ACM-ChargeX Prescribed Testing Program at CharIN May 2025 Testival:

Outcomes and Future Recommendations

By The American Center for Mobility
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Authors

Ashwin Kumar [1]
Sindhura Repaka [1]
Shreeprasad Jadhav [1]
Monish Balachander [1]
Sushanta Das [1]
Erika Meyers [2]
Sam Thurston [3]
Sally Glass [3]
Affiliation: [1] American Center for Mobility; [2] CharIN; [3] ChargeX Consortium

Any questions involving the Prescribed Testing Program report can be shared with Ashwin.Kumar@acmwillowrun.org or Sushanta.Das@acmwillowrun.org.

Contributors

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Disclaimer

Revision Log

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Executive Summary

Electric vehicle (EV) charging continues to present a complex set of challenges, particularly around interoperability between different OEMs, component suppliers, and charging technologies. Differences in hardware, firmware, and protocol interpretation often lead to inconsistent user experiences, making it critical to identify and resolve issues early in development cycles. Real-world testing environments, such as those offered at CharIN Testivals and the American Center for Mobility EV Charging Testbed, are essential for surfacing and addressing these interoperability gaps in a collaborative, cross-industry setting.

Building on the success of prior Testivals, the ChargeX Consortium's Testing Task Force executed its third Prescribed Testing Plan (PTP) during the 2025 CharIN North America Spring Testival at the American Center for Mobility (ACM) in Ypsilanti, Michigan from May 13-14, 2025. The Testival utilized the ACM EV Charging Basecamp facilities as the testing site and conference center.

The 2025 Testival showcased significant progress in interoperability, particularly with the North American Charging Standard (NACS), also known as SAE J3400. The event featured:

- 7 passenger cars, 6 heavy-duty vehicles – the largest concentration of heavy-duty vehicles at a North American event to date. Of this number, 6 of the EVs featured a native NACS inlet.
- 9 test systems – the largest concentration at a single event to date in North America13 EVSEs, of which 12 included a NACS connector.
- 300 attendees over the course of three days, including 100 at the Public Day event.
- 11 CCS to NACS adapters- for the first time, all adapters used during the event were evaluated for electrical safety by UL Solutions.

Two-thirds of the test equipment at the Testival, including EVs, EVSE, and test systems — totaling 23 pieces of equipment — voluntarily took part in the ChargeX Challenge, which represented the largest population of participants over the past three events. The May Testival also introduced the most comprehensive version of the PTP to date, spanning two full days of testing with a fully gamified format, expanded scoring logic, and structured moderator oversight.

EV and EVSE pairings participated in a series of predefined test scenarios, earning points based on criteria met, with additional emphasis on stretch goals and advanced behaviors. These efforts are aimed not only at measuring baseline interoperability but also to incentivize deeper engagement and showcase implementation maturity.

Major milestones at this event beyond record levels of participation, included stronger levels of interest in participating in future PTPs, higher levels of satisfaction, stronger support for the gamification aspect of the event, and stronger motivations to support data collection activities that benefit the industry.

The PTP plan covered key test cases, such as Start and Stop methods, HLC protocol selection, fault injection error reporting, Pause & Resume, Plug & Charge, adapter integration, and Vehicle-to-Grid functionalities.

- Other major milestones also include the improvements in overall success for prescribed test outcomes and pass criteria achieved for the following advanced charge tests:
- Two test pairings for TS10: Activating Pause & Resume using charge scheduling, an advanced charging feature that requires negotiation between both EV and EVSE to develop a charge schedule.
- Two test pairings for TS12: Plug & Charge using expired EV certificates, falling back to EIM (an example of seamless retry), some of which utilized external PKI providers to accomplish this.
- Three test pairings for TS3: ISO 15118-20 basic charge start, some with TLS and some without.
- One test pairing for the most advanced test TS16: V2G Dynamic Bidirectional Power Transfer using ISO 15118-20 and TLS.

This report documents the structure, execution, outcomes, and lessons learned from the event, providing insight into the evolving state of EV-EVSE interoperability and the continued refinement of prescribed testing frameworks.

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1. Introduction

Electric vehicle (EV) charging continues to present a complex set of challenges, particularly around interoperability between different OEMs, component suppliers, and charging technologies. Differences in hardware, firmware, and protocol interpretation often lead to inconsistent user experiences, making it critical to identify and resolve issues early in development cycles. Real-world testing environments, such as those offered at CharIN Testivals and the ACM EV Charging Testbed, are essential for surfacing and addressing these interoperability gaps in a collaborative, cross-industry setting.

In the US, approximately 10-20% of charging stations are out of order according to a 2023 study by J.D. Power. These malfunctioning charging stations have far-reaching consequences for the widespread adoption and acceptance of e-mobility. Here are a few of the challenges EV drivers face when trying to charge their vehicles:

- Communication problems – difficulty initiating charging due to communication problems between the vehicle and the charging station
- Connector misalignment – physical connection problems due to the misalignment of the charging connector and the vehicle inlet
- 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 delivering the expected power

Interoperability challenges are getting more difficult as more products are being deployed in the field with new technologies and features. Several key factors contribute to the complexity of interoperability, including:

1) Evolution of charging standards – standards are constantly changing to keep pace with technological advances. While this progress is critical, it can also create compatibility gaps between older and new implementations, posing a challenge to seamless interoperability
2) Complexity of standards – the intricate nature of standards can make accurate and consistent implementation difficult. Even when standards are well defined, complexity can lead to differences in interpretation and application.
3) 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.
4) The growing role of software – the pressure to bring products to market quickly often affects the quality of value-added software. Interoperability relies on both software and firmware implementations, and differences in how these components are developed, tested, and updated can lead to variations in how different systems communicate and interact.

The Charging Interface Initiative (CharIN) was established specifically to mitigate interoperability issues by collaboratively aligning interpretations, improving test procedures, and promoting standardized implementations. The foundation for interoperability is open standards, and CharIN has led the way to promote transparency, consistency, and vendor neutrality that has resulted in global improvements to EV charging interoperability through technical working groups, standards development, and hands-on testing events. Since 2015, CharIN has hosted Testivals across the globe, typically 7 to 9 annually, including two in North America each year. These events bring together vehicle manufacturers, EVSE providers, and test equipment vendors to conduct structured testing with pre-production or in-field hardware and software. Testivals are hosted by CharIN member organizations, supported logistically by CharIN Academy GmbH, and technically by Keysight Technologies for matchmaking and event coordination.

A typical testival includes the following key aspects:

- Inclusive participation: These events are open to everyone, including CharIN members and non-members. This approach encourages collaboration and knowledge sharing and transfer among industry players.
- Multiple test spots: To facilitate extensive testing activities, Testivals typically offer around 20 test spots.
- Structured test days: Testivals occur over three days, during which participants can test for about ten 90-minute test slots. These are organized into approximately seven pre-planned pairing sessions and three dynamic (unscheduled) pairing sessions. This structure allows attendees to efficiently allocate their testing resources and explore a wide range of scenarios.
- Diverse range of EVs: Testivals are designed to accommodate everything from passenger cars to large commercial vehicles such as buses and trucks. This provides a test environment that reflects real-world conditions and challenges, allowing for comprehensive testing across the EV spectrum.

Building on the success of prior Testivals, the ChargeX Consortium's Testing Task Force executed its third PTP during the CharIN May 2025 Testival at the ACM in Ypsilanti, Michigan. This event introduced the most comprehensive version of the PTP to date, spanning two full days of testing with a fully gamified format, expanded scoring logic, and structured moderator oversight. EV and EVSE pairings participated in a series of predefined test scenarios, earning points based on criteria met, with additional emphasis on stretch goals and advanced behaviors. These efforts are aimed not only at measuring baseline interoperability but also at incentivizing deeper engagement and showcasing implementation maturity.

The 2025 Testival displayed considerable progress in interoperability, particularly with the North American Charging Standard (NACS), also known as SAE J3400. The event featured:

- 7 passenger cars, 6 heavy-duty vehicles – the largest concentration of heavy-duty vehicles at a North American event to date. Of this number, 6 of the EVs featured a NACS inlet.
- 9 test systems – the largest concentration at a single event to date in North America 13 EVSEs, of which 12 included a NACS connector.
- 300 attendees over the course of three days
- 11 CCS to NACS adapters- for the first time, all adapters used during the event were evaluated for electrical safety by UL Solutions

Two-thirds of the test equipment at the Testival, including EVs, EVSE, and test systems — totaling 23 pieces of equipment — voluntarily took part in the ChargeX Challenge, which represented the largest population of participants to date. This event introduced the most comprehensive version of the PTP to date, spanning two full days of testing with a fully gamified format, expanded scoring logic, and structured moderator oversight.

2. Event Details and Program Structure

This section provides a comprehensive overview of the event planning, program architecture, and execution strategy of the interoperability testing program PTP led by the ChargeX Consortium that took place at CharIN May 2025 Testival with respect to the core goals of the Testing Task Force.

2.1 CharIN May 2025 Testival

The ChargeX PTP was developed to serve as a foundational mechanism for structured EV-EVSE interoperability testing across multiple vendors and implementations. The event planning process included Participant Coordination, Test Case Design and Validation, Scheduling and Resource Allocation, On-Site Logistics and Data Collection and Feedback Mechanisms.

CharIN May 2025 Testival took place during May 13-14, 2025, and was hosted by ACM in Ypsilanti, MI utilizing their facilities as testing grounds and conference center. Figure 1 shows the layout and electrical connections present at ACM and Table 1 contains a list of all the participants of the PTP including EVs, EVSEs and Test Systems.

