White Paper

OMRON

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High-Capacity Power Relay Suitable for High Voltage DC Circuits up to 600 VDC, 50 A (Standard Model) and 800 VDC, 100 A* (High-Capacity Model)

*** Maximum 600 VDC when Switching 100 A**

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.

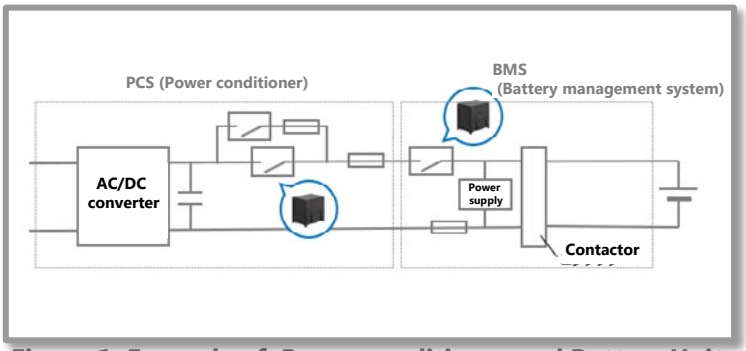


Figure 1: Example of Power conditioner and Battery Unit relay application

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 G9KB series achieves a high capacity of 600 VDC / 50 A (standard model) and 800 VDC / 100 A* (high-capacity model) through the control design of energizing current and bidirectional arc interrupting technology, thereby expanding your design possibilities. Also, an efficient low coil holding voltage can be applied contributing to reduce power consumption during relay operation (Figure 2).

Item		Standard model (G9KB-1A)	High-capacity model (G9KB-1A-E)
Coil	Coil voltage	12 VDC, 24 VDC	12 VDC, 24 VDC
	Power consumption	Approx. 2.8 W (Approx. 0.57 W at holding voltage 45%)	Approx. 2.8 W (Approx. 0.57 W at holding voltage 45%)
Contact	Contact form	1a	1a
	Rated load (Resistive)	600 VDC, 50 A / 600 VDC, 1 A	600 VDC 100 A／500 VDC 100 A／800 VDC 50 A ／800 VDC 18 A
	Contact resistance	≤5 mΩ (measurement condition: 6 VDC 20 A (after 30 sec.) voltage drop method)	≤5 mΩ (measurement condition: 6 VDC 20 A (after 30 sec.) voltage drop method)
	Contact gap	≥3.6 mm	≥3.6 mm
Endurance	Mechanical	1,000,000 operations min. (at 10,800 operations/h)	1,000,000 operations min. (at 10,800 operations/h)
	Electrical	600 VDC, 50 A, 2,000 operations min. 600 VDC, 1 A, 100,000 operations min. (Switching frequency: 1 second ON - 9 seconds OFF at 85°C and 25% to 75% RH)	600 VDC, 100 A, 100 operations min. 500 VDC, 100 A, 300 operations min. 800 VDC, 50 A, 10 operations min. 800 VDC, 18 A, 6,000 operations min. (Switching frequency: 1 second ON - 9 seconds OFF at 85°C and 25% to 75% RH)
	Switching current direction	Bidirectional direction acceptable	Bidirectional direction acceptable
Ambient operating temperature		-40°C to 85°C (with no condensation or icing)	-40°C to 85°C (with no condensation or icing)
Terminal type		Printed circuit board	Printed circuit board
Safety standard		UL 60947-4-1, EN 61810-10, CQC	UL 60947-4-1, EN 61810-10, CQC

