Panasonic
INDUSTRY

HIGH POWER RELAYS HE SERIES

Switching high loads on the PCB made easy

WHITEPAPER
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INTRODUCTION

As global awareness about ecological and energy concerns broadens, newly developed relays that meet the changing needs of the energy and automotive sectors have been increasingly in demand. Energy generation from wind and especially solar panels is becoming more widespread than ever, as private households install their own photovoltaic systems and connect them with battery storage systems. At the same time, electromobility is promising to usher in a new age of transportation.

"Higher switching capacities and smaller dimensions – these are the demands relays are facing today."

These are exciting new markets for relay technologies, but they come with a need for new switching solutions. Higher switching capacities and smaller dimensions – these are the demands relays are facing today. Switch solutions that can handle the high currents involved in energy management systems are becoming paramount. At the same time, components such as Printed Circuit Boards (PCBs) have been getting more intricate, both in size and complexity. New multilayer circuit boards, high power connectors and advanced materials are just some of the innovations that have been introduced in the last few years.

As a result, downsizing and energy saving have become more and more pertinent for electromechanical relays as well. As a leading force in switching technology, Panasonic Industry has made massive strides in this direction. The overall volume in cm^3 has more than halved in the last twenty years, whereas output density rose from around 0.8 to 1.1 KVA/cm^3 since 2010. Today more than ever, it is easier to control high loads with increasingly smaller relays.

Combining the new sophisticated PCBs with a cutting-edge high-power relay portfolio, Panasonic Industry offers a solution that switches high loads directly on the PCB: the HE series for high power applications.

SWITCHING HIGH LOADS ON THE CIRCUIT BOARD

The HE series can withstand loads up to 120A for the HE-N and up to 1000VDC for the HE-V in ambient temperatures of up to 85°C. This makes the PCB relays suited for high power applications, such as solar inverters, automotive charging stations, or battery storage systems. The relay is no longer responsible for controlling a secondary contactor, switching about 500mA up to a few amperes – it becomes the central load-carrying element, making other contactors unnecessary in a lot of cases. Switching high currents on the PCB becomes easier than ever.

This comes with a number of advantages: compared to contactors, the high-power PCB relays are much more compact. The HE-S, for example, manages to integrate two NO contacts into extremely small dimensions of 30x36x40mm. Furthermore, as the relays are mounted directly on the PCB, they require no control cabinet. A developer can thus switch from a screwed or wired solution to a switching element that is directly connected to the PCB. This not only saves space, but also makes manual assembly unnecessary and installation a lot easier – two factors that contribute to cost savings.

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Apart from component size, minimal energy consumption is a central feature of the HE series relays. Extremely low power dissipation at the contacts is achieved by reducing the contact resistance to between 1 and 3mΩ. Thus, no significant heating occurs at the contact and thermal losses are reduced – with a current of 35A and a contact resistance of 2mΩ, power dissipation is only 2.54W. Combined with the use of Pulse Width Modulation technology (PWM), which brings down the relay's operating power (170mW for the HE-S), energy consumption is decreased significantly. This is further helped by the fact that, due to reduced waste heat, ventilation is no longer necessary in most cases.

All relays in the series offer a contact distance of at least 2.5mm up to 3.8mm and high creepage clearance. This makes them well-insulated and guarantees high dielectric strength and protection against surge voltages. The unique relay structure of the HE-S allows a normally closed (1FormB) monitoring contact to be implemented, which recognizes when welding of the main contacts occurs. This feedback contact is compliant with EN60947-4-1 for safety circuits and conforms to EN61851-1, which makes it suitable for automotive charging solutions.

With a mechanical life of at least one million operations, the HE series guarantees a problem-free and long service life. Overall, the PCB relays help to cut back on space, energy consumption, and costs.

The HE power relays can switch high loads.

OVERVIEW OF THE HE SERIES

The HE series was designed for a number of application scenarios that demand electrically protective separation, carry high currents or require an emergency cut-off. To meet these ranging needs, all relays in the series come with a specific set of features and characteristics – from switching currents between 20A and 120A to a maximum switching voltage between 277VAC and 1000VDC.