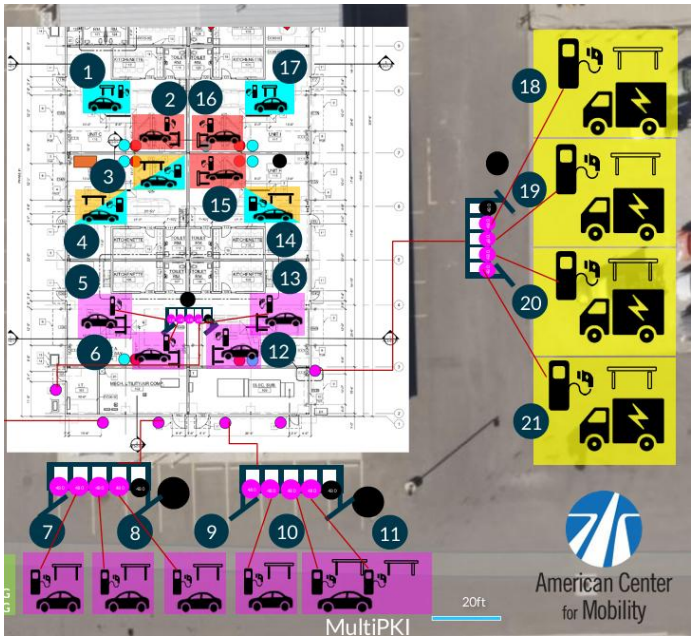


Figure 1: ACM in Ypsilanti, MI testing grounds map

EV	EVSE	Test Systems
BMW of North America	Lincoln Electric	dSPACE
BMW of North America	Autel	Dover Fueling
KPIT Technologies Inc	EVgo	Dekra
Chroma ate	Chargepoint	
Nissan North America	ABB E-Mobility	
Chargebyte Inc.	Power Electronics	
Keysight Technologies	GENIS KOREA	
Rivian	Shenzhen sinexcel	
Lucid Motors	Rivian Automotive	
Robert Bosch LLC	Chargepoint	
Ford Motor Company		

Table 1: List of all CharIN June 2025 Testival Participants

For event scheduling, Monday was a dedicated equipment setup day for EVs and EVSEs. Scheduled testing was performed on days 1 and 2 (Tuesday and Wednesday; test slots 1-7), and day 3 (Thursday). Testing slots were dedicated for dynamic testing (test slots 8-10). In addition to testing on day 2, CharIN hosted a "public day" for non-testers to attend presentations, demonstrations, and observe testing activities. The ChargeX team executed PTP entirely on days 1 and 2, a schedule for which can be seen below in Figure 2 along with day 2 demonstrations and presentations.

	= PTP	DAY 1 Tuesday, May 13, 2025								
= No Test	= Not PTP	Test Slot #1 - 9:45am - 11:30am Group A: 10:00 - 10:40am Group B: 10:50 - 11:30am			Test Slot #2 - 1:30 - 3:00pm Group A: 1:30 - 2:10pm Group B: 2:20 - 3:00pm			Test Slot #3 - 3:30 - 5:00pm Group A: 3:30 - 4:10pm Group B: 4:20 - 5:00pm		
Group A	Moderators	EVSE	EV	Location#	EVSE	EV	Location#	EVSE	EV	Location#
A	Mod 3	EVSE11	EV12	7	EVSE11	EV3	7	EVSE2	EV11	18
A	Mod 4	EVgo	TE3	19	EVSE3	EV2	11	EVSE9	EV6	20
A	Mod 5							TE3	EV2	15
A	Mod 6				EVSE10	EV8	3	EVSE13	EV7	6
A	Mod 7				Evgo	TE2/TE4	19	EVSE4	EV8	10
Group B										
B	Mod 1	EVSE8	EV6 - Gravity GT	2	EVSE8	EV5	2			
B	Mod 2	EVSE5	EV13	13	EVSE5	TE4	13			
B	Mod 3	EVSE4	BMW - NACS	10	EVSE4	Ford	10			
B	Mod 4	EVSE9	TE2	20	EVSE9	Chroma ate	20	EVSE8	TE2	2
B	Mod 5	TE1	EV7	16				TE1	EV3	16
B	Mod 6	EVSE16	KPIT / Honda	4				EVSE5	EV4	13
B	Mod 7	TE2/TE4	EV5	12						

Figure 2: Day 1 ChargeX PTP Schedule

	= PTP	DAY 2 Wednesday, May 14, 2025											
= No Test	= Not PTP	Test Slot #4 - 9:00 - 10:30am			Test Slot #5 - 11:00am - 12:30pm			Test Slot #6 - 2:30 - 4:00pm			Test Slot #7 - 4:30 - 6:00pm		
Group A	Moderators	EVSE	EV	Location#	EVSE	EV	Location#	EVSE	EV	Location#	EVSE	EV	Location#
A	Mod 1	EVSE2	EV10	11	EVSE6	EV8	1	EVSE8	EV4	2	EVSE2	EV5	11
A	Mod 2	EVSE7	EV11	14	EVSE5	EV3	13	EVSE7	EV7	14	EVSE13	TE2	10
A	Mod 3	EVSE11	EV2	7	EVSE12	EV4	17	EVSE11.	TE2	7	EVSE11.	EV8	7
A	Mod 4	EVSE1	EVSE15	19	EVSE1	EV11	19	EVSE1	EV10	19	EVSE8	EV11	2
A	Mod 5	TE1	EV6	15	EVSE15	EV2	15	TE1	EV2	15	TE4	EV6	12
A	Mod 6	EVSE10	EV11	3	EVSE2	TE4	11	EVSE10	EVSE15	3	EVSE1	EV2	19
A	Mod 7	EVSE12	EV5	17	EVSE3	EV7	18	EVSE12	Chroma ate	17	EVSE3	EV3	18
Group B													
B	Mod 1				TE2	EV11	16						
B	Mod 2	EVSE5	EV7	13									
B	Mod 3	EVSE13	EV8	10	EVSE13	EV6	10	EVSE13	EV5	10	EVSE4	EV11	6
B	Mod 4	EVSE9	EV4	20				EVSE9	EV11	20	EVSE9	EV10	20
B	Mod 5				TE1	EV10	12						
B	Mod 6							EVSE2	EV6	11	TE1	EV9	15
B	Mod 7	EVSE8	TE3	2	EVSE8	EV9	2	TE4	EV3	16			

Figure 3: Day 2 ChargeX PTP Schedule

At the heart of every Testival is a carefully planned round-robin rotation scheme that creates a dynamic and structured environment for testing EVSE and EVs. EVSEs are installed at designated test spots and carefully connected to the host's electrical system to ensure reliable operation. After each test slot, time is given to move the EVs to the next test spot according to the pairing schedule. Test participants have autonomy in choosing which aspects of the EV charging technology they wish to test. Some examples of what is typically testing during a Testival include:

- Communication protocols: Evaluating the implementation of communication protocols, such as ISO 15118
- 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. At this event, Hubject was the Plug & Charge Testing Partner. Further, multiple-root certificates were provided from other vendors to allow for multi-PKI testing.[1]

- 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 against 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.

2.2 ChargeX PTP Structure

In 2024, CharIN teamed up with ChargeX to offer prescribed testing at the Spring Testival in Cleveland, Ohio and the Fall Testival in San Bernardino, CA. The results of these events may be found on the ChargeX website.[2]

Different prescribed tests were offered at each Testival based on input provided by industry members. The tests were administered by ChargeX Consortium/ national laboratory staff. ChargeX helped to support the development of the prescribed tests for this event in conjunction with the ACM.

Comparisons between the events are included in Table 2. The biggest difference was the number of test scenarios included in the PTP, which doubled between June 2024 and May 2025. The full list of test scenarios for May 2025 is shown in Figure 4. Further, $2,000 rebates were offered per piece of equipment to incentivize participation, but a rebate was not offered for May 2025 due to lack of available funds. One other difference was the length of the prescribed test duration, which increased in November 2024 to 40 minutes to account for additional test scenarios. The May 2025 prescribed test was also assigned 40 minutes, but based on feedback from participants, this was not sufficient time in some cases. Figure 3 outlines the test slot times and timing between groups 1 and 2, which were necessary for the support team given the large number of participants.

