

CharIN Festival



A global platform for Interoperability Testing

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Importance of Conformance and Interoperability Testing

To reduce greenhouse gas emissions and mitigate climate change, electric vehicles powered by green energy sources are essential. Interoperability and conformance testing play an important role in driving the global adoption of e-mobility by addressing key challenges and promoting a reliable, easy-to-use and standardized charging infrastructure.

Current Situation:

The E-Mobility market is on the rise, but it's still in its early stages. Unfortunately, many electric vehicle (EV) users frequently encounter challenges while charging, which are impeding the growth of this industry. The reliability of charging networks is declining, and this issue is particularly pronounced in both the United States and the European Union.

In the US, approximately 10-20% of charging stations are out of order according to a study by J. D. Power. These malfunctioning charging stations have far-reaching consequences for the widespread adoption and acceptance of e-mobility.

Electric vehicle adoption is already hindered by several reservations and concerns among potential users, and the unreliability of charging networks only exacerbates these issues. Here are some of the challenges that EV owners face when trying to charge their vehicles:

- Communication problems – difficulty initiating charging due to communication problems between vehicle and charging station
- Connector misalignment – physical connection problems due to misalignment of the charging connector
- Authentication failures – EV users are unable to verify their identity or payment information
- Power delivery issues – Slow charging or incomplete charging sessions due to the charging station have problems delivering the expected power

These are just a few of the challenges the electric vehicle industry is facing. Addressing these issues is critical to ensure a smooth and reliable charging experience for EV users, which in turn will help drive acceptance and adoption of electric vehicles in the future. The goal for public charging should be to match and exceed the convenience and reliability of today's gas pumps.



Challenges:

Interoperability challenges are intensifying as the e-mobility market accelerates its growth. This rapid expansion brings with it a diverse set of stakeholders, including manufacturers, utilities, and regulators, each with their own unique requirements and priorities. The electric vehicle (EV) industry is evolving rapidly, with a constant influx of new technologies, features, and products, while the demand for faster, smarter, and safer charging solutions continues to grow.

Several key factors contribute to the complexity of interoperability in this dynamic landscape:

- **Evolution of charging standards** – Charging standards are constantly evolving to keep pace with technological advances. While this progress is critical, it can also create compatibility gaps between older and newer implementations, posing a challenge to seamless interoperability.
- **Complexity of standards** – The intricate nature of these standards can make accurate and consistent implementation a daunting task for stakeholders. Even when standards are well defined, complexity can lead to differences in interpretation and application.
- **Differing technical understanding** – Despite clear standards, differences in technical understanding, priorities, or design philosophies among vendors can lead to variations in the implementation of complex protocol stacks. This divergence can hinder widespread adoption and, consequently, interoperability.
- **The growing role of software** – A significant portion of the value added in today's products comes from software. The pressure to bring products to market quickly often affects the quality of this software. Interoperability relies heavily on software and firmware implementations, and differences in how these components are developed, tested, and updated can lead to variations that affect how different systems communicate and interact.

Overcoming these challenges it is critical to ensure that the e-mobility industry can meet the evolving needs of its stakeholders and deliver the seamless charging experiences that consumers increasingly demand. Efforts to bridge these interoperability gaps will be critical to the continued growth and success of the electric vehicle market.

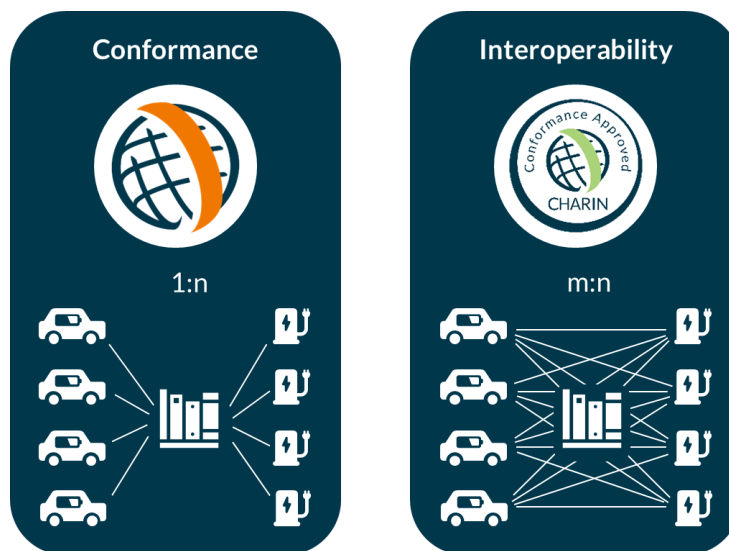
Conformance Certification and Interoperability Testing:

