White Paper

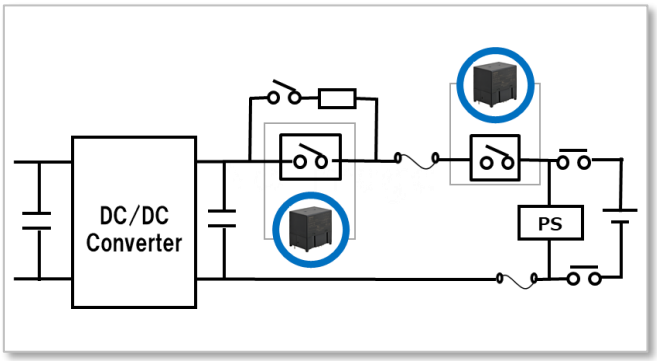
OMRON

Issue Date: 11th July 2022

600 VDC 50 A High-power PCB relay G9KB
Instruction of product performance and reference circuit

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.

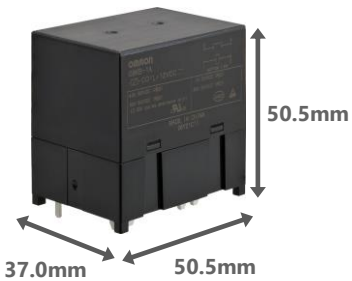


To meet evolving needs in the sector, we are constantly developing our range of components to support the next generation of energy systems. This includes an expanding range of high-power PCB relays with a focus on low contact resistance to increase the safety, reliability, durability, and cost-effectiveness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

Figure 1: Example of Power conditioner and Battery Unit relay application

Overview

G9KB relay expands your design possibilities with a high DC load capability (600V 50A), designed to handle continuous carry current and provide highly effective non-polarized arc-controlled switching to maximise performance. Also, an efficient low coil holding voltage can be applied contributing to reduce power consumption during relay operation (Figure 2).



Specifications		G9KB-1A
Coil	Coil voltage	12VDC, 24VDC
	Power consumption	Approx. 2.8W (Approx. 0.57W at holding voltage 45%)
Contact	Contact form	1a
	Rated load (Resistive)	600VDC, 50A / 600VDC, 1A
	Contact resistance	≦5mΩ (measurement condition: DC6V 20A (after 30sec.) voltage drop method)
	Contact gap	≧3.6mm
Endurance	Mechanical	1,000,000 operations min. (at 10,800 operations/h)
	Electrical	600VDC, 50A, 2000 operations min. (Switching frequency: 1 second ON - 9 seconds OFF at 85°C and 25% to 75% RH) 600VDC, 1A, 1,000,000 operations min. (Switching frequency: 1 second ON - 9 seconds OFF at 85°C and 25% to 75% RH)
	Switching current direction	Bidirectional direction acceptable
Ambient operating temperature		-40°C～＋85°C
Safety standard		UL60947-4-1, EN61810-10, CQC

Figure 2: G9KB relay specifications

600VDC 50A High power PCB relay G9KB
Instruction of product performance and reference circuit

Energy Management trend for Carbon Neutral

The world is transitioning towards a carbon-neutral society. The use of natural energy such as solar power generation is steadily expanding, and the use of storage batteries is indispensable.
Efficient use of self-generated energy systems will increasingly depend on effective battery management that will continue to expand in the future. DC power to charge the battery will utilize higher voltages requiring a switching device that enables safe and dependable cut-off.

