Issue Date: March 2025

High-capacity power relay G7EB series for printed circuit boards with a maximum contact voltage of 800 VAC and rated carry currents of 100 A/120 A/150 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.

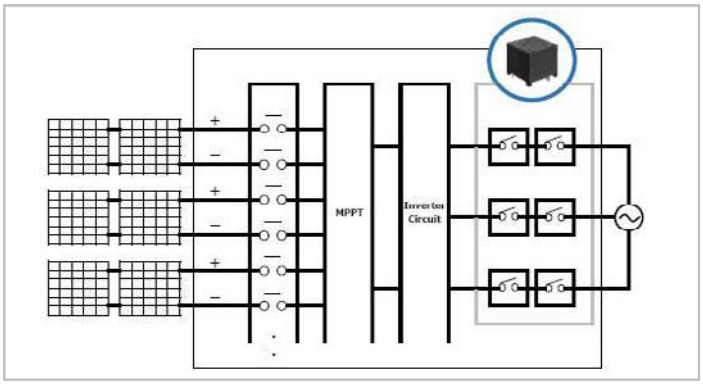
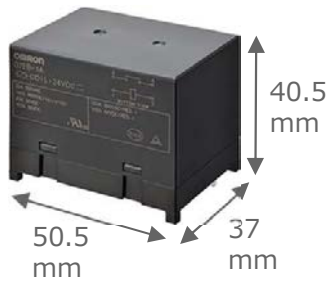


Figure 1: Example of PV inverter relay application

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

G7EB series expands your design possibilities with low contact resistance 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		Standard Model (G7EB-1A,G7EB-1AP1)	High-Capacity Model 120A (G7EB-1A-E,G7EB-1AP1-E)	High-Capacity Model 150A (G7EB-1A-E2)
Coil	Coil voltage	12VDC、24VDC		
	Power consumption	Approx. 2.8W (575mW at Holding voltage 45%)		Approx. 3.5W (709mW at Holding voltage 45%)
Contact	Rated load (Resistive)	100A at 480VAC, 40A at 800VAC 100A at 60VDC, 50A at 60VDC, 40A at 60VDC		150A at 480VAC, 150A at 800VAC, 800VAC making: 40A、carrying: 150A, breaking: 40A, 150A at 60VDC, 40A at 60VDC
	Contact resistance	Initial ≦ 5mΩ @ 6VDC 20A		
	Contact gap	3.6mm or larger		
Endurance	Mechanical	1,000,000 ops.		
	Electrical (Resistive) *1sON/9sOFF at 85℃	480VAC 100A 300 ops.	480VAC 100A 300 ops.	480VAC 150A 100 ops.
		800VAC Make 40A, Carry 100A、Break 40A 30,000 ops.	800VAC Make 40A, Carry 120A、Break 40A 30,000 ops.	800VAC 150A 30 ops.
		60VDC 100A 400 ops.	60VDC 100A 400 ops.	800VAC Make 40A, Carry 150A、Break 40A 30,000 ops.
		60VDC 50A 1,000 ops.	60VDC 50A 1,000 ops.	60VDC 150A 400 ops.
		60VDC 40A 6,000 ops.	60VDC 40A 6,000 ops.	60VDC 40A 6,000 ops.
Ambient temperature range		-40℃ to 85℃ (with no icing or condensation)		
Terminal type		PCB		
Safety standard		UL/C-UL, TUV, CQC		

Figure 2: G7EB series specifications

High-capacity power relay G7EB series for printed circuit boards with a maximum contact voltage of 800 VAC and rated carry currents of 100 A/120 A/150 A

G7EB series is widely used in commercial and industrial PV inverters, industrial online uninterruptible power supplies (UPS) and industrial inverters. Moreover, G7EB series have DC contact rating, and it can be used for low voltage (≤60VDC) battery application such as energy storage system (ESS).

