Issue Date: December 2024

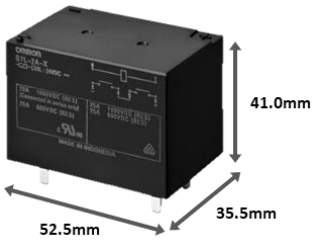
1000 VDC High-power (Total Contact Gap: 2 pole series wiring 6.0mm) PCB relay G7L-X Instruction of product performance and reference circuit

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, bidirectional switching and cost-effectiveness of your products. Our relays are trusted worldwide and are making an important contribution for more energy-efficient future.

Overview

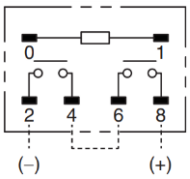
G7L-X relay expands your design possibilities with high DC voltage switching .
G7L-X contributes to your design with efficient low coil holding voltage and bidirectional contact capability.



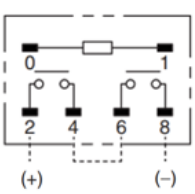
Specifications		Standard model	Low contact resistance model	General-purpose model
Coil	Coil Voltage	DC12V, DC24V		
	Power consumption	2.3W(0.6W at Holding voltage 50%)		
Contact	Contact form	DPST(2a)		
	Rated Load (Resistive)	<Normal polarity> 600VDC,30A /1,000VDC,25A/500VDC,40A <Reverse polarity> 600VDC,-30A/500VDC,-40A		<Normal polarity> 1,000VDC, 20A/ 600VDC, 20A <Reverse polarity> 400VDC,-20A
	Rated carry current	40A*1		20A
	Contact resistance (measurement condition: DC5,1A voltage drop method)	≦100mΩ	≦10mΩ	≦100mΩ
	Contact Gap	6.0mm (two-pole series wiring)		
Ambient temperature		-40℃ ～ +85℃		
Safety standard		UL, VDE		

*1. For carry of 30A, use a holding voltage of 50-60%.

<Normal polarity>

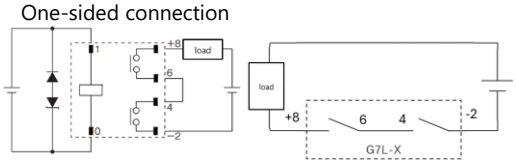


<Reverse polarity>

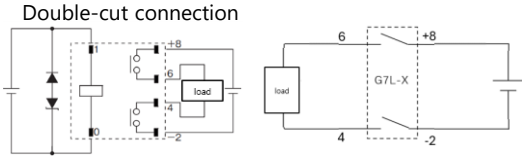


<Circuit diagrams>

One-sided connection



Double-cut connection



Note:1.
Since this product is dedicated for DC high voltage, the final failure mode may lead to the inability to shut down, and in the worst case, the fire may spread to surrounding parts.
Do not use this product for applications other than DC high voltage or use it beyond the ratings and number of times described in this manual.
In addition, take safety measures such as safety circuits to minimize damage in the event of a malfunction.

Figure 1: G7L-X relay specifications

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Energy management trend for carbon neutral

The world is transforming 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 for efficient use of the generated self-generated energy. Therefore, as the self-power generation system expands, the battery management system will continue to expand in the future (Figure 3). DC power is used to charge the battery, and since high voltage is used, a switching device that enables safe cut-off switching of DC high capacity is required.