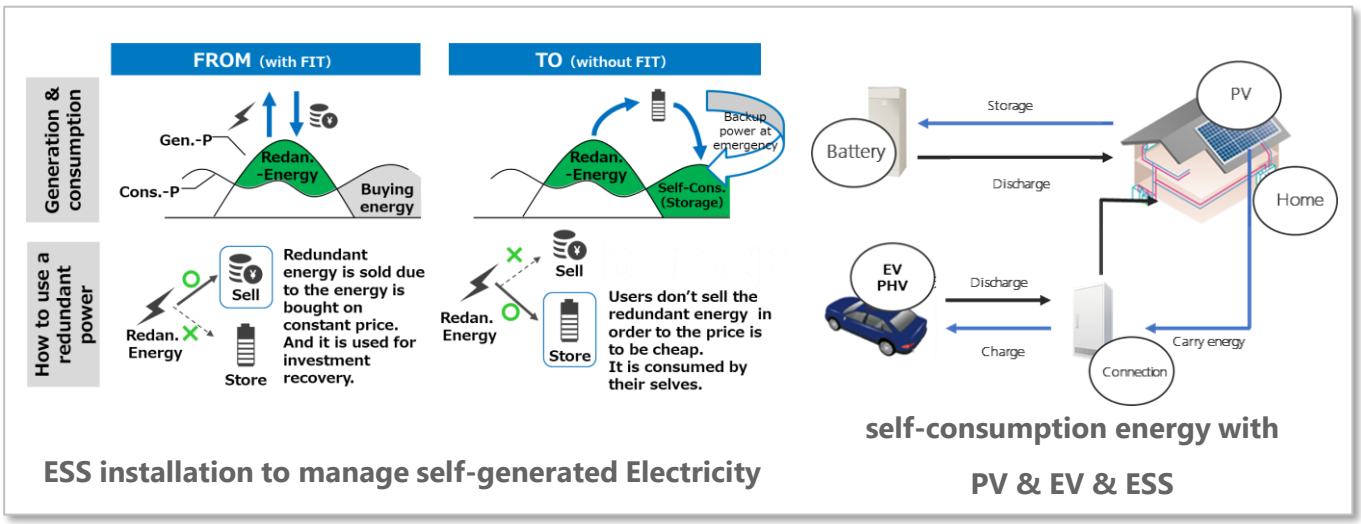


Figure 3: Background of market trend for G9KB relay

G9KB relay is widely expected to be used in commercial and industrial energy storage system (ESS), battery applications power conditioner (PCS) and Battery Unit (BMU) and industrial / Residential EV Charger (Mode 4). Moreover, G9KB can also be relied upon to provide durable bidirectional switching for V2H and V2G applications.

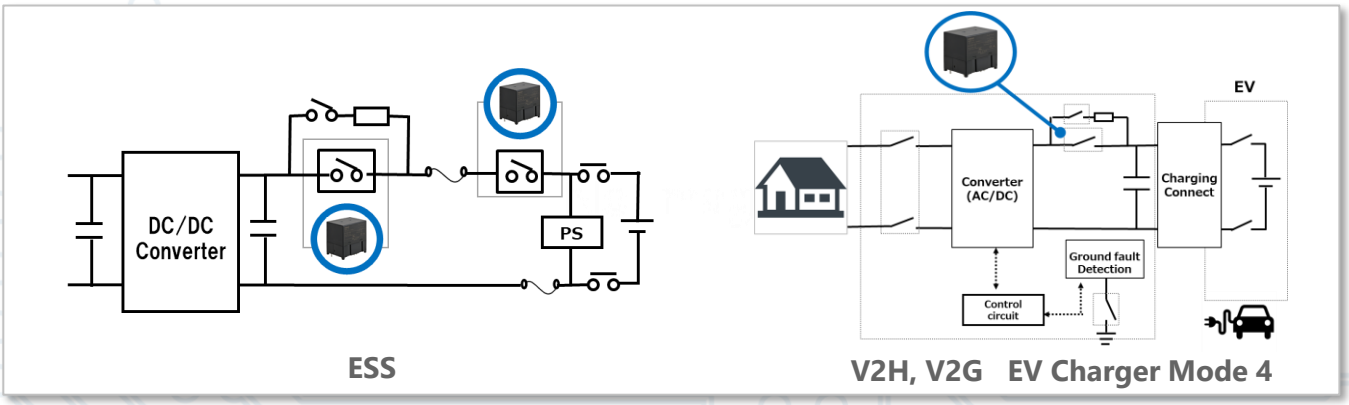


Figure 4: Example of commercial and industrial ESS and V2H, V2G application

600VDC 50A High power PCB relay G9KB
Instruction of product performance and reference circuit

High-power 600VDC 50A bidirectional switching capability

Since a large amount of arc discharge energy is generated when switching high capacity DC voltage (cut-off), it is generally encountered to be difficult to open and close it with conventional PCB relays. We have made this possible by creating a new relay with improved switching technology.