[1] More details about the Plug & Charge testing can be found on the event website at https://www.charin.global/events/charin-testival-north-america-2025-detroit/#accordion-c4d62637-daa3-48af-8e6c-8b9a64560b80-1

[2] Idaho National Lab/ ChargeX Consortium, June Testival report (https://inl.gov/content/uploads/2023/07/ChargeX-Prescribed-Testing-Program-at-CharIN-June-2024-Testival-Outcomes-Future-Recommendations.pdf), November Testival report (https://inl.gov/content/uploads/2024/01/ChargeX_Prescribed-Testing-Program-at-CharIN-Nov2024-Testival.pdf)

PTP Event Details	ChargeX June 2024 PTP	ChargeX November 2024 PTP	ChargeX May 2025 PTP
Total test slot duration	90-minutes	90-minutes	90-minutes
Ad-hoc testing duration	60-minutes	60-minutes	60-minutes
Prescribed testing duration	30-minutes	40-minutes	40-minutes
Sequential or Gamified testing	Sequential	Gamified	Gamified
Moderators	1 moderator per pairing	1 moderator per pairing	1 moderator per pairing
PKI Providers available	Hubject certificate pool	Hubject certificate pool	Hubject certificate pool
# of Test Scenarios	8	13	16
Test Categories	HLC protocol selection, Authentication types/methods, Timeouts, Fault injections/MRECs, Plug&Charge/Certificates	HLC protocol selection, Authentication types/methods, Timeouts, Stop methods, Fault injections/MRECs, Plug&Charge/Certificates	HLC protocol selection, Authentication types/methods, Timeouts, Stop methods, Fault injections/MRECs, Plug&Charge/Certificates
Participation rebate	$2000 per asset	$2000 per asset	no rebate

Table 2: PTP Event Details June vs November

Tuesday Day 1 (May 13th)					
Registration Opens	Welcome & Intro	Test Slot #1	Lunch	Test Slot #2	Test Slot #3
8:00am	9:00am	9:45am	11:30am	1:30pm	3:30pm
Wednesday Day 2 (May 14th)					
Registration Opens	Test Slot #4	Test Slot #5	Lunch	Test Slot #6	Test Slot #7
8:00am	9:00am	11:00am	12:30pm	2:30pm	4:30pm
Test Slot Timing					
Group #1			**Group #2**		
1. **Prescribed** Testing: 40 min			1. **Adhoc** Testing: 50 min		
2. **Adhoc** Testing 50 min			2. **Prescribed** Testing: 40 min		
3. Move to Next Slot: 30 min			3. Move to Next Slot: 30 min		

Figure 4: ChargeX PTP Test Scenarios

Test Name	Min	Max	Max+SG
TS1: Auth. Types: Authenticate-first using DIN 70121 or J1772	2	6	--
TS2: Auth. Types: Authenticate-first using ISO 15118-2	2	8	--
TS3: Auth. Types: Authenticate-first using ISO 15118-20	2	14	--
TS4: Fault Stops: Disconnect Pilot @EVSE or @EV during PT	3	9	14
TS5: Fault Stops: Press Latch during Session Initialization (SI)	3	9	--
TS6: Fault Stops: Press EVSE emergency stop during PT, attempt to unplug cable from EV	3	11	16
TS7: Fault Stops: Disconnect network connection, then attempt Authentication	3	9	14
TS8: Fault Stops: Disconnect all network connections during PT	3	9	14
TS9: Pause & Resume: Manually Curtail EVSE to Zero Current during PT	4	14	--
TS10: Pause & Resume: Activating a "Pause" during PT using Charge Scheduling	7	21	--
TS11: PnC: Valid EV & EVSE Certificates	5	13	17
TS12: PnC: Expired EV Contract Certificate – session terminates and/or fallback to EIM	5	15	19
TS13: Adapters: Plug-In to Connector First	3	11	15
TS14: Adapters: Plug-In to Vehicle First	3	11	15
TS15: V2G: EVSE Spoof-matches EV Current Request over HLC, but commands -5Amps	6	16	--
TS16: V2G: Dynamic Bi-directional Power Transfer using ISO15118-20, command -5Amps	8	24	--

Figure 5: ChargeX PTP Test Scenarios and Points

Gamification & Scoring

This event contained a gamification approach to test scenario completion, meaning that points were designated for attempting and meeting specifically defined pass criteria for each test scenario. Further details can be found below on this gamification approach to prescribed testing:

- Testers received points as a pairing, not as individual testers. EV and EVSE pairings worked together to meet test pass criteria successfully, with a moderator present to track results.
- Points were separated into the following 4 categories:
    - Attempt points: Points awarded for attempting a test scenario.
    - EVSE pass criteria points: Points awarded for EVSE meeting pass criteria; multiple pass criteria are listed increasing in points with increased complexity.
    - EV pass criteria points: Points awarded for EV meeting pass criteria; multiple pass criteria are listed increasing in points with increased complexity.
    - Stretch goal pass criteria points: Points awarded for additional "stretch-goal" pass criteria, may be specific to either EV or EVSE. These pass criteria go above and beyond EV & EVSE pass criteria and are worth high points.

Multiple attempts for a single test were able to be made, however only the best performing attempt overall score (Attempt+EVSE+EV+SG) was used for that scenario.

Awards

Along with the gamified approach, awards were available for the top scorers and those who participated in the PTP event. The categories were split into EV, EVSE, and Test Equipment, with the top 3 in each category getting a trophy. All who participated in the PTP also received a certificate to showcase their efforts in testing.

LEADER BOARD			
Category	**Place**	**Company Rolling Results**	**Points**
Electric Vehicle	1st	EV1	380
	2nd	EV2	336
	3rd	EV3	287
EVSE	1st	EVSE1	420
	2nd	EVSE2	367
	3rd	EVSE3	339
Test System	1st	TE1	326
	2nd	TE2	310
	3rd	TE3	272

Table 3: ChargeX PTP Awards

Description of Meta Data

Section A: EVSE Meta Data *complete once per EVSE equipment*

QA1: Specify Equipment Type ..... (EVSE)

QA2: Select level of charging available:
- AC Charging ..... (Yes / No)
- DC Charging ..... (Yes / No)

QA3: Select charging handle types available:
- J1772 ..... (Yes / No)
- CHAdeMO ..... (Yes / No)
- CCS Type 1 ..... (Yes / No)
- CCS Type 2 ..... (Yes / No)
- NACS ..... (Yes / No)
- SAE J3400 ..... (Yes / No)

QA4: Select Product stage ..... (Prototype / Pre-Production / Series Production / Not Scheduled)

QA5: Select common implemented protocols available for testing:
- DIN SPEC 70121:2014 OR SAE J2931/4 2014-10 & SAE J2847-2 2015-04 ..... (Yes / No)
- ISO/IS 15118-2:2014 & ISO/IS 15118-3:2015 ..... (Yes / No)
- ISO/IS 15118-20:2022 & ISO/IS 15118-3:2015 ..... (Yes / No)

QA6: Select supported ISO/IEC 15118-2 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QA7: Select supported ISO/IEC 15118-20 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QA8: Select supported ISO/IEC 15118-20 transport protocols:
- TCP (for testing only) ..... (Yes / No)
- TLS 1.2 (for testing only) ..... (Yes / No)
- TLS 1.3 (standard) ..... (Yes / No)

QA9: Select EIM types available:
- Credit Card INSERT ..... (Yes / No)
- Credit Card TAP ..... (Yes / No)
- RFID ..... (Yes / No)
- App ..... (Yes / No)
- Other EIM _____

Figure 6: EVSE Meta Data

Section B: EV Meta Data *complete once per EV equipment*

QB1: Specify Equipment Type ..... (EV)

QB2: Select the level of charging available:
- AC Charging ..... (Yes / No)
- DC Charging ..... (Yes / No)

QB3: Select charging inlet types available:
- J1772 ..... (Yes / No)
- CHAdeMO ..... (Yes / No)
- CCS Type 1 ..... (Yes / No)
- CCS Type 2 ..... (Yes / No)
- NACS ..... (Yes / No)
- SAE J3400 ..... (Yes / No)

QB4: Select Product stage ..... (Prototype / Pre-Production / Series Production / Not Scheduled)

QB5: Select common implemented protocols available for testing:
- DIN SPEC 70121:2014 OR SAE J2931/4 2014-10 & SAE J2847-2 2015-04 ..... (Yes / No)
- ISO/IS 15118-2:2014 & ISO/IS 15118-3:2015 ..... (Yes / No)
- ISO/IS 15118-20:2022 & ISO/IS 15118-3:2015 ..... (Yes / No)

QB6: Select supported ISO/IEC 15118-2 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QB7: Select supported ISO/IEC 15118-20 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QB8: Select supported ISO/IEC 15118-20 transport protocols:
- TCP (for testing only) ..... (Yes / No)
- TLS 1.2 (for testing only) ..... (Yes / No)
- TLS 1.3 (standard) ..... (Yes / No)

Figure 7: EV Meta Data

Section C: Test Slot Meta Data *complete every Test Slot*

Pre-test data

QA1: Test Slot Number _____

QA2: Moderator Name _____

QA3: Prescribed Testing Start Time _____

QA4: EVSE enrolled in Prescribed Testing ..... (Yes / No)

QA5: EV enrolled in Prescribed Testing ..... (Yes / No)

QA6: The following has been reviewed with testers ..... (Yes / No)
- List of test scenarios
  - Desired or possible tests for testing pair (recommend all 8 is possible)
  - Remind how long per test that equates to (30min ÷ #tests)
- Structure of test scenarios:
  - Test purpose, preconditions, steps, pass criteria, results tracking, etc.
- EVSE Meta Data collected.
- EV Meta Data collected.
- Even if tests have already been completed in ad hoc, instruct to re-perform them now during prescribed testing (time taken to complete, are steps accurate, feedback on pass criteria, etc.).
- Any additional open questions

QA7: Which tests desired/possible ..... (TS1 / TS2 / TS3 / TS4 / TS5 / TS6 / TS7 / TS8)

- Float moderator will go around to each pairing at the start of session to record who is attempting PnC testing. He will let Hubject team know which requires expired EV certificates and will begin issuing

Post-test data

QA8: Number of tests attempted _____

QA9: Which tests attempted (circle) ..... (TS1 / TS2 / TS3 / TS4 / TS5 / TS6 / TS7 / TS8)

