APPLICATION NOTE

POWER DISTRIBUTION AND SAFETY CONSIDERATIONS IN MEGAWATT EV CHARGING

Background

As the expansion of electrified vehicles continues, charging efficiency and speed remains a key component challenging adoption in some areas – particularly with heavy-duty fleets with higher power needs and range requirements. Those trends are driving battery capacities toward one megawatt hour and increasing electrical, thermal, and safety demands on the vehicle as well as charging infrastructure.

A Megawatt Charging System can deliver up to roughly 3.75 megawatts at about 1,250 volts DC, cutting dwell time but raising requirements for continuous current carry, robust thermal paths, reliable charger communications, electromagnetic compatibility, and cyber security.

With increased power, the severity of any faults also increases as prospective short-circuit energies can reach tens of kiloamperes, which requires rapid detection and interruption to protect people, packs, and power electronics.

Thermal management becomes central because I2R losses scale with current, so even small resistances at kiloamp levels generate substantial heat that must be conducted quickly into cold plates. Packaging constraints such as multiple packs, remote inlets, and under frame routing push designers toward compact, low resistance components and serviceable, sealed enclosures.

On the vehicle side, the high voltage distribution unit becomes the hub that safely switches, protects, senses, and communicates across the traction, auxiliary, and charge paths while meeting compliance expectations for high voltage commercial transport.

On the charger side, Within the charging system, contactors are used in the switching matrix to control the power output, generally positioned in parallel and series to achieve the requested charging power. As charging power increases, the rated current for the contactor needs to increase accordingly. With higher charging power, also the possible short circuit current will become bigger - for megawatt charging, the short circuit peak current should be limited to 70kA – creating the need for a fast interruption of the circuit.

Solution

Sensata components play critical roles on both the charger and vehicle side of challenging megawatt charging applications.

On the vehicle side High voltage distribution units (HVDUs) in vehicles, such as power distribution units, charge units, and charge PDUs, integrate switching, protection, sensing, control, and communications to manage battery charging and power delivery.

Used in heavy-duty electric trucks, these systems feature low resistance contactors, high bandwidth current sensing, and pyrofuse fast disconnects for rapid fault isolation.

Thermal efficiency is improved with optimized busbar routing, direct liquid cooling, and careful component selection to minimize losses during kiloamp charging. Integrated controllers enable charger handshakes via ISO 15118 and Ethernet, while insulation monitoring devices provide continuous isolation health and diagnostics.

Designs address EMC, functional safety, cybersecurity, ingress protection, and clearance for systems above one kilovolt. Modularity enables remote inlets and multi-pack architectures with passive or liquid cooling. This integrated approach to HVDU system design delivers shorter charge times, improved uptime, and a validated path to megawatt charging at production scale.

On the charger side Power output within the switching matrix itself can also be managed through reliable Gigavac contactors, in many cases the GXVB611, which delivers reliable switching in one of the smallest 1000V/600A packages available on the market. As voltages increase to 1250VDC, the HX and GTM series may also be potential solutions.

Short circuit interruption can also be managed via Sensata's STPS500 Series PyroFuse - a pyrotechnic circuit breaker designed for rapid and reliable protection in high-voltage applications, with an interrupt/clear time of less than 1ms. This is often paired in series with the contactor. To protect the charging system it is important that the fast disconnect device will break the overload and/or short circuit load the contactor is not capable of breaking.

RECOMMENDED PRODUCTS

Reference on Diagram	Product	Features	Function
1	 High Voltage Distribution Units (HVDUs)	• Option to combing charging and power distribution into one enclosure • Active or passive cooling options for thermal management • Compatible with multiple charging standards • Including electronics and software • Vertically integrated units	Manage electrical power in heavy duty electric commercial vehicles
2	 GXVB611 Contactor	• High voltage bi-directional DC contactor • 1000VDC rated voltage, 600A nominal current • Built-in coil suppression	Switching power output in switching matrix
3	 PyroFuse	• Active safety with external trigger • Fast disconnect <1ms • High post IR >50MΩ @ 1000V • Lightweight design and small form factor	Rapid and reliable circuit protection in high-voltage applications

DIAGRAM

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