* Maximum 600 VDC when switching 100 A

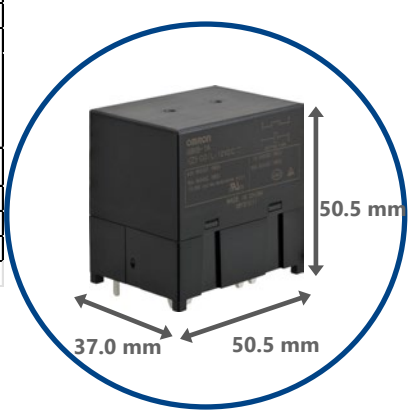


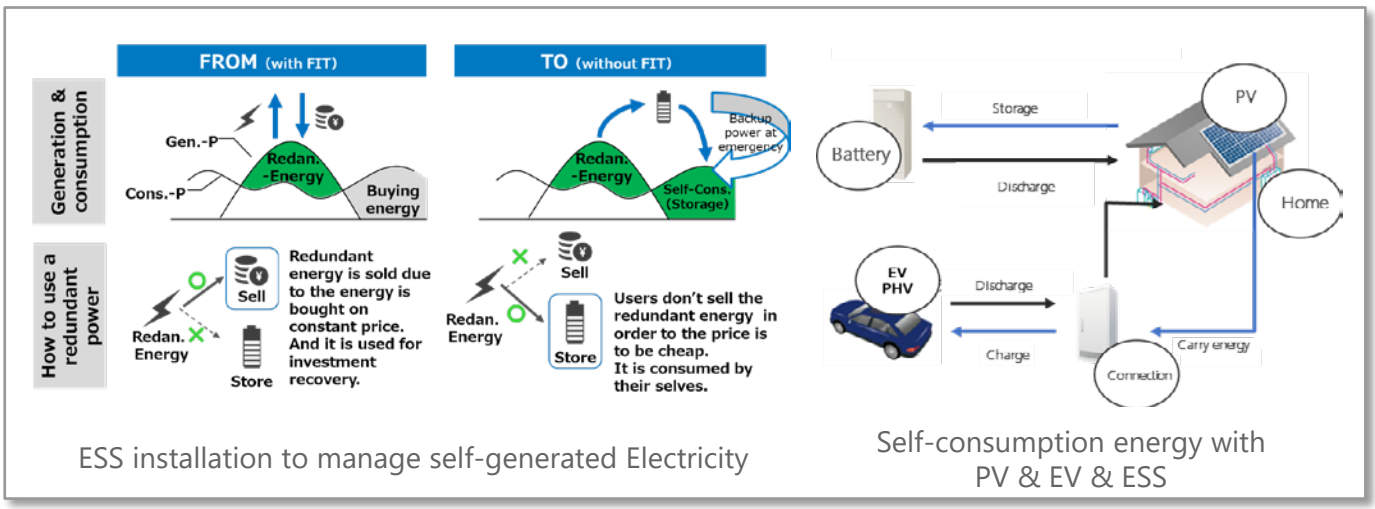
Figure 2: G9KB relay specifications

High-Capacity Power Relay Suitable for High Voltage DC Circuits up to 600 VDC, 50 A (Standard Model) and 800 VDC, 100 A* (High-Capacity Model)

*** Maximum 600 VDC when Switching 100 A**

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.



ESS installation to manage self-generated Electricity

Self-consumption energy with PV & EV & ESS

Figure 3: Market trends related to energy management

High-Capacity Power Relay Suitable for High Voltage DC Circuits up to 600 VDC, 50 A (Standard Model) and 800 VDC, 100 A* (High-Capacity Model)

*** Maximum 600 VDC when Switching 100 A**

The G9KB series is suitable for a wide range of applications, including stationary energy storage systems (ESS), power conditioners for energy storage (PCS), battery management systems (BMS), and rapid EV chargers (Mode 4). The G9KB series is also suitable for highly durable bidirectional switching in V2H and V2G.