Addressing these challenges will require a concerted effort from all stakeholders, including standards organizations, manufacturers, regulators, and technology developers.

This is where CharIN comes in. CharIN is a global industry association with more than 300 members from all parts of the EV charging ecosystem. As the EV charging industry continues to mature, CharIN is helping

to mitigate interoperability issues by collaboratively aligning interpretations, improving test procedures, and promoting standardized implementations.

The foundation for interoperability is open standards, and CharIN is a proponent of these standards. Open standards provide a common ground for disparate systems to communicate and collaborate. By promoting transparency, consistency, and vendor neutrality, they foster an environment in which interoperability becomes possible.



Conformance and interoperability testing can help verify and ensure interoperability.

Conformance testing ensures that an EV or EVSE conforms to specific standards, such as ISO 15118. It verifies that an implementation accurately follows the prescribed rules and protocols defined in the standards and provides a baseline for the expected behavior of a system.

Interoperability testing ensures that different products from different vendors and OEMs will work together seamlessly without unexpected problems. It addresses the "real-world" scenarios where different implementations of EVs and EVSEs must communicate, exchange data, and successfully perform charging. Interoperability testing uncovers integration challenges, communication errors and incompatibilities that can occur when EVs and EVSEs interact. It ensures that an EV not only conforms to a standard, but also works well with EVSEs and vice versa.

Interoperability testing and conformance testing serve different but complementary purposes in ensuring the functionality, compatibility, and quality of systems and products such as an EV and an EVSE. As both types of testing are essential to identify and resolve issues prior to deployment, CharIN offers both.



Conformance testing is addressed through the CharIN Conformance Certification Program whereas interoperability testing is addressed through the CharIN Festivals.

Evolution of CharIN Festivals

Compared to conformance testing, interoperability testing is very difficult to scale. For a single company, especially small and medium sized companies, testing the interoperability of their products with products from other companies is hardly affordable (in terms of cost and time) or even possible.

This is where the CharIN Festival comes in. CharIN Festivals provide a platform for interoperability testing. Instead of talking about interoperability, this is a hands-on event. Companies from all over the world come together to test the compatibility of their EVs and EVSEs.

History:

This unique type of event has already a long history. The original idea for the event came up as part of the German research project called “eNterop”. eNterop was a cooperation project conducted in the timeframe from mid-2012 until the end of 2014. This project had the goal to develop an ISO 15118 reference implementation and to define a common and systematic approach for automated test procedures of ISO 15118 including the formal description and specification of test cases.