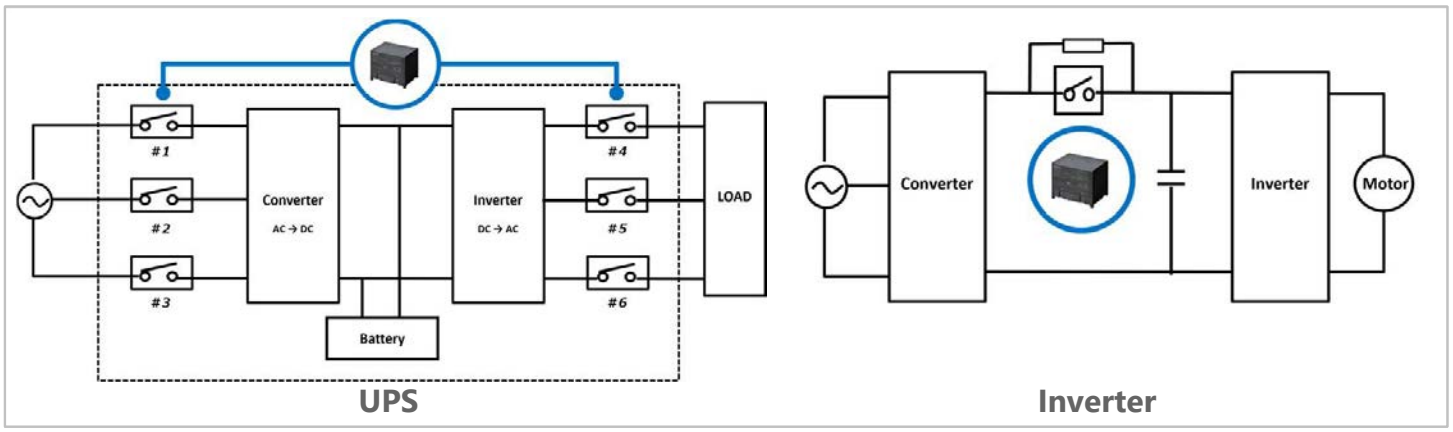


Figure 3: Example of commercial and industrial UPS and Inverter application

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.

● Typical initial contact resistance value

The warrantied contact resistance of G7EB series is 5 mΩ or less, but an example of initial contact resistance measurement is shown in Figure 4.

● Contact resistance at end of life

Generally, contact resistance increases due to the contact aging caused by opening and closing. But our proven competences in structures, materials and manufacturing maintains low contact resistance throughout the lifetime of G7EB series (Figure 5.)

