White Paper

Issue Date: May 2025

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.

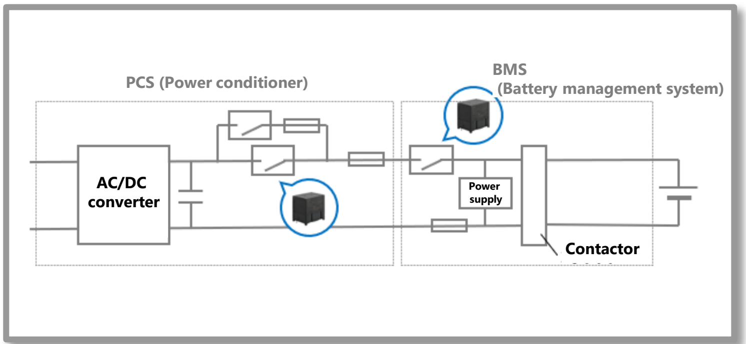

Figure 1: Example of Power conditioner and Battery Unit relay application

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 / 500 VDC, 25 A / 600 VDC, 10 A /600 VDC, Make 1A Carry 35 A Break 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 500 VDC, 25 A, 12,000 operations min. 600 VDC, 10 A, 50,000 operations min. 600 VDC, Make 1 A Carry 35 A Break 1 A, 50,000 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/C-UL, TUV, CQC	UL/C-UL, TUV, CQC

* Maximum 600 VDC when switching 100 A

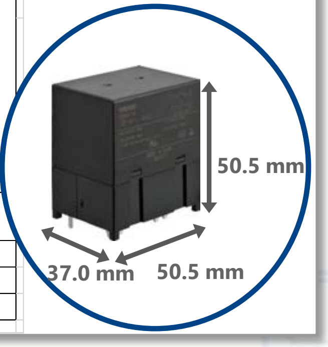

Figure 2: G9KB series specifications

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.

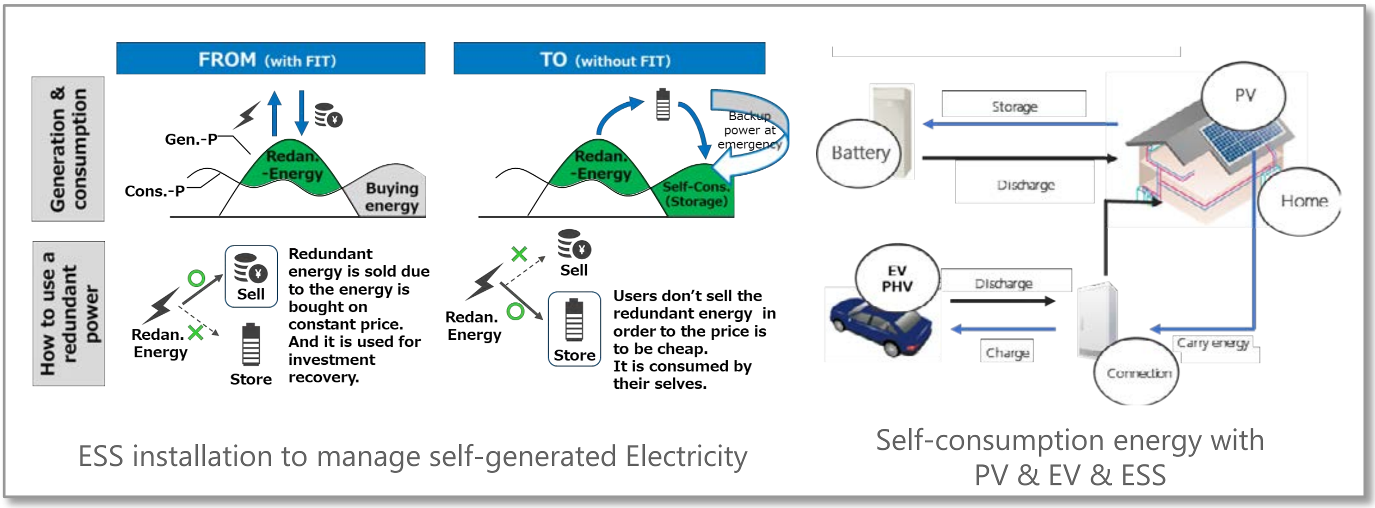

Figure 3: Market trends related to energy management

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.