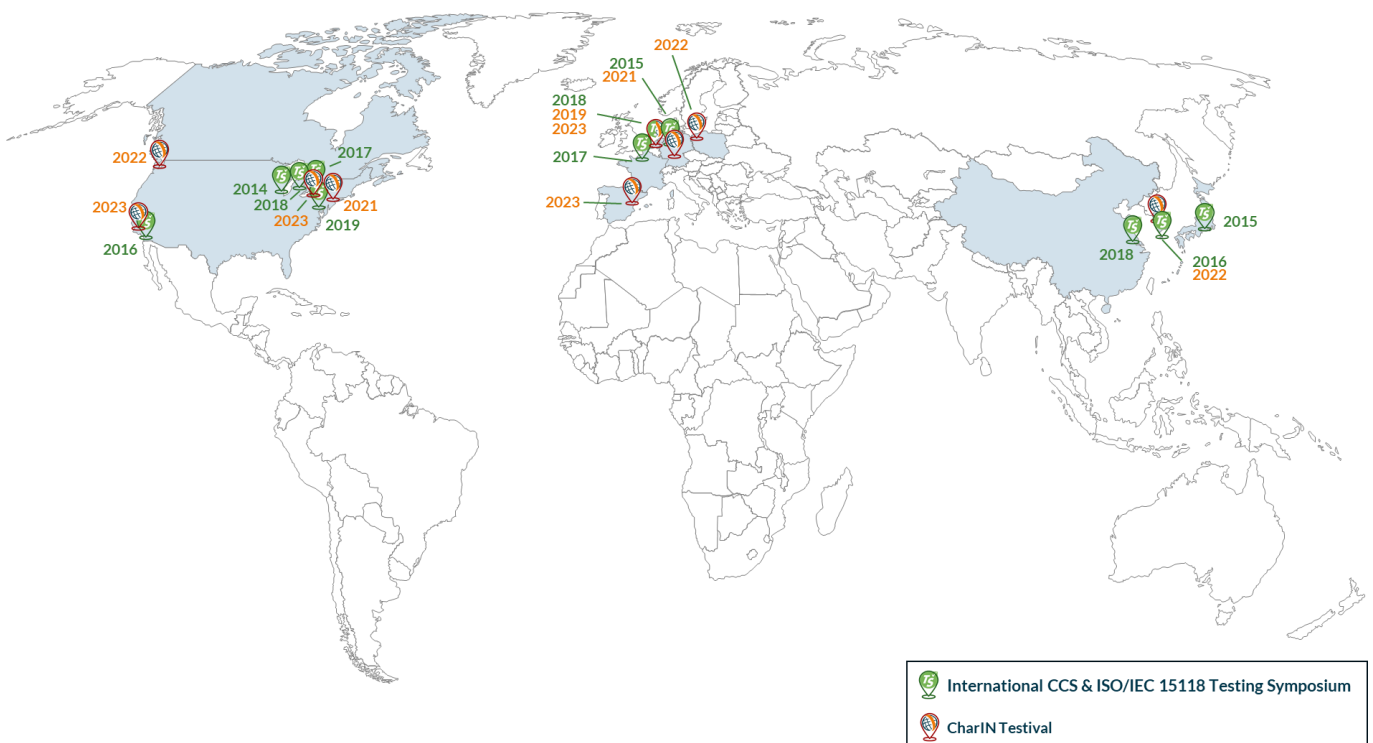
To validate the specification work on conformance testing as well as its implementation, the eNterop consortium organized a testing event at the TU Dortmund and invited potential vendors of ISO 15118 implementations to test against the eNterop conformance test system. The feedback of all participants of this initial test event was very good. Hence, the consortium decided to propose the organization of international test events alongside regular ISO/IEC 15118 joint working group meetings. The community that was working on ISO 15118 and other standards granted the proposal. That was the birth of the “International CCS & ISO/IEC 15118 Testing Symposium”.

The first International CCS & ISO/IEC 15118 Testing Symposium marked the beginning of a highly successful series of testing events. Twelve Testing Symposia have been held around the world between late 2014 and early 2019. In 2016, one year after its inception, CharIN officially began supporting the International CCS & ISO/IEC 15118 Testing Symposium. This significant collaboration greatly enhanced the visibility of the Symposium within the wider CCS & EV charging community. In addition, this very good cooperation has manifested itself in the form of an official liaison with the ISO / TC 22 / SC 31 / JWG1.

Year by year, the event grew larger and broader. At the beginning, the scope was limited to EV or EVSE ECU-testing only. Later, more and more prototype vehicles and charging stations were participating. To be able to handle the growing demand for interoperability testing, CharIN introduced in 2019 its CharIN

Testival. With the introduction of the CharIN Testival, the International CCS & ISO/IEC 15118 Testing Symposium will only cover communication controller / control unit testing. The event focuses on further development and advanced features of ISO 15118 standards. Whereas the focus of the CharIN Testival is on system and product level testing as well as testing of near-serial production features. The CharIN Testivals include real EV and EVSE interoperability tests, as well as communication controller / control unit tests and tests with CCS Test Systems for EV/EVCC/EVSE/SECC. Co-located with the CharIN Testivals, there are several side events like conferences, panels, demos and workshops providing a unique networking platform.