Technology that enables large voltage and current opening and closing by arc control traditionally has been solved by the utilization of a permanent magnet system. Through new simulation analysis technology (CAE) we have succeeded to further optimize arc control resulting in a compact package with high capacity switching up to 50A (Figure 6).

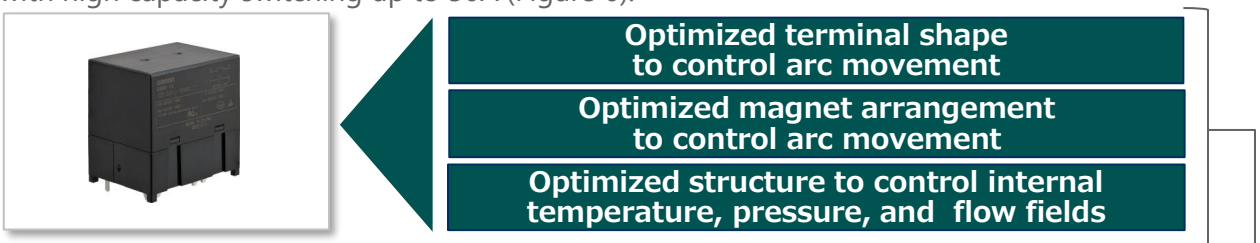


Figure 5: G9KB high technology control of contact arcing

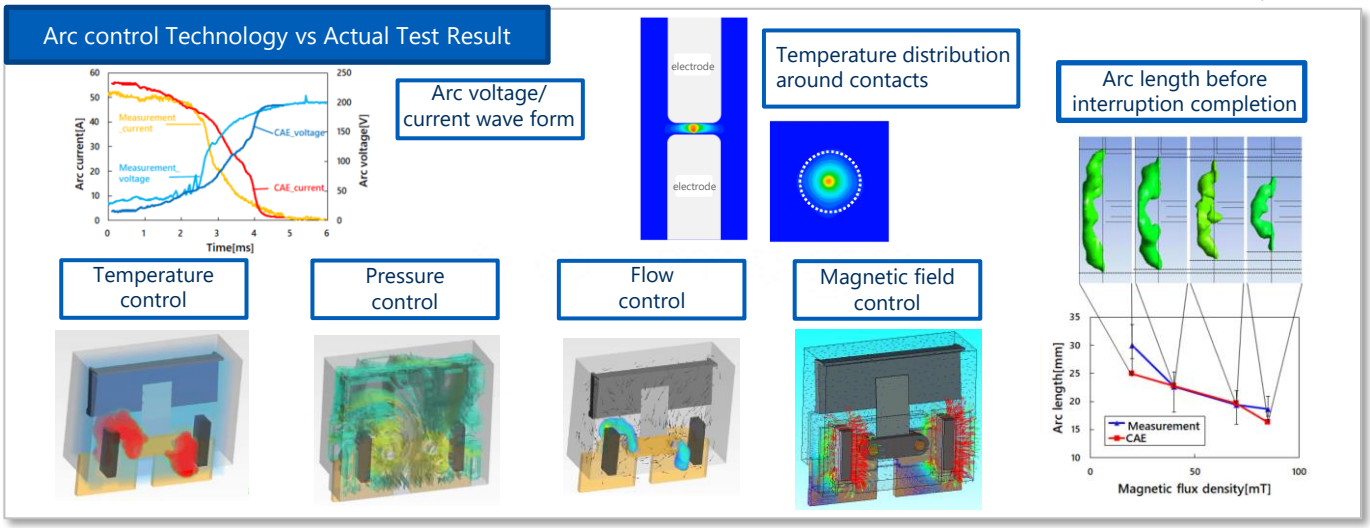


Figure 6: Analyzed optimal arcing movement simulation technology

All ESS and DC Charger systems can take advantage of the enhanced arc control we apply in G9KB ensuring reliable performance especially for bidirectional contact switching performance.