Series	HE-V	HE-S	HE-Y5	HE-Y6	HE-N
Switching current	20A	35A	48A	90A	120A
Dimensions	41 x 50 x 39, 4mm	30 x 36 x 40mm	38 x 33 x 36, 3mm	38 x 33 x 38, 8mm	50 x 40 x 43mm
Holding Power*	210mW	170mW	310mW	310mW	400mW
Contact Gap	3.8mm	3.2mm	2.5mm	3.0mm	3.6mm
Ambient Temperature	-40 to +85°C	-40 to +85°C	-50 to +85°C	-40 to +85°C	-40 to +85°C
Contact Arrangement	2FormA	2FormA. 2FormA1FormB	1FormA	1FormA	1FormA
Max. Switching Voltage	1000VDC	480VAC	277VAC	277VAC	800VAC

* with reduced coil holding voltage

APPLICATION SCENARIOS

"Specifically, the use of HE relays in (solar) inverters, automotive charging solutions and battery storage systems has proven beneficial."

The PCB high power relays in the HE series make them perfect for the field of energy management, where high currents need to be switched safely, reliably, and cost-efficiently. Specifically, the use of HE relays in (solar) inverters, automotive charging solutions and battery storage systems has proven beneficial.

INVERTERS

In the three years between 2012 and 2015, global sales of solar inverters have risen from approx. 2,800,000 to 4,000,000 units. Since then, this trend has only accelerated. Private households are routinely installing photovoltaic systems in their homes, connecting them to storage batteries and the power grid. These wall-mounted inverters are becoming smaller and lighter, while at the same time, higher performance classes between 60kW and 100kW are becoming more common. This also has an effect on the relays used, which are increasingly required to deliver higher switching capacities.

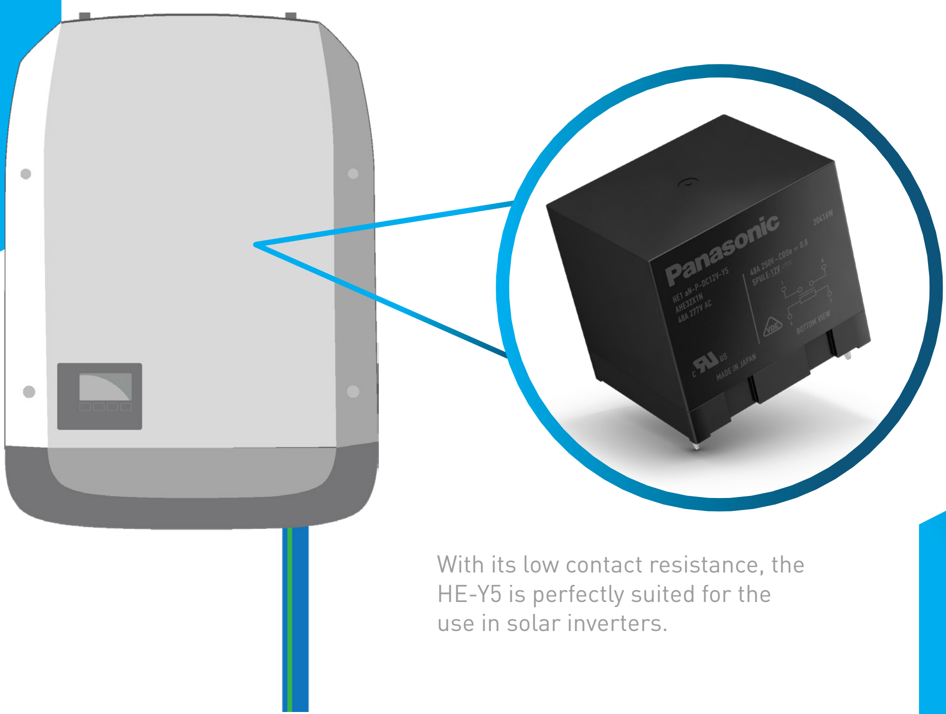
"While the inverter usually switches currents by a semiconductor, a relay is used to bypass it during the pre-charging process."

Inside the converter, very high currents occur during the charging of the capacitor. This component is used to prevent voltage fluctuations on the input side when a large load is connected to the output side. To limit the inrush current, a pre-resistor is used to pre-charge the capacitor with approximately 10A for 0.5 seconds. While the inverter usually switches currents by a semiconductor, a relay is used to bypass it during the pre-charging process. As soon as the current stabilizes, the relay closes and the current flows through the closed contacts.

