White Paper

Issue Date: September 2025

The G9KA series 800 VAC 260 A / 1000 VAC 300 A PCB Relay with ultra-low contact resistance feature

Introduction

Today's energy industry is working towards the goal of self-generated solar power which can be used as a primary source of electricity. While maximizing power availability, designers and manufacturers need to improve the reliability and safety of their systems in balance of the costs.

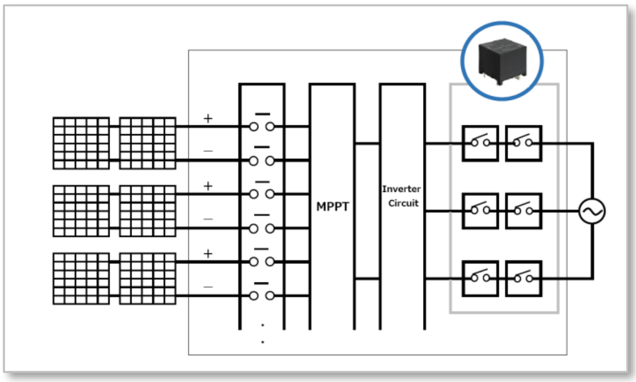
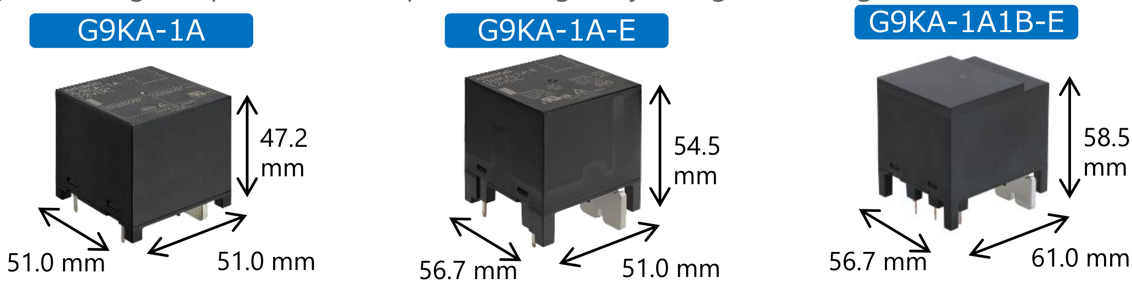


Figure 1: Example of PV inverter relay application

To meet evolving needs in the sector, we are constantly developing our range of components to support the next generation of energy systems. This includes an expanding range of high-power PCB relays with a focus on low contact resistance to increase the safety, reliability, durability, and cost-effectiveness of your products (Figure 1). Our relays are trusted worldwide and are making an important contribution for more energy-efficient future.

Overview

The G9KA series expands your design possibilities with ultra-low contact resistance (Typical ≤ 0.2 mΩ) maintained throughout the lifetime of the relay. Also, efficient low holding voltage capability contributes to your design enabling low power consumption during relay energization (Figure 2).



Terms		G9KA-1A	G9KA-1A-E	G9KA-1A1B-E
Coil	Coil voltage	12 VDC, 24 VDC		
	Power consumption	Approx. 5.0 W (1,012 mW at holding voltage 45%)		6.0 W (1,012 mW (at 41% holding voltage))
Contact	Rated load (Resistive)	800 VAC Make 50 A Carry 260 A Break 50 A 800 VAC Make 150 A Carry 260 A Break 260 A 60 VDC 200 A	1,000 VAC Make 50 A Carry 300 A Break 50 A 1,000 VAC Make 150 A Carry 300 A Break 300 A	1,000 VAC Make 50 A, Carry 300 A, Break 50 A / 1,000 VAC Make 150 A, Carry 300 A, Break 300 A
	Auxiliary contact	-	-	30 VDC 1 A
	Contact resistance	Initial ≤ 0.2 mΩ at 6 VDC 200 A		Main contact: 0.2 mΩ or less (6 VDC 200 A voltage drop method) Auxiliary contact: 100 mΩ or less (5 VDC 1 A voltage drop method)
	Contact gap	4.0 mm		Main contact: 4.0 mm or more Auxiliary contact: 0.5 mm or more (when main contact is welded)
Endurance	Mechanical	100,000 ops.		
	Electrical *1sON/9sOFF at 85℃	800 VAC Make 50 A Carry 260 A Break 50 A 30k ops. 800 VAC Make 150A Carry 260 A Break 260 A 10 ops. 60 VDC 200 A 2k ops.	1,000 VAC Make 50 A Carry 300 A Break 50 A 30k ops. 1,000 VAC Make 150 A Carry 300 A Break 300 A 10 ops.	Main contact: 1,000 VAC Make 50 A, Carry 300 A, Break 50 A 30k ops. Main contact: 1,000 VAC Make 150 A, Carry 300 A, Break 300 A 10 ops. Auxiliary contact: 30 VDC 1 A 100k ops.
Ambient temperature range		-40℃ to 85℃ (with no icing or condensation)		
Terminal type		PCB		
Safety standard		TUV、UL/C-UL、CQC		

Figure 2: G9KA series specifications

*1 According to OMRON's research in February 2023
Comparison of catalog values for relays with a maximum flowing current of 200 A to 300 A

Usage examples

The G9KA series is suitable for industrial power conditioners, uninterruptible power supplies (UPS), industrial inverters, and EV quick chargers. Note that in the output switching circuit part of an EV quick charger, switching is generally performed with no load (0 A), so AC relays may be used instead of DC relays. When using relays with no load switching(so-called dry switching), please refer to the precautions on p11.
If a welding detection function is required, consider a model with an auxiliary contact (G9KA-1A1B-E). Please refer to this document for details.