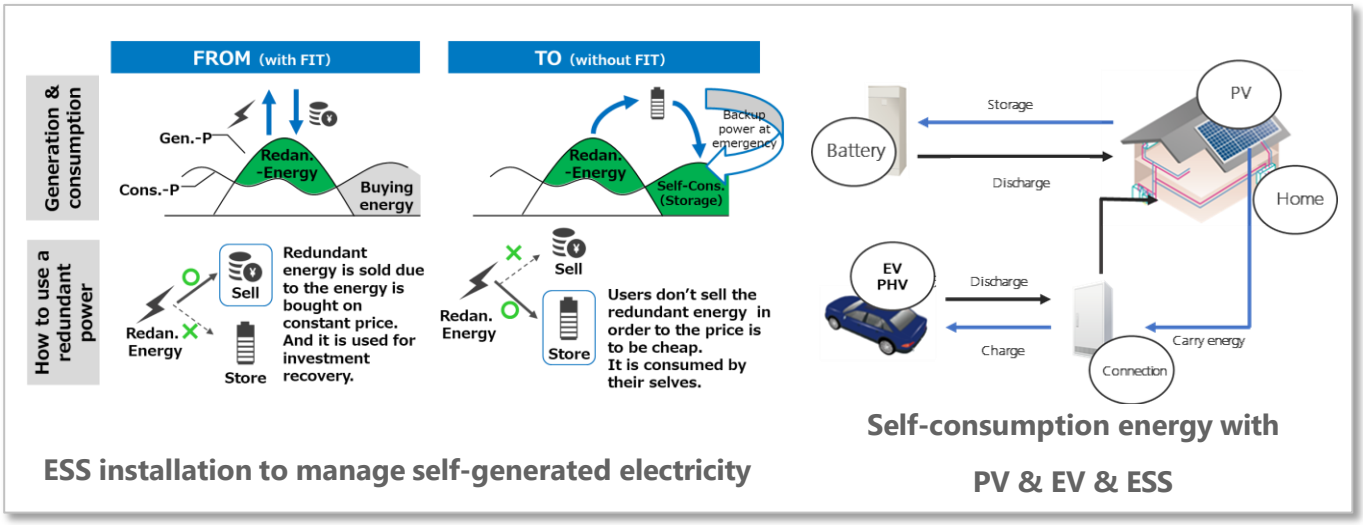

Figure 2: Background of market trend for G7L-X relay

G7L-X can be used for bidirectional switching. Therefore, G7L-X relay is widely expected to be used in commercial and industrial energy storage system (ESS), battery applications Solar inverter and Battery Unit (BMU) and V2H of industrial / Residential EV Charger (Mode 4) (Figure 4).

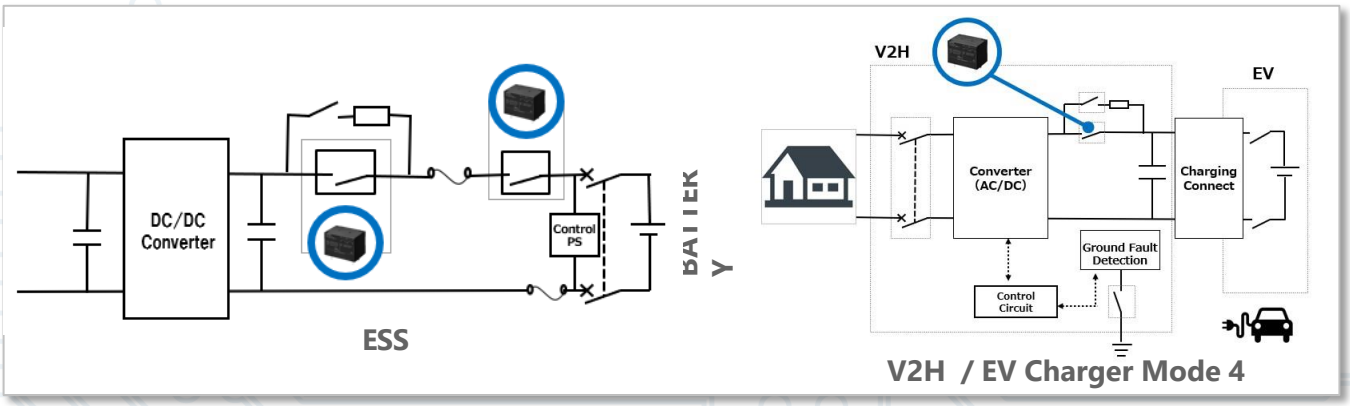

Figure 3: Example of V2H application and commercial and industrial ESS

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High-power bidirectional switching capability