QA10: Any outstanding issues _____

QA11: Tester1 comments _____

_____

QA12: Tester2 comments _____

_____

QA13: Moderator comments _____

_____

_____

Figure 8: Test Slot Meta Data

Test Scenario 7: Disconnect all Network Connections then Attempt Authentication						
Test Identifier:	Test Scenario 7					
Test Name:	Disconnect all Network Connections then Attempt Authentication					
Test Type:	Intentional Faults					
Test Category:	Session Initialization (SI) Tests					
Purpose:	- To emulate a loss of network connection prior to payment - To test if EVSE will allow session to authenticate without any network connection					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response					
Intended MRECs/Errors:	"NoInternet", "AuthenticationFault"					
Possible MRECs/Errors:						
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Plug-In				
	HLC Protocol:	DIN 70121 / J1772, ISO 15118-2, or ISO 15118-20				
	Involved Systems:	EV, EVSE				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Plug-in vehicle				
	4	Disconnect all network connections from EVSE (Wi-Fi, Ethernet, and LTE)				
	5	If fault occurs, end test				
	6	If no immediate fault, Provide **'Authentication Type'**				
	7	If no further fault, terminate session 30-60 seconds into power transfer				
	8	Unplug EV				
Pass Criteria: **(Check box if met)**			**A1**	**A2**	**A3**	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	3pt
	#4 EVSE: EVSE does not fault, session begins		☐	☐	☐	3pt
	#3 EVSE: EVSE visual "AuthenticationFault" or similar error, session ends		☐	☐	☐	3pt
	#2 EVSE: EVSE visual generic error, session ends		☐	☐	☐	2pt
	#1 EVSE: EVSE no visual error, session ends		☐	☐	☐	1pt
	#4 EV: EV does not fault, session begins		☐	☐	☐	3pt
	#3 EV: EV visual "AuthenticationFault" or similar error, session ends		☐	☐	☐	3pt
	#2 EV: EV visual generic error, session ends		☐	☐	☐	2pt
	#1 EV: EV no visual error, session ends		☐	☐	☐	1pt
	Stretch Goal: EVSE "NoInternet" MREC is thrown		☐	☐	☐	5pt
	Total Points					
Comments						

Figure 9: ChargeX PTP Test Scenario 7 Tabular Details

A moderator schedule was created and used to keep track of which tester pairings would be assigned to each moderator throughout the event, as well as some initial tracking of results and comments throughout to be adaptable to changes that could arise. This moderator tracking sheet can be seen in Figure 3 where moderators, EVs, EVSEs, and test device names have been kept anonymous. This schedule was compiled based on the CharIN November 2024 Testival matchmaking schedule developed by Keysight Technologies for CharIN, where indicators for those who opted in to the ChargeX PTP were present. This moderator schedule included pairings where both testers had opted-in, as well as those where only one tester had opted-in. Pairings where neither tester had opted in to the PTP, and those paired with test devices were not considered in the making of this schedule. Those highlighted green indicated opted-in, yellow indicated opted-out, and red indicated not included in prescribed testing (i.e. test devices).

3. Results and Feedback

The following sections contain the results of the competition side of PTP, results from the individual TS, the comments, feedback received, and recommendations for future implementations of PTP.

3.1 Competition Results

Throughout the ChargeX Challenge, the event moderation team maintained a real-time leaderboard to track and display cumulative scores for EV-EVSE test pairings. After each test slot, the leaderboard was updated with the latest point of tallies, reflecting the top three highest-scoring pairings and their relative positions. This feature responded to strong participant interest, as many testers actively monitored their progress to understand their standing and how many additional points were needed to reach a top three ("podium") finish.

The competition among the leading pairings remained close, with the first-place team securing an impressive 127 points. The top five final pairing scores are provided in the table below, showcasing the high level of interoperability and performance achieved during the event.

Place	Points
1st Place	127
2nd Place	116
3rd Place	91
4th Place	90
5th Place	90

Figure 10: Top 5 Highest Pairing Points Achieved:

To ensure fairness in determining individual EV and EVSE awards, especially in cases where prescribed testing was not possible due to scheduling constraints (e.g., pairings with opted-out testers or test systems), a score normalization strategy was implemented. For each test slot, the average points earned by other testers were assigned to opted-in participants who did not undergo prescribed testing during that period. This method ensured equitable score representation and comparability across all participants. Final individual EV and EVSE scores are summarized in the table below.

Highest Scoring Individual EV, EVSE, Test Equipment:

Test Equipment	Total Points
TE1	326
TE2	310
TE3	272
TE4	205

EV	Total Points
EV1	380
EV2	336
EV3	287
EV4	274
EV5	267
EV6	260
EV7	231
EV8	179
EV9	170

EVSE	Total Points
EVSE1	420
EVSE2	367
EVSE3	339
EVSE4	314
EVSE5	276
EVSE6	275
EVSE7	255
EVSE8	217
EVSE9	144
EVSE10	118
EVSE11	56

Figure 11: Individual points achieved by EVs, EVSEs and TEs in PTP

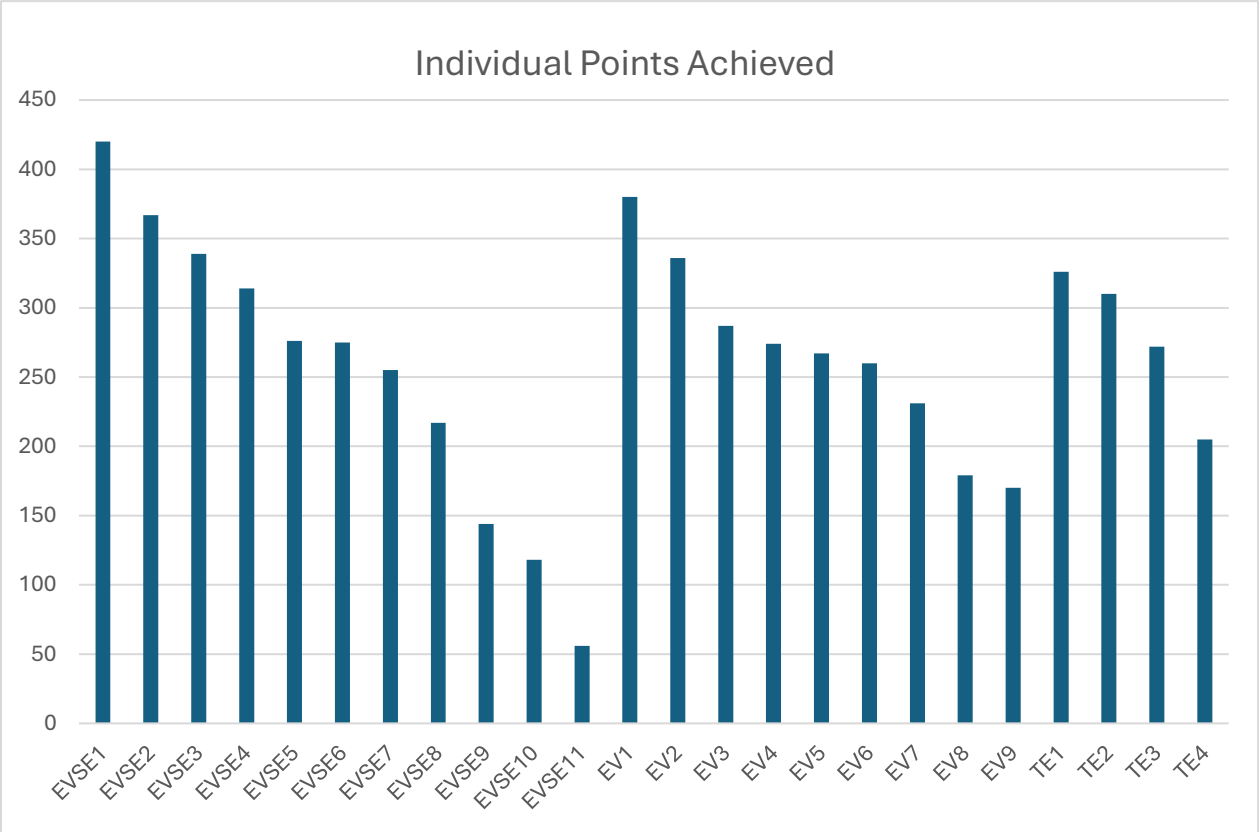


Figure 12: Chart for Individual points achieved by EVs, EVSEs and TEs in PTP

Test Slot 7					
Group A 4:30 - 5:10		Slot #7 Color code & Pts		Group B 5:20 - 6:00		Slot #7 Color code & Pts
EVSE	EV			EVSE	EV	
A	1	75				
B	2	88				
C	3	0		A	1	73
D	4	80		B	2	52
E	5	73				
F	6	116		C	3	90
G	7	82		D	4	127
H		73		E		73
I		73				
J		73				