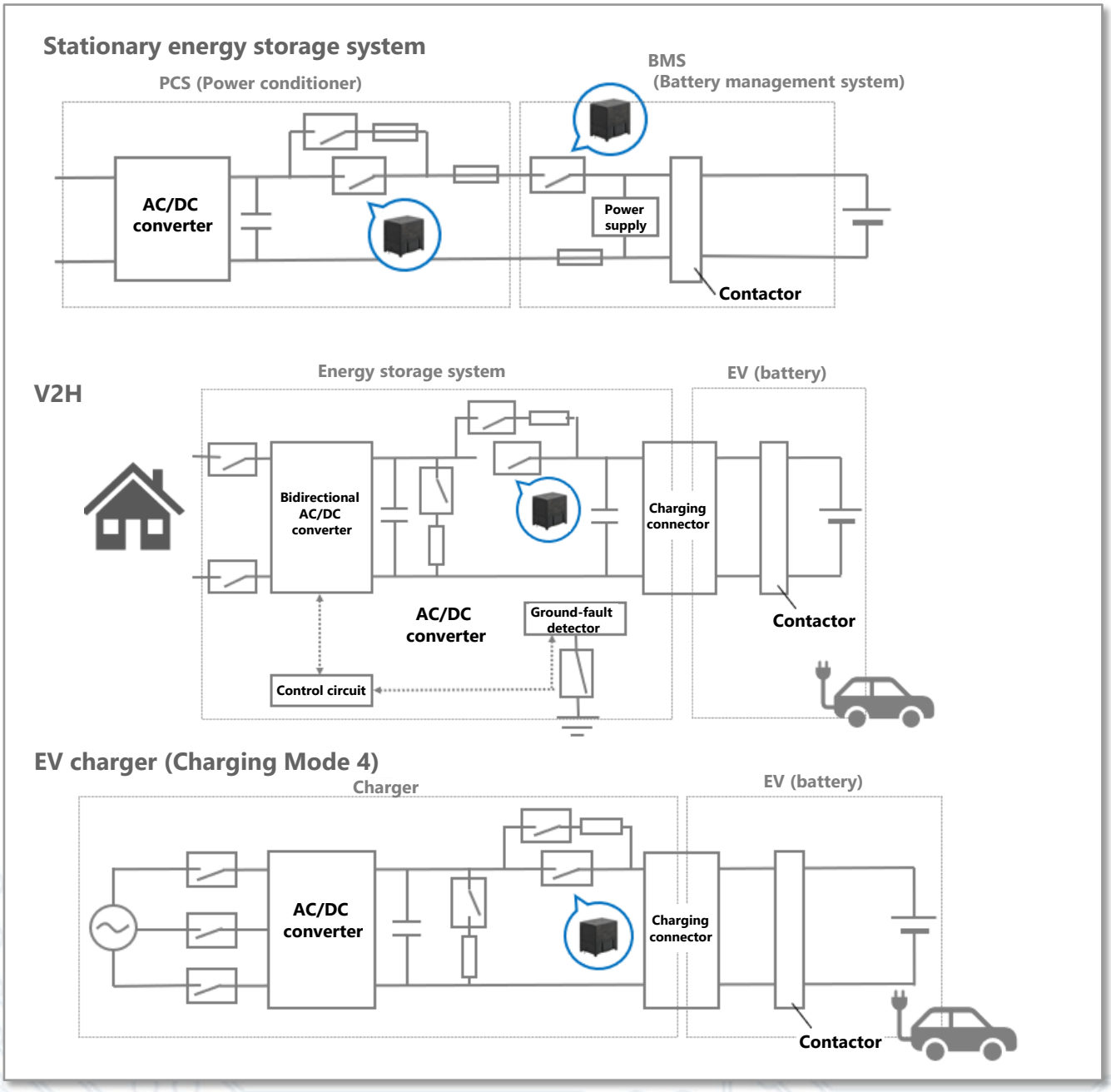


Figure 4: Examples of ESS use in EV charging, V2H, and V2G

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High-Power 800 VDC 100 A Bidirectional Switching Capability

Since a large amount of arc discharge energy is generated when switching high-capacity DC voltage (cut-off), it is generally difficult to open and close it with conventional PCB relays. By creating a new relay with improved technology, we have made this possible for easier switching capabilities.
Through new simulation analysis technology (CAE) we have succeeded to further optimize arc control resulting in a compact package with a high capacity of 50 A for the standard model and 100 A for the high-capacity model (Figure 6). Traditionally, technology that enables large voltage and current opening and closing by arc control were solved by the utilization of a permanent magnet system.

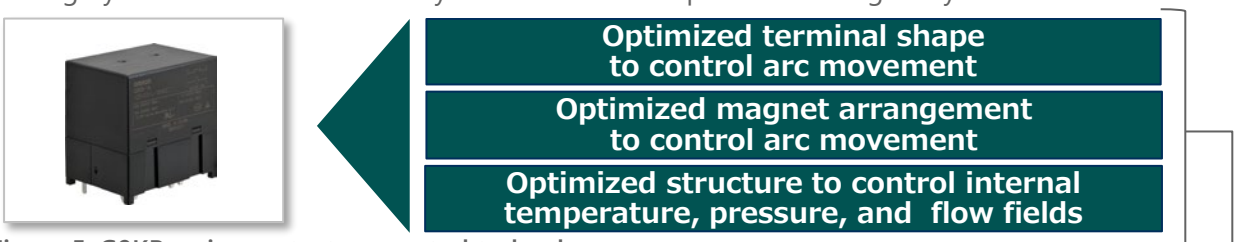


Figure 5: G9KB series contact arc control technology

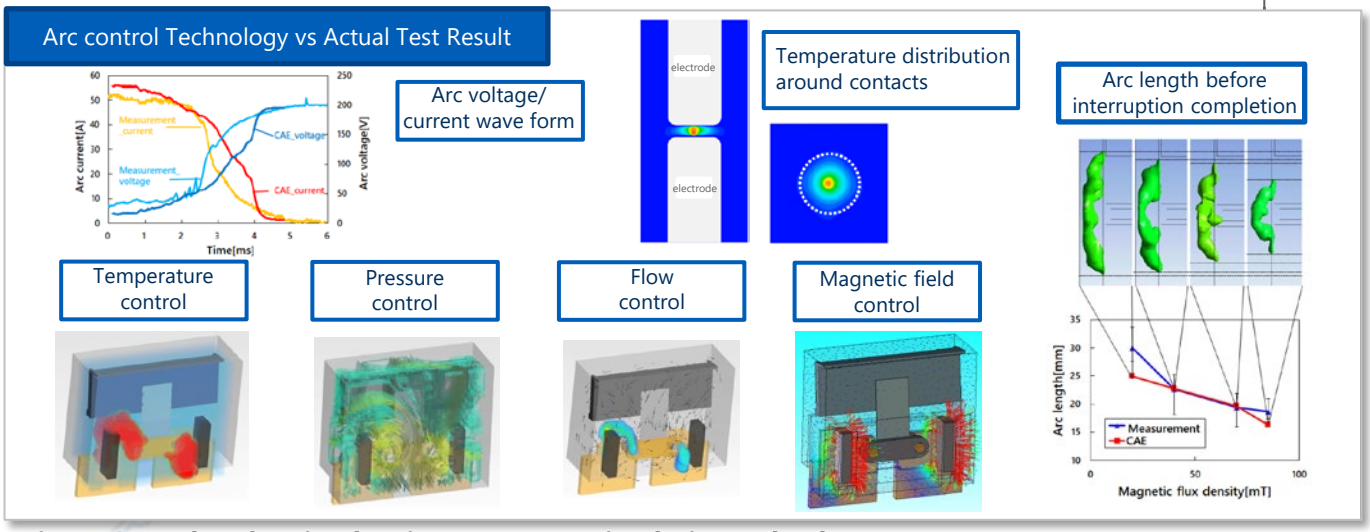


Figure 6: Analyzed optimal arcing movement simulation technology

The arc control technology applied to the G9KB series provides reliable switching performance in all stationary energy storage systems and DC power supply systems, especially for bidirectional contact switching performance.