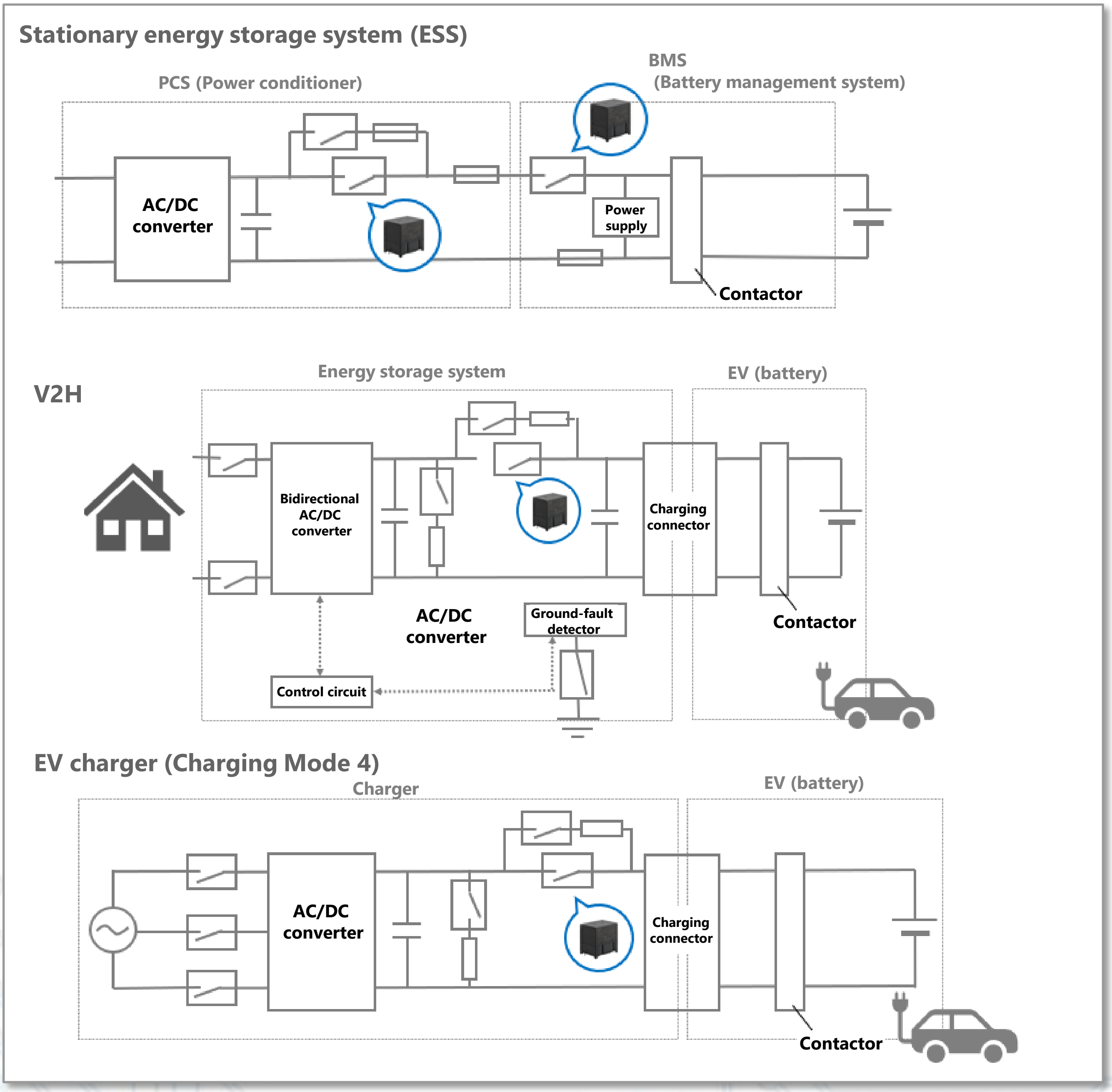

Figure 4: Example of use with ESS, V2H, and EV chargers

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

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.

