White Paper

OMRON

Issue Date: 1st March 2023

G9KA 800 VAC 200 A / 1000 VAC 300A PCB Relay with ultra low contact resistance feature

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.

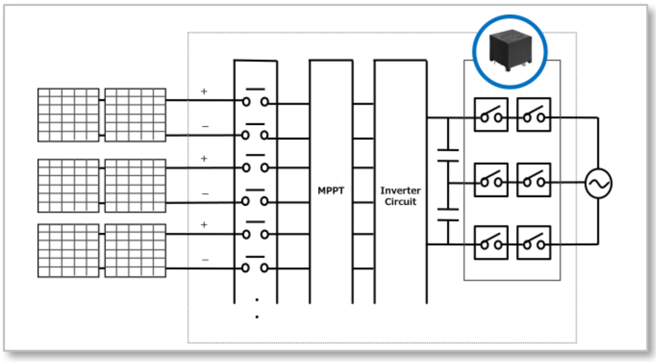
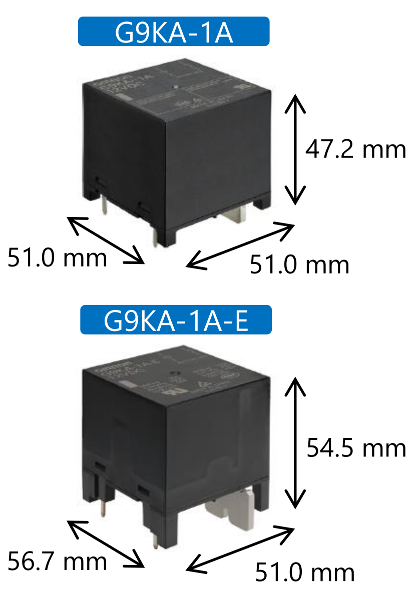


Figure 1: Example of PV inverter relay application

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

G9KA relay expands your design possibilities with ultra low contact resistance (Typical ≤ 0.2 mΩ) 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		G9KA-1A	G9KA-1A-E
Coil	Coil voltage	12 VDC, 24 VDC	
	Power consumption	5.0 W (1,012 mW at holding voltage 45%)	
Contact	Rated load (Resistive)	800 VAC Make 150A Carry 200A Break 200A 800 VAC 50A	1,000 VAC Make 150 A Carry 300 A Break 300 A 1,000 VAC Make 50 A Carry 300 A Break 50 A
	Contact resistance	Initial ≤ 0.2mΩ at 6 VDC 200 A	
	Contact gap	4.0mm	
Endurance	Mechanical	1,000,000 ops.	
	Electrical *1sON/9sOFF at 85℃	800 VAC Make 150 A Carry 200 A Break 200 A 10 ops.	1,000 VAC Make 150 A Carry 300 A Break 300 A 10 ops.
		800 VAC Make 50A Carry 200A Break 50A 30k ops.	1,000 VAC Make 50 A Carry 300 A Break 50 A 30k ops.
		60 VDC 200A 2k ops.	
Ambient temperature range		-40℃ to 85℃	
Terminal type		PCB	
Safety standard		TUV、UL、CQC	

Figure 2: G9KA relay specifications

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G9KA relay is suitable for commercial and industrial PV inverters, industrial online uninterruptible power supplies (UPS) and industrial inverters. Moreover, G9KA-1A can be applicable for up to 250A carry current load condition with specific heat dissipation design in actual application. Please refer more detail in this document.