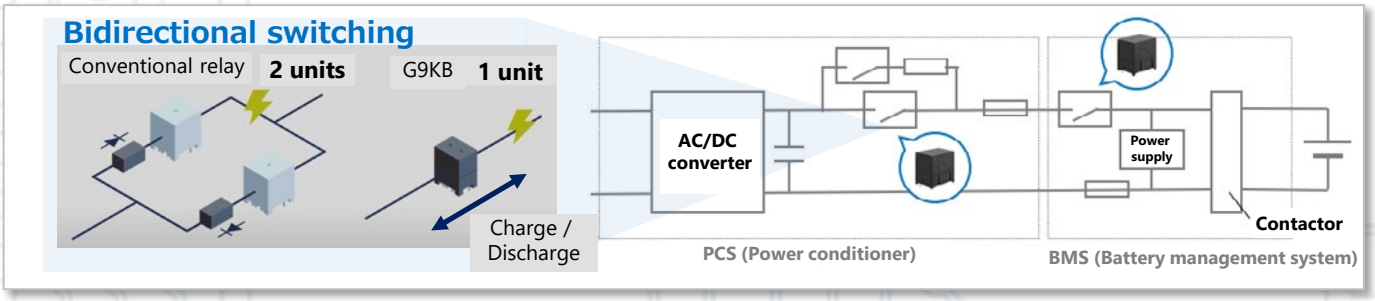


Figure 7: Bidirectional switching applications in energy storage system

High-Capacity Power Relay Suitable for High Voltage DC Circuits up to 600 VDC, 50 A (Standard Model) and 800 VDC, 100 A* (High-Capacity Model)

* Maximum 600 VDC when Switching 100 A

G9KB Series Overseas Standard Certification Ratings

The G9KB series is designed to meet your high-voltage and high-current needs.

The G9KB series has obtained UL/TUV/CQC certifications (Figure 8). The rated values certified by overseas standards are different from the individually determined performance values, so please check the values before use.

The standard model has a rated performance of 2,000 switching times at 600 VDC, 50 A (resistive load, 85°C), while the high-capacity model has a maximum contact voltage of 800 VDC and an energizing/switching capacity of 600 VDC, 100 A.

● **UL/C-UL Certified: (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
G9KB-1A-E	SPST-NO (1a)	12, 24 VDC*	600 VDC 100 A (Resistive) 85°C	100
			500 VDC 100 A (Resistive) 85°C	300
			800 VDC 50 A (Resistive) 85°C	10
			800 VDC 18 A (Resistive) 85°C	6,000

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

● **EN/IEC, TÜV Certified: (Certificate No. R50528195)**

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
G9KB-1A-E	SPST-NO (1a)	12, 24 VDC*	600 VDC 100 A (Resistive) 85°C	100
			500 VDC 100 A (Resistive) 85°C	300
			800 VDC 50 A (Resistive) 85°C	10
			800 VDC 18 A (Resistive) 85°C	6,000

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

● **CQC Certified: (Certificate No. CQC2100232255)**

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
G9KB-1A-E	SPST-NO (1a)	12, 24 VDC*	600 VDC 100 A (Resistive) 85°C	100
			500 VDC 100 A (Resistive) 85°C	300
			800 VDC 50 A (Resistive) 85°C	10
			800 VDC 18 A (Resistive) 85°C	6,000

Figure 8: G9KB series overseas standard certification ratings

High-Capacity Power Relay Suitable for High Voltage DC Circuits up to 600 VDC, 50 A (Standard Model) and 800 VDC, 100 A* (High-Capacity Model)

*** Maximum 600 VDC when Switching 100 A**

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.

The contact resistance of the G9KB series is guaranteed to be an initial value of 5 mΩ or less (after 30 seconds at 6 VDC, 20 A, using the voltage drop method). Figure 9 shows the initial distribution of contact resistance of the G9KB series.