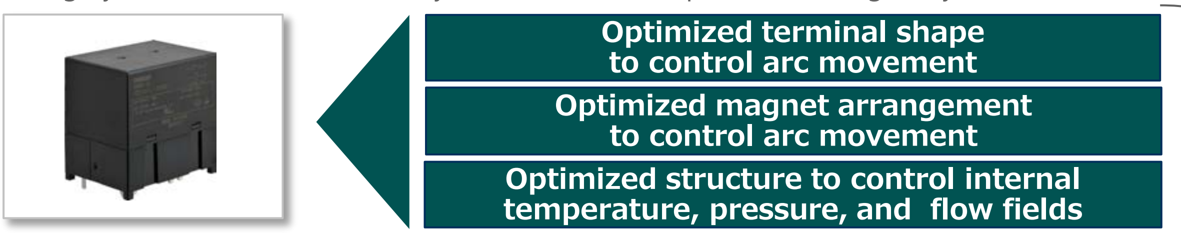

Figure 5: G9KB series contact arc control technology

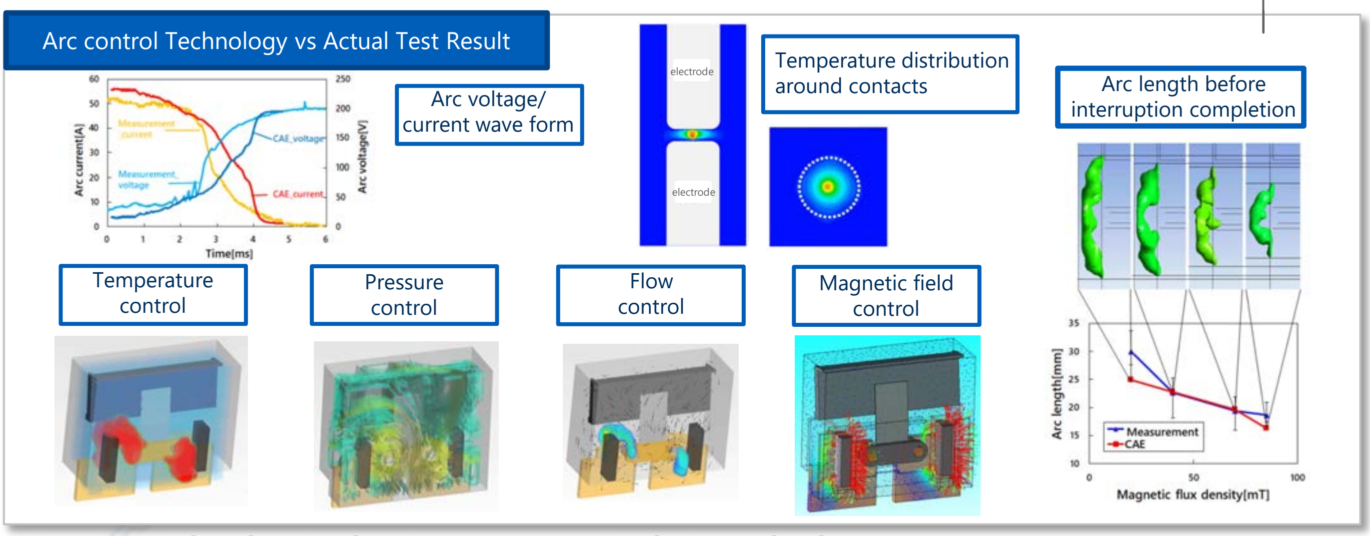

Figure 6: Analyzed optimal arcing movement simulation technology

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.

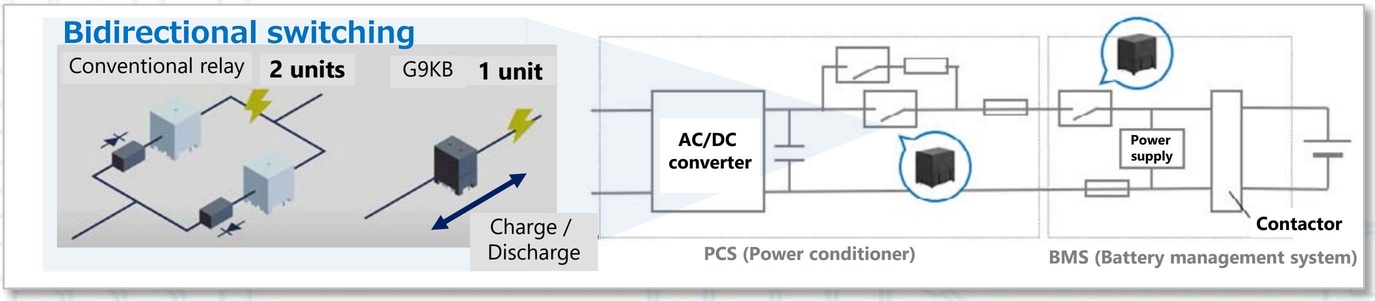

Figure 7: Bidirectional switching applications in energy storage system

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
			400 VDC 46A (Resistive) 85°C	6,000
			500 VDC 25A (Resistive) 85°C	12,000
			600 VDC 10A (Resistive) 85°C	50,000
			600 VDC Make 1A, Carry 35A, Break 1A 85°C	50,000
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
			830 VDC 20 A (Resistive) 85°C	2,500

* 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
			830 VDC 20 A (Resistive) 85°C	2,500

* 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
			830 VDC 20 A (Resistive) 85°C	2,500

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

Figure 8: G9KB series overseas standard certification ratings

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

Low Contact Resistance

Contact resistance is one of the key characteristics for high-power relay to control heat generation inside the relay. Lower contact resistance which generates lower heat makes PWB more reliable with lower heat stress on it.

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.