Through Omron`s long-cultivated technical knowledge, we have achieved opening and closing performance in the bidirectional contact switching performance. Especially, V2X applications use bidirectional current supply, which G7L-X can contribute to customer application. (Figure4)

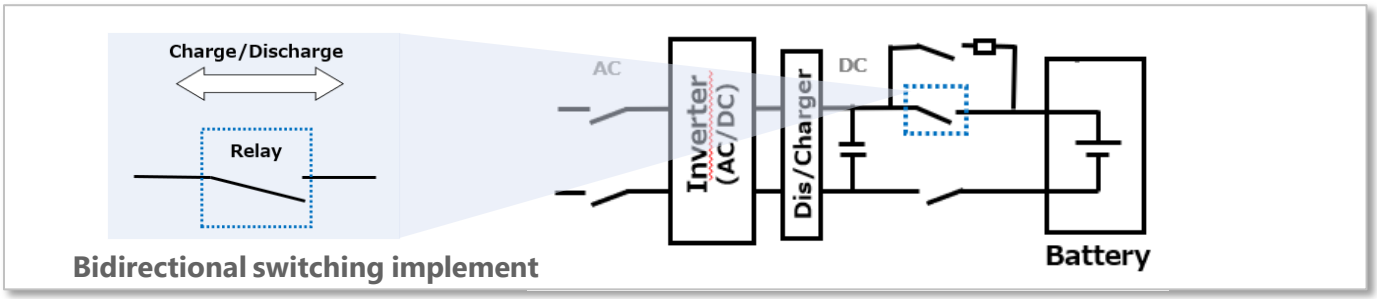

Figure 4: Bidirectional switching

Approved safety standards

DC switching performance is proven by UL/ VDE certification as you can see in Figure 5

Approved Standards

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

UL Recognized (File No. E41515)

Model	Coil ratings	Contact ratings	Number of test operations
G7L-2A-X G7L-2A-X-SI	12 VDC, 24 VDC	15 A at 1,000 VDC (Resistive) 85°C, Connected in series or Break all lines	6,000
		20 A at 1,000 VDC (Resistive) 85°C, Connected in series	
		25 A at 600 VDC (Resistive) 85°C, Connected in series or Break all lines	
		30 A at 600 VDC (Resistive) 85°C, Connected in series or Break all lines	
		Make 1 A, carry 35 A, break 1 A, 1,000 VDC, 85°C, Connected in series	20,000
		Make 0.5 A, carry 35 A, break 0.5 A, 800 VDC, 85°C, Connected in series	20,000
		Make 1 A, carry 35 A, break 1 A, 700 VDC, 85°C, Connected in series	50,000
		Make 0.5 A, carry 35 A, break 0.5 A, 600 VDC, 85°C, Connected in series	30,000
G7L-2A-X-L	12 VDC, 24 VDC	15 A at 1,000 VDC (Resistive) 85°C, Connected in series or Break all lines	6,000
		20 A at 1,000 VDC (Resistive) 85°C, Connected in series	
		20 A at 600 VDC (Resistive) 85°C, Connected in series or Break all lines	

● **EN/IEC and VDE Approval** (Approval No.40045061)

Model	Coil ratings	Contact ratings	Number of test operations
G7L-2A-X G7L-2A-X-SI	12 VDC, 24 VDC	25 A at 1,000 VDC (Resistive) 85°C, Connected in series or Break all lines	50
		15 A at 1,000 VDC (Resistive) 85°C, Connected in series or Break all lines	8,000
		25 A at 600 VDC (Resistive) 85°C, Connected in series or Break all lines	10,000
		32 A at 600 VDC (Resistive) 85°C, Connected in series or Break all lines	3,000
G7L-2A-X-L	12 VDC, 24 VDC	20 A at 1,000 VDC (Resistive) 85°C, Connected in series or Break all lines	50
		15 A at 1,000 VDC (Resistive) 85°C, Connected in series or Break all lines	6,000
		20 A at 600 VDC (Resistive) 85°C, Connected in series or Break all lines	10,000

Figure 5: G7L-X approval safety standards

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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 PCB design reliability by reducing the heat stress of terminal solder joint and surrounding components.