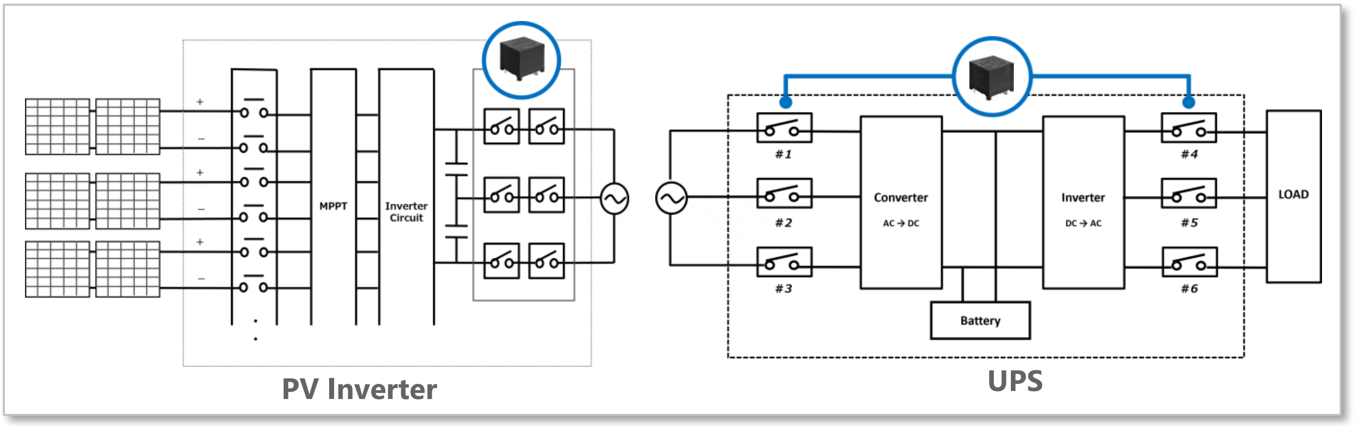

Figure 3: Example of PV Inverter and UPS application

Low contact resistance

Contact resistance is one of the key characteristics for PCB high-power relay to reduce heat generation inside the component. This simplifies your thermal design process and offers wider design possibilities, including the use of smaller heatsinks and cooling fans. Ultimately, this will improve the efficiency and create cost saving of your product design.

● Ultra low contact resistance

G9KA benefits from a highly optimized plunger actuator and terminal structure to realize 0.2 mΩ max. ultra-low contact resistance with compact dimensions. This low contact resistance performance is a major advancement compared with equivalent PCB relays (Figure 4)

Contact resistance specification

Omron G9KA	Equivalent A	Equivalent B
0.2mΩ max.	1mΩ max.	6mΩ max.

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Figure 4 shows a thermal simulation comparison done at 200 A carry current, ambient temperature 85˚C with heat dissipation PCB design including fan, duct and heatsinks. This result clearly shows contact resistance performance has the potential to make a big difference for reducing PCB heat stress.