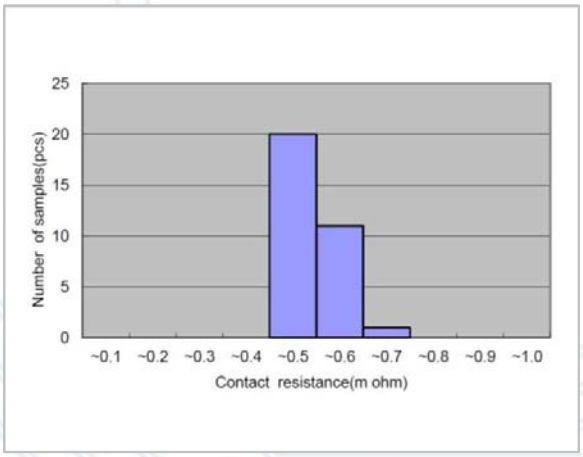


Figure 4: Initial contact resistance

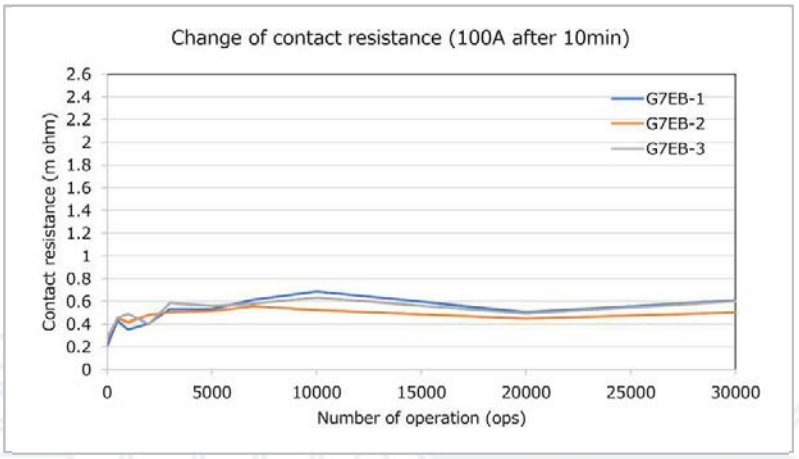
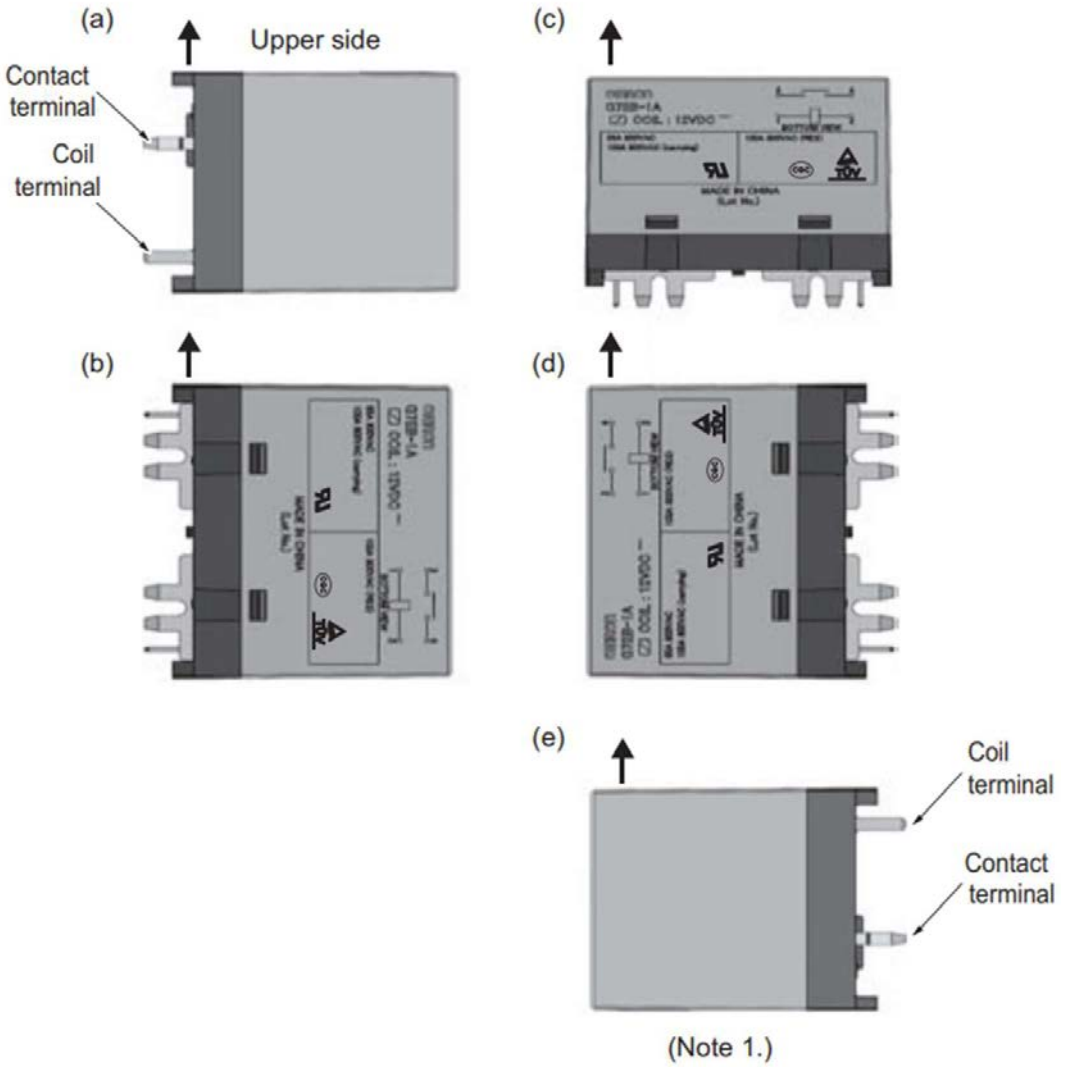


Figure 5: Reference data of contact resistance change

High-capacity power relay G7EB series for printed circuit boards with a maximum contact voltage of 800 VAC and rated carry currents of 100 A/120 A/150 A

Mounting Direction

・The relay is limited for mounting direction due to the specification of operation voltage and electrical durability.
Do not use in any other direction except as indicated in below chart. There is a risk of reduced operational lifetime for failure to observe this warning.



Note 1. Operating voltage and coil applied voltage are different, so please check the datasheet.

Figure 6: Mounting Direction

High-capacity power relay G7EB series for printed circuit boards with a maximum contact voltage of 800 VAC and rated carry currents of 100 A/120 A/150 A

Low power consumption

G7EB series coil power consumption is 2.8W (standard model, high-capacity model 120A) and 3.5W (high-capacity model 150A) at rated coil voltage, however actual power consumption can be reduced to 575mW (standard model, high-capacity type 120A) and 709mW (high-capacity type 150A) by reducing voltage by 45%. PWM control is another method to reduce the coil power consumption. G7EB series is applicable for both methods by following reference circuit diagrams.