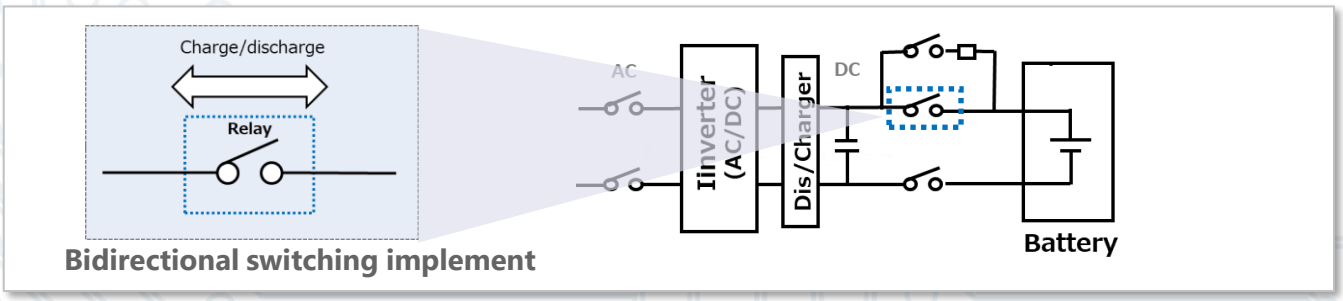


Figure 7: Bidirectional switching

600VDC 50A High power PCB relay G9KB
Instruction of product performance and reference circuit

DC switching performance is proven by UL/ TUV/ CQC certification (Figure. 8).
G9KB is capable of providing up to 600 VDC 50 A (resistive load, 85℃), 2,000 operations. Longer switching life can be expected when utilized at lower load power. (e.g. 600 VDC 1 A (resistive load, 85℃), 100,000 operations)

Approval Standard

UL/C-UL Certificated: (File No. E41515)

Model	Contact form	Coil ratings	Contact ratings	Number of test operations
G9KB-1A	SPST-NO(1a)	12, 24 VDC *	600 VDC 40 A (Resistive) 85°C	6,000
			600 VDC 50 A (Resistive) 85°C	2,000

* Holding voltage of 45% (after applying rated voltage to coil for 0.1 seconds)

EN/IEC, TÜV Certificated: (Certificate No. R 50528195)

Model	Contact form	Coil ratings	Contact ratings	Number of test operations
G9KB-1A	SPST-NO(1a)	12, 24 VDC *	600 VDC 1 A (Resistive) 85°C	100,000
			600 VDC 50 A (Resistive) 85°C	2,000

* Holding voltage of 45% (after applying rated voltage to coil for 0.1 seconds)

CQC Certificated: (Certificate No. CQC21002322255)

Model	Contact form	Coil ratings	Contact ratings	Number of test operations
G9KB-1A	SPST-NO(1a)	12, 24 VDC *	600 VDC 1 A (Resistive) 85°C	100,000
			600 VDC 50 A (Resistive) 85°C	2,000

* Holding voltage of 45% (after applying rated voltage to coil for 0.1 seconds)

Figure 8: G9KB approval safety standards

Low contact resistance

Contact resistance is one of the key characteristics for PCB high-power relay to reduce heat generation inside the component. Lower contact resistance improves PWB reliability by reducing the heat stress of terminal solder joint and surrounding components.

● Initial contact resistance value

G9KB contact resistance is defined as <5 mΩ initial value for warranty (6 VDC at 20 A after 30 seconds N=32 pcs) see Figures. 9, 10, initial contact resistance and contact resistance performance after switching 600VDC, 1A, 100,000 operations.