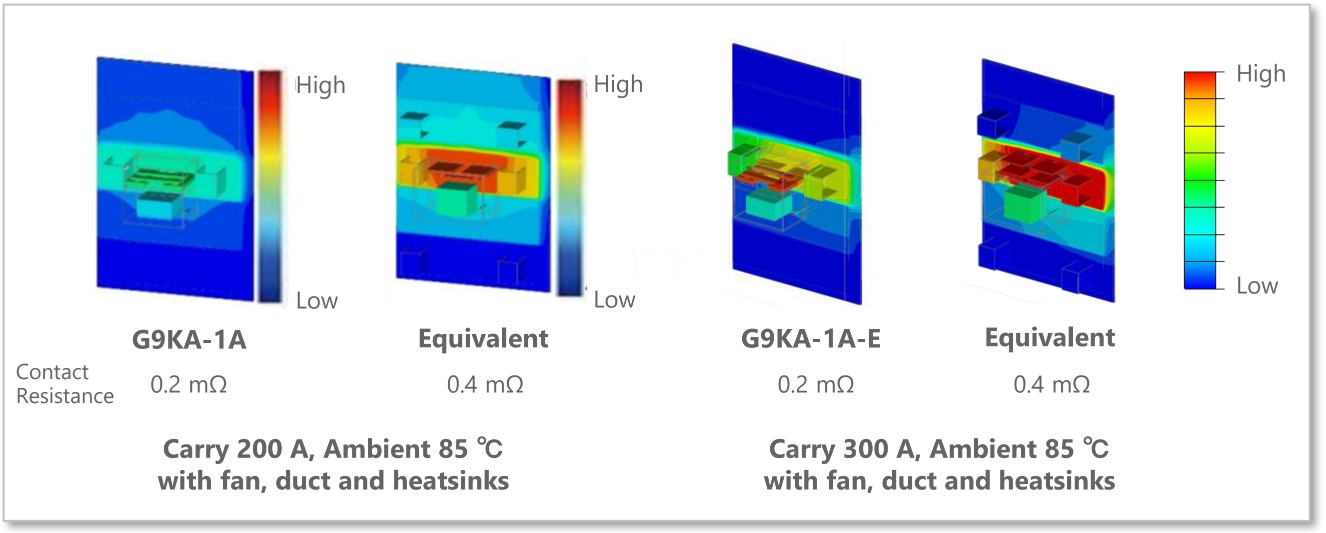

Figure 4: Comparison with equivalent relays

● Contact resistance at end of life

Generally, contact resistance increases due to the contact aging caused by switching. But our proven competences in structures, materials and manufacturing maintains low contact resistance throughout the lifetime of G9KA relay. (Figure 5, contact resistance max. 0.3 mΩ measured at 6 VDC 200 A / 300 A after 30 minutes N=2 pcs) This test was done 30k operations under make 50 A carry 200 A / 300 A break 50 A load conditions.

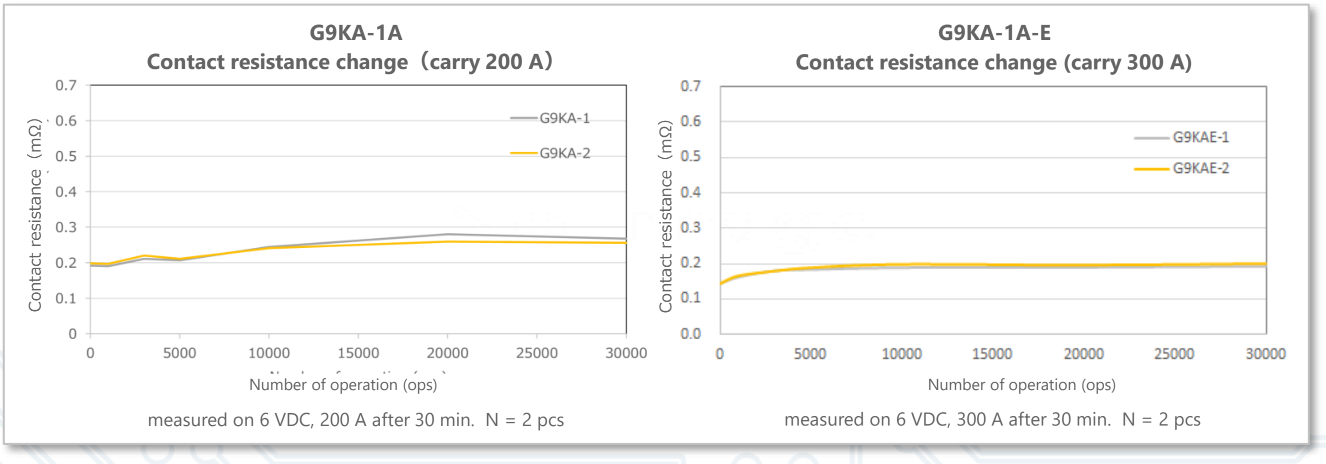

Figure 5: Reference data of contact resistance change

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Over 200A load current capability (only for G9KA-1A)

Although the nominal contact rating (carry current) is G9KA-1A is 200 A, it is applicable for over 200 A loads under specific heat dissipation design such as PCB, heatsink and cooling fan. We evaluated G9KA-1A in following test conditions (Figure 6) and confirmed terminal temperature will be lower than 115℃. This target value is generally acknowledged to reduce the heat stress of PCB solder joint and ensure the long life of final product with G9KA-1A implemented. Thanks to G9KA-1A ultra-low contact resistance feature for this positive result.Please contact Omron for further details about test condition including heat sink dimensions.