The reasons for using a relay in this instance are simple: electromechanical relays like HE-Y5 have a much lower and more stable contact resistance than high power semiconductors. Thus, unwanted consequences like power dissipation and heat generation remain minimal.

"Compared to the HE-Y5 relay, industrial contactors take up a lot of space, have a high power dissipation and are more expensive."

For switching currents above 60 A, industrial contactors have been mainly used so far. As the IEC62109-1 solar industry standard requires single fault protection as soon as inverters are connected to the public grid, two separately controlled contacts per phase must therefore be connected in series. This ensures that, if one contact is welded, the second contact can still open safely. With industrial contactors, two three-pole contactors are therefore required for three phases. Even though six relays are necessary for the same purpose, the total balance in terms of energy and cost efficiency is still better: compared to the HE-Y5 relay, industrial contactors take up a lot of space, have a high power dissipation and are more expensive. While energy savings for each individual relay are rather small, the surplus adds up when considering the sheer number of inverters currently on the market. Therefore, selecting a higher quality relay instead of a secondary contactor pays off.



With its low contact resistance, the HE-Y5 is perfectly suited for the use in solar inverters.

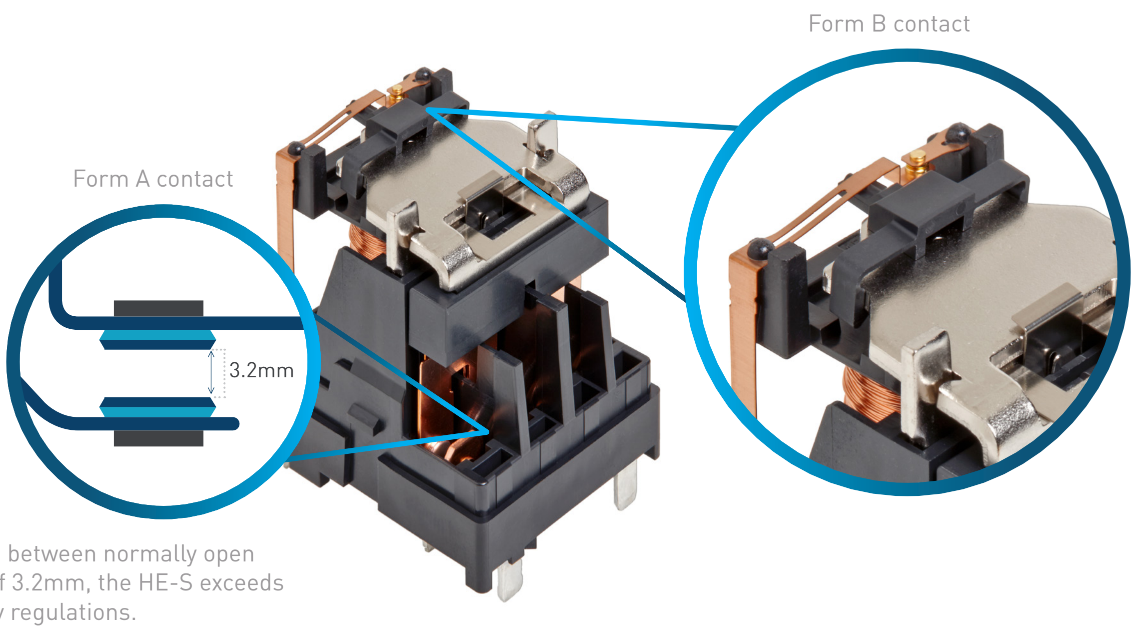
CHARGING STATIONS

With national and global commitments to reduce CO2 emissions, e-mobility concepts have experienced a veritable boost in the span of just a few years. Consequently, the necessary charging infrastructure, rather neglected until recently, has also returned to the attention of politics and engineers. In addition to a public charging infrastructure, household charging systems are increasingly emerging as a viable option. Currently, drivers of e-cars can charge their vehicles either at a AC/DC charging station, a AC/DC wallbox installed in their garage, or a special charging cable that gets connected to a regular household outlet or CEE-socket.