The first CharIN Testival was held at the end of 2019 in Arnhem, the Netherlands. Since this successful event, the demand for more Testivals is growing steadily.



Added values of CharIN Testivals:

Participating in hands-on testing of real-world scenarios provides a unique opportunity in the EV charging industry. It condenses testing opportunities into a short timeframe, allowing for efficient validation of implementations and rapid identification of problems. This process also creates direct feedback loops that facilitate rapid iterations and improvements.



In addition, these testing events serve as hubs for knowledge and data sharing, bringing together experts, peers, potential partners, and customers to share insights and experiences. It's a chance to network with those at the forefront of the field, fostering valuable connections that can lead to future collaborations.

Festivals provide educational opportunities in addition to hands-on testing. Attendees can gain insights into the latest technologies, standards, and best practices for EV charging. This educational aspect is critical in an ever-evolving landscape, ensuring that individuals and organizations stay up to date with industry advancements.

Furthermore, these events are crucial for raising awareness of interoperability challenges and potential solutions. By highlighting the issues faced in achieving seamless integration and demonstrating the progress made, these events contribute to the collective effort to improve interoperability across the EV charging industry.

In summary, hands-on testing events not only provide concentrated testing opportunities, but also serve as multi-faceted platforms for learning, networking, and advancing the understanding of interoperability in the rapidly evolving world of technology and innovation.

A CharIN Festival provides a focused and structured environment for stakeholders to address challenges, test solutions and foster collaboration. It serves as a catalyst to advance the development of interoperable systems, products and services that benefit both industry and end users.

The results of the Festivals are then shared with the CharIN community as input for white papers and implementation guides, feedback to standardization bodies, and input into the development of the CharIN Conformance Test Program.

CharIN Festival Structure and Procedures

A typical Festival is a collaborative effort bringing together a wide range of stakeholders to advance EV charging technologies. What sets these events apart is their inclusive nature, designed to foster collaboration and innovation. Here are the key aspects that define a typical Festival:

- **Organized by CharIN:** CharIN, a global association dedicated to promoting EV charging standards, takes the lead in organizing Festivals. This neutral organization ensures that these events adhere to industry best practices and the latest technological advancements.
- **Hosted by different entities:** Festivals are not tied to a single host or location. They can be hosted by a variety of companies or institutions, and membership in CharIN is not a prerequisite for hosting. This open approach encourages a wide range of organizations to participate, enriching the diversity of perspectives and expertise.
- **Inclusive participation:** One of the most remarkable aspects of the Festivals is their inclusivity. These events are open to everyone, including CharIN members and non-members. This approach



encourages collaboration and knowledge sharing and transfer among industry players, fostering a sense of community and shared purpose.

- **Multiple test spots:** To facilitate extensive testing activities, Festivals typically offer around 20 test spots. This infrastructure allows for thorough testing and validation of EV charging technologies, ensuring that they meet rigorous standards and compatibility requirements.
- **Structured test days:** Festivals last approximately three days, during which participants can engage in approximately 10 90-minute test slots. These slots are organized into approximately seven pre-planned pairing sessions and three on-site dynamic pairing sessions. This structure allows attendees to efficiently allocate their testing resources and explore a wide range of scenarios.
- **Diverse range of EVs:** Festivals are designed to accommodate a wide range of electric vehicles. These include passenger cars and larger commercial vehicles such as buses and trucks. This diversity ensures that the test environment reflects real-world conditions and challenges, allowing for comprehensive testing across the EV spectrum.

In summary, Festivals are more than just testing events; they are dynamic platforms for collaboration, innovation and the advancement of EV charging standards. With CharIN at the helm, these events bring together a wide range of participants, foster inclusivity, and provide structured testing opportunities for a variety of EV charging technologies. As the EV industry continues to evolve, Festivals are playing an increasingly important role in shaping the future of sustainable transportation.