Relay type		G9KA-1A
Load condition		250 A
Ambient temperature		85℃
PCB	Copper thickness	100 µm per layer
	Layer number	4
Wiring	Size	80 sq
Fan	Wind speed	1.5 m/s
Heat sink	Material	Cupper

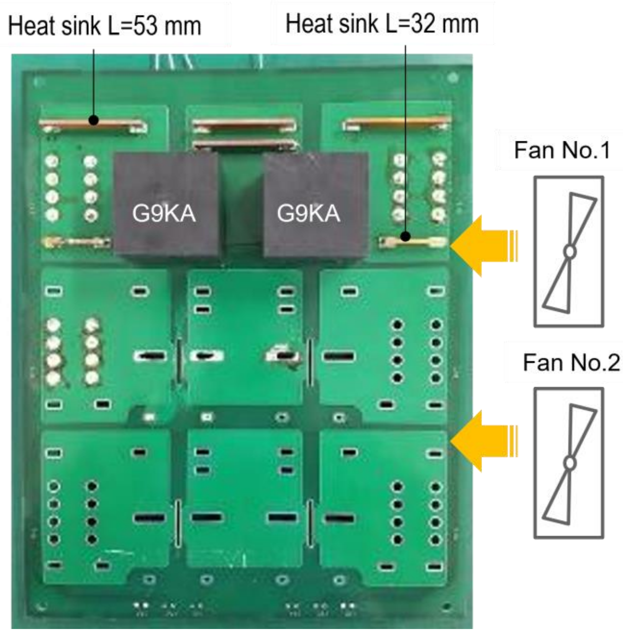

Figure 6: G9KA-1A over 200A test conditions

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Low power consumption

G9KA coil power consumption is 5.0 W at rated coil voltage. Actual power consumption can be reduced to 1,012 mW by holding voltage 45 %. PWM control is another method to reduce the coil power consumption. G9KA is applicable for both methods by following reference circuit diagrams.

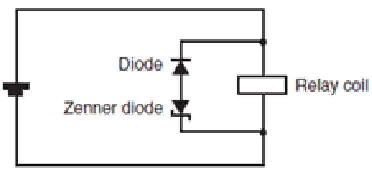
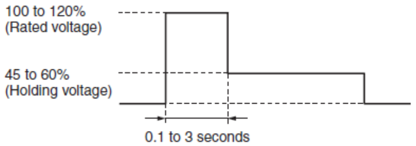


Figure 7: Diode connection

Please use a diode for coil surge absorption. A zener diode is also required in combination to maintain the G9KA switching performance. Diode connection is required in reverse polarity of the voltage applied to the coil.

- Recommended zener diode is two times of the rated coil voltage.
- Please use diodes with reverse dielectric strength 10 times or more of coil rated voltage. And forward current more than coil current.



	Applied coil voltage	Coil resistance *	Coil power consumption
Rated voltage	100 to 120%	28.8 Ω (DC12) 115.2 Ω (DC24)	Approx. 5 to 7.2 W
Holding voltage	45 to 60%		Approx. 1.0 to 1.8 W

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

Figure 8: 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 120 % and acceptable holding voltage is 45 to 60 % (Figure 8).

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 9). 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 %.

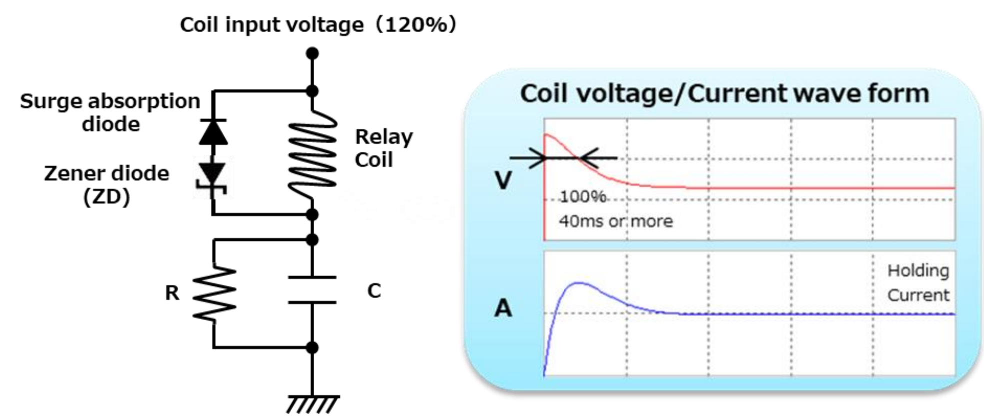


Figure 9: Reference of holding voltage CR circuit diagram

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A switching device can be use as an alternative to capacitor (Figure 10). Rated coil voltage will apply to the relay when switch is turned on and coil voltage will decrease when switching device turns off.