A whole arsenal of mains isolating relays is currently required for a safe recharging, depending on the charging system and national standards. Thus, standard IEC 61851-1 distinguishes between charging modes on the basis of their installation and system components. However, all require a switching device in the power range from 16A/250VAC to 63 A/380VAC. This is used to connect and disconnect the electricity supply system to and from the vehicle. The latter is usually the case when a fault mode occurs, e.g. when a creepage current is detected.

The HE-S power relay has already been approved for many charging stations in the market and is especially suited for wallbox systems with charging capacities of up to 22kW and 43kW. It is able to carry high charging currents at ambient temperatures of 85°C for several hours, even under direct sunlight. Furthermore, the relay's lowest holding power is 170mW, and features a clearance and creepage distance of more than 8mm between the coil and the contacts.

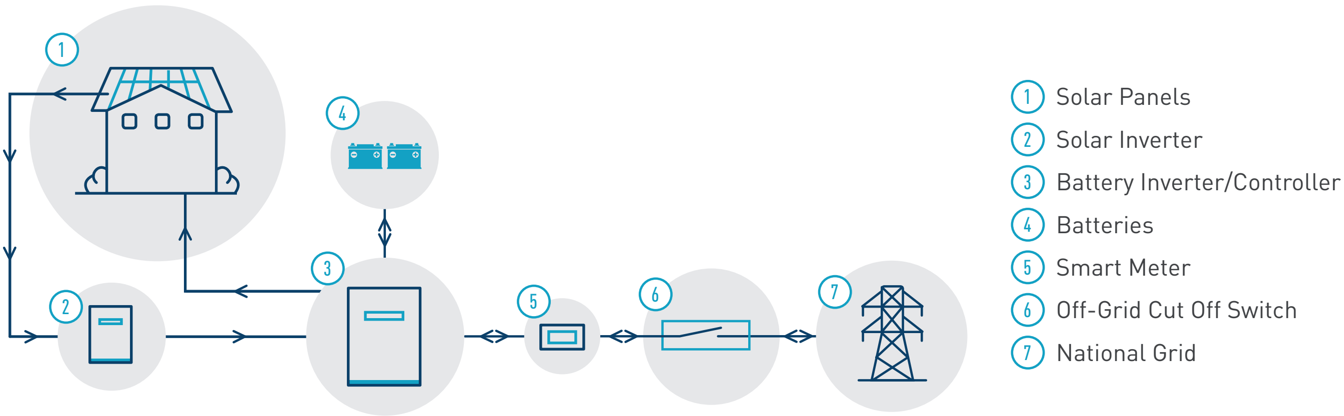
"The HE-S relay accommodates two NO bridge contacts with a contact gap of 3.2mm and is also available with an auxiliary contact. With welded main contacts, this contact retains an opening of at least 0.5mm and can switch 1A at 230VAC."



With a gap between normally open contacts of 3.2mm, the HE-S exceeds mandatory regulations.

Similar to the solar industry, automotive charging systems require a contact distance of at least 1.8mm; for many applications, an electrically protective separation of 3mm is mandatory. The HE-S relay accommodates two NO bridge contacts with a contact gap of 3.2mm and is also available with an auxiliary contact. With welded main contacts, this contact retains an opening of at least 0.5mm and can switch 1A at 230VAC. This configuration is certified for mirror contacts by the VDE in accordance with IEC 60947-4-1. As the auxiliary contact is switched via a separate actuator, it is electrically isolated from the contact set – its connections are routed outwards parallel to the coil terminals. This, combined with a large contact gap, makes the HE-S perfectly suited for automotive charging scenarios.