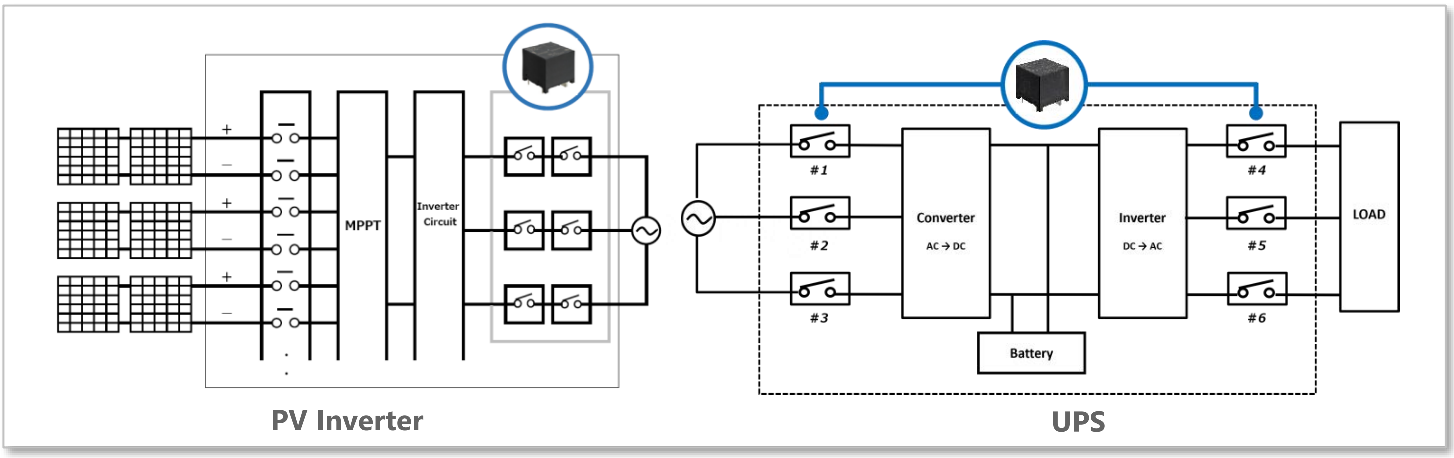


Figure 3: Example of PV inverter and UPS application

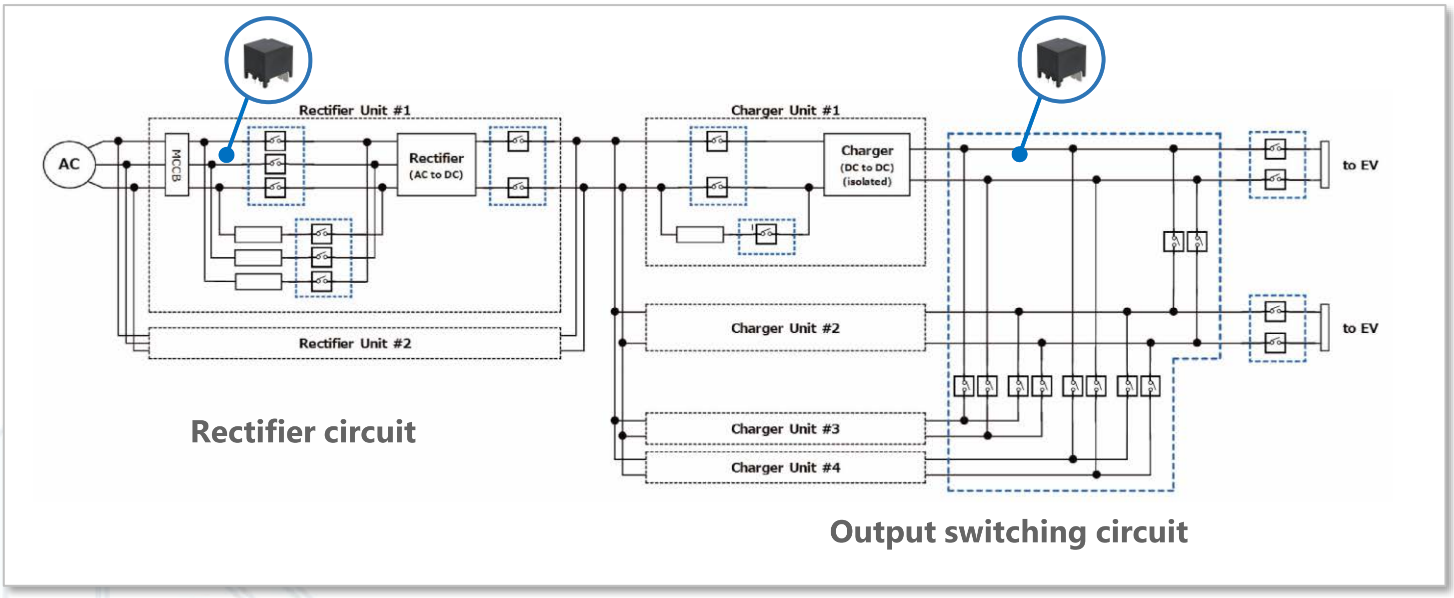


Figure 4: Example of use in an EV quick charger

Low contact resistance

Contact resistance is one of the key characteristics for PCB high-power relay to reduce heat generation inside the component. This simplifies your thermal design process and offers wider design possibilities, including the use of smaller heatsinks and cooling fans. Ultimately, this will improve the efficiency and create cost saving of your product design.

● Industry-leading*1 ultra-low contact resistance

The G9KA series benefits from a highly optimized plunger actuator and terminal structure to realize 0.2 mΩ max. ultra-low contact resistance with compact dimensions. This low contact resistance performance is a major advancement compared with equivalent PCB relays (Figure 5).

Contact resistance specification

OMRON G9KA series	Equivalent A	Equivalent B