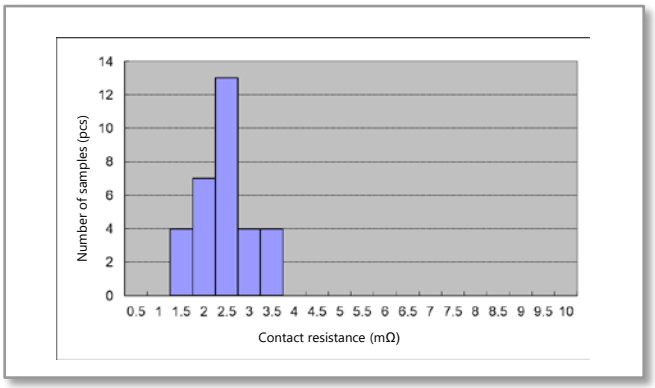
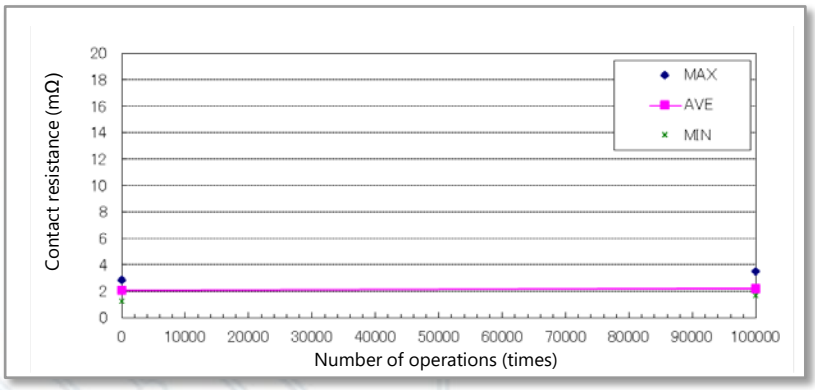


Figure 9: G9KB series initial contact resistance (measured value)

Figure 10 shows the contact resistance of G9KB-1A, and Figures 11 and 12 show the contact resistance of G9KB-1A-E after load switching.

● G9KB-1A Contact Resistance



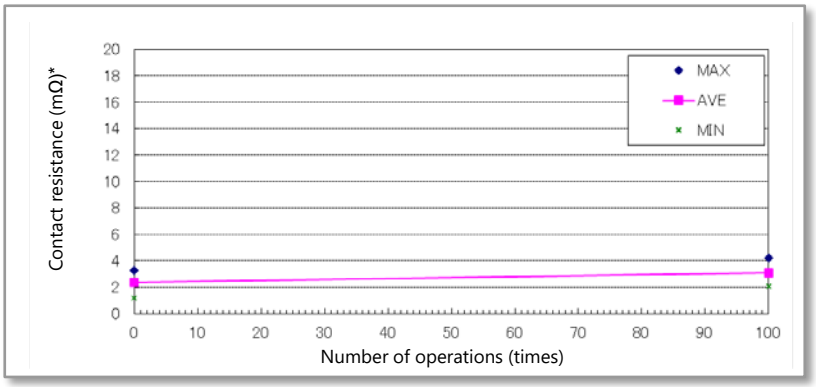
The contact resistance after 30 seconds at 6 VDC, 20 A measured using the voltage drop method. (Ambient temperature 23°C)

Figure 10: Contact resistance of G9KB-1A after 100,000 switching times at 600 V, 1 A

High-Capacity Power Relay Suitable for High Voltage DC Circuits up to 600 VDC, 50 A (Standard Model) and 800 VDC, 100 A* (High-Capacity Model)

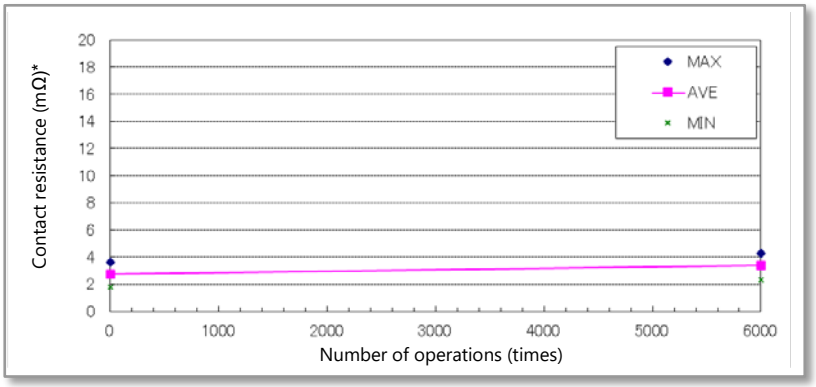
*** Maximum 600 VDC when Switching 100 A**

● G9KB-1A-E Contact Resistance



The contact resistance after 30 seconds at 6 VDC, 20 A measured using the voltage drop method. (Ambient temperature 23°C)

Figure 11: G9KB-1A-E contact resistance after switching 100 times at 600 V, 100 A



The contact resistance after 30 seconds at 6 VDC, 20 A measured using the voltage drop method. (Ambient temperature 23°C)

Figure 12: G9KB-1A-E contact resistance after switching 6,000 times at 800 V, 18 A

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* Maximum 600 VDC when Switching 100 A

Durability Performance

The durability curve for the G9KB series is shown in Figure 13. The G9KB series with its high-voltage DC load switching capability supports the rated voltage of 600 V for G9KB-1A and 800 V for G9KB-1A-E, contributing to the development of storage battery applications with increasingly higher voltages. Depending on your system voltage and current conditions, please use this data as a guideline for the number of possible switching times.
Note that this data is for reference only, and you are requested to make your own evaluation and judgment of usability in actual applications.