Organization before, during and after the event:

Preparation:

- **Technical support and briefings with the host:** Collaborative discussions with the host are essential for understanding the technical infrastructure. This includes details such as electrical connections, available power (voltage, phases, frequency), equipment for each test slot (outlet types, outlets, distribution), and the layout of test slots (desk space, rotation considerations).
- **Technical registration assistance:** Assisting participants in completing the technical registration form, ensuring that essential information about the test subjects is provided. This information includes implemented protocols, features, and electrical characteristics critical to technical pairing.
- **Technical scheduling and pairing:** Careful pairing of test partners for each round of testing requires consideration of several factors. These include technical equipment details (protocols, features, AC/DC), avoiding duplicates, considering local conditions at the host site (power supply, outlet types, test slot size), and planning for smooth rotations between rounds. Ideally, minimal movement of EVs and test systems should be required, and test slots should not be blocked.
- **Provision of plans:** Providing comprehensive plans, including a detailed overview of test matches with protocol and feature details, simplified test plans for each day (without technical specifics), and rotation plans for each test round.



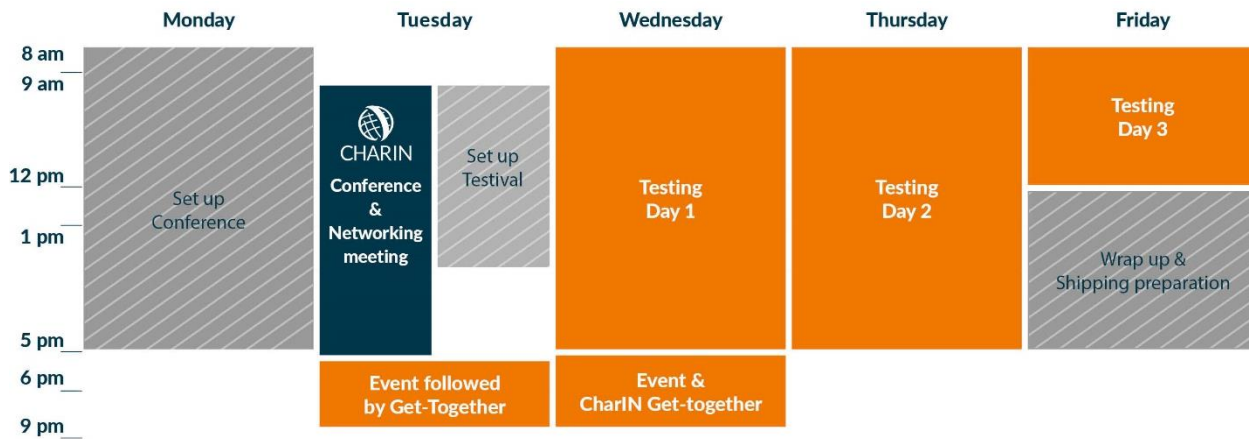
- **Technical briefings:** Conducting virtual meetings with Festival participants prior to the event. These briefings cover the event agenda, test procedures, and rotation logistics. It also summarizes technical requirements, site conditions, and general information in collaboration with the host. A technical Q&A session ensures that participants are well prepared.

Implementation:

- **On-site support:** During the Festival, on-site support plays an important role. This includes checking technical and logistical conditions during the setup day, serving as a point of contact for test procedures and scheduling, coordinating rotations between test rounds, making ad hoc changes to pairings (updating plans and schedules), moderating test plans, and ensuring the smooth setup and execution of dynamic pairings.
- **Data collection:** Collect, aggregate, and anonymize generalized test results and include them in an event results report. Test results will be aggregated so that individual companies or devices cannot be identified. The goal of the report is to help the industry identify common compliance gaps and develop a set of best practices and recommendations for future industry improvements.

Follow-up phase:

- **Feedback evaluation:** Assisting in the evaluation and analysis of attendee feedback to support the further development of the Festival and the technical registration process, with a focus on the evolving EV charging market.
- **General support:** Providing ongoing support to attendees with any questions or concerns they may have.
- **Technical insights:** Providing a platform for the reflection of technical and content-related insights from the symposia within the CharIN Focus Groups. This feedback loop ensures that valuable insights from the Festivals contribute to broader industry discussions and advancements.



Test procedure:

At the heart of every Testival is a carefully planned round-robin rotation scheme that creates a dynamic and structured environment for testing electric vehicle supply equipment (EVSE) and electric vehicles (EVs).