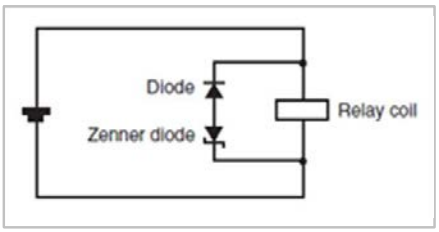


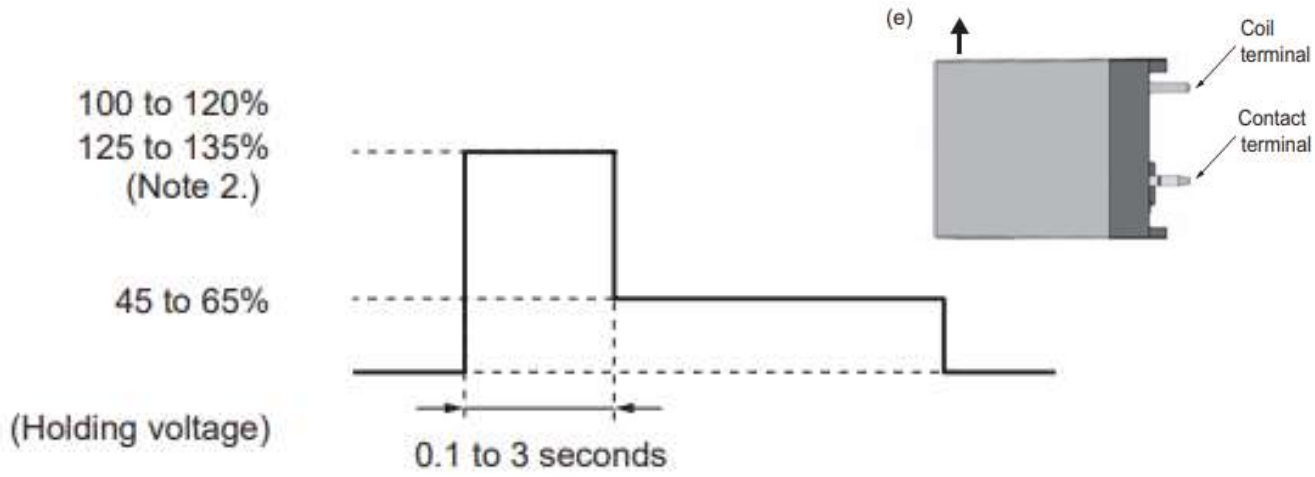
Figure 7: Diode connection

Please use a diode for coil surge absorption. A Zener diode is also required in combination to maintain the G7EB series switching performance. Diode connection is required in reverse polarity of the voltage applied to the coil (Figure 6).

- Recommended Zener diode is 3 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 to 3.0 seconds at first. The range of coil rated voltage must be set as 100 to 120 % (125 to 135% only for the installation direction (e) where the contact terminal is downwards) and acceptable holding voltage is 45 to 65 % (Figure 8).



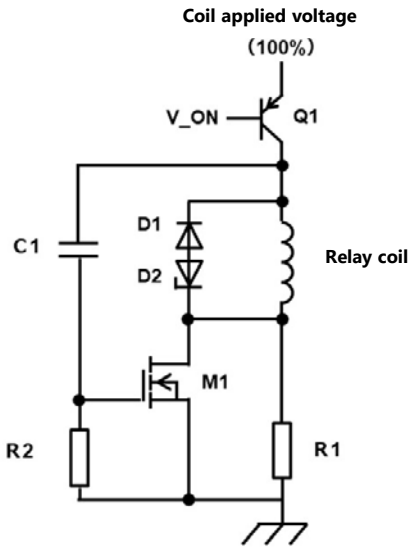
Note 2. For contact terminals mounted in the downward direction (e), the applied coil voltage will be 125% to 135%.

Figure 8: Coil voltage reduction after operation

High-capacity power relay G7EB series for printed circuit boards with a maximum contact voltage of 800 VAC and rated carry currents of 100 A/120 A/150 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 9 and 10)