● **Initial contact resistance value**

The contact resistance of G7L-X is under 10mΩ actual typical value , AVE: 2mΩ (for 1A at 5VDC with voltage drop method).(Figure 6).

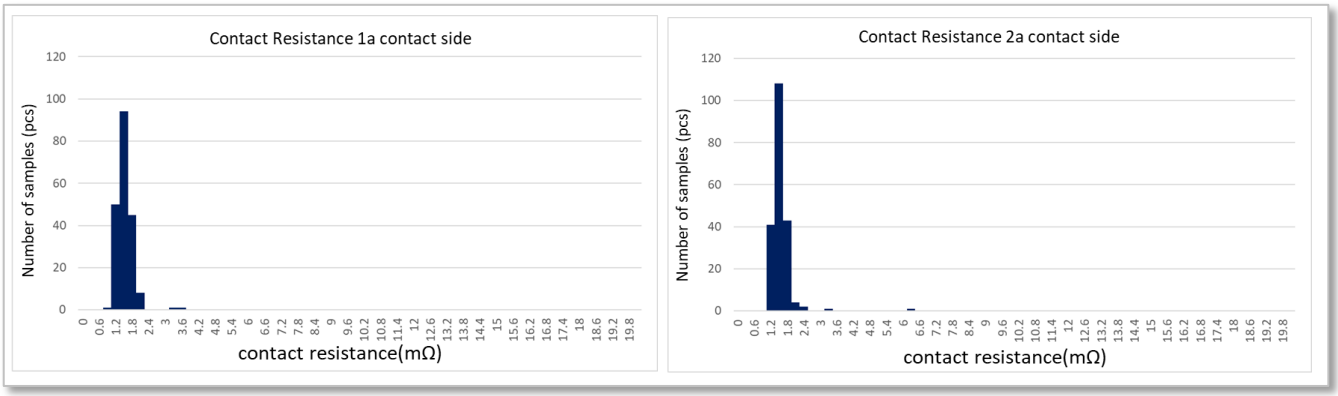
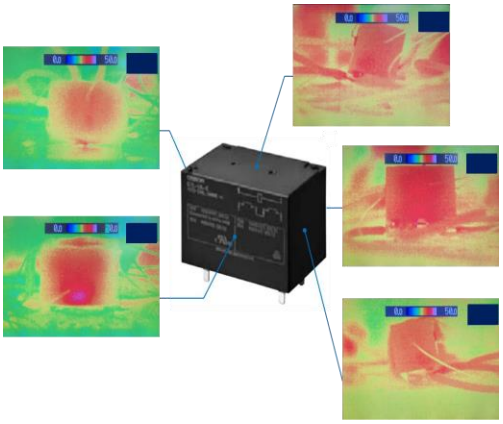


Figure 6: Initial contact resistance value (Total : 200 pcs)

● **Product temperature rising performance [Reference data]**

G7L-X product temperature rise when 30A carry current is applied through contacts (Figure 7).

[Reference data of product temperature rise]
Measurement product surface temperature to carry current 30A providing in two contacts, coil holding voltage 50% rated coil voltage. Ambient temperature is 25℃.



Result :
Highest product surface temperature is 37.8℃
(at 25℃ ambient temperature.)

Figure 7: Reference data of temperature rise with carry current 30A at 25℃ ambient temperature

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Low coil power consumption control

G7L-X coil power consumption is approx. 2.3W at rated coil voltage, however actual power consumption can be reduced to approx. 0.6 W by Holding voltage 50 %. PWM control is another method to reduce the coil power consumption. G7L-X relay is applicable for both methods by following reference circuit diagrams.