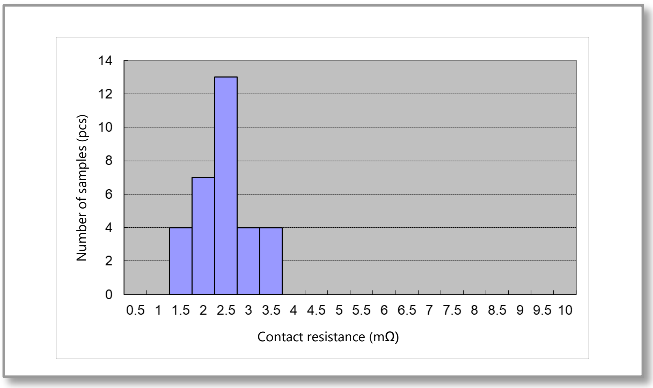
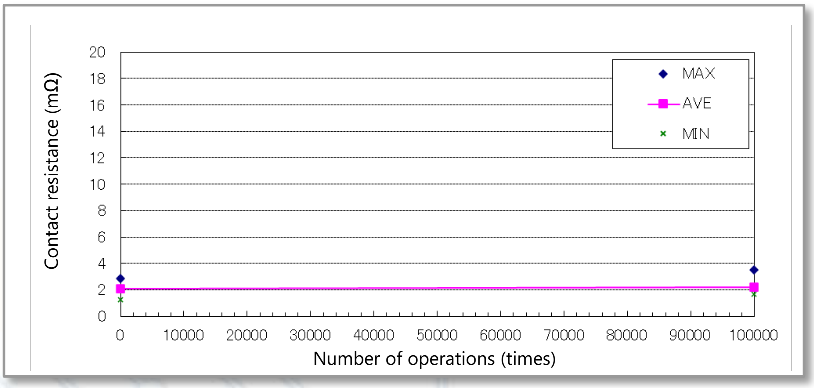


Figure 9: G9KB series initial contact resistance (measured value)

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

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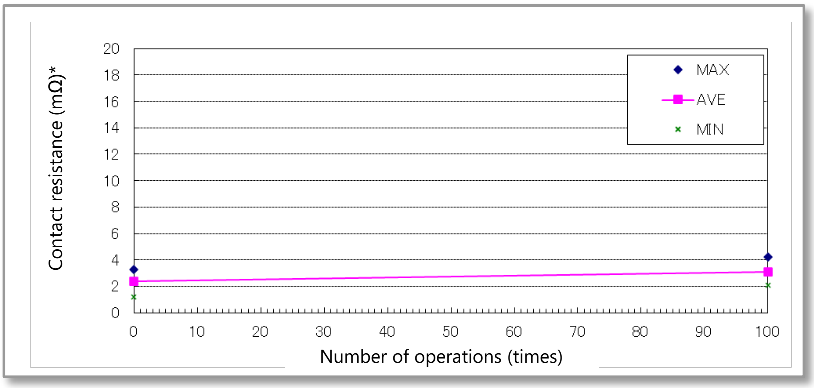
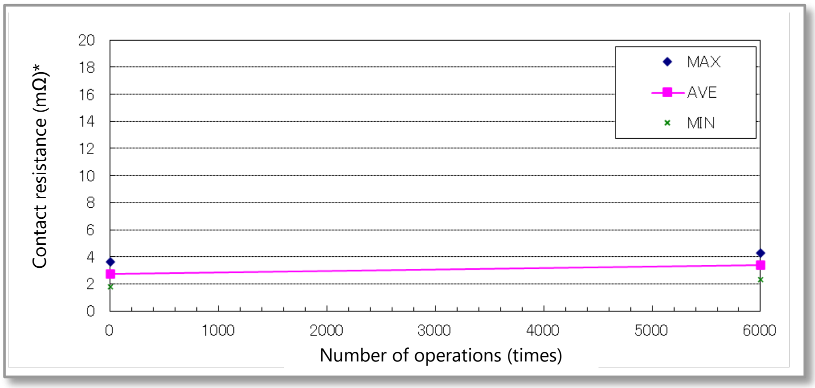
* Maximum 600 VDC when Switching 100 A

● 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

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

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.

