Addressing Design Challenges for EV Charging Systems
By **Mark Swinbgurn**

Charging electric vehicles (EVs) need more than just a power socket in a driveway. With more EVs on the road, more energy is needed — with improved grid management systems, more efficient chargers and integration of home energy management.

There is now a great demand for smart charging at home and work, and for faster charge times, which necessitates the move from AC to DC chargers. Additionally, there is safety to consider, including authenticating the EV battery. Users also expect to able to charge anywhere, and either pay securely as they go or link their charging to one central account and bill.

Security Is the Key

Incorporating secure elements to comply with industry standards like ISO 15118 or calibration laws (such as the German Eichrecht) is crucial. NXP's latest EdgeLock® SE05x family of embedded security solutions, for example, help to ensure the entire value chain can be secure against cyberattacks, while the point of connection will still be safe and easy to use.

To avoid unauthorized access, secure protocols based on the industry standard NFC can be used to unlock the EV charging station via credentials like a physical smartcard or smartphone. These also enable other smart city applications, such as parking and public transport. NXP's smartcard solutions leverage the large MIFARE® contactless ecosystem that the company has built in more than 750 smart cities worldwide.

Powering Up

Today, many charge points deliver AC. Often this is single-phase, but access to 3-phase AC charge points is increasing. There is a small yet growing number of high-voltage DC charge points available, which can deliver much higher levels of power than an AC charge point and therefore reduce charging time. As a result, most EV OEM suppliers look to develop both charger types. This means they can benefit from NXP's technology building block approach, which should ease development and increase reuse.

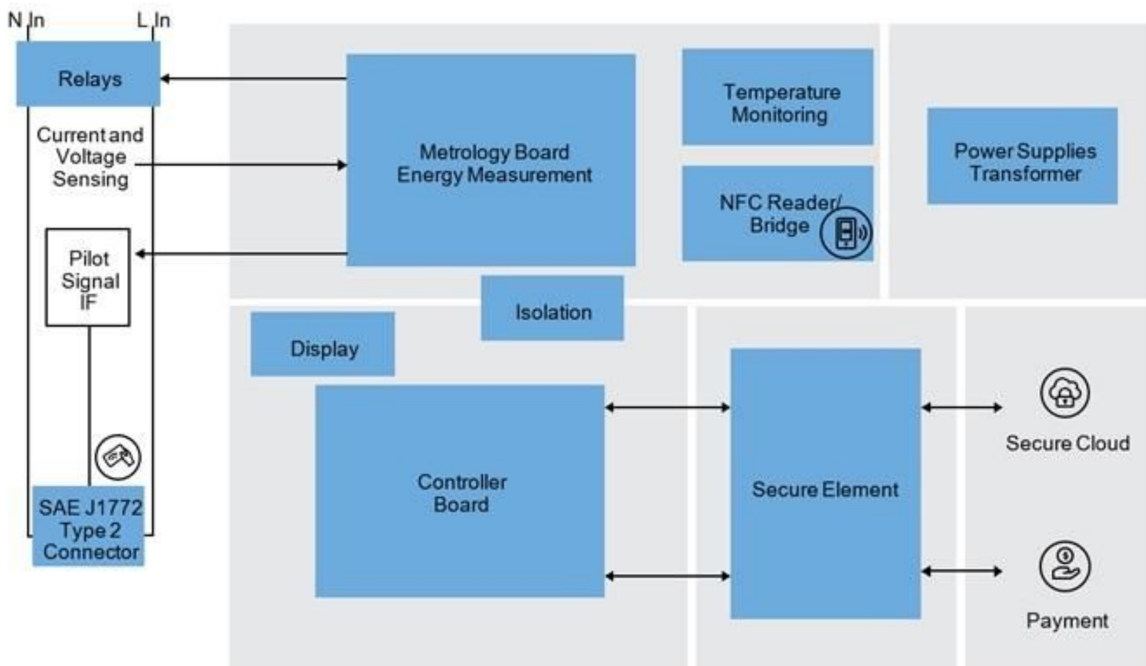
The EV Charging Solution

As well as interacting with the user, the charging station, or electric vehicle sourcing equipment (EVSE), also needs to communicate to the grid for functions including load balancing, vehicle to grid (V2G) including ISO 15118, smart charging, Open Charge Point Protocol (OCPP) and tariffs.