Figure 13: Test Slot 7 Points Tracking with Normalization Added

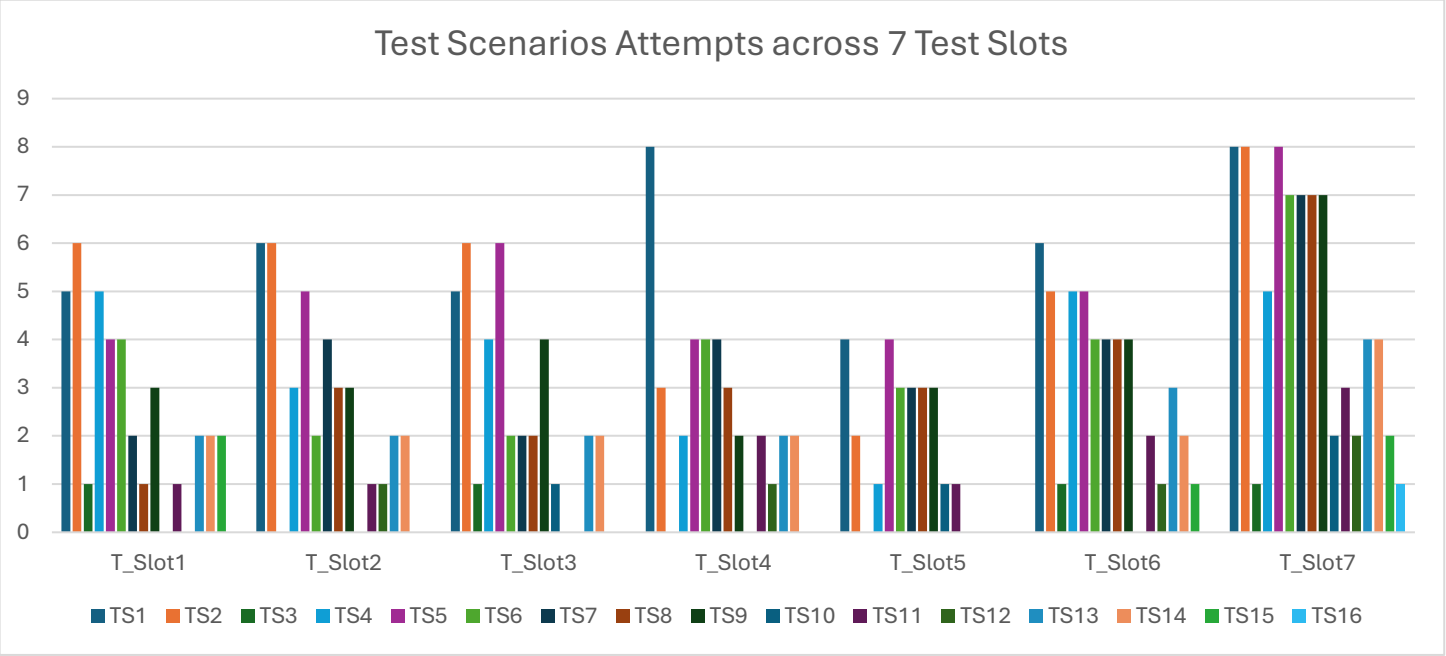


Figure 14: Test Scenarios Attempted for Each Test Slot

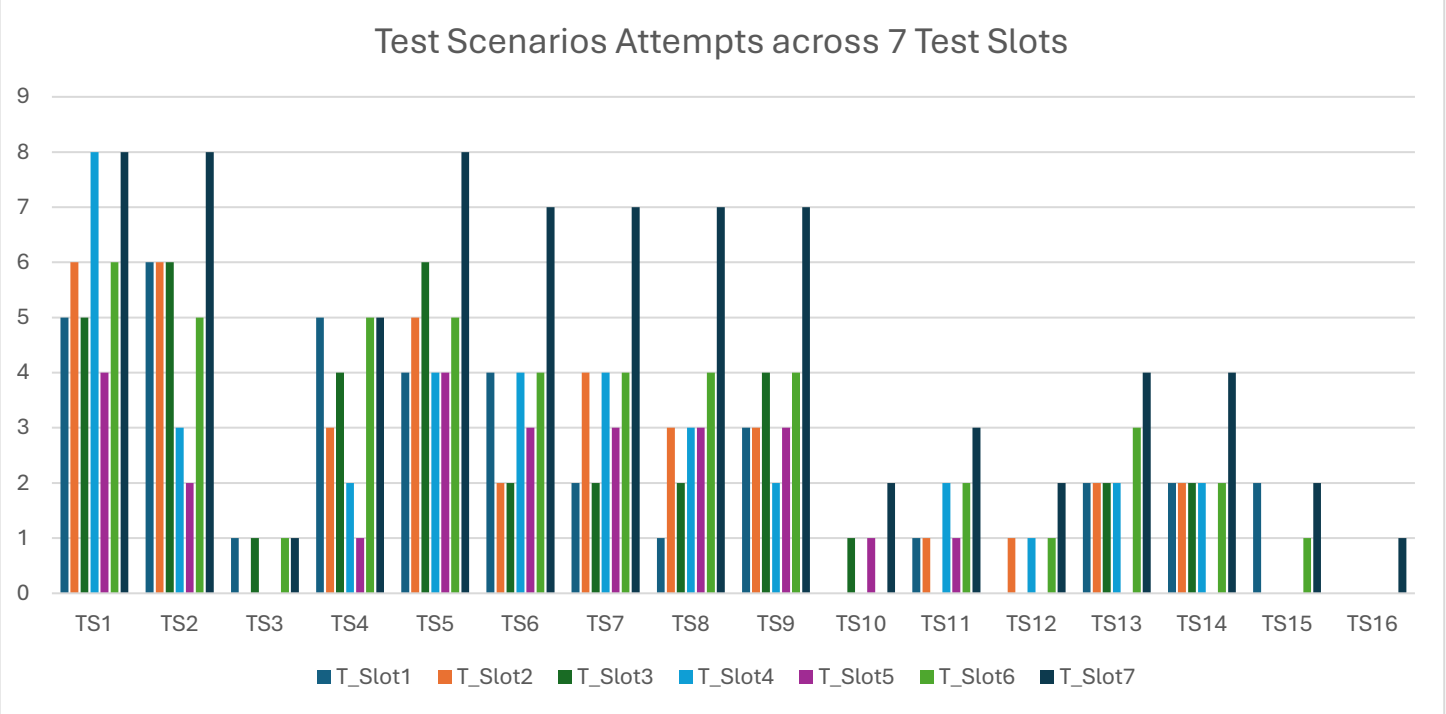


Figure 15: Test Scenarios Attempted across 7 test slots

3.2 Equipment Meta data

Comprehensive metadata collection for EVs and EVSEs is a critical component of the ChargeX PTP. Metadata enables traceability, supports accurate performance comparisons, and provides contextual understanding for interpreting test outcomes. Key metadata attributes include manufacturer details, firmware versions, hardware revisions, connector types, communication protocols, and other relevant specifications.

This information is not only valuable for contextualizing specific testing results — such as explaining why certain Test Scenarios (TS) were not attempted or were unsuccessful — but also serves as a foundation for benchmarking device capabilities over time. By comparing metadata across multiple testing events, stakeholders can identify industry trends, gaps in compatibility, and areas of development focus.

The figures below illustrate the diversity and technical composition of equipment tested during the event. These figures help correlate test outcomes with device characteristics and can inform future event planning and testing protocol development.

All metadata collected has been consolidated in the ACM-ChargeX PTP at CharIN May 2025 Testival Outcomes and Future Recommendations report. This dataset serves as a valuable reference for future interoperability evaluations.