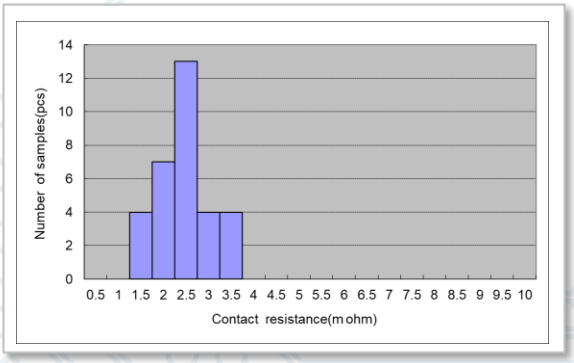


Figure 9: Initial contact resistance

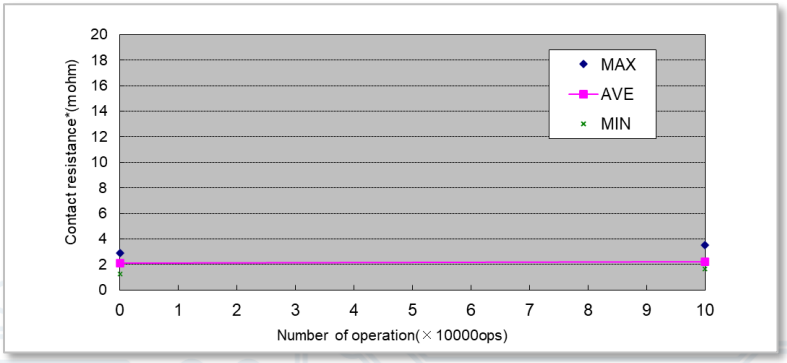


Figure 10: Reference data after switching 600VDC 1A (resistive load, 85℃) contact resistance (100,000 operations).

600VDC 50A High power PCB relay G9KB
Instruction of product performance and reference circuit

Low power consumption

G9KB coil power consumption is approx.2.8W at rated coil voltage, however actual power consumption can be reduced to approx. 0.57W by Holding voltage 45 %. PWM control is another method to reduce the coil power consumption. G9KB relay is applicable for both methods by following reference circuit diagrams.

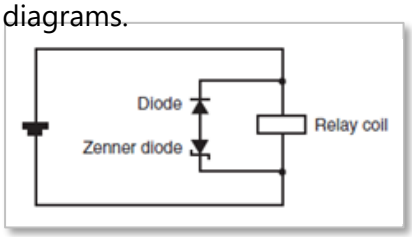


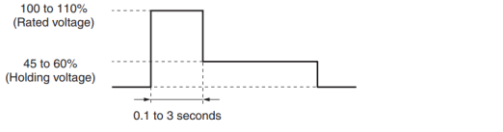
Figure 12: Diode connection

Please use a diode for coil surge absorption. A Zener diode is also required in combination to maintain the G9KB switching performance. Diode connection is required in reverse polarity of the voltage applied to the coil (Figure 12).

- Recommended Zener diode is 3 times the rated coil voltage.
- Please use diodes with reverse dielectric strength 10 times or more the coil rated voltage.

● Holding voltage

To reduce actual coil power consumption, please apply rated coil voltage for 0.1 to 3.0 seconds at first. The range of coil rated voltage must be set as 100 to 110 % and acceptable holding voltage is 45 to 60 % (Figure 13).



	Applied coil voltage	Coil resistance *	Coil power consumption
Rated voltage	100 to 110%	51 Ω (12 VDC) 206 Ω (24 VDC)	Approx. 2.8 to 3.4 mW
Holding voltage	45 to 60%		Approx. 0.57 to 1.1 mW

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

Figure 13: Coil voltage reduction after operation

A CR circuit might be the simplest configuration to realize holding voltage. Operate the relay by current through capacitor and coil current will be reduced by the resistance (Figure 14). Please select the capacitor that can provide rated coil current for 40 ms or more. Choose the resistance value so that coil voltage will be over 45%.

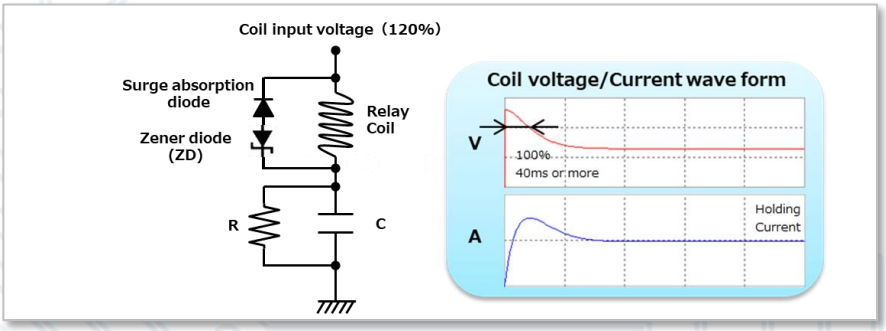


Figure 14: Reference of holding voltage CR circuit diagram

600V 50A DC High power PCB relay G9KB
Instruction of product performance and reference circuit

A switching device can be use as an alternative to capacitor (Figure15). Rated coil voltage will apply to the relay when switch is turned on and coil voltage will decrease when switching device turns off.