0.2 mΩ max.	1 mΩ max.	6 mΩ max.

*1 According to OMRON's research in February 2023
Comparison of catalog values for relays with a maximum flowing current of 200 A to 300 A

Figure 5 shows a thermal simulation comparison done at 200 A / 300 A carry current, ambient temperature 85˚C with heat dissipation PCB design including fan, duct and heatsinks. This result clearly shows contact resistance performance has the potential to make a big difference for reducing PCB heat stress.

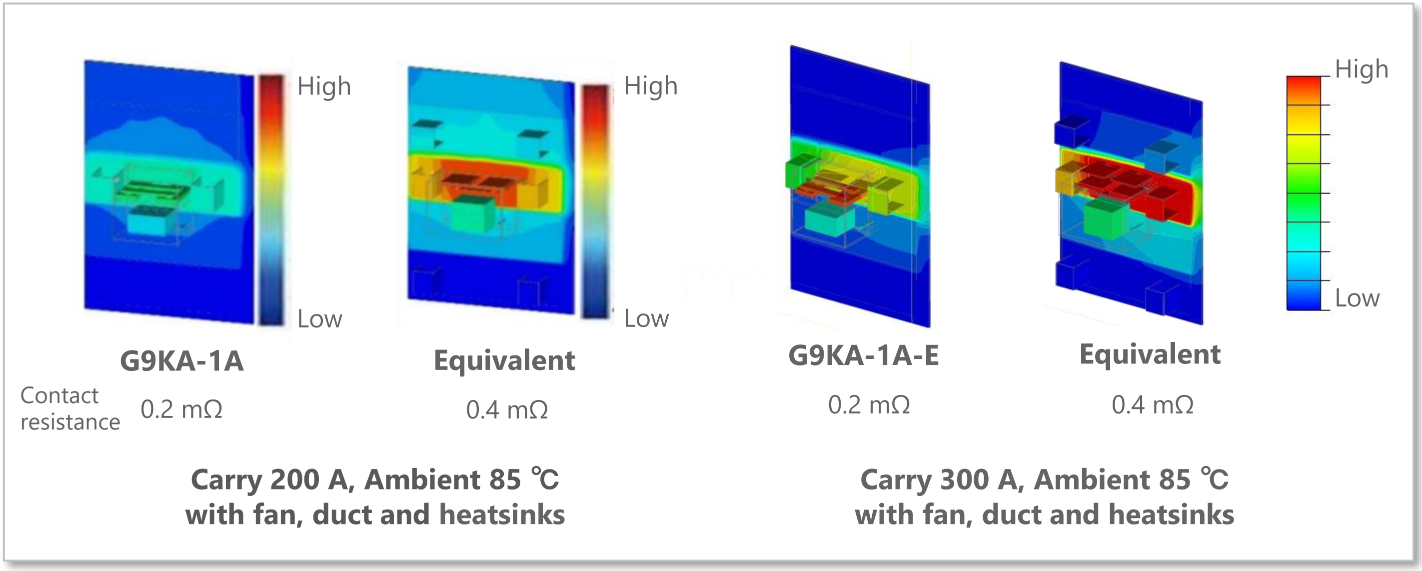


Figure 5: Comparison with equivalent relays

●Contact resistance at end of life

Generally, contact resistance increases due to the contact aging caused by switching. But our proven competences in structures, materials and manufacturing maintains low contact resistance throughout the lifetime of the G9KA series. (Figure 5, contact resistance max. 0.3 mΩ measured) This test was done 30k operations under make 50 A carry 200 A / 300 A break 50 A load conditions.