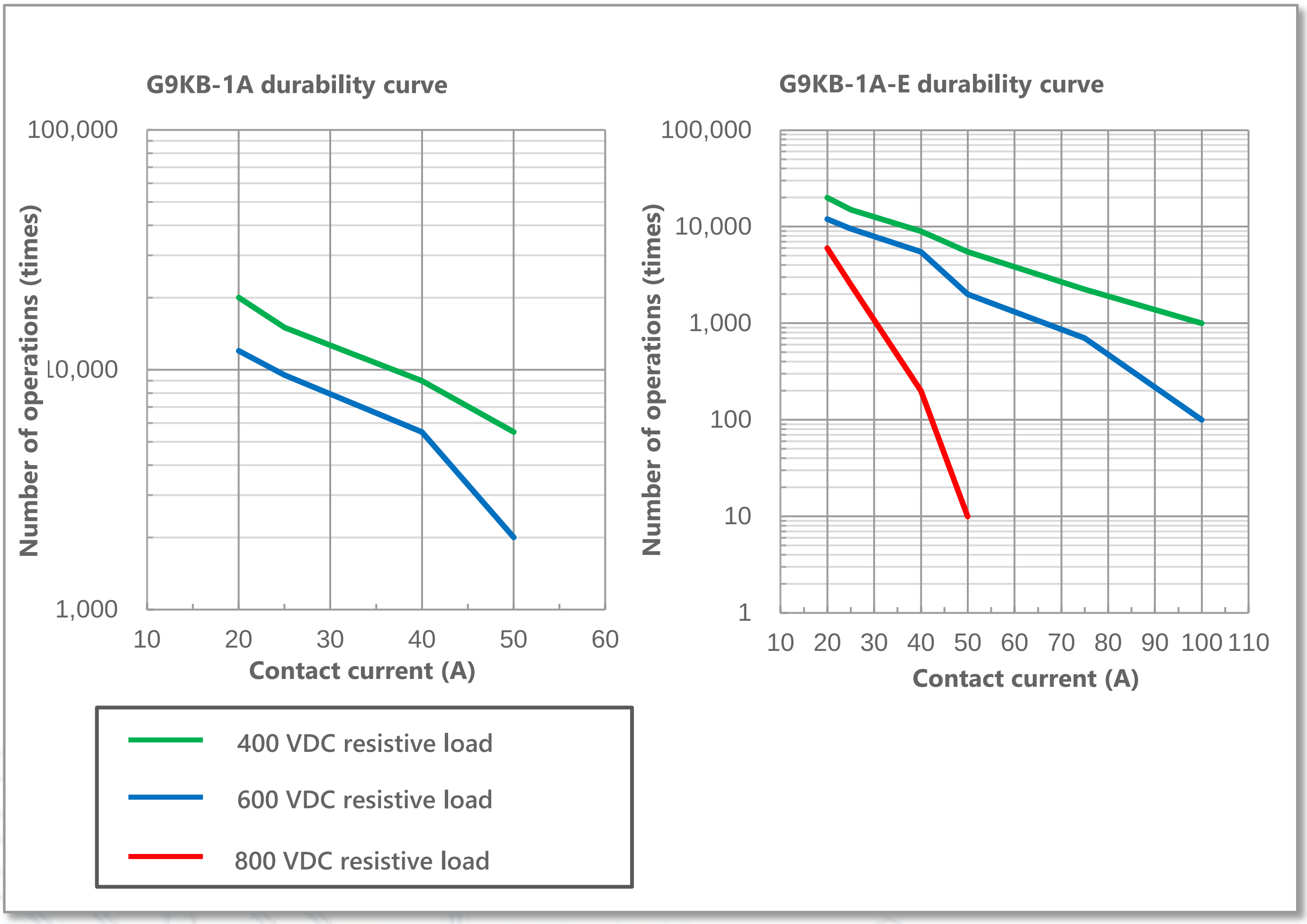


Figure 13: G9KB series durability curve

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.

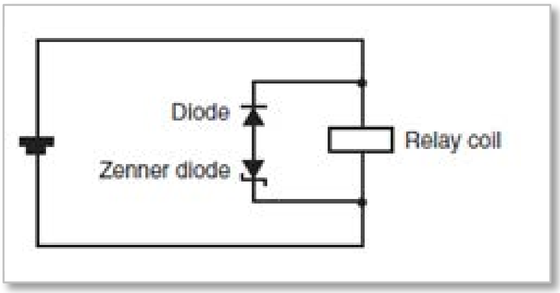


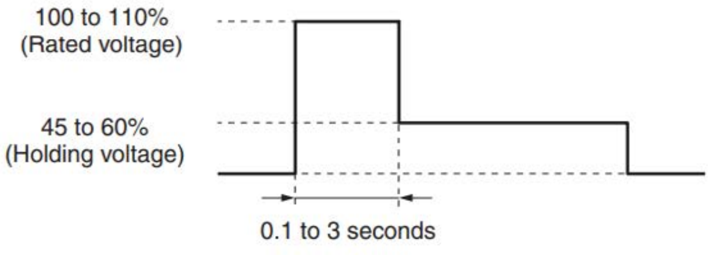
Figure 14: Diode connection

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.

● 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).



