

Building the next generation of electric vehicle charging stations

How to design a more functional, durable EV charger

The electric vehicle (EV) market has exploded in recent years as governments and OEMs alike have pledged to increase the number of fuel-efficient and environmentally friendly vehicles on the road. According to the International Energy Agency, in 2010, there were only about 17,000 EVs in use around the world, but that number increased to [7.2 million by 2019](#). In just the short period from 2020 to 2021, [EV sales grew an estimated 85%](#), according to the U.S. Department of Energy.

This movement toward EVs has created significant opportunities for OEMs and other manufacturers and

suppliers in the industry. In particular, as the demand for vehicles has gone up, so too has demand for EV chargers. This whitepaper offers insights on how OEMs can develop more advanced EV chargers by focusing on five main areas: thermal management, display, sealing, EMI shielding, and emblem attachment. By diving into the available materials and key considerations involved in developing solutions for each of these challenges, eMobility and energy equipment manufacturers can create the next generation of EV chargers to capture market share in a rapidly growing industry.

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Types of charging stations

Different OEMs have developed their own proprietary charging systems and charger designs. But regardless of the specific brand, there are three main types of charging stations available in the market today: **outdoor, household, and fast charging stations**. Each type of charger presents its own set of unique needs and challenges.

For example, harsh environmental conditions require specialized labels and sealing to meet UL standards for outdoor chargers. For fast charging stations, sometimes called superchargers, thermal management is often the biggest challenge because of the extraordinary amount of heat generated by those systems.

Satisfying project requirements comes down to design, materials selection, and ultimately the manufacturing process.

Thermal management

Thermal management is one of the most critical challenges when developing EV chargers because of the significant levels of heat these systems create. Liquid cooling plates, heat exchangers, fans and blowers, heat sinks, and other thermal management

materials and components are used frequently to prevent overheating, thermal runaway, and mitigate risk of fire.

Fast charging stations create excessive heat as a function of space. Large current volume is passed through smaller diameter cables, generating excess heat. Fast charging stations often implement cable cooling solutions to manage touch temperatures and control system temperatures to prevent long-term systemic damage and help protect users.

Some chargers can convert AC power from the grid into DC current that will safely charge an EV battery. These types of chargers use an electrical inverter, or a series of electrical switches that rapidly alternate to transform the AC current to a DC current. These switches fire quickly to enable fast charging and generate large amounts of heat in the process. This waste heat poses a risk to safe charger operation and reliability.

Because thermal management is so integral to the performance of EV charging stations, it should be a constant consideration when selecting materials and making design decisions during product development.

Display

Displays in EV chargers are a critical part of the user experience and need to be designed properly to ensure they can be read in various conditions and ruggedized to withstand harsh conditions.

For both indoor and outdoor charging stations, there are a number of films that can limit glare and reflection within a full display stack-up to improve image clarity. In particular, 3M has many specialty display enhancing materials like light control films, brightness enhancing films, visible-light reflective films and light diffusing films. As a Preferred 3M Converter, Boyd has unique access to these materials and the ability to convert them to improve manufacturing efficiency and meet project requirements.

When designing EV charger displays, OEMs should consider the opportunity for a better user experience to create competitive advantage. While many early station designs featured only a small digital screen or none at all, innovative chargers feature larger displays with more detailed graphic capabilities to provide users with different types of information or facilitate interactive experiences via touchscreen technology. Just as many modern gas pumps play ads, EV chargers could also be an opportunity to sell ad space or promote other branded products. The key here is to ensure displays of all types won't be adversely affected by environmental conditions and are easy to use.

Sealing

It's hard to overstate the importance of [ingress protection](#) for any electronic device, but particularly for outdoor EV charging stations. Engineers have to make sure chargers are sealed properly so interior components won't be damaged by moisture from precipitation or other contaminants like dirt and dust.

Ensuring proper ingress protection often comes down to the resilient materials and adhesive solutions used to bond the seal to the housing of the charging unit.



Silicone materials and other foams and rubbers are often the go-to choice for these seals because of compressibility, resilience, UV resistance, and UL ratings. Commonly used adhesives include double-sided tapes, acrylic adhesives, VHB tapes, and differential adhesives to bond seals to the enclosure cabinet.