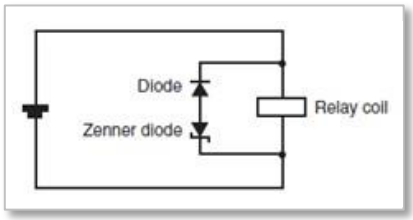


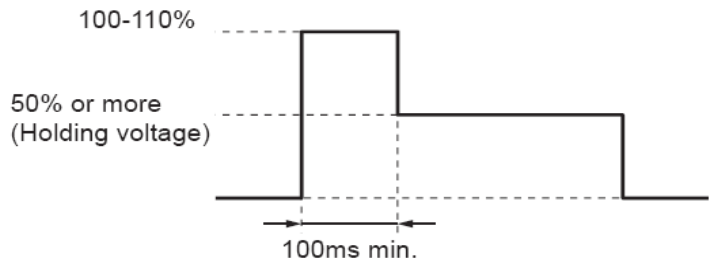
Figure 8: Diode connection

Please use a diode for coil surge absorption. A Zener diode is also required in combination to maintain the G7L-X switching performance. Diode connection is required in reverse polarity of the voltage applied to the coil (Figure 8).

- Recommended Zener diode is 1 to 2 times of the rated coil voltage.
- Please use diodes with reverse dielectric strength 10 times or more of coil rated voltage.

● **Holding voltage**

To reduce actual coil power consumption, please apply rated coil voltage for 0.1 seconds at first. The range of coil rated voltage must be set as 100% and acceptable holding voltage is 50% (Figure 9). However, for current flow in excess of 30A, use a holding voltage of 50-60%. Do not allow the voltage to fall below this level due to coil voltage fluctuations or other factors.



	Applied coil voltage	Coil resistance*	Power consumption
Rated voltage	100%	63Ω(DC12) 250Ω(DC24)	Approx. 2.3W
Holding voltage	50%		Approx. 0.6W

* The coil resistance were measured at a coil temperature of 23°C with tolerances of ± 15%.

Figure 9: Coil voltage reduction after operation

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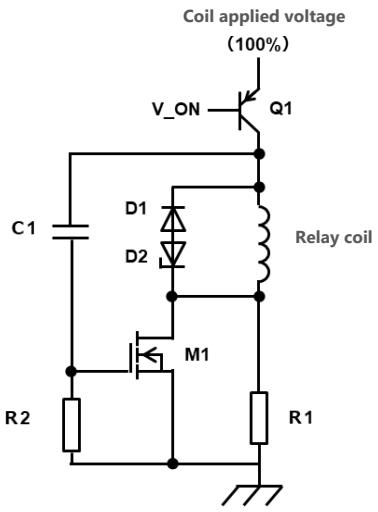
● CR method

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

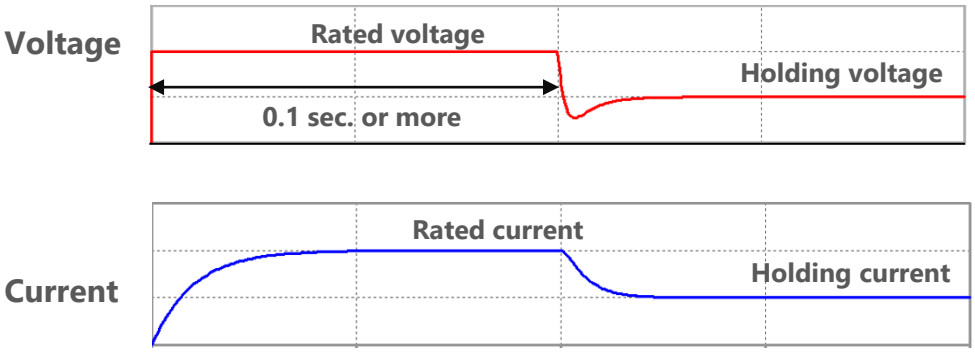


Figure 11: Example of coil voltage and current waveforms in CR circuit

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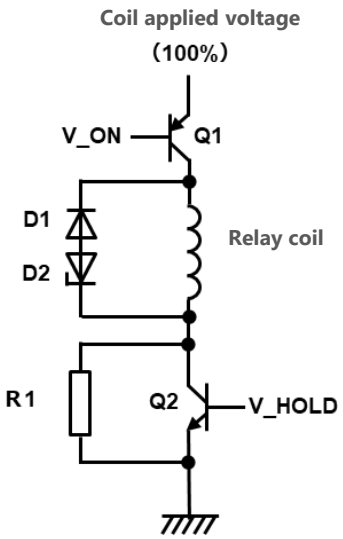
● Switching method (1)