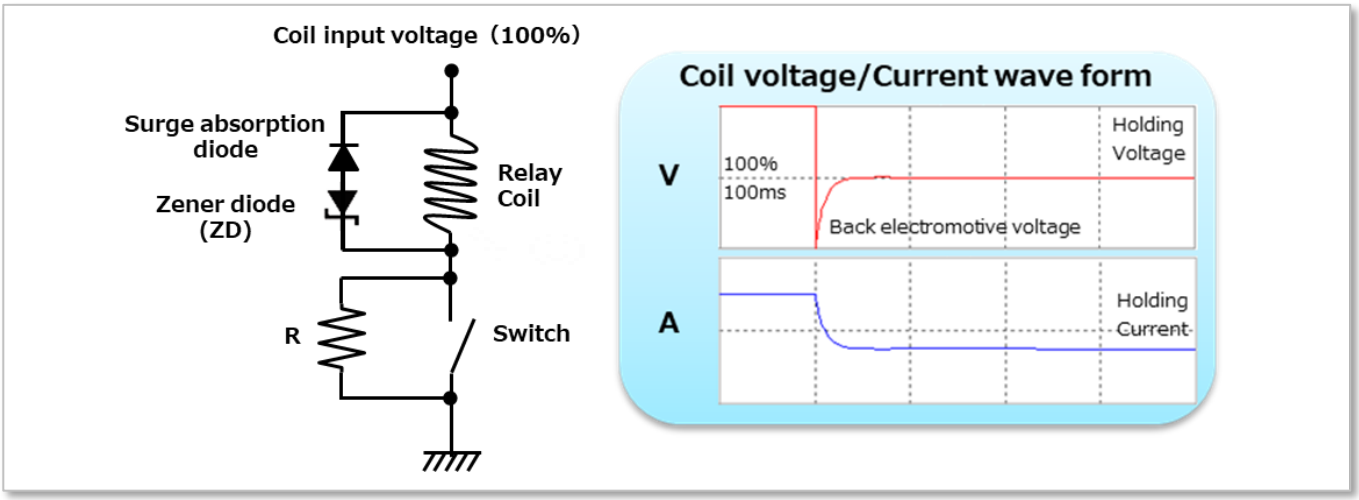


Figure 15: Reference of holding voltage by switch

● PWM control

To avoid the power loss caused by the Zener diode, generally PWM control circuit is not recommended. Please implement switching device in parallel with Zener diode and bypass it during the PWM control (Figure 16). Turn off the switching device first and thereafter relay will turn off properly by Zener diode and diode.