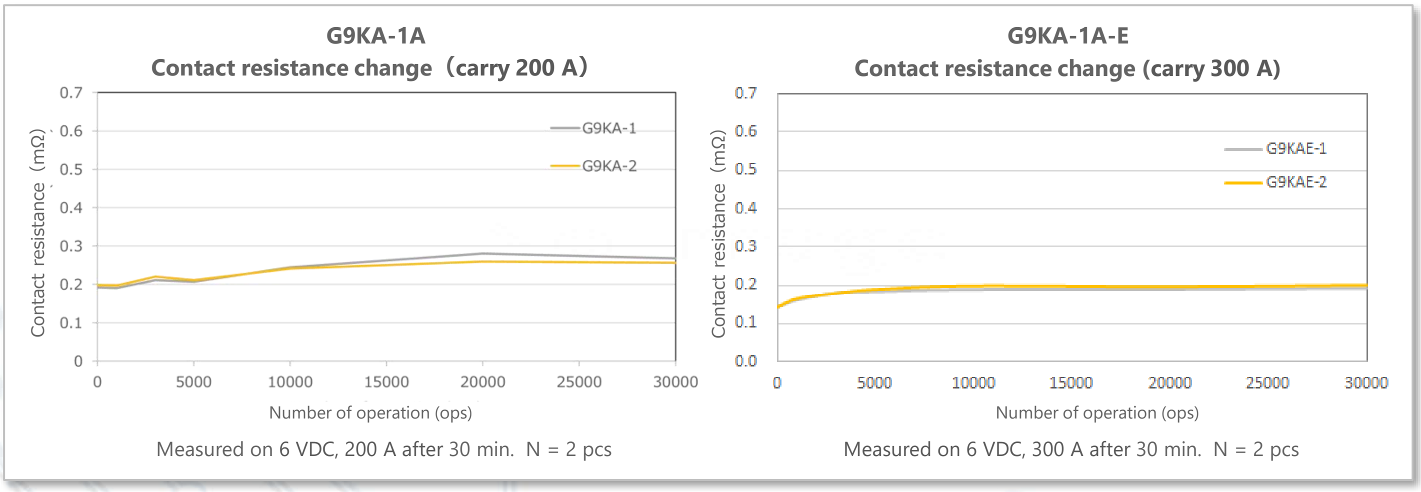


Figure 6: Reference data of contact resistance change

Low power consumption

The G9KA series coil power consumption is 5.0 W at rated coil voltage. Actual power consumption can be reduced to 1,012 mW by holding voltage 45 %. PWM control is another method to reduce the coil power consumption. The G9KA series is applicable for both methods by following reference circuit diagrams.

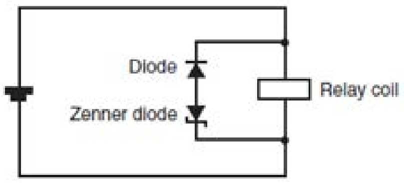


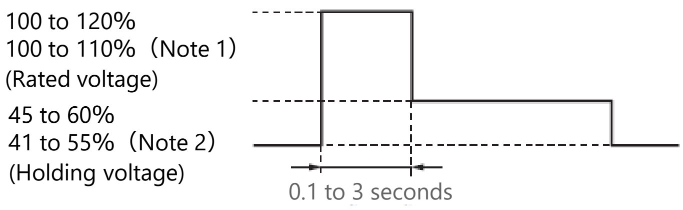
Figure 7: Diode connection

Please use a diode for coil surge absorption. A Zener diode is also required in combination to maintain the switching performance. Diode connection is required in reverse polarity of the voltage applied to the coil.

- Recommended Zener diode is two times of the rated coil voltage.
- Please use diodes with reverse dielectric strength 10 times or more of rated coil voltage. And forward current more than coil current.

● Holding voltage

To reduce actual coil power consumption, please apply rated coil voltage for 0.1 to 3.0 seconds at first. Set the rated coil voltage range to 100 to 120% (100 to 110% for G9KA-1A1B-E only) and the allowable holding voltage to 45 to 60% (41 to 55% for G9KA-1A1B-E only).



・G9KA-1A/G9KA-1A-E

	Applied coil voltage	Coil resistance*	Coil power consumption
Rated voltage	100 to 120%	28.8 Ω (DC12) 115.2 Ω (DC24)	Approx. 5 to 7.2 W
Holding voltage	45 to 60%		Approx. 1.0 to 1.8 W

・G9KA-1A1B-E

	Applied coil voltage	Coil resistance*	Coil power consumption
Rated voltage	100 to 10%	24 Ω (DC12) 96 Ω (DC24)	Approx. 6 to 7.3 W
Holding voltage	41 to 55%		Approx. 1.0 to 1.8 W

