

Benefits Of PCB-Mounted Relays In Energy Infrastructure And Tips For Applying Them

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Energy infrastructure equipment such as PV inverters and EV chargers must handle high-current and high-voltage loads. To ensure safety, this equipment incorporates disconnection components capable of controlling high electrical power. Traditionally, contactors have been used as safety disconnection devices in such equipment due to their suitability for high-power control.

However, with the growing demand for compact, lightweight, and slim designs, there is increasing interest in replacing bulky contactors with high-capacity PCB-mounted relays (PCB relays), which offer a smaller size while still enabling high-current and high-voltage disconnection (see the figure). This article outlines the advantages of replacing contactors with PCB relays in energy infrastructure equipment and recommends strategies for optimal PCB design.



Figure. The availability of PCB-mounted relays with higher power ratings makes them viable replacements for bulkier contactors in photovoltaic (PV) inverters and EV chargers, especially level 3 dc fast chargers.

Contactors Vs. PCB Relays

Contactors are commonly used in large-scale equipment because they are specifically designed to handle higher currents and voltages than typical relays. They offer high robustness and can manage loads of several thousand volts and currents exceeding 1000 A.

However, contactors tend to be physically larger and heavier than relays, and their switching speed is slower. Additionally, the electromagnetic coil that drives the switching mechanism scales with the disconnection capacity, resulting in higher power consumption. Contactors are typically mounted using screw-fastening methods.

PCB relays, while less robust than contactors, have evolved through advancements in magnetic flux design, contact shape design, and arc interruption path optimization. These improvements now allow PCB relays to handle loads up to approximately 1000 V and 300 A. Compared to contactors, PCB relays are more compact, lightweight, and consume less power. Their terminal configuration is designed for printed circuit boards (PCB terminals), enabling integration with surrounding components directly on the board.

Advantages Of PCB Relays

In applications such as commercial and industrial (C&I) PV inverters and high-power EV chargers (with outputs in the hundreds of kilowatts), the load range typically falls below 1000 V and 300 A. In this load range, there are many benefits in replacing conventional contactors with PCB relays.

Compact And Lightweight Equipment

One major advantage is the reduction in size and weight of the equipment. For example, in PV inverters, safety disconnection devices are installed in series—two per phase—on the three-phase connection lines to the electrical system. Traditionally, this setup uses two three-pole contactors rated for 200 A to 300 A in series.

By replacing them with six single-pole PCB relays rated for 200 A to 300 A (two per phase × three phases), it is estimated that the overall volume can be reduced by approximately 85% and the weight by around 70%, according to OMRON research.

Reduced Assembly Workload

This benefit is particularly significant for EV chargers, especially dc fast chargers installed at large-scale stations. These chargers often include internal systems for output sharing—such as power distribution units or matrix switches—to enable simultaneous charging of multiple EVs. To achieve power sharing, numerous contactors are installed, and in some cases, a single charger may contain over 100 contactors.

Assembly of these units involves labor-intensive tasks such as screw-fastening contactors and busbars, crimping terminals, and wiring. As a result, assembling one charger can take several hours. By integrating these units onto a PCB and using PCB relays for circuit switching, the workload associated with cable wiring and screw fastening can be significantly reduced, leading to lower production costs.

Improved Quality Consistency

Another advantage is the ability to achieve stable product quality. Since contactor screw fastening is performed manually, variations in torque—despite predefined specifications—can occur due to differences in individual worker technique. By replacing contactors with PCB relays and integrating them onto the board, such inconsistencies can be eliminated, ensuring more uniform and reliable product quality.

Guidelines For PCB Design

When using PCB relays to control high currents on a circuit board, suppressing temperature rise is critical. Copper foil is used on PCBs as a conductor to transmit electrical signals and current between various components and circuits. As current increases, heat generation intensifies in the copper foil areas and components—including the relays—leading to a rise in board temperature.

This temperature rise can ultimately degrade the durability of the PCB itself. To address this, it is essential to increase the cross-sectional area of the copper foil (thickness × width), thereby reducing resistance in the current-carrying paths.

During the development of high-capacity PCB relays, OMRON focused on mounting relays on a two-layer PCB with 500- μm -thick copper foil. As previously mentioned, increasing copper thickness enlarges the cross-sectional area, helping to suppress temperature rise. However, market research revealed that PCBs with 500- μm copper foil are not widely available, making them difficult to procure and costly.

As an alternative, we recommend using a multilayer PCB with 105- μm -thick copper foil. While this approach may require a larger board size to ensure sufficient total cross-sectional area, it offers advantages in terms of availability and cost. In fact, our market research has confirmed examples of 200-A-class PCB relays being mounted on six-layer PCBs with 105- μm copper foil. For those considering PCB integration but facing challenges in implementation, we strongly encourage exploring this design approach.

As energy infrastructure evolves, the need for safer, more compact, and highly efficient solutions becomes ever more critical. Integrating PCB relays not only meets the stringent technical demands of modern PV inverters and EV chargers but also advances industry-wide goals of miniaturization and cost efficiency.

About The Author



Yuki Kawamoto is now in his 11th year at OMRON where he serves as assistant manager and applies his expertise to drive innovative solutions and growth. At Omron, Yuki began in domestic sales, where he excelled in the home appliance sector, before transitioning into marketing to lead planning efforts for high-capacity relays in the energy industry. Throughout his career, he has demonstrated a strong commitment to continuous learning and professional development. Yuki pursued his academic studies in law and international politics at Osaka University, building a strong foundation for his career at OMRON.

For more on power protection, see the *How2Power Design Guide* and select the "[Power Protection](#)" search results.