	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

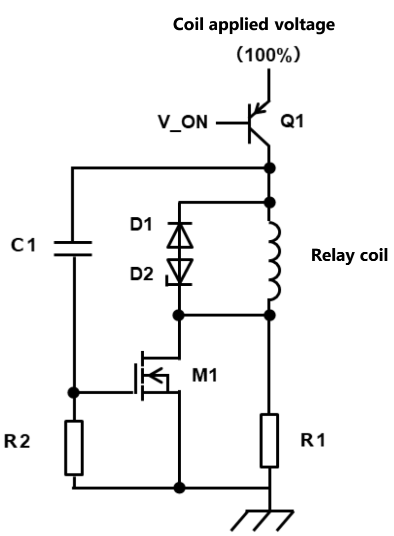
* The coil resistances were measured at a coil temperature of 23°C with tolerances of ± 10%.

Figure 15: Coil voltage reduction after operation

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

● 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. (Figures 16 and 17)



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 coil rated 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 16: Recommended holding voltage CR circuit example and peripheral component selection method

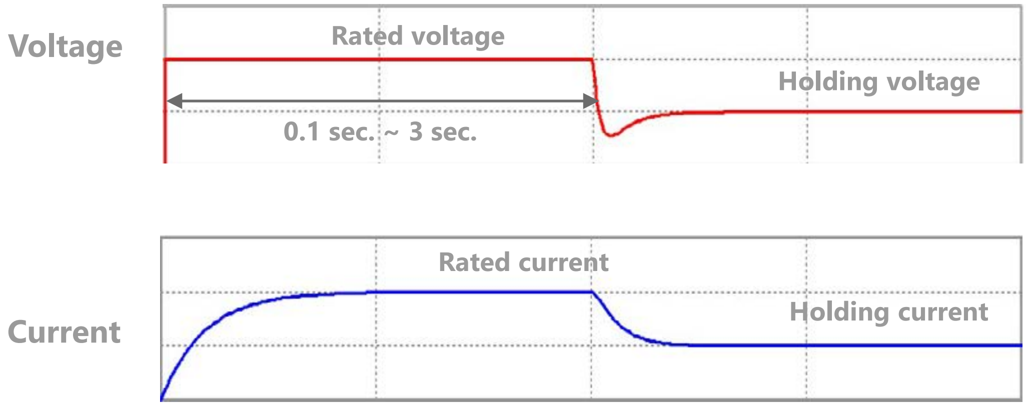
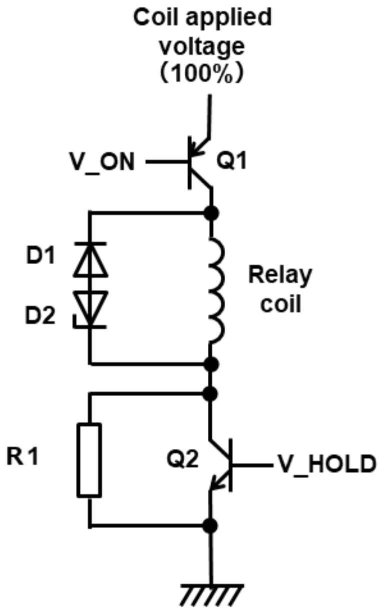


Figure 17: Example of coil voltage and current waveforms in CR circuit

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

● 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 18 and 19)



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 coil rated 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 coil rated current.