*** The coil resistance were measured at a coil temperature of 23℃ with tolerance of ±10℃.**

Note 1: 100 to 110% for G9KA-1A1B-E only
Note 2: 41 to 55% for G9KA-1A1B-E only

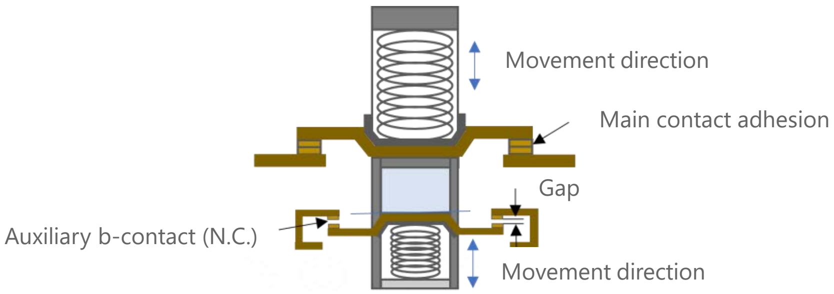
Figure 8: Coil voltage reduction after operation

Auxiliary contact (Mirror contact structure)

G9KA is also available with an optional auxiliary contact (G9KA-1A1B-E: Contact form 1a1b (SPST-NO/SPST-NC)).
By utilizing an auxiliary contact, it is possible to constantly monitor the open/closed status of the main contact and detect any abnormalities. There are other methods of detecting welding besides the auxiliary contact method, but using an auxiliary contact makes it possible to achieve a simpler circuit.

This auxiliary contact complies with the mirror contact structure specified in IEC 60947-4-1 Annex F, Section 7.2. It is mechanically linked to the main contact and is designed so that the contact gap of the auxiliary contact is 0.5 mm or more even if the main contact is welded, ensuring high reliability in status detection.

G9KA contributes to improving user safety.

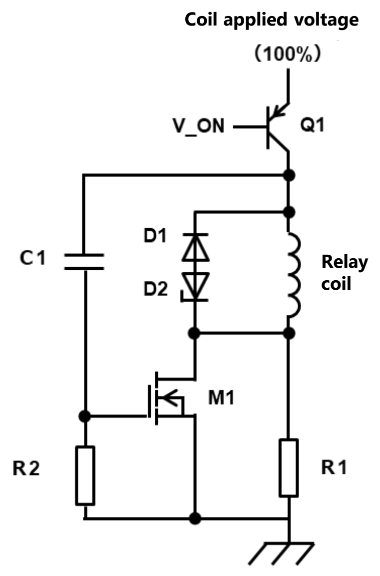


In the combination of the relay body and the auxiliary contact block, if the N.O. contact (main contact) of the relay body welds, all N.C. contacts of the auxiliary contact block have a structure that satisfies an impulse withstanding voltage of 2.5 kV or more, or ensures a contact gap of 0.5 mm or more, even when the coil is de-energized.

Figure 9: Mirror contact structure image diagram

● 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 so that the coil voltage is 45 to 60% of the rated voltage (41 to 55% for G9KA-1A1B-E only). 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. (Figures 10 and 11)



Symbol	Component	Selection method
Q1	Relay drive transistor	"Vce" is more than the coil voltage plus ZD voltage. "Ic" is equal to, or more than 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.
D2	Zener diode	Zener voltage specified in catalog Wattage is the shear head surge reverse current (power) greater than or equal to the relay's rated current (power)
C1	Time constant capacitor	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.
M1	Current switching MOS FET	Select at "Vds" more than the coil voltage plus ZD 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.

Figure 10: Recommended holding voltage CR circuit example and peripheral component selection method

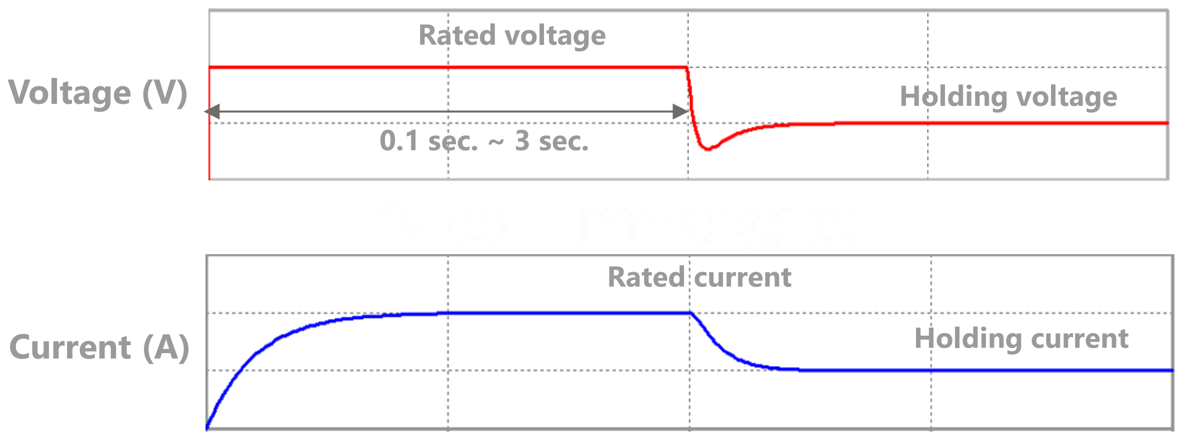
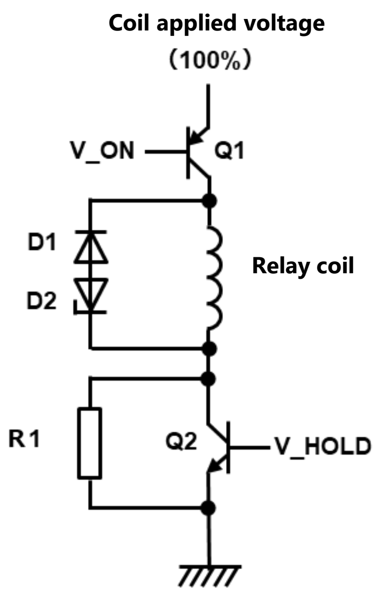