BATTERY STORAGE

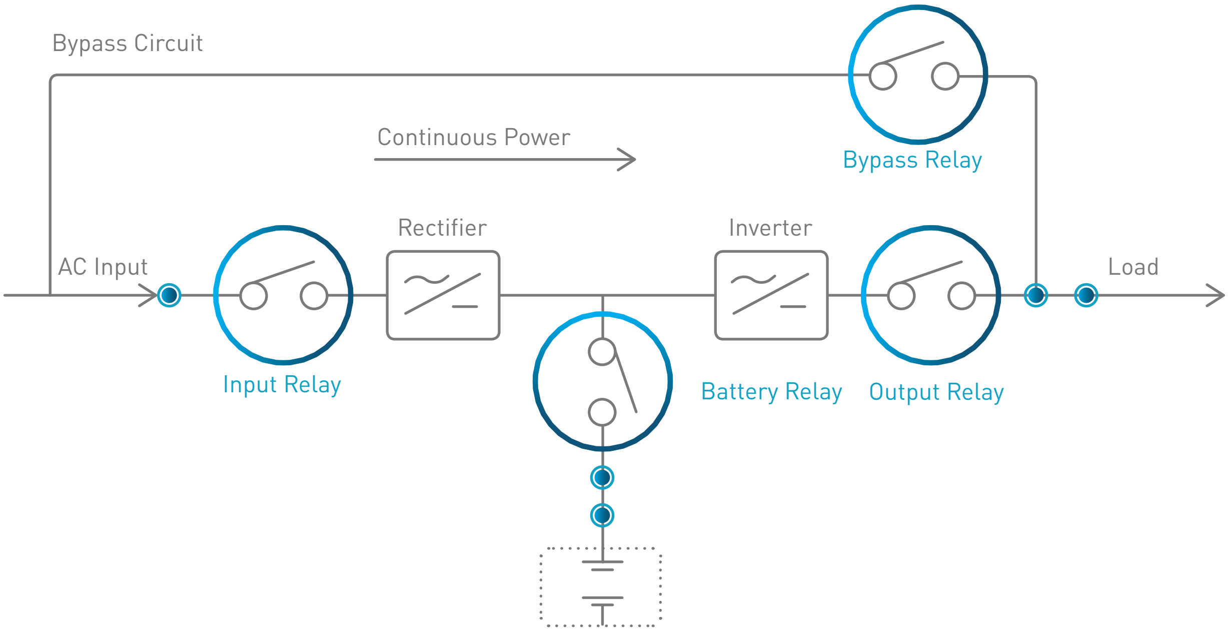


"In addition to a public charging infrastructure, household charging systems are increasingly emerging as a viable option."

Connected to the application scenarios mentioned above is a growing need for safe and effective battery storage solutions. It is therefore hardly surprising that fixed storage battery sales are growing – in Japan alone, the sales have almost tripled in the years from 2012 to 2015, especially in the infrastructure and household sectors (approx. 10.000 to approx. 30.000 units).

Relays that are used for charging and discharging batteries must naturally be able to carry high currents over a longer period of time. Even more important, however, is that the relay is able to cut off even a high current safely and reliably. An emergence cut-off occurs when equipment fails or a malfunction occurs. Thus, when lightning strikes a solar panel that is connected to a battery storage system, the resulting overcharge can cause damage and poses a safety hazard. DC Cut-off is therefore required for all major solar and battery storage systems on the market.

Power relays like the HE-V can be used for cutting off both positve and negative lines on the DC side, with a maximum of 1,000VDC. It uses a blow-out magnet mechanism and serial contact connection to maintain the required arc and gap length for high DC voltage cut-off. If a problem occurs in a photovoltaic system, the relay can short the connection between the panel and junction box. The same principle can also be applied to increase energy efficiency when a panel is in the shade. Furthermore, the HE-V power relay prevents inrush currents to the storage battery and is suitable for a rapid shutdown system, where the cut-off is effected by the push of an emergency button. The HE-S relay, on the other hand, is designed for AC safety cut-offs. Thus, the power relays in the HE series improve safety both on the input and the output side of energy storage solutions.



CONCLUSION

"It seems highly unlikely that the trends towards renewable energy and alternative driving dynamics should grind to a halt anytime soon."

Energy management, be it in electric vehicles, solar or wind power stations or photovoltaic systems in private households, is a market that is still far from reaching its peak potential. It seems highly unlikely that the trends towards renewable energy and alternative driving dynamics should grind to a halt anytime soon. For electrical companies, this is a great opportunity, but it also calls for new solutions that can handle high loads in a way that is both efficient and safe.

The power relays of the HE series have the potential to revolutionize the role relays play in this field. With an improved internal architecture and compact design, they are able to control high currents directly in the circuit board. For manufacturers, this opens up new possibilities in terms of design and efficiency. The potential benefits are wide-reaching, as the application scenarios in this whitepaper show, ranging from significant improvements in energy efficiency to safety considerations. In a nutshell, trading in secondary connectors for power relays mounted on the PCB means saving space, energy, and ultimately costs – without compromising on quality or performance.

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