Communication technologies could include ISM and cellular, implemented using a product like NXP's IW620 dual-band solution that combines Wi-Fi® and Bluetooth®, or the OL2385 RF transceiver designed for sub-GHz protocols. These could be combined with devices like the LPC55S69 MCUs, which is ideal for implementing NBIoT, as well as wired communications such as PLC.

This is closely linked to the SE05x-based security functional block, which provides authentication with end-to-end cryptography to exchange sensitive information such as billing data. It can also manage the exchange of data between the vehicle's on-board charger (OBC) all the way to the backend servers.

The controller board will use both the security and external communications blocks to manage the main functions and services, such as high-level communications, as well as running protocol stacks used in the EVSE applications. This includes the ISO 15118 standard defined for V2G communications and may also include the OCPP. The processor options available from NXP cover a wide performance spectrum from MIMX8xx MPU application processors to the MIMXRT11xx family based on Arm® Cortex®-M7 real-time MCU cores, through the latest LPC55x series of Cortex-M33 based MCUs.



System-level view of an EVSE

Intelligent Charging

Intelligent wall boxes and charging stations are usually connected to the cloud. The connectivity between consumers, the charging station and cloud are typically handled via Ethernet or with Wi-Fi 6, Zigbee® or other wireless technologies. Intelligent charging stations are often combined with smart metering solutions, which increases the amount and complexity of data handled.

To provision the charging station to the cloud (cloud onboarding), a simple provisioning and ownership process is required that maintains high security. NXP supports a zero-touch onboarding process to major cloud partners through its SE05x and EdgeLock 2GO service, which also authenticates sensitive user data like consumption profiles and payment data.

Another emerging requirement is how charge stations accommodate autonomous vehicles. The objective is for them to guide themselves to a charging station accurately enough to connect without a human or (expensive) robot assistant to provide that "last cm" connection. This could be achieved with a highly accurate localization wireless technology, such as ultra-wideband (UWB), thus enabling an autonomous vehicle to steer itself into exactly the right position.

Cloud-Connected Reference Design

Integrating products from across NXP, our cloud-connected EV charging station reference design, the EasyEVSE, allows customers to accelerate innovation and simplify the design process. Customers can quickly load the Azure RTOS-based application software on NXP's i.MX RT1064 crossover MCU and securely connect the simulated EV charging station to Microsoft Azure IoT Central. The reference design features NXP Kinetis® metrology MCUs, which include their own reference designs, schematics and metrology software. because secure communication between the car, the EV station and the cloud is a requirement, the reference design shows how to leverage the NXP EdgeLock secure element to meet ISO 15118 security and safety requirements. Customers can use the platform as the foundation for a full, differentiated EVSE system. EasyEVSE EV Charging Station Development Platform

Local Storage for EV Charging

As charging stations migrate from AC to DC, the grid must meet peak demand for high-power (350 kW or more) outputs, with battery voltages up to 1000 V. Local storage is addressing this using batteries and NXP's battery management system (BMS). When the local battery is fully charged, it can deliver energy to the EV first before drawing more from the grid.

When no EVs are charging, the local battery storage can be recharged from the grid or even onsite arrays of solar cells for smoothing out demand peaks on the grid, as well as securing power in case of power outage on the grid. This local energy balancing is enabled by the battery management unit (BMU) based on, for example, NXP's FS32K family, power management ICs enabling functional safety, BMS gateway enabling SW-free battery packs and high-accuracy analog front ends providing battery state. ISO 15118 security and safety requirements. Customers can use the platform as the foundation for a full, differentiated EVSE system.

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Conclusion

Electric vehicles are becoming more common, creating a need to develop wide networks of charging stations that are both safe and secure.

NXP has a history of delivering power conversion and secure data transactions and device authentication. In EV charging, these two domains come together in a new way.

With a growing number of evaluation kits and reference designs, covering most of the requirements of AC and DC EV charging stations, NXP is well placed to provide the technical insights that manufacturers and service providers need, and to support the rapid growth of the EV industry.

Author

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