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

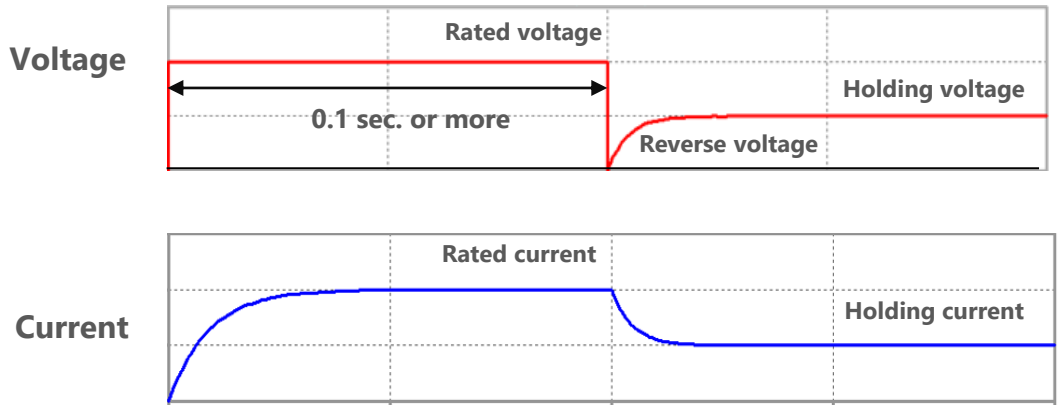


Figure 13: Example of coil voltage and current waveforms in holding circuit with switch

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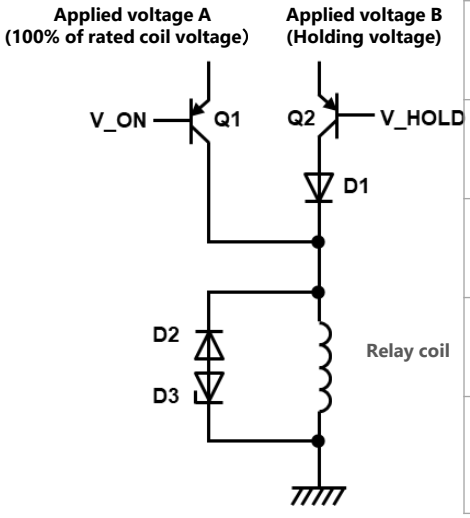
● Switching method (2)

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

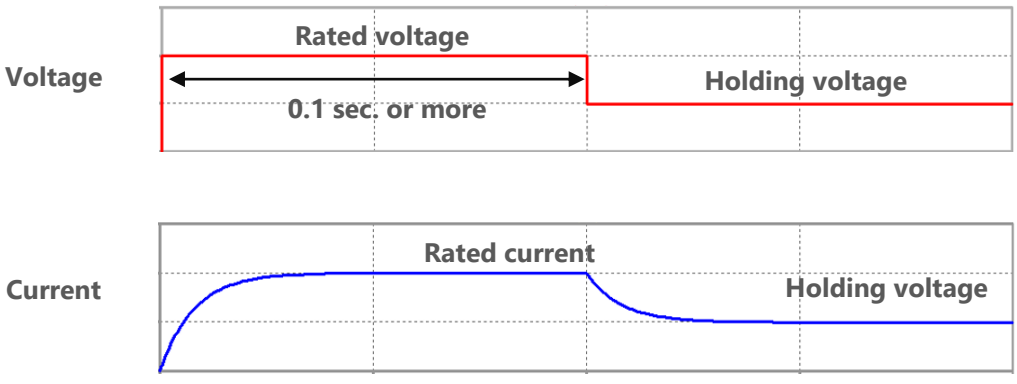


Figure 15: Example of coil voltage and current waveforms in holding circuit with switch