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

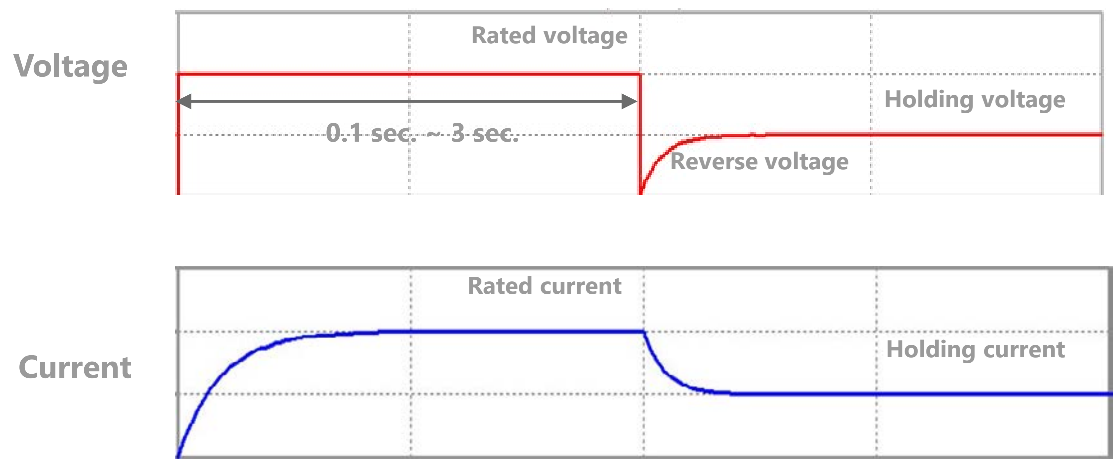


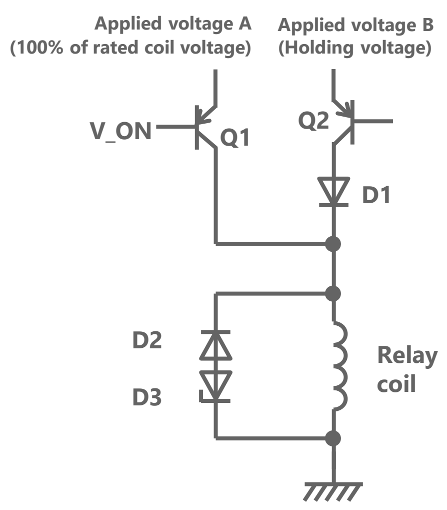
Figure 19: Example of coil voltage and current waveforms in holding circuit with switch

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**

● 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 20 and 21)



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 coil rated current.
Q2	Holding current transistor	"Vce" is more than the coil voltage plus ZD voltage. "Ic" is equal to or more than coil rated 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.
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 20: Recommended holding voltage circuit example with switch, and peripheral component selection method

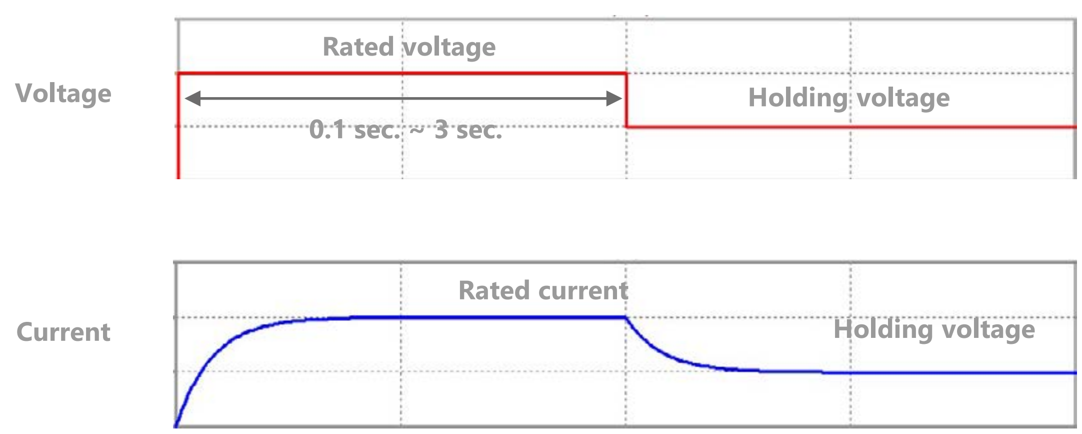


Figure 21: Example of coil voltage and current waveforms in holding circuit with switch

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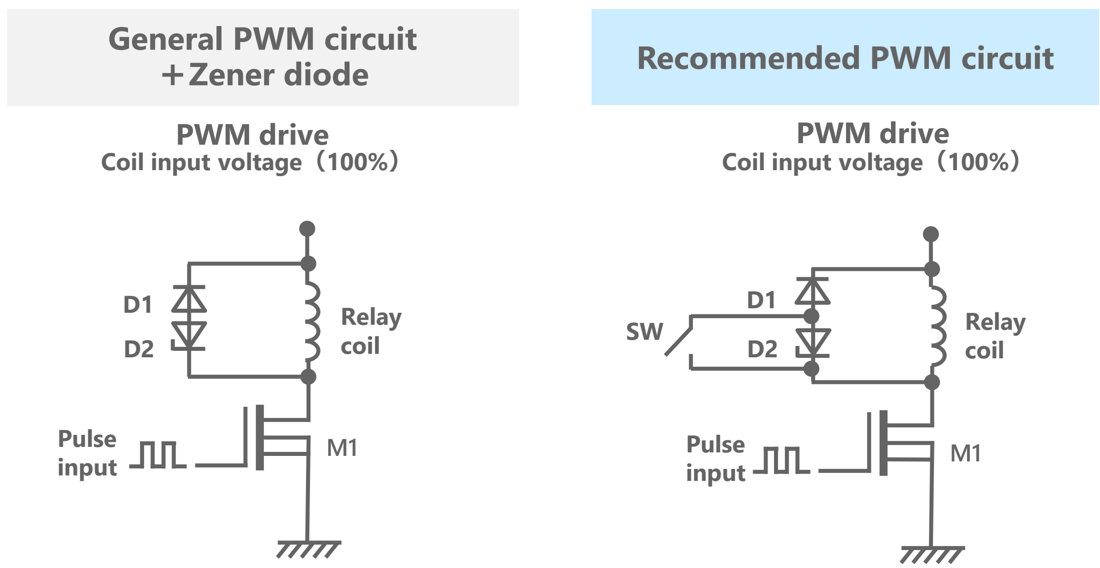
High-Capacity Power Relay Suitable for High Voltage DC Circuits up to 600 VDC, 50 A (Standard Model) and 800 VDC, 100 A* (High-Capacity Model)