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

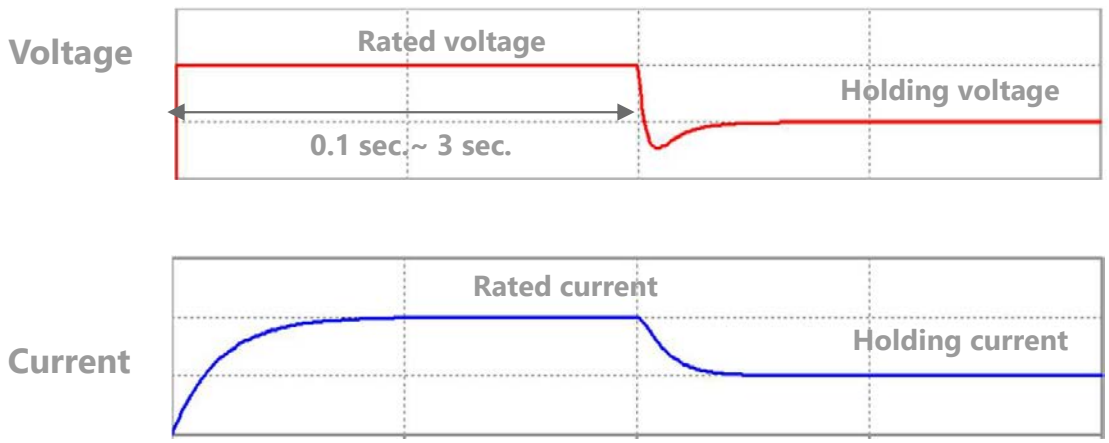
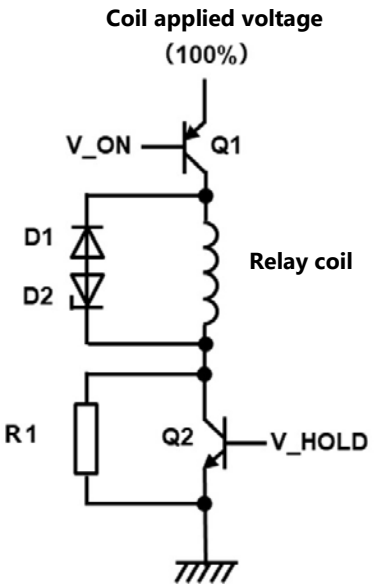


Figure 10: Example of coil voltage and current waveforms in CR circuit

High-capacity power relay G7EB series for printed circuit boards with a maximum contact voltage of 800 VAC and rated carry currents of 100 A/120 A/150 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 11 and 12)



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

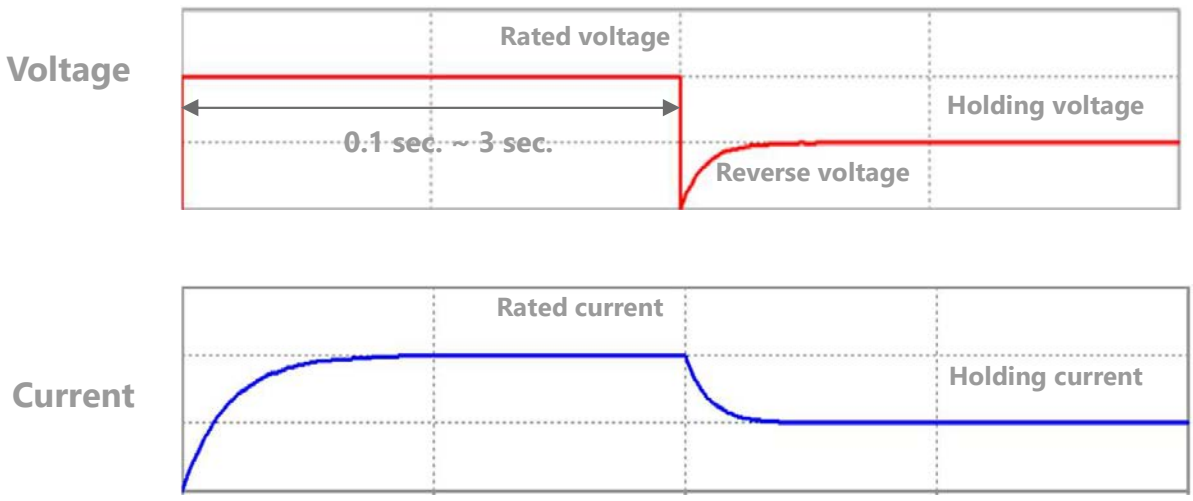
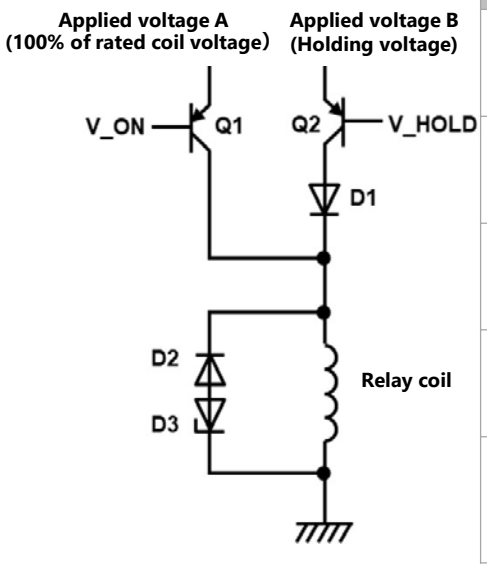


Figure 12: Example of coil voltage and current waveforms in holding circuit with switch

High-capacity power relay G7EB series for printed circuit boards with a maximum contact voltage of 800 VAC and rated carry currents of 100 A/120 A/150 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. 13 and 14).