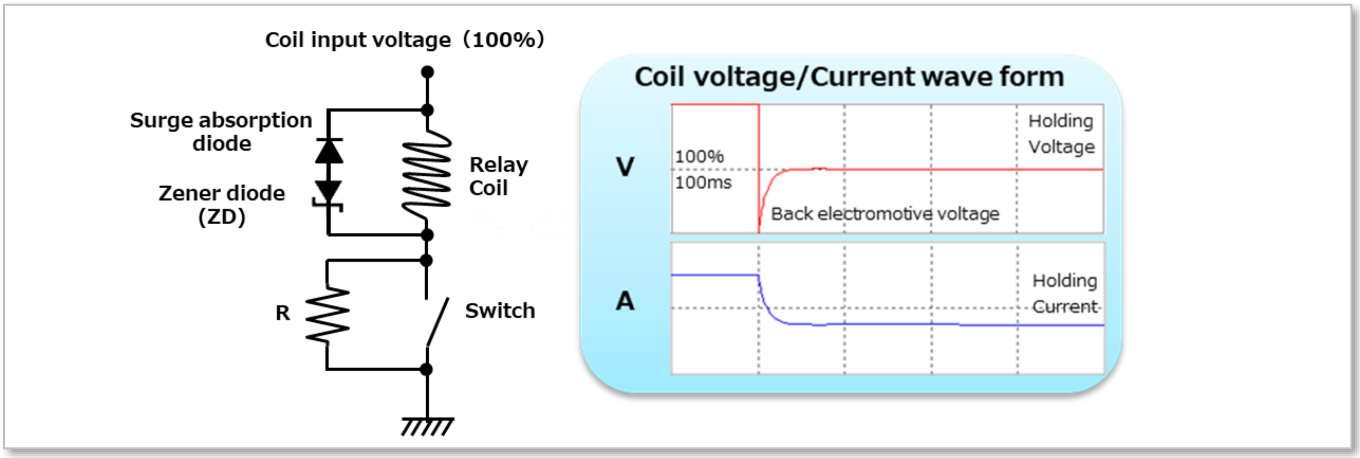

Figure 10: Reference of holding voltage by switch

● PWM control

To avoid the power loss caused by the zener diode, general PWM control circuit is not recommended. Please implement switching device in parallel with zener diode and bypass it during the PWM control (Figure 11). Turn off the switching device first and thereafter relay will turn off properly by zener diode and diode.