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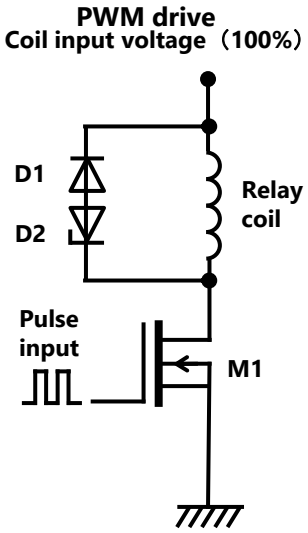
●PWM (Pulse Width Modulation) control

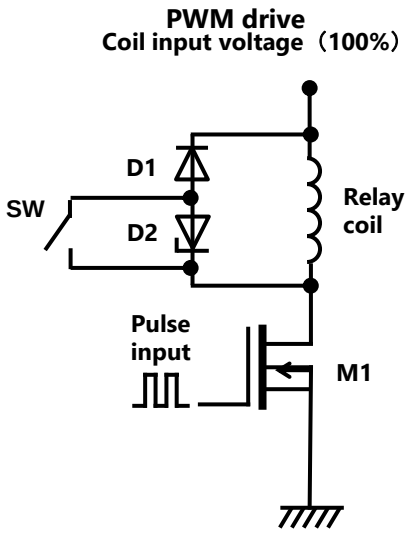
In PWM control, a general PWM control circuit is not recommended to avoid power loss due to the Zener diode. A switch should be mounted in parallel with the Zener diode and bypassed during PWM control (Figire 16). When the relay is turned off, first turn off the switch to turn off the applied voltage 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. (See Figure 17).

General PWM circuit +Zener diode



Recommended PWM circuit



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

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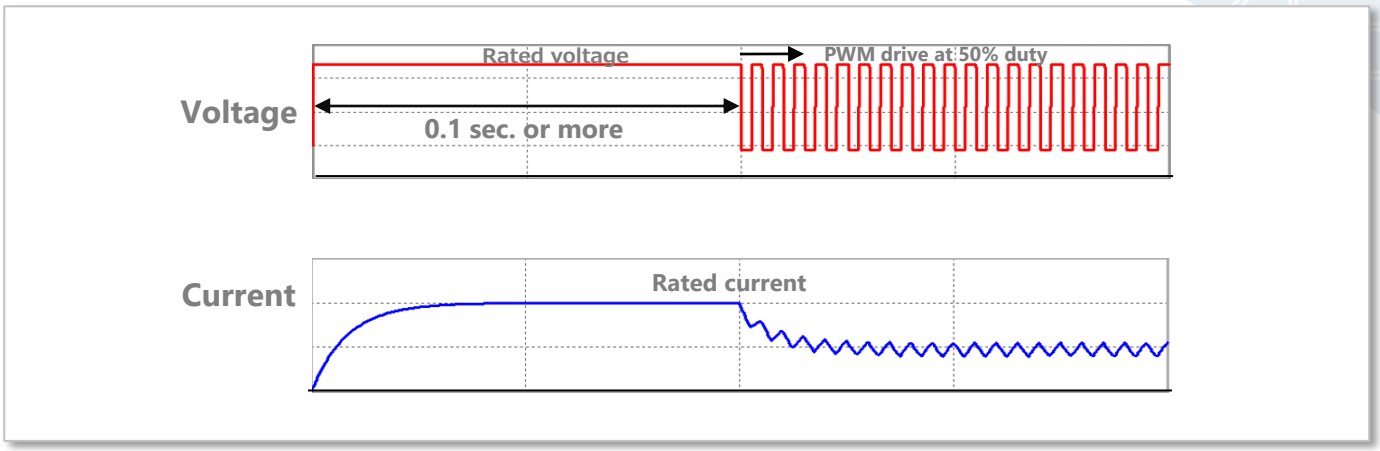

Figure 17: Example of coil voltage and current waveforms in PWM control circuits

Afterword

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