* Maximum 600 VDC when Switching 100 A

● 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 22). 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 22)

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 23)



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 22: Recommended PWM control circuit example and peripheral component selection method

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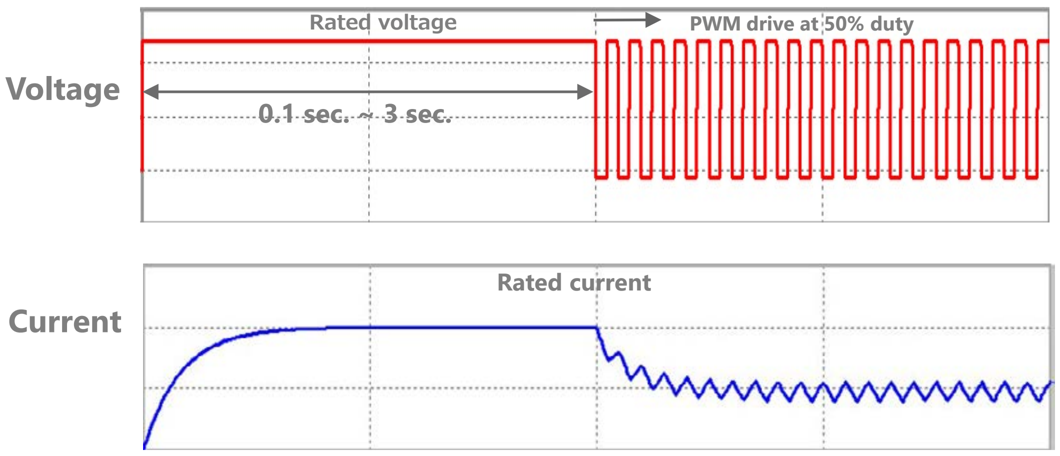

Figure 23: Example of coil voltage and current waveforms in PWM control circuits

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

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.

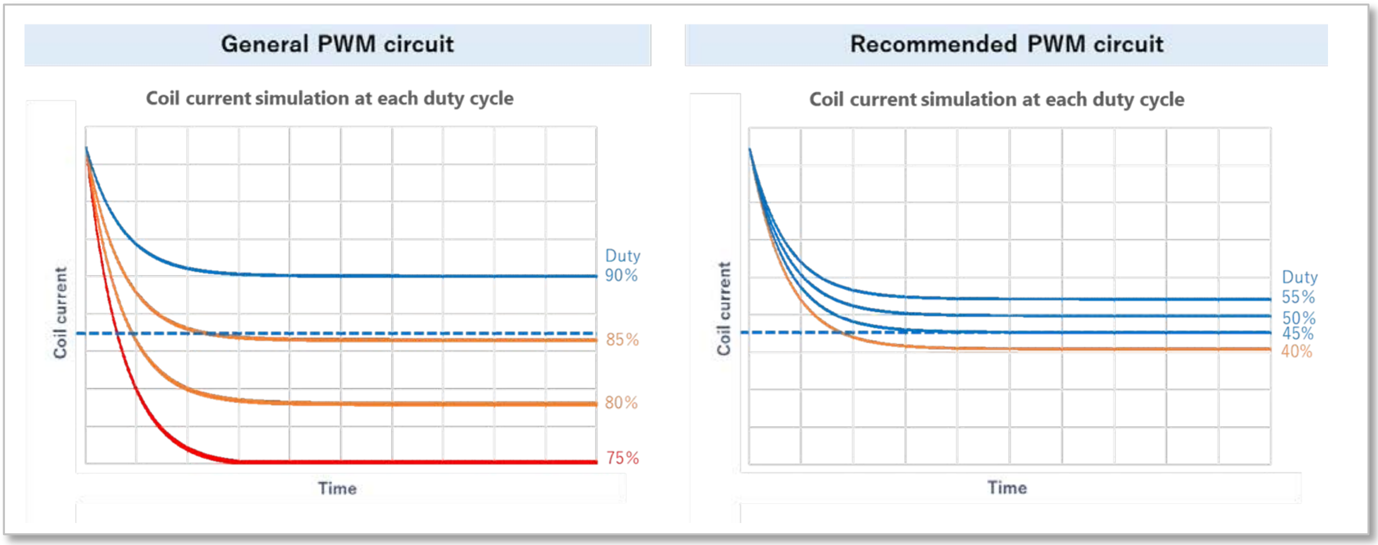

Figure 24: Reference of PWM control circuit diagram

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]

White Paper

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In the interest of product improvement, specifications are subject to change without notice.

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