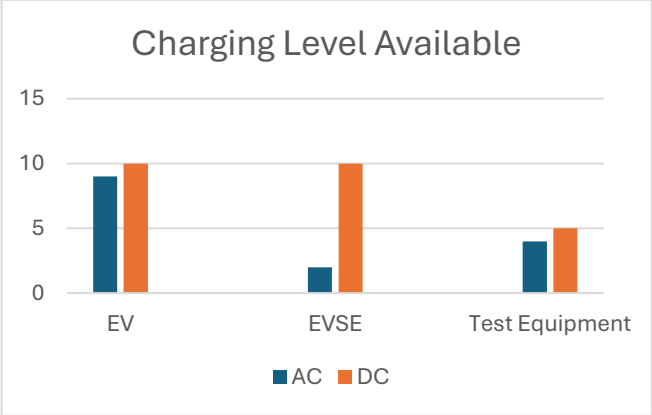


Figure 16: Charging level available

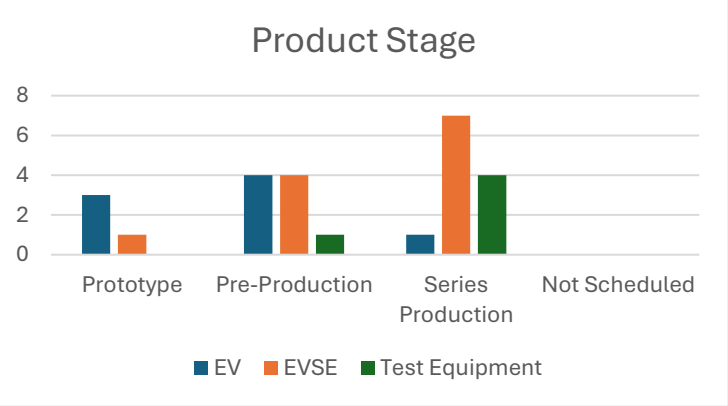


Figure 17: Product Stage

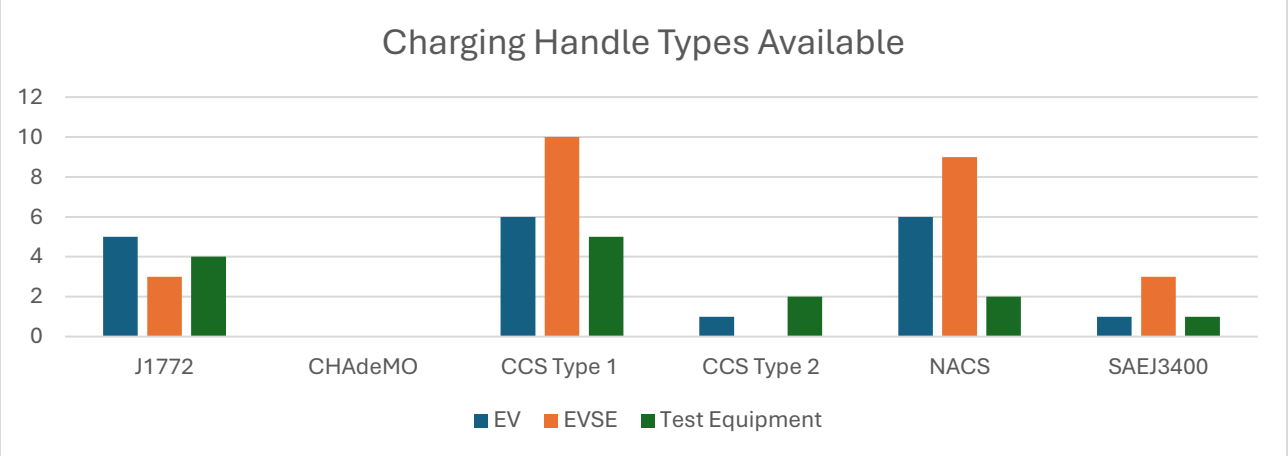


Figure 18: Charging handle types available

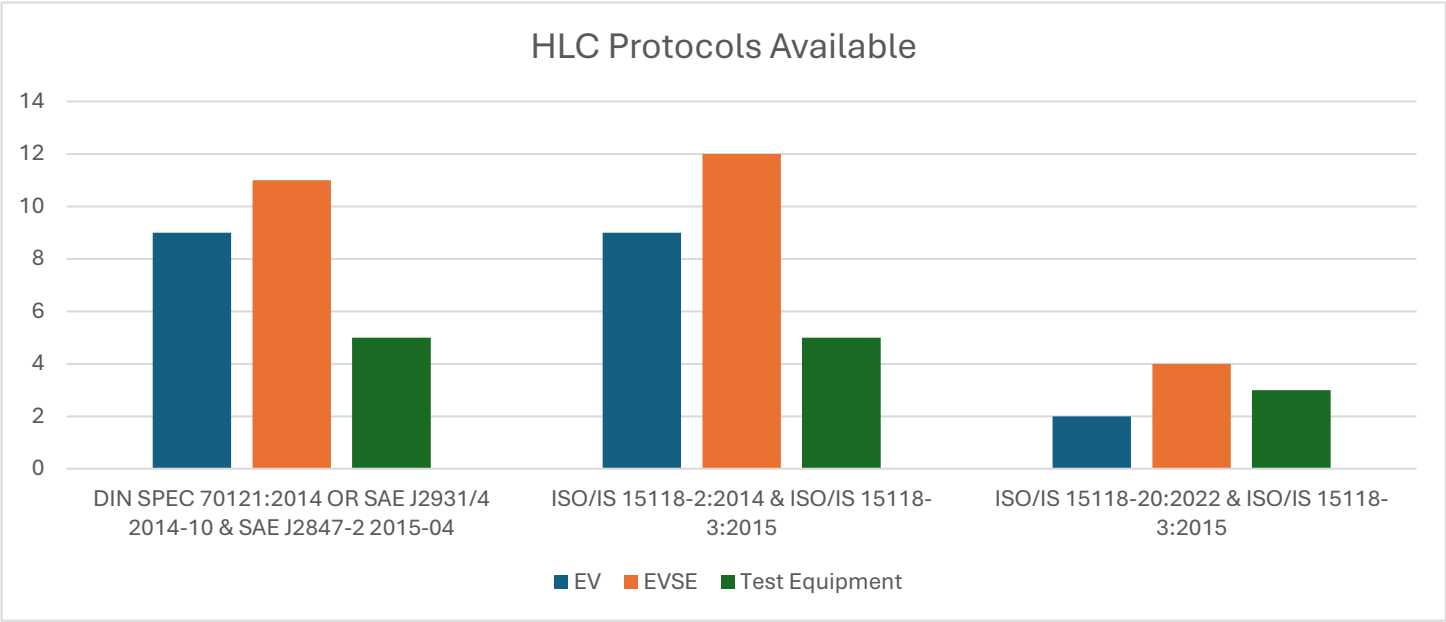


Figure 19: HLC Protocols available

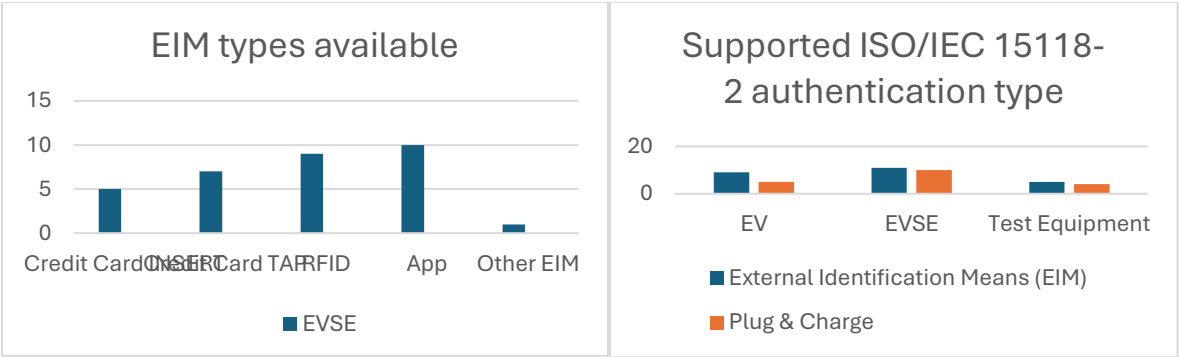


Figure 20: EIM Types available and Supported ISO/IEC 15118-2 authentication type

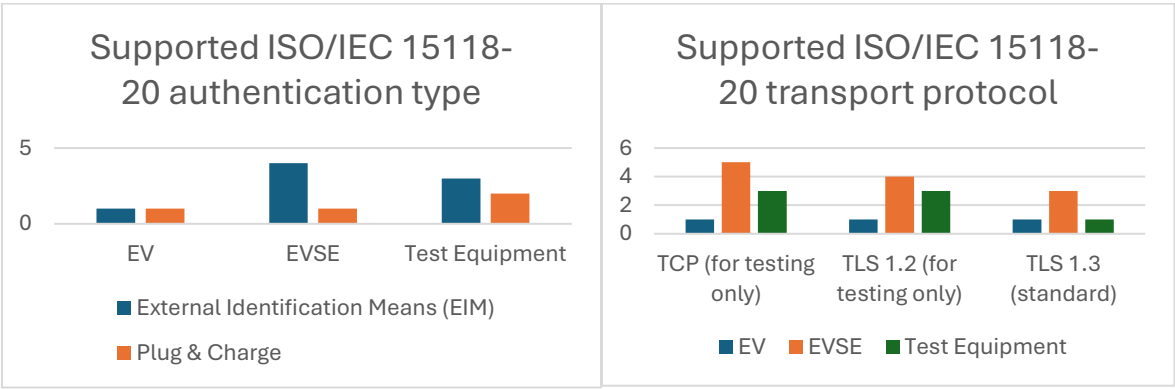


Figure 21: Supported ISO/IEC 15118-20 authentication type & transport protocol

3.3 Test Scenario Results

The below figures illustrate the distribution of total attempts across seven test slots under 16 different test scenarios.

- Figure 21 presents a bar chart with a trendline, showing that Test Slot 7 recorded the highest number of attempts, while Test Slot 5 had the lowest.
- Figure 22 complements this with a pie chart, providing a percentage breakdown of attempts per slot. It highlights that Test Slot 7 accounted for the largest share (26%), followed by Test Slot 6 (16%), while Test Slot 5 contributed only 8%.

These visualizations help identify testing patterns and focus areas across the test slots.