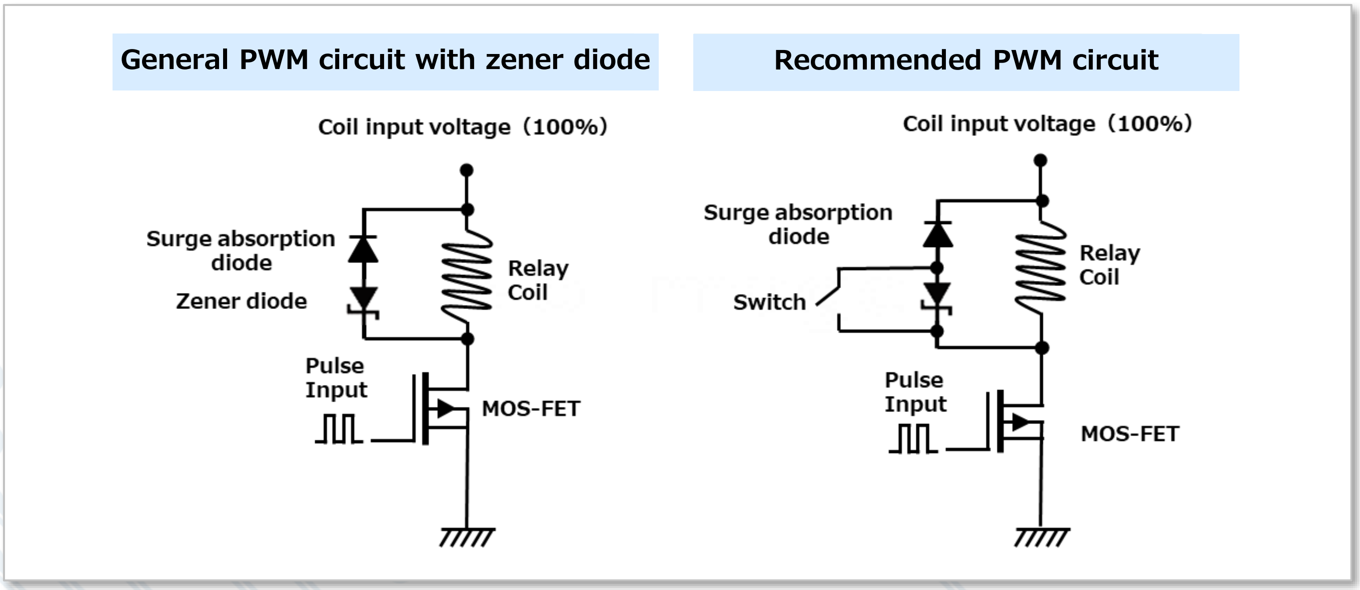

Figure 11: Reference of PWM control circuit diagram

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Figure 12 shows the comparison of coil current at each duty cycles. Generally, a PWM circuit requires over 86% duty cycle to keep the relay turned on, which makes more power consumption than the recommended circuit and raises temperature of the relay. Note that, over 45% duty cycle is acceptable for recommended PWM circuit to achieve the holding coil current criteria.

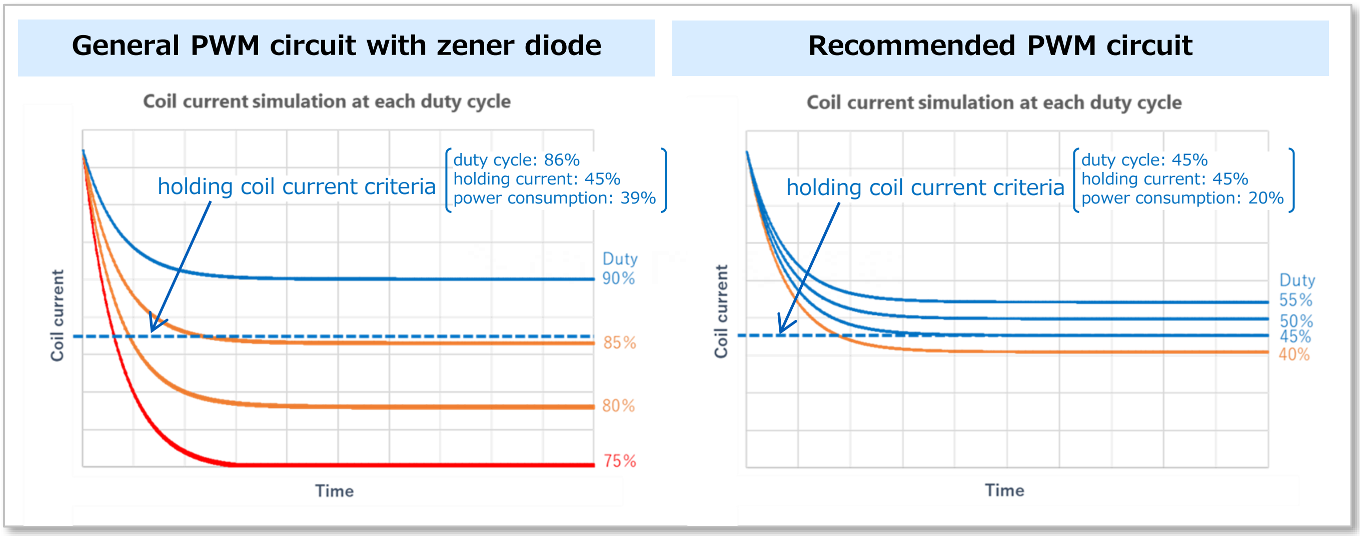

Figure 12: Reference of PWM control circuit diagram

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.

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