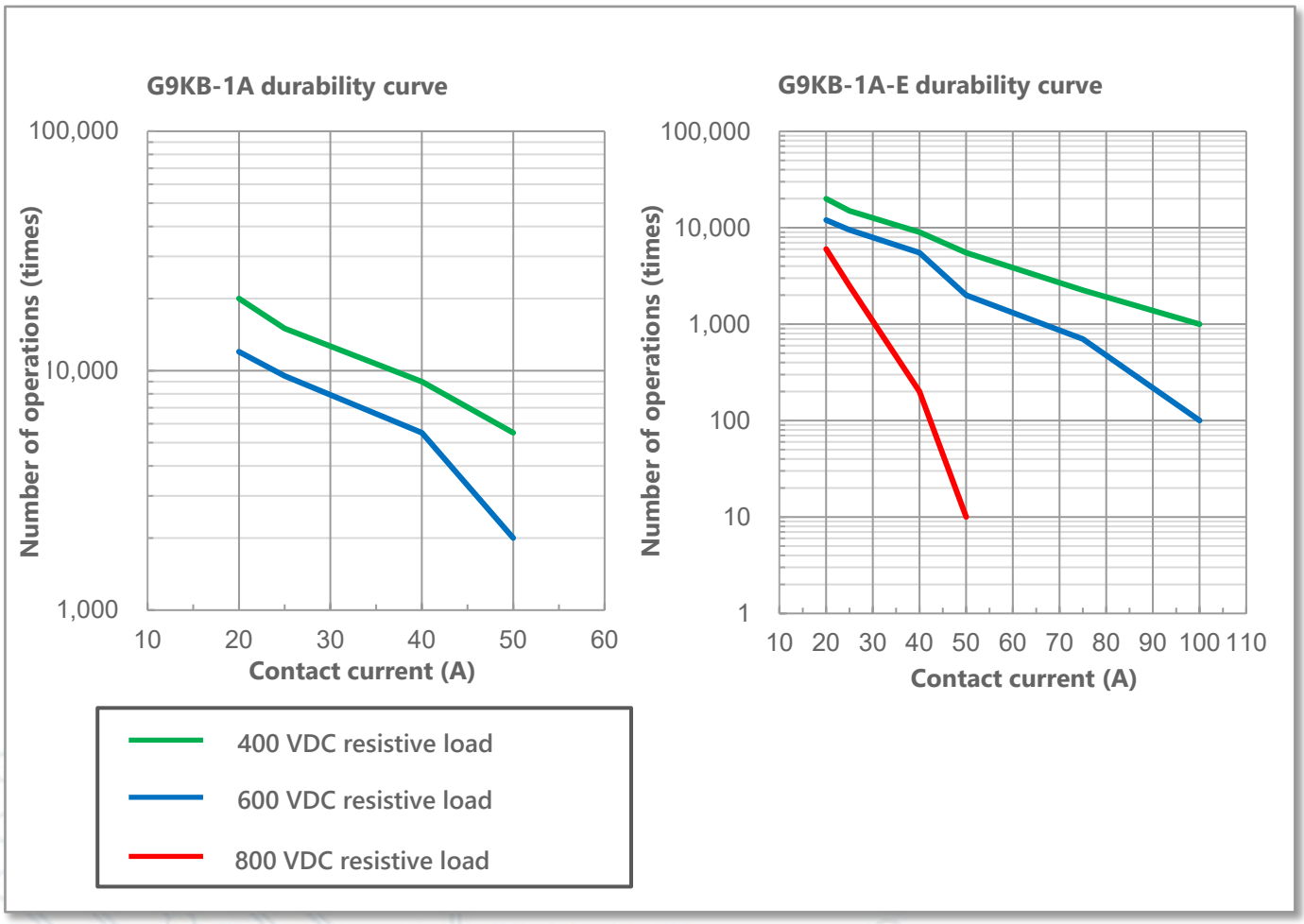


Figure 13: G9KB series durability curve

High-Capacity Power Relay Suitable for High Voltage DC Circuits up to 600 VDC, 50 A (Standard Model) and 800 VDC, 100 A* (High-Capacity Model)

*** Maximum 600 VDC when Switching 100 A**

Low Power Consumption

The coil power consumption of the G9KB series is approximately 2.8 W at rated coil voltage, but it is reduced to approximately 0.57 W at 45% holding voltage. PWM control is another method to reduce the coil power consumption. G9KB relay is applicable for both methods by following reference circuit diagrams.

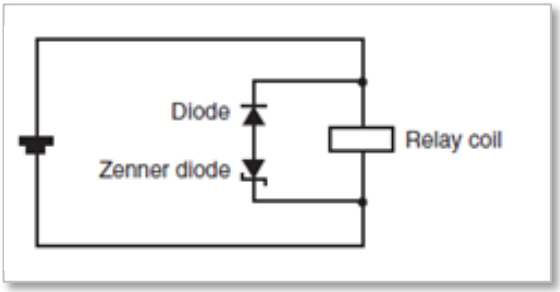
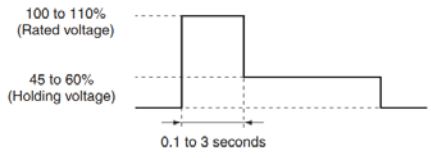


Figure 14: Diode connection

Please use a diode for coil surge absorption. A Zener diode must also be used to maintain the switching performance of the G9KB series. Diode connection is required in reverse polarity of the voltage applied to the coil (Figure 14).