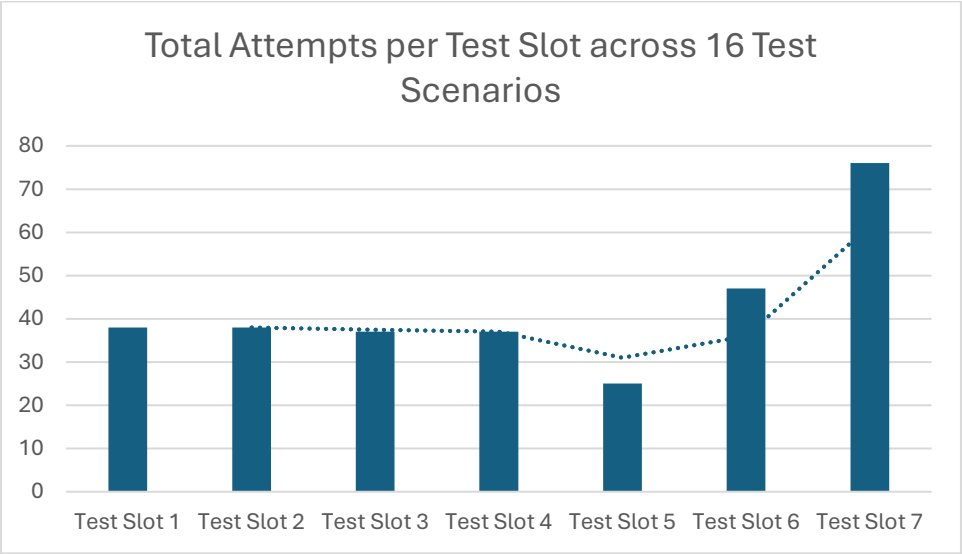


Figure 22: Bar chart for total attempts per test slot across 16 test scenarios

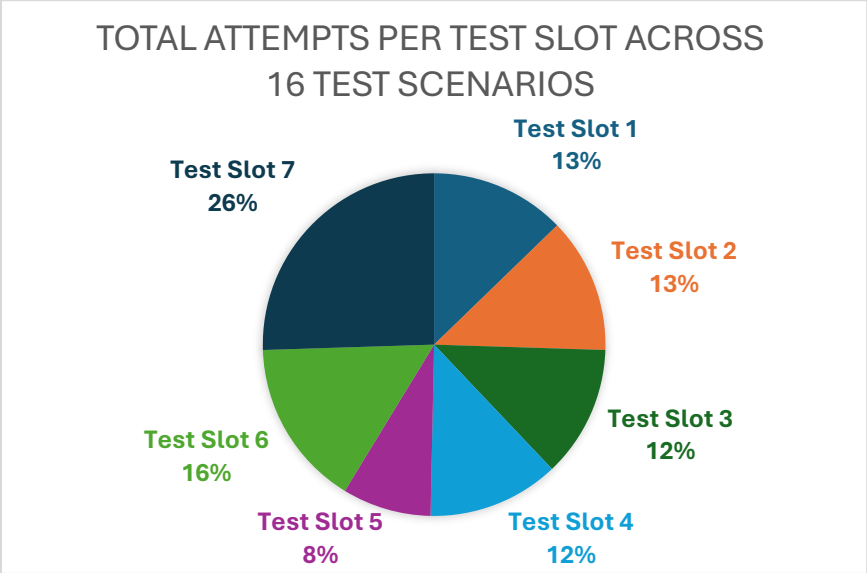


Figure 23: Pie chart for total attempts per test slot across 16 test scenarios

3.3.1 Test Scenario 1

TS 1, “Authenticate-first using DIN 70121 or J1772”, had a high attempt rate and success rate with 37 of the 41 attempts meeting all pass criteria and an average test duration of 2.1 minutes. Though there were many successful test attempts, there were many comments captured on errors that occurred due to a variety of reasons, mainly because it is the first test teams do. The summary of this TS and testing outcomes/comments can be seen below.
Comments: Used ISO-2 by mistake, Used NACS Adapter, Troubleshooting

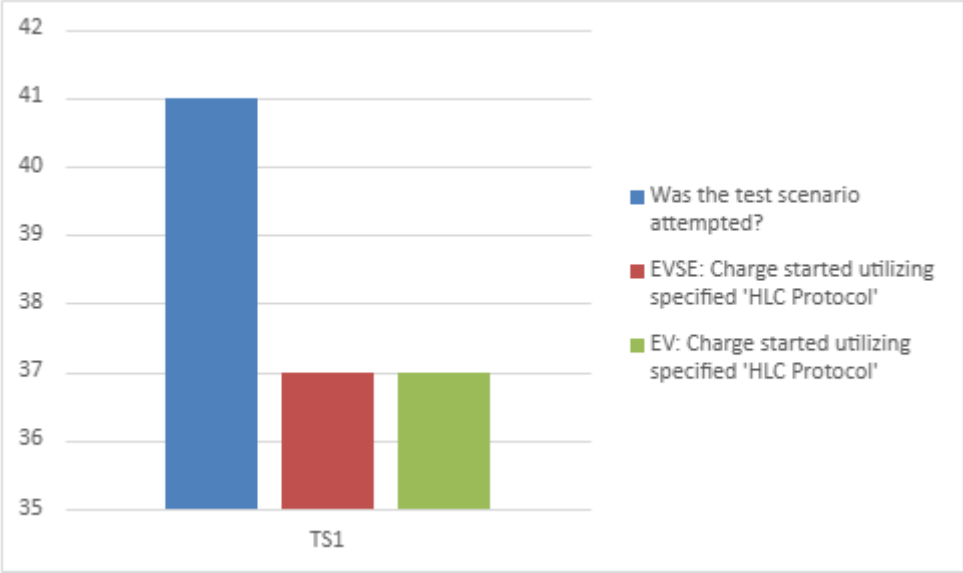


Figure 24: Test Scenario 1 results

3.3.2 Test Scenario 2

TS 2, “Authenticate-first using ISO 15118-2”, had a high attempt rate and success rate with 32 of the 35 attempts meeting all pass criteria and an average duration of 1.8 minutes. Some of the issues noted by moderators involved HLC communication, protocol selection, and authentication. The summary of this TS and testing outcomes/comments can be seen below.
Comments: EV not supporting, Authentication failing, SLAC takes time to match, Troubleshooting

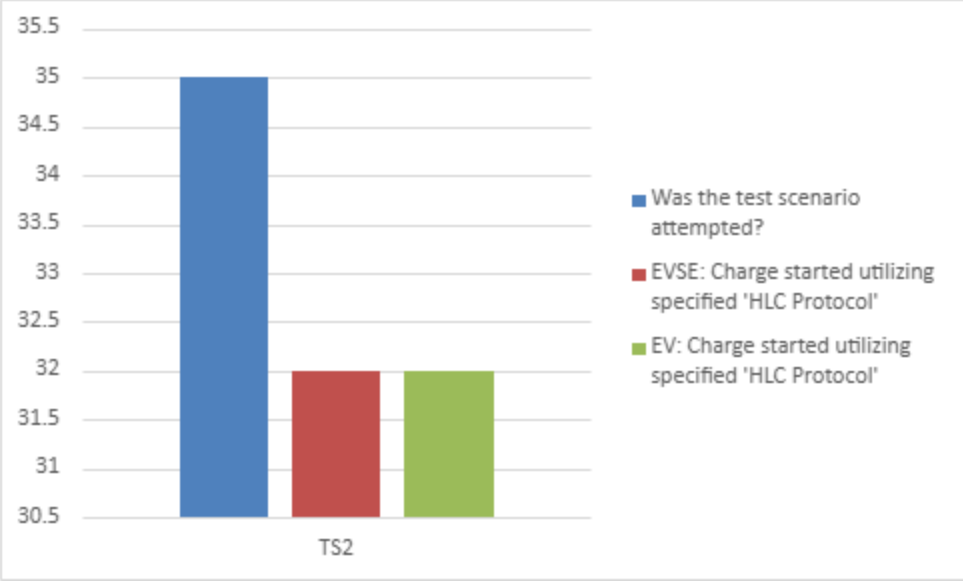


Figure 25: Test Scenario 2 results

3.3.3 Test Scenario 3

TS 3, “Authenticate-first using ISO 15118-20”, had a very low attempt rate and success rate with 1 of the 4 attempts meeting all pass criteria. Some of the issues noted from moderators involved TLS, as well as teams not wanting to participate in this test. The summary of this TS and testing outcomes/comments can be seen below.
Comments: EV can’t support -20, Authentication failing, Troubleshooting

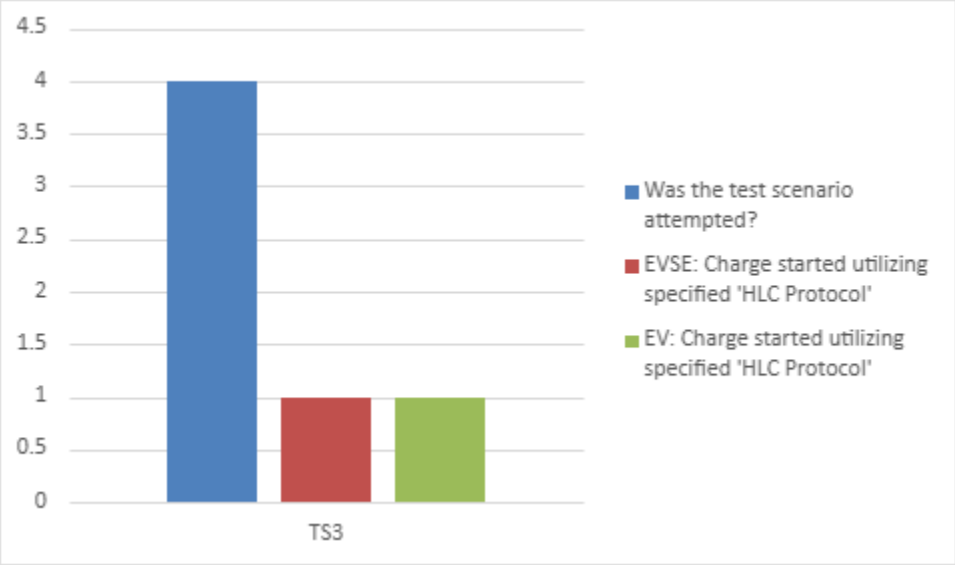


Figure 26: Test Scenario 3 results

3.3.4 Test Scenario 4

TS 4, “Disconnect Pilot @EVSE or @EV during Power Transfer (PT)”, had a medium attempt rate and success rate and an average duration of 2.3 minutes. This test has multiple pass criteria that are mutually exclusive. Most teams could give a generic visual error, but only 3 teams could give a visual pilot error. The summary of this TS and testing outcomes/comments can be seen below.
Comments: No Error Message on EV; did not have method to cause fault with charger + vehicle