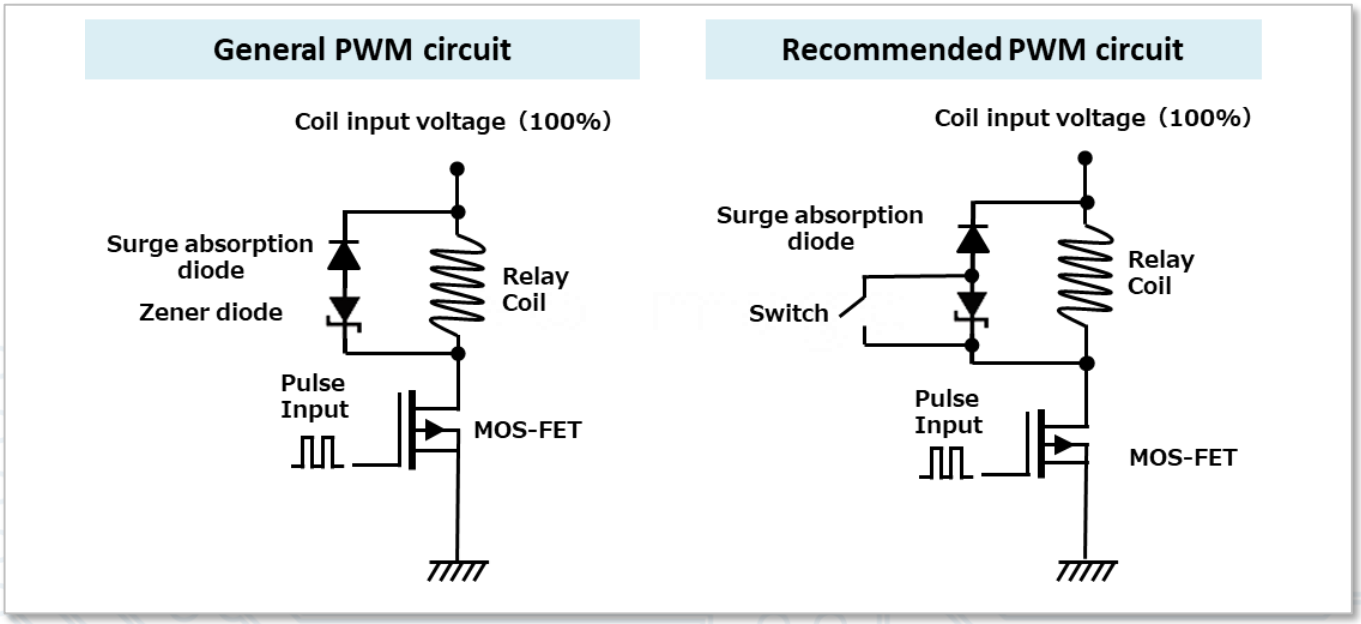


Figure 16: Reference of PWM control circuit diagram

600V 50A DC High power PCB relay G9KB
Instruction of product performance and reference circuit

Figure 17 shows the comparison of coil current at each duty cycle. Generally PWM circuit requires over 90 % duty cycle to keep the relay turned on. On the other hand, over 45 % duty cycle is acceptable for recommended PWM circuit to achieve the holding coil current criteria.

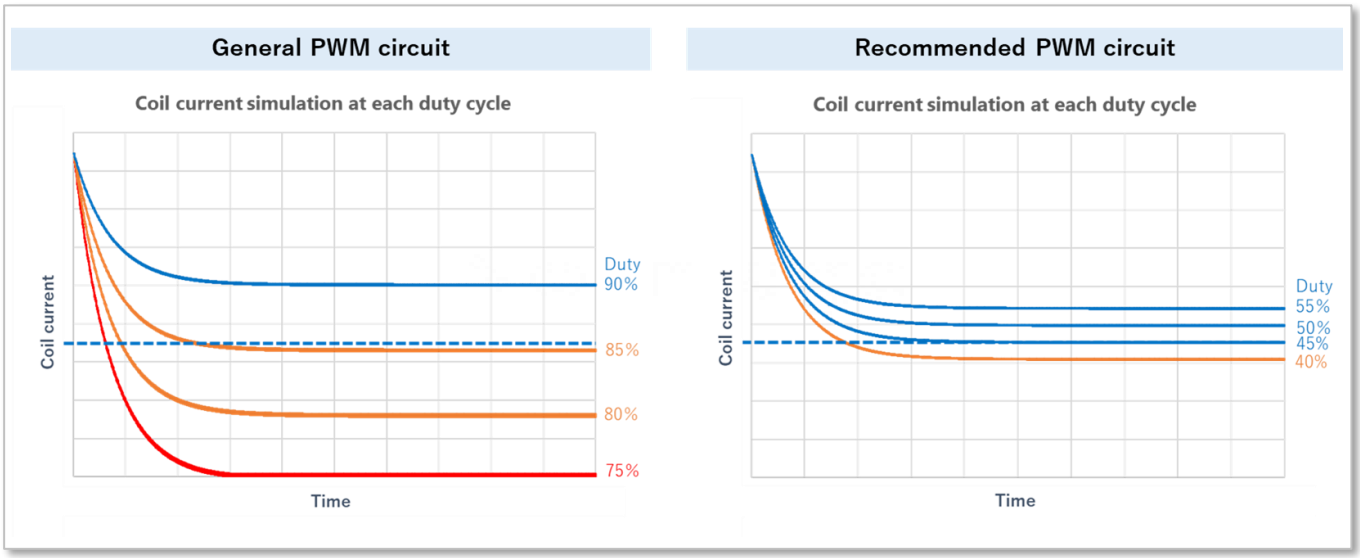


Figure 17: Reference of PWM control circuit diagram

Afterword

We hope you found this material useful. By adopting some or all of these suggestions contained in this material you'll be able to get maximum usage benefit as we intended. Please contact us in case you need further detail.

White Paper

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
http://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. K343-E1-02
0722