Figure 11: Example of coil voltage and current waveforms in CR circuit

● 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. (Figures 12 and 13)



Symbol	Component	Selection method
Q1	Relay drive transistor	"Vce" is more than the coil voltage plus ZD voltage. "Ic" is equal to, or more than 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.
D2	Zener diode	Zener voltage specified in catalog Wattage is the shear head surge reverse current (power) greater than or equal to the relay's rated current (power)
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
Q2	Holding voltage switching transistor	"Vce" is more than the coil voltage plus ZD voltage. "Ic" is equal to, or more than rated coil current.

Figure 12: Recommended holding voltage circuit example with switch, and peripheral component selection method

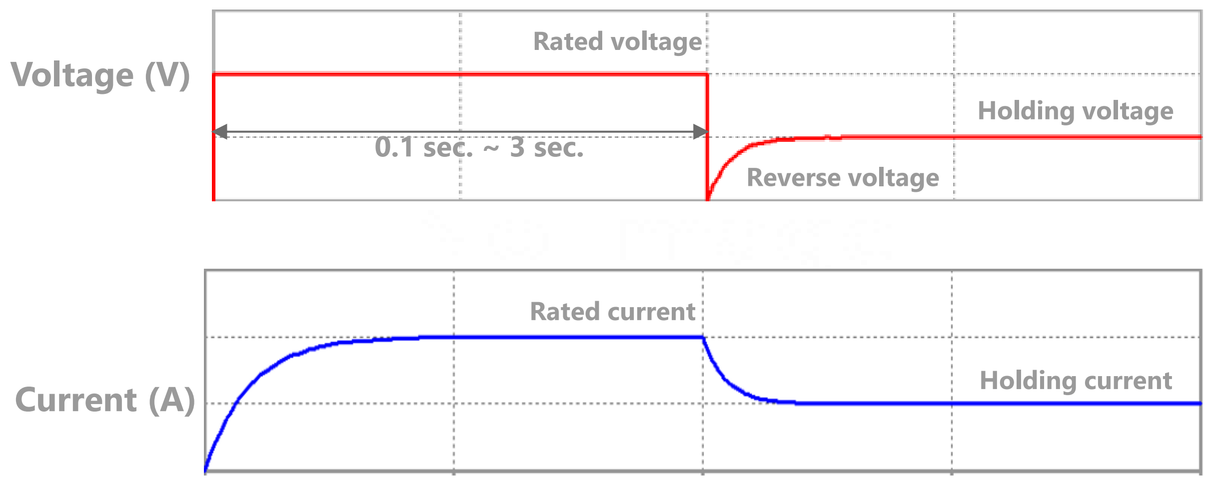
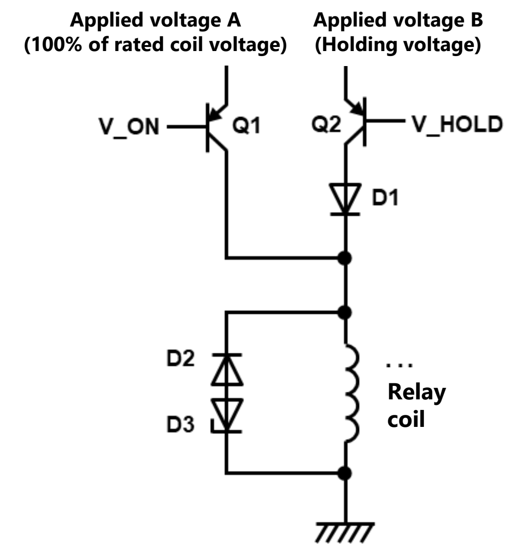


Figure 13: Example of coil voltage and current waveforms in holding circuit with switch

● 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. (Figures 14 and 15)



Symbol	Component	Selection method
Q1	Relay drive transistor	"Vce" is more than the coil voltage plus ZD voltage. "Ic" is equal to, or more than rated coil current.
Q2	Holding current transistor	"Vce" is more than the coil voltage plus ZD voltage. "Ic" is equal to, or more than 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	Zener diode	Zener voltage specified in catalog Wattage is the shear head surge reverse current (power) greater than or equal to the relay's rated current (power)
D3	Zener Diode	Zener voltage specified in catalog Wattage is the shear head surge reverse current (power) greater than or equal to the relay's rated current (power).