Because sealing solutions involve multiple types of adhesive materials or gaskets, OEMs should look for partners with the converting capabilities to create multilayer stack-ups with dissimilar materials, like silicone and differential adhesives. For example, a stack-up may require laminating a PSA to a silicone foam, die cutting those materials, then adding a continuous liner to the back, and a top liner on the other side for easier manufacturability. Having a trusted partner who can design and then manufacture complex, integrated stack-ups from end to end will be critical for achieving the manufacturing and assembly speed and efficiency necessary to thrive in the EV market.

When it comes to cost-effective sealing solutions, Boyd has a unique ability to create a seal around a display edge without wasting material while providing world-leading, precision tolerances. We use a proprietary process to create a full frame of adhesive or adhesive-backed gasket that meets IP ratings with minimal waste to limit cost and deliver ultra-tight tolerances. This process and technology help our EV customers not only improve profit margins, but also contribute to a brand's sustainability initiatives to further enhance the environmental impact of the EV movement.

EMI shielding

As with any other electronics application, resistance to electromagnetic interference (EMI) is paramount to ensure EV chargers perform to required levels. In EV charging stations, comprehensive [EMI shielding](#) often involves one or more of the following:

▶ **Gasketing solutions** – Highly conductive materials such as a conductive foam or stamped metal gaskets are fabricated in custom configurations to line the seams of a charging station enclosure.

▶ **EMI absorbers** – Often made with conductive foam or magnetic particle filled polymeric sheets, absorbers offer high permeability and conductivity to absorb EMI within an electronic system.

▶ **Shielding materials** – Often designed as interior components in complex stack-ups, conductive foils, foams, elastomers, and adhesives can block EMI from reaching sensitive electrical components.

The most important EMI application for OEMs to consider is designing EMI shielding and absorption components in and around openings, gaps, and seams. This creates a barrier to unwanted external energy and electromagnetic waves, protecting signal integrity within and reliable performance of the charger. Many thermal management materials can pull double duty and provide EMI protection as well. So, it's important to think holistically about EMI needs and how to meet those requirements in the most efficient way.

Emblem attachment

In such a crowded marketplace, it's important for brands to differentiate and build strong relationships with customers. One way to do that is by adding aesthetic branding elements to EV chargers. Emblem

attachment goes beyond company logos to include [safety labels](#), [barcoded labels](#), [regulatory labels](#), nameplates, and badges for branding purposes, to enhance the user experience, and improve safe operation.

For example, safety labels and warnings help protect users from harm. Cable wrap labels, system information labels, and warranty labels can vastly improve the user experience by eliminating confusion and making maintenance more efficient. Many people are starting to use EV chargers regularly for the first time; using these types of safety, informational, warning, and regulatory labels takes on more importance by proactively guiding safe use and instruction.

[Nameplates and badges](#) can be attached to EV chargers using VHB tape because of its high-strength bond, durability, and water-resistant characteristics. Durable labels made from vinyl, polyethylene, polypropylene, and polyester are also commonly used for outdoor charging stations because they are water and UV resistant. Material selection is often determined by the type of charger and environmental conditions it will face (e.g. outdoor chargers available to the public may require more durable labels for operating instructions than an in-home private charging station).



The bottom line

Durable, reliable, easy-to-use EV chargers are increasingly needed to power the new generation of electric vehicles. OEMs and others need to find ways to not only achieve target product performance, but also ensure an efficient manufacturing process that gets products into market quickly to beat out the competition.

One of the best ways to overcome challenges in the design and production process is to partner with a converter like Boyd that has experience developing custom solutions for all types of EV chargers. With our design engineering and materials science expertise, we help develop new products and convert materials to improve efficiency in the manufacturing and assembly process.

By taking time to fully consider some of the most pressing challenges in designing and building EV chargers, OEMs can streamline the product development process and identify the materials and design necessary to deliver the best possible user experience.



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About Boyd

With over 90 years of customer-focused performance, Boyd's innovative, sustainable engineered material and thermal solutions make our customers' products better, safer, faster, and more reliable.

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your next project?**

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