EVSEs are installed at designated test spots and carefully connected to the local power grid to ensure reliable operation. After each test slot, time is given to move the EVs to the next test spot according to a pre-planned pairing schedule.

Test participants enjoy a degree of autonomy in choosing which aspects of EV charging technology they wish to test. In addition, CharIN provides test plans that provide structured guidance for test scenarios. Some examples of what is typically tested during a Testival include:

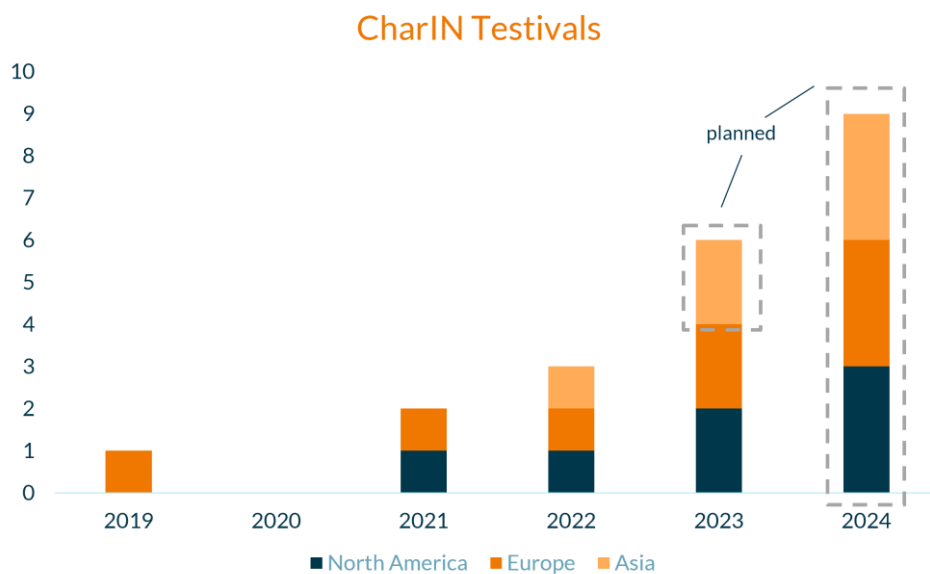
- Communication protocols: Evaluating the implementation of communication protocols, such as ISO 15118, that are critical to a seamless EV charging experience.
- End-to-end Plug & Charge testing: Evaluating the functionality of Plug & Charge, including the necessary backend systems, using both valid and expired certificates to assess security and interoperability.
- Smart charging: Exploring the capabilities of smart charging features such as charging schedules that optimize EV charging based on various factors.
- Bi-directional power transfer: Evaluating the ability of bi-directional power transfer to allow EVs to not only draw power from the grid, but also return power to the grid when needed.
- Security testing: Assessing the security measures in place, including encryption and authentication, to protect EV charging transactions.
- Safety testing: Evaluating safety features, such as plug locking mechanisms, in various scenarios to ensure a safe and reliable charging experience for users.



In essence, the Testival's test procedure is a well-orchestrated dance of interoperability testing, collaboration, and innovation.

Outlook

As the electric vehicle market continues to expand, interoperability and conformance testing will become increasingly important, serving as the cornerstone for sustaining the industry's growth by facilitating a cohesive charging infrastructure, ensuring vehicle and charging infrastructure compatibility, and building consumer confidence, ultimately solidifying the foundation for widespread adoption of electric mobility and the transition to a more sustainable transportation ecosystem.



CharIN's strategic decision to expand the Testivals globally is in direct response to the growing demand for interoperability testing within the electric vehicle industry, addressing the critical need for standardized charging solutions while fostering collaboration among stakeholders worldwide. This expansion aligns seamlessly with the growth of the CharIN Conformance Certification Program, creating a synergistic approach to meeting the evolving needs of the industry. The insights gained from these testing events play a critical role in refining and expanding the conformance test case packages, ensuring the continued relevance and effectiveness of the certification standards in the ever-changing landscape of electric vehicle technology and infrastructure.