Figure 14: Recommended holding voltage circuit example with switch, and peripheral component selection method

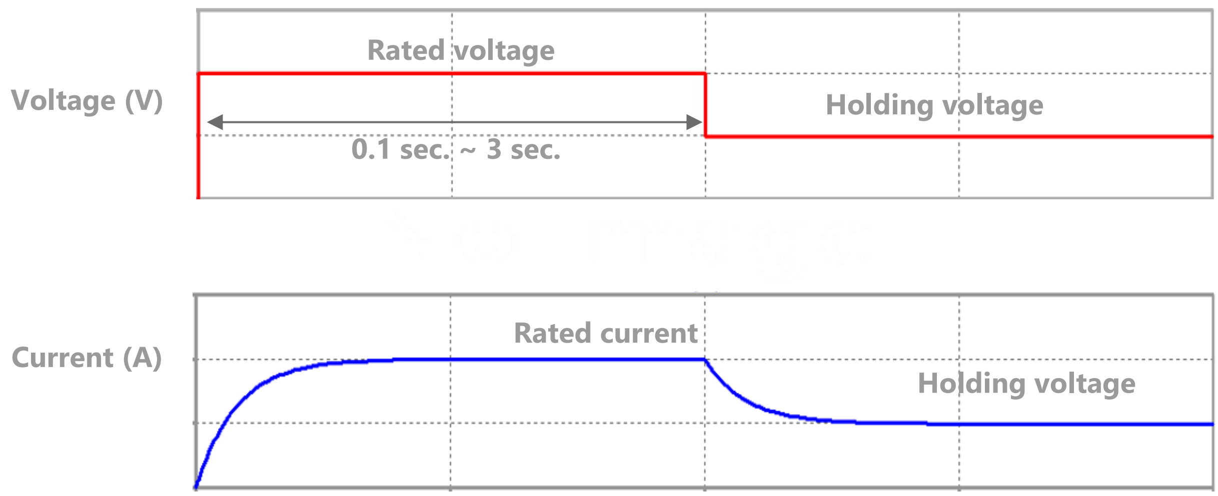
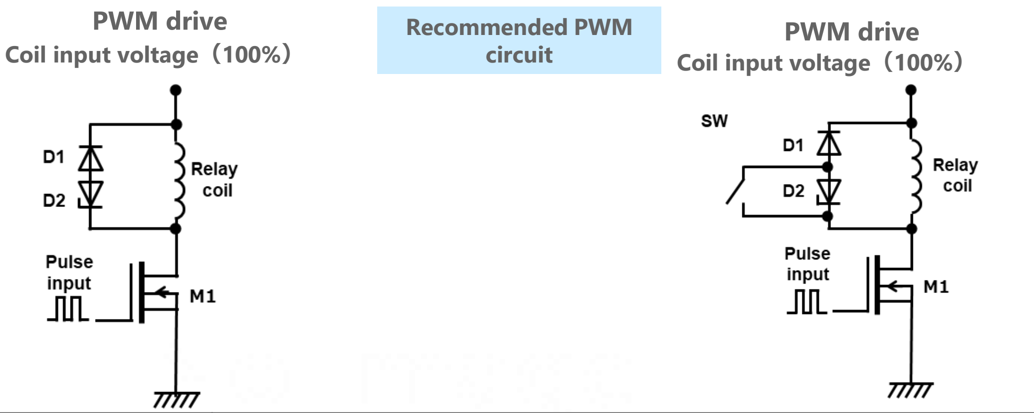


Figure 15: Example of coil voltage and current waveforms in holding circuit with switch

● PWM (Pulse Width Modulation) control

In PWM control, a general PWM control circuit is not recommended to avoid power loss due to the Zener diode. A switch should be mounted in parallel with the Zener diode and bypassed during PWM control (Figure 14). When the relay is turned off, first turn off the switch to turn off the applied voltage of the drive circuit, then the relay is normally turned off by the Zener diode + diode. (Figure 16)

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. (Figure 17)



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.
D2	Zener diode	Zener voltage specified in catalog Wattage is the shear head surge reverse current (power) greater than or equal to the relay's rated current (power)
M1	PWM control MOS FET	Select at "Vds" more than the coil voltage plus ZD voltage. Select "Ids" more than the coil current.
SW	Mechanical Relay for ZD bypass	A small relay, such as a signal relay, is sufficient

Figure 16: Recommended PWM control circuit example and peripheral component selection method