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

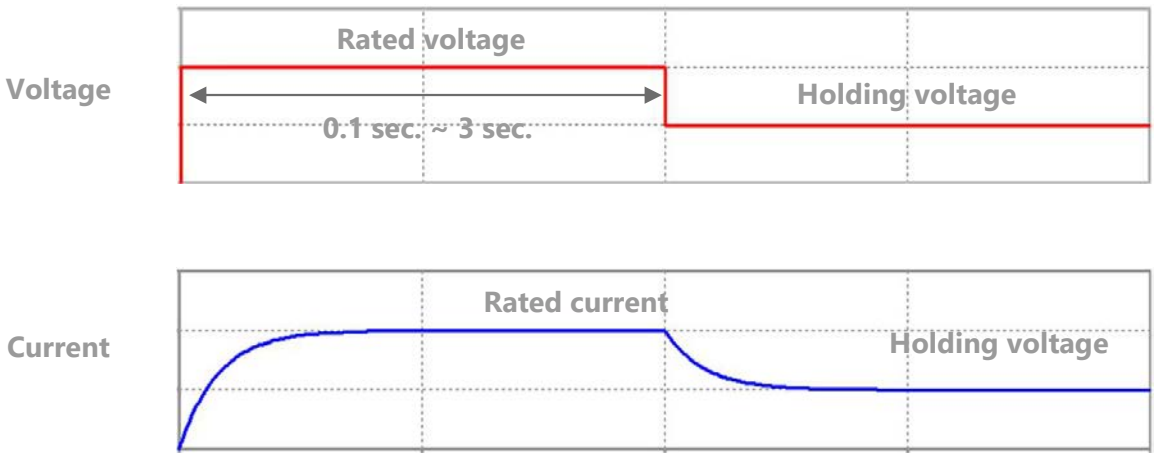


Figure 14: Example of coil voltage and current waveforms in holding circuit with switch

High-capacity power relay G7EB series for printed circuit boards with a maximum contact voltage of 800 VAC and rated carry currents of 100 A/120 A/150 A

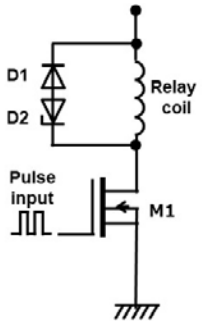
● PWM (Pulse Width Modulation) control

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 (Fig. 15). 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. 15)

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 16).

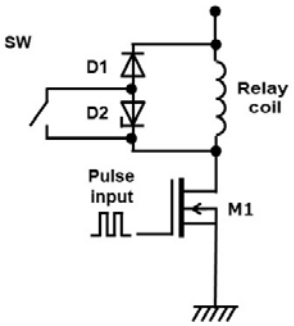
General PWM circuit ＋Zener diode

PWM drive
Coil input voltage（100%）



Recommended PWM circuit

PWM drive
Coil input voltage（100%）



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

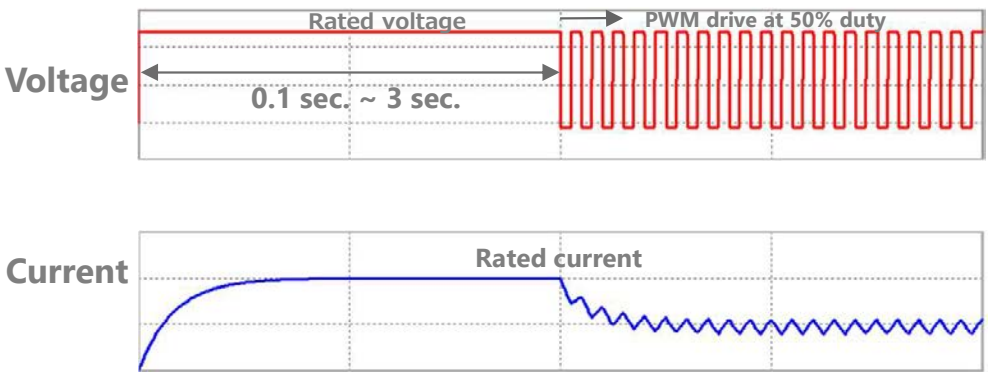


Figure 16: Example of coil voltage and current waveforms in PWM control circuits

High-capacity power relay G7EB series for printed circuit boards with a maximum contact voltage of 800 VAC and rated carry currents of 100 A/120 A/150 A