- 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.



	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 15: Coil voltage reduction after operation

● 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 15).

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 16). 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%.

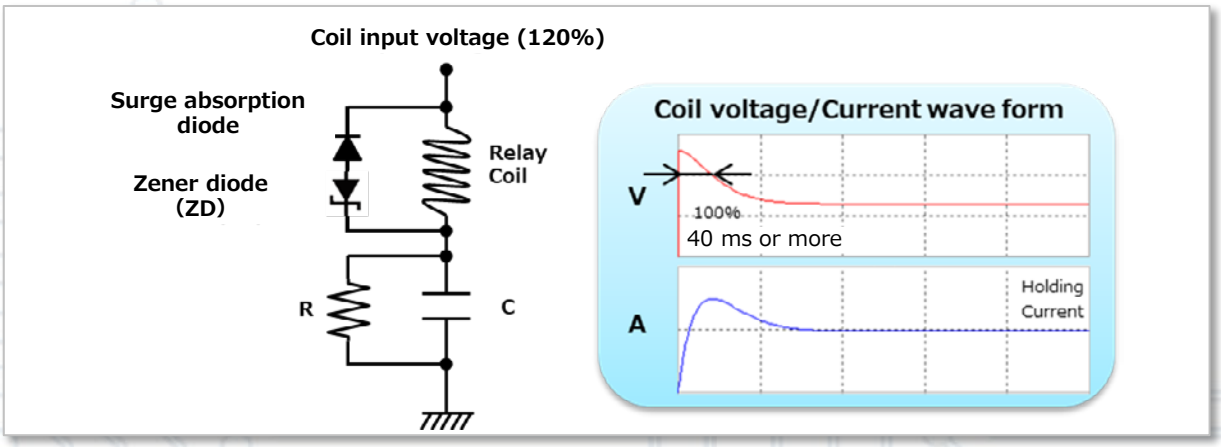


Figure 16: Reference of holding voltage CR circuit diagram

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*** Maximum 600 VDC when Switching 100 A**

A switching device can be used as an alternative to capacitor (Figure17). Rated coil voltage will apply to the relay when switch is turned on and coil voltage will decrease when switching device turns off.

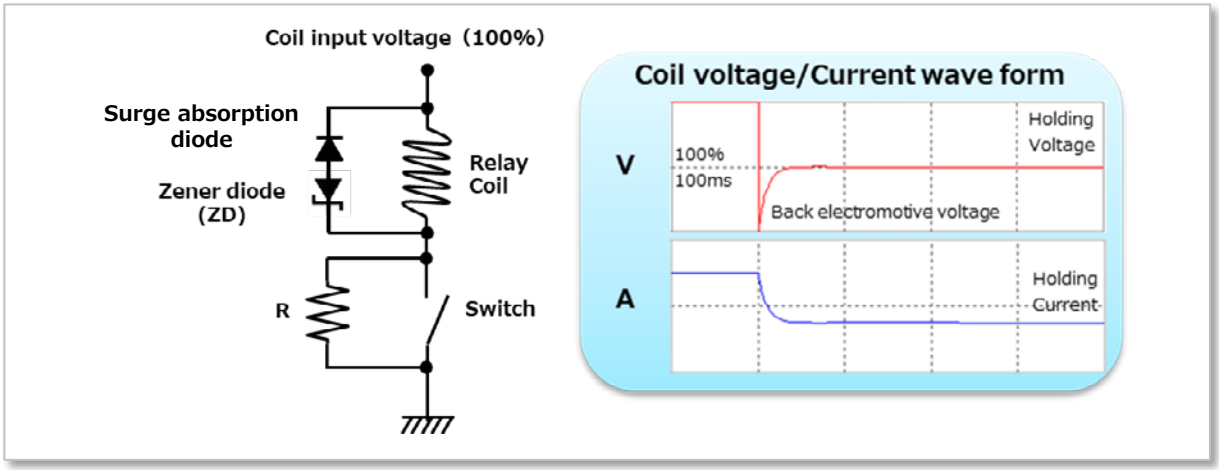

Figure 17: Reference of holding voltage by switch

● 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 18). Turn off the switching device first and thereafter relay will turn off properly by Zener diode and diode.

