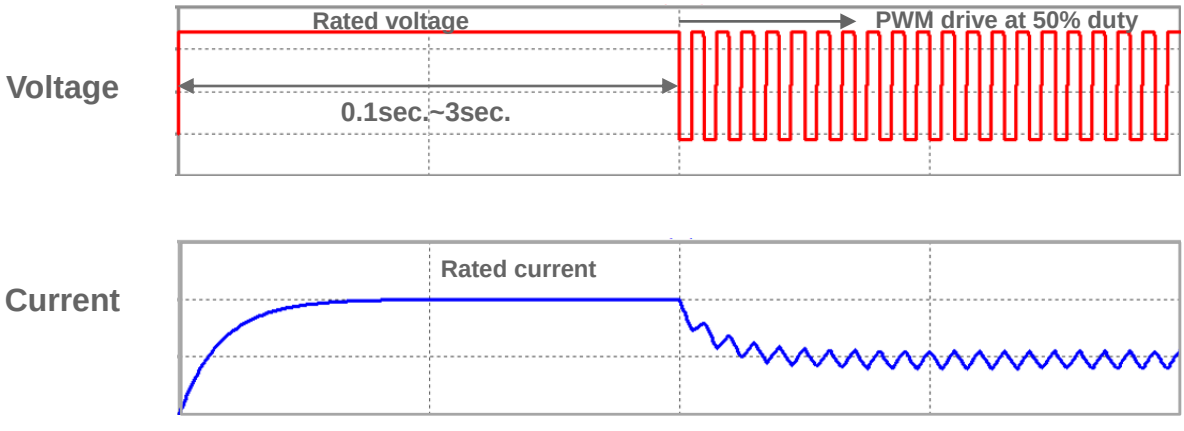


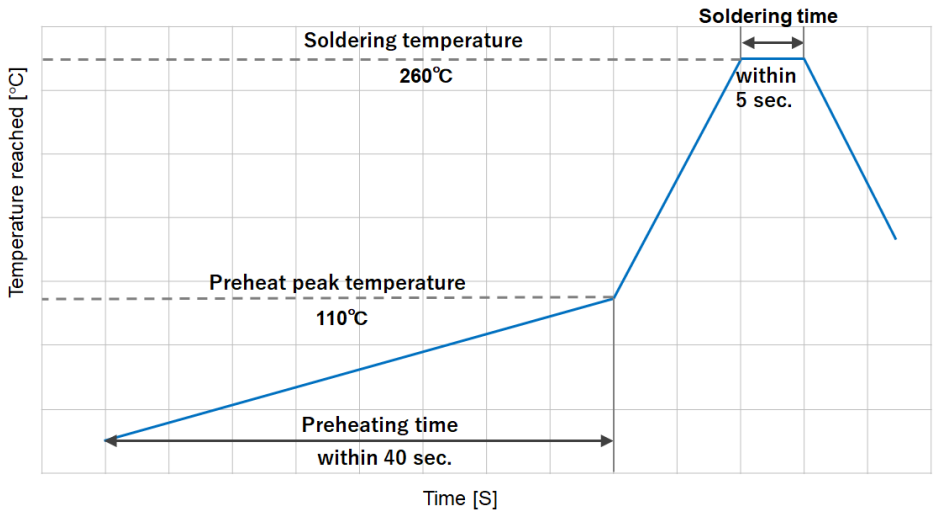
Figure 21: Example of coil voltage and current waveforms in PWM control circuits

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

How to use G6QG

(3) Soldering conditions

- Hand soldering condition
  350°C within 3 seconds
- Flow soldering condition
  See Figure 22



Note: This profile is only an indication of the conditions based on the evaluation conducted by our company and does not guarantee the solder mounting conditions, etc. Customers are requested to determine the actual mounting conditions (profile) after their own evaluation.

Figure 22: Flow solder mounting profile

Compact, Low-profile Power Relay G6QG with One-pole 480VAC/55A Load Switching

Other reference materials

Please make use of our technical support page on high-capacity relays, which provides detailed explanations of “What is difficult to understand” when using large-current and high-voltage PCB power relays, including reverse voltage, holding voltage application circuits, recommended conditions for large-current PCB flow soldering, effects of magnetic fields, and precautions for series/parallel connections.

- OMRON America：https://components.omron.com/us-en/solutions/relays/power-relays-support
- OMRON Europe： https://components.omron.com/eu-en/solutions/relays/power-relays-support
- OMRON Asia Pacific： https://components.omron.com/sg-en/solutions/relays/power-relays-support

For the latest product specification information, please refer to the G6QG datasheet.

- OMRON America：https://components.omron.com/us-en/datasheet_pdf/K353-E1.pdf
- OMRON Europe：https://components.omron.com/eu-en/datasheet_pdf/K353-E1.pdf
- OMRON Asia Pacific：https://components.omron.com/sg-en/datasheet_pdf/K353-E1.pdf

Please check each region's Terms & Conditions by region website.

OMRON Corporation
Device & Module Solutions Company

Regional Contact

Americas
https://components.omron.com/us-en/

Europe
https://components.omron.com/eu-en/

Asia-Pacific
https://components.omron.com/sg-en/

China
https://components.omron.com.cn/

Korea
https://components.omron.com/kr-en/

Japan
https://components.omron.com/jp-ja/

Cat. No. K358-E1-02
1124