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

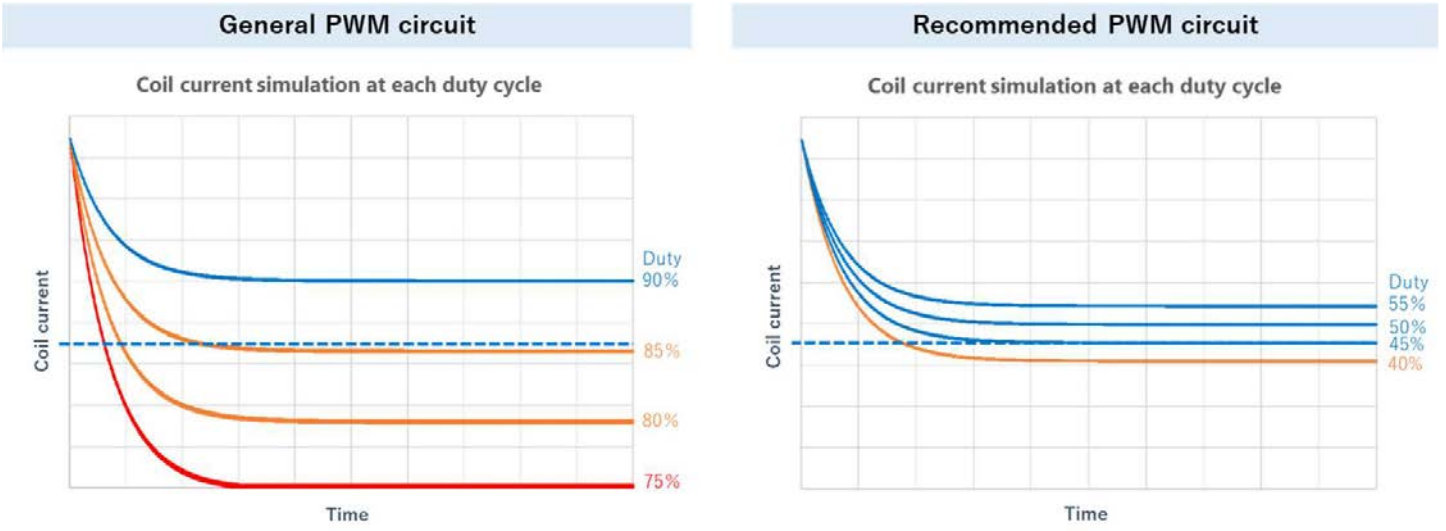


Figure 17: Reference of PWM control circuit diagram

DC contact rating

Battery management equipment is one of the market sectors which is significantly growing. Energy storage system (ESS) for residential applications is commonly designed with low voltage batteries (≤ 60 VDC) and relays are used for charge and discharge main line disconnection in safety purpose (Figure 18).
Relays are expected to have DC bidirectional switching capability and G7EB series has the potential to contribute to this expectation. Thanks to over 3.6 mm double break wide contact gap structure which ensures stable bidirectional DC arc switching (Figure 19).

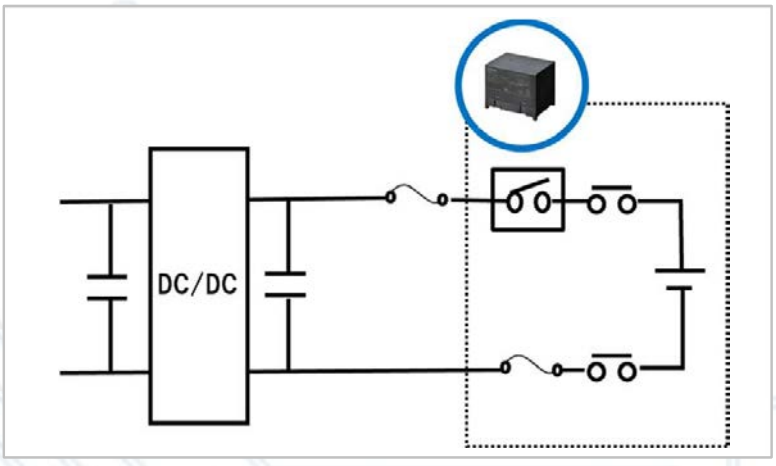


Figure 18: Example of energy storage application

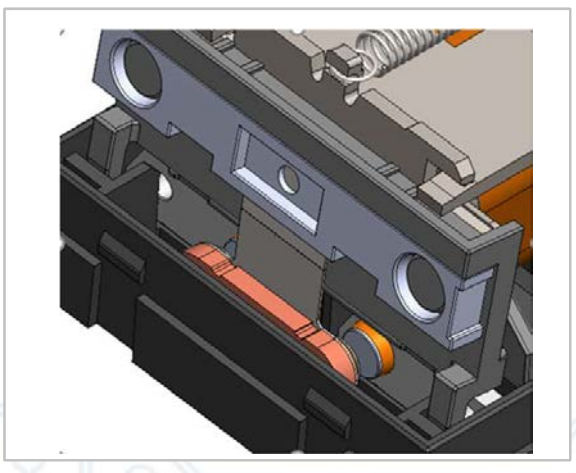


Figure 19: Contact structure of G7EB series

High capacity power relay G7EB series for printed circuit boards with a maximum contact voltage of 800 VAC and rated carry currents of 100 A/120 A/150 A