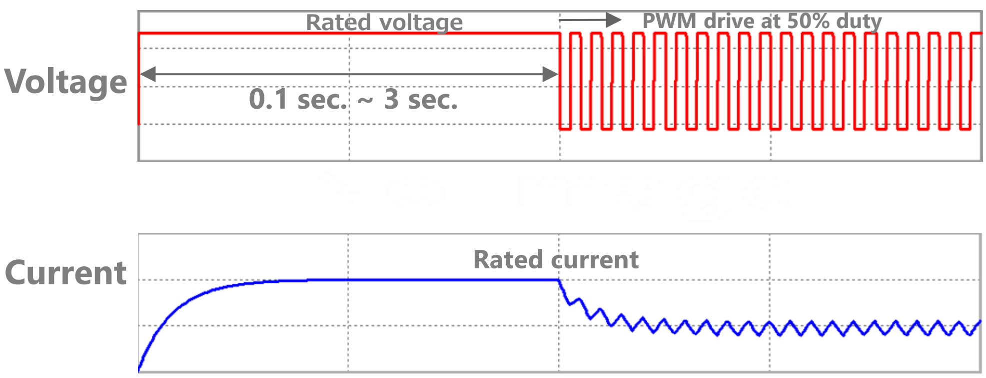


Figure 17: Example of coil voltage and current waveforms in PWM control circuits

Figure 18 shows the comparison of coil current at each duty cycles. Generally, a PWM circuit requires over 86% duty cycle to keep the relay turned on, which makes more power consumption than the recommended circuit and raises temperature of the relay. Note that, over 45% duty cycle is acceptable for recommended PWM circuit to achieve the holding coil current criteria.

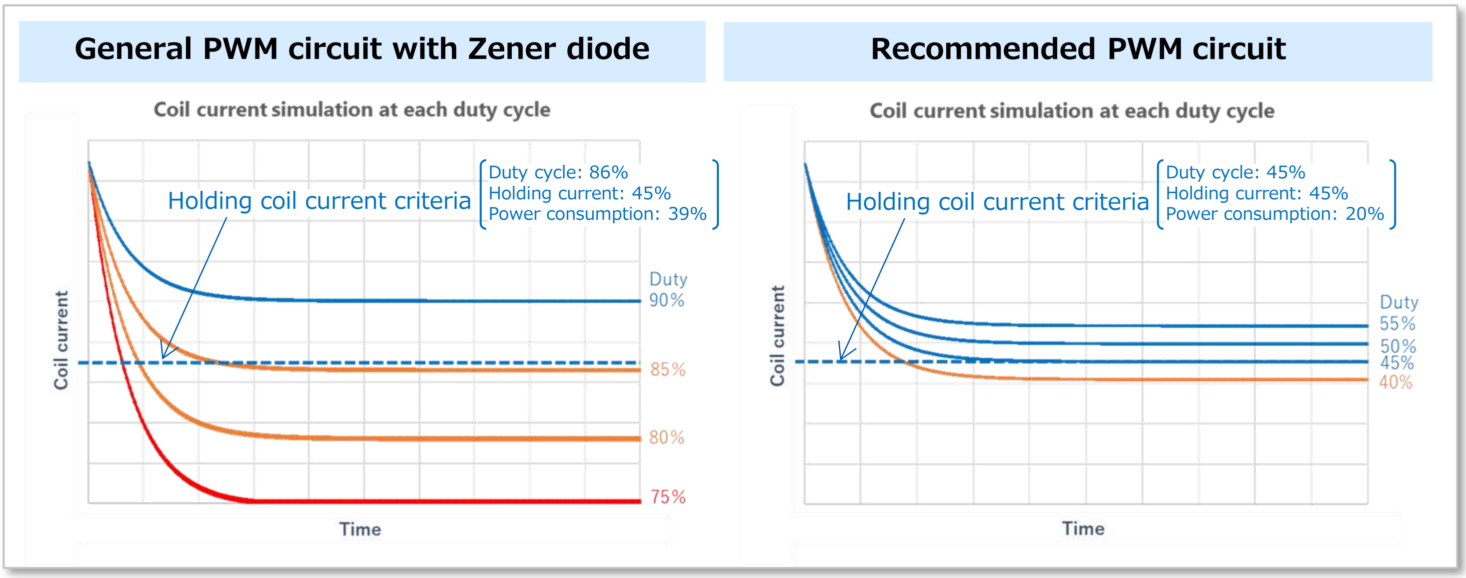


Figure 18: Reference of PWM control circuit diagram

Precautions

When using the G9KA series, please observe the following precautions and use it safely.

- Do not use a relay that has fallen, the relay may not work properly.
- Do not use clips or sockets to connect to the relay alone, and do not mount it outside the recommended soldering conditions. Insufficient connection may cause abnormal heat generation.
- Use a protection circuit together so that the current stops when the relay fails. When the relay fails, there is a risk of abnormal heat generation.
- When using relays with no load switching (so-called dry switching), please be sure to contact our sales representative for support.
- Dry switching does not provide the arc-cleaning effect on the contacts, which may cause contact resistance to increase.
- We do not recommend dry switching unless measures are taken to counteract this increase in contact resistance.

In addition to the above, please be sure to check the precautions on the data sheet G9KA when using.

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

https://components.omron.com/sites/default/files/datasheet_pdf/CDPA-022.pdf

OMRON Corporation
Device and Module Solutions Company

Regional Contact

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

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

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

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

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

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

Cat. No. K342-E1-05
0925 (0323)