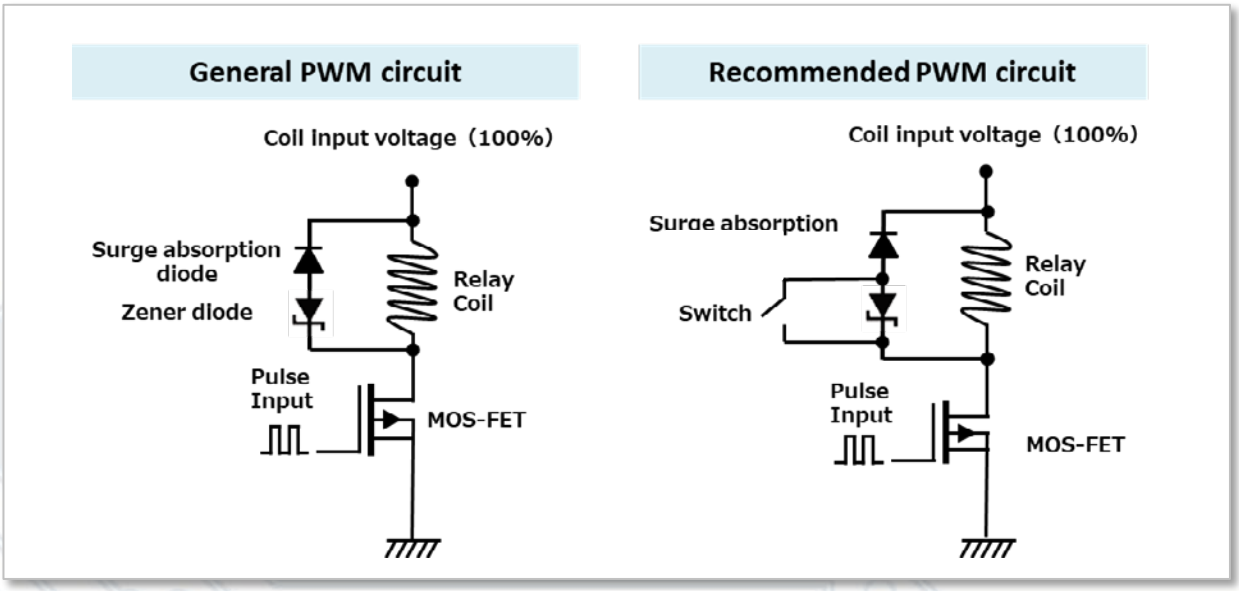

Figure 18: Reference of PWM control circuit diagram

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Figure 19 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.

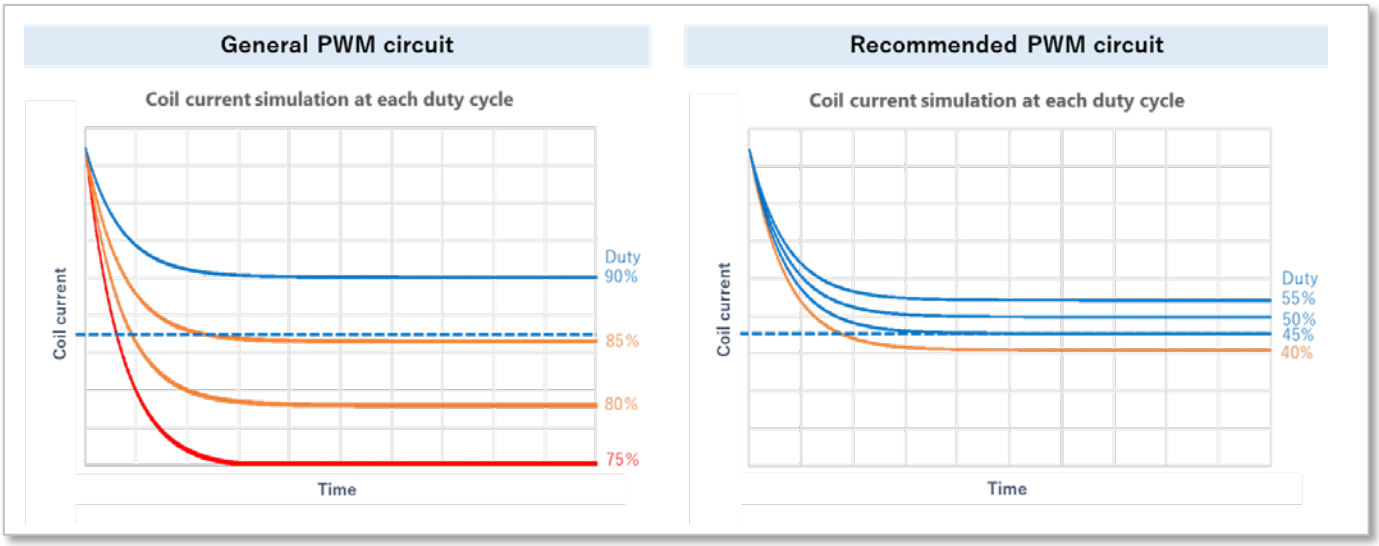

Figure 19: Reference of PWM control circuit diagram

Other Related Documents

OMRON offers technical support pages for high-capacity relays that provide detailed explanations of "what is difficult to understand" when using PCB power relays with high current and high voltage, including coil counterelectromotive voltage, holding voltage application circuit, recommended conditions for high current board flow soldering, magnetic field effects, and precautions for series/parallel connection. Please use these pages as well.

Technical professionals provide easy-to-understand explanations of the unknowns when using high-capacity power relays. | OMRON Device & Module Solutions - Americas

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