DC switching performance is proven by UL/C-UL/TUV/CQC certification as you can see in Figure 14. G7EB series is capable to provide to 60 VDC 100 A (for high-capacity 150A model) , 400 operations at resistive load. Longer life can be expected in case contact current is lower than 100 A. (e.g. 60 VDC 40 A, 6,000 operations)

Approval Standard

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

Model	Contact form	Coil ratings	Contact ratings	Number of test operations
G7EB-1A G7EB-1AP1 G7EB-1A-E G7EB-1AP1-E	SPST-NO(1a)	12, 24 VDC	800 VAC 55 A (Resistive) 85°C	6,000
			800 VAC making 40 A, carrying 100 A, breaking 40 A 85°C	30,000
			60 VDC 40 A (Resistive) 85°C	6,000
			60 VDC 100 A (Resistive) 85°C	400
G7EB-1A-E G7EB-1AP1-E	SPST-NO(1a)	12, 24 VDC	800 VAC making 40 A, carrying 120 A, breaking 40 A 85°C	30,000
G7EB-1A-E2	SPST-NO(1a)	12, 24 VDC	480 VAC 150A (Resistive) 85°C	100
			800 VAC 150A (Resistive) 85°C	30
			800 VAC making 40 A, carrying 150 A, breaking 40 A 85°C	30,000
			60 VDC 150A (Resistive) 85°C	400
			60 VDC 40A (Resistive) 85°C	6,000

EN/IEC, TÜV Certificated: (Certificate No. R50416743)

Model	Contact form	Coil ratings	Contact ratings	Number of test operations
G7EB-1A G7EB-1AP1 G7EB-1A-E G7EB-1AP1-E	SPST-NO(1a)	12, 24 VDC	800 VAC, 100 A (Resistive) 85°C	200
			60 VDC 40 A (Resistive) 85°C	6,000
			60 VDC 50 A (Resistive) 85°C	1,000
			60 VDC 100 A (Resistive) 85°C	400
G7EB-1A-E G7EB-1AP1-E	SPST-NO(1a)	12, 24 VDC	800 VAC making 40 A, carrying 120 A, breaking 40 A 85°C	30,000
G7EB-1A-E2	SPST-NO(1a)	12, 24 VDC	480 VAC 150A (Resistive) 85°C	100
			800 VAC 150A (Resistive) 85°C	30
			800 VAC making 40 A, carrying 150 A, breaking 40 A 85°C	30,000
			60 VDC 150A (Resistive) 85°C	400
			60 VDC 40A (Resistive) 85°C	6,000

CQC Certificated: (Certificate No. CQC18002207225)

Model	Contact form	Coil ratings	Contact ratings	Number of test operations
G7EB-1A G7EB-1AP1 G7EB-1A-E G7EB-1AP1-E	SPST-NO(1a)	12, 24 VDC	800 VAC, 100 A (Resistive) 85°C	200
			60 VDC 100 A (Resistive) 85°C	400
G7EB-1A-E G7EB-1AP1-E	SPST-NO(1a)	12, 24 VDC	800 VAC making 40 A, carrying 120 A, breaking 40 A 85°C	30,000
G7EB-1A-E2	SPST-NO(1a)	12, 24 VDC	480 VAC 150A (Resistive) 85°C	100
			800 VAC 150A (Resistive) 85°C	30
			800 VAC making 40 A, carrying 150 A, breaking 40 A 85°C	30,000
			60 VDC 150A (Resistive) 85°C	400
			60 VDC 40A (Resistive) 85°C	6,000

Creepage distance (required value)		12.5 mm min. (IEC/UL)
Clearance (required value)		8 mm min. (IEC/UL)
Insulation material group		IIIa
Type of insulation	coil-contact circuit	Basic (800 V, OV-cat, III, up to 2,000 m above sea level) Basic (800 V, OV-cat, II, up to 4,000 m above sea level)
	open contact circuit	Micro disconnection
Rated insulation voltage		800 V
Pollution degree		3
Rated voltage system		800 V
Category of protection (IEC61810-1)		RT II
Flammability class (UL94)		V-0
Coil insulation system (UL)		Class F

Figure 20: G7EB series Safety Standards Certification Rating

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.

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