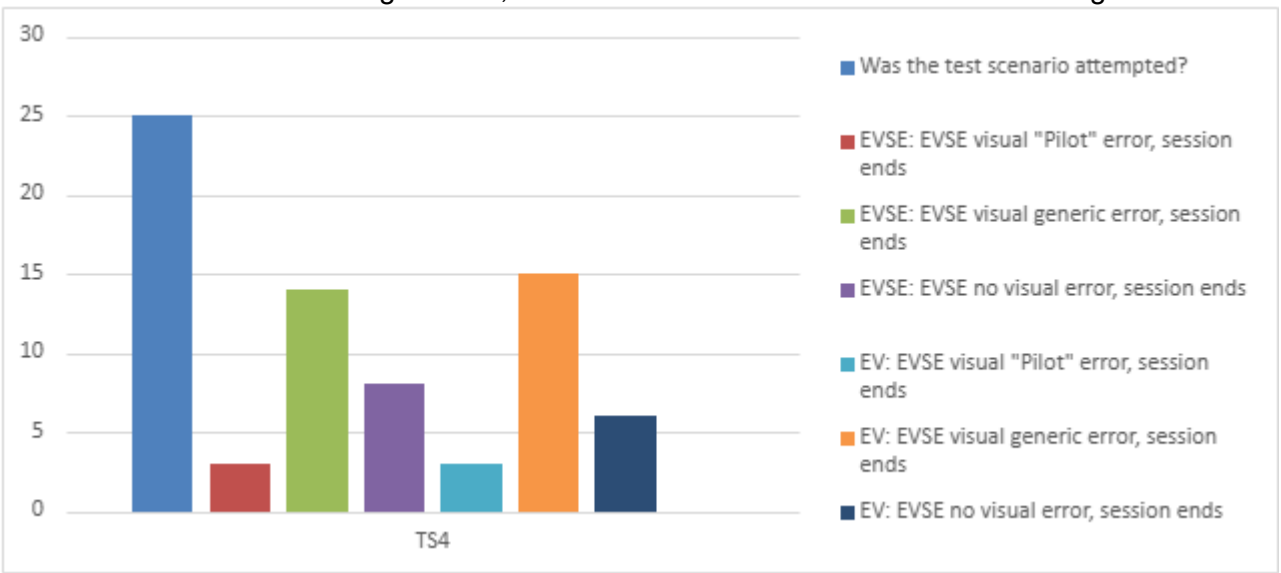


Figure 27: Test Scenario 4 results

3.3.5 Test Scenario 5

TS 5, “Press Latch during Session Initialization (SI)”, had a high attempt rate and a relatively medium success rate and an average test duration of 2.5 minutes. This test has multiple pass criteria that are mutually exclusive. Most teams could give a generic visual error, a “connector lock” error, or not have the latch able to be pressed. The summary of this TS and testing outcomes/comments can be seen below.

Comments: Latch can be pressed but charging did not stop, No latch on NACS

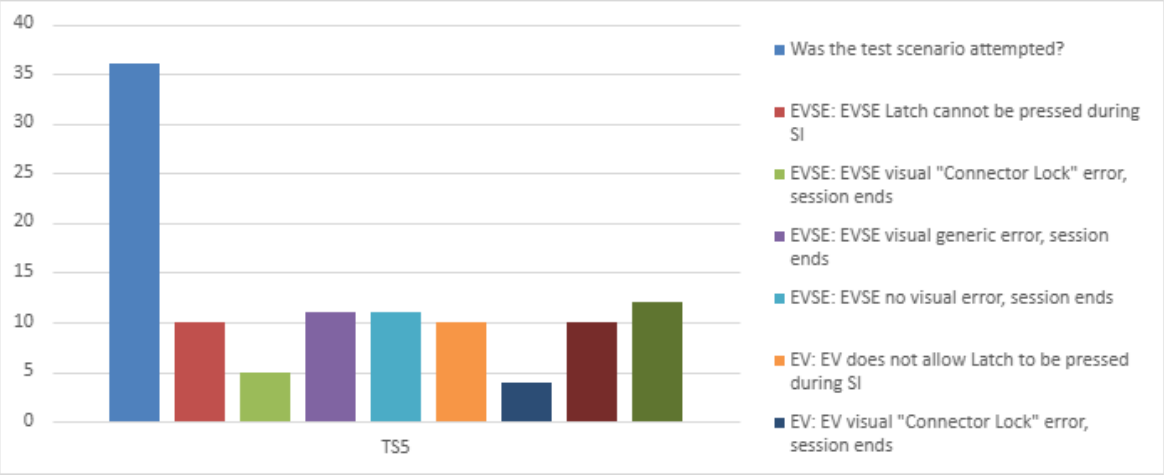


Figure 28: Test Scenario 5 results

3.3.6 Test Scenario 6

TS 6, “Press EVSE Emergency Stop during PT then Attempt Unplug from EV”, had a medium attempt rate and a relatively medium success rate and an average duration of 1.25 minutes. This test has multiple pass criteria that are mutually exclusive. 15 of the teams allow for the charger to disconnect after the emergency stop, while 10 teams had an ‘Emergency Stop” error. Some EVSE’s did not have an Emergency Stop button. The summary of this TS and testing outcomes/comments can be seen below.

Comments: No Emergency Stop. Used Command live-not on this system

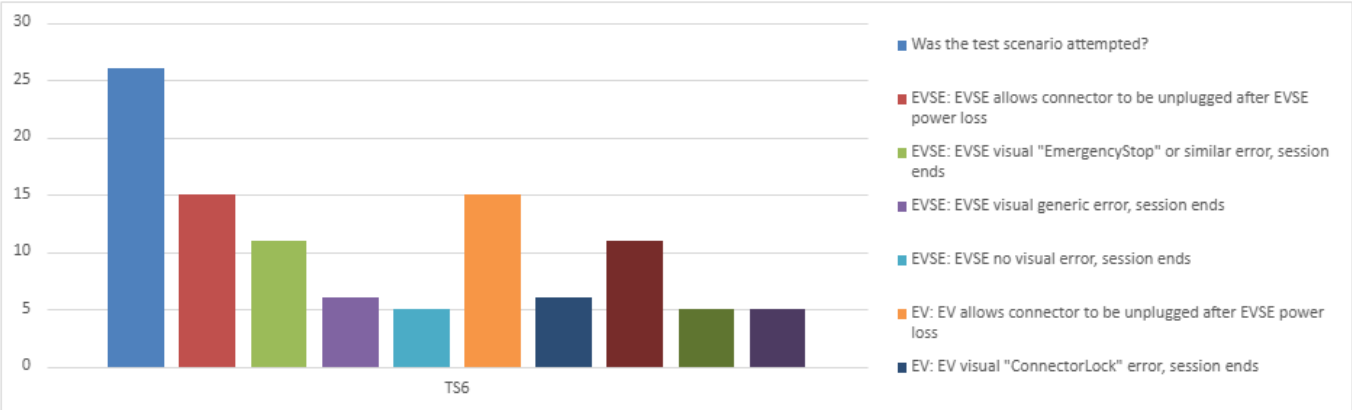


Figure 29: Test Scenario 6 results

3.3.7 Test Scenario 7

TS 7, “Disconnect all Network Connections then Attempt Authentication”, had a medium attempt rate and a relatively medium success rate and an average duration of 1.6 minutes. This test has multiple pass criteria that are mutually exclusive. 9 of the teams did not give a fault and continued charging, and 9 EVSE’s also had an “Authentication Fault” error. The summary of this TS and testing outcomes/comments can be seen below.

Comments: backend network connected

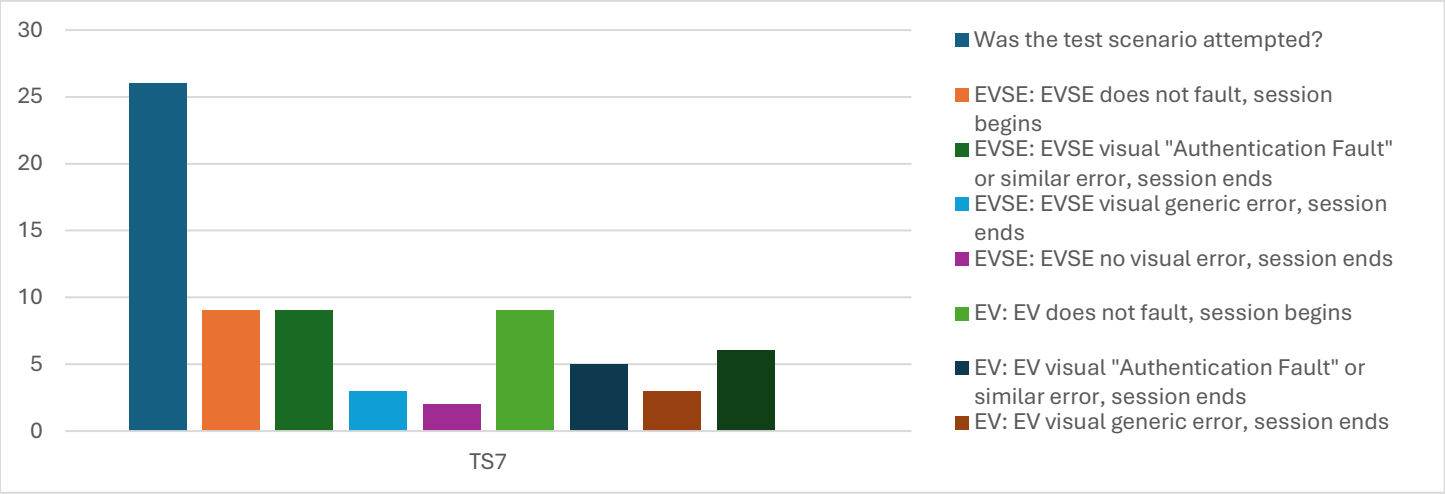


Figure 30: Test Scenario 7 results

3.3.8 Test Scenario 8

TS 8, “Disconnect all Network Connections during Power Transfer (PT)”, had a medium attempt rate and a high success rate and an average duration of 1.5 minutes. This test has multiple pass criteria that are mutually exclusive. 20 of the teams did not give a fault and continued charging, and 3 teams also had an “Authentication Fault” error. The summary of this TS and testing outcomes/comments can be seen below.

Comments: Had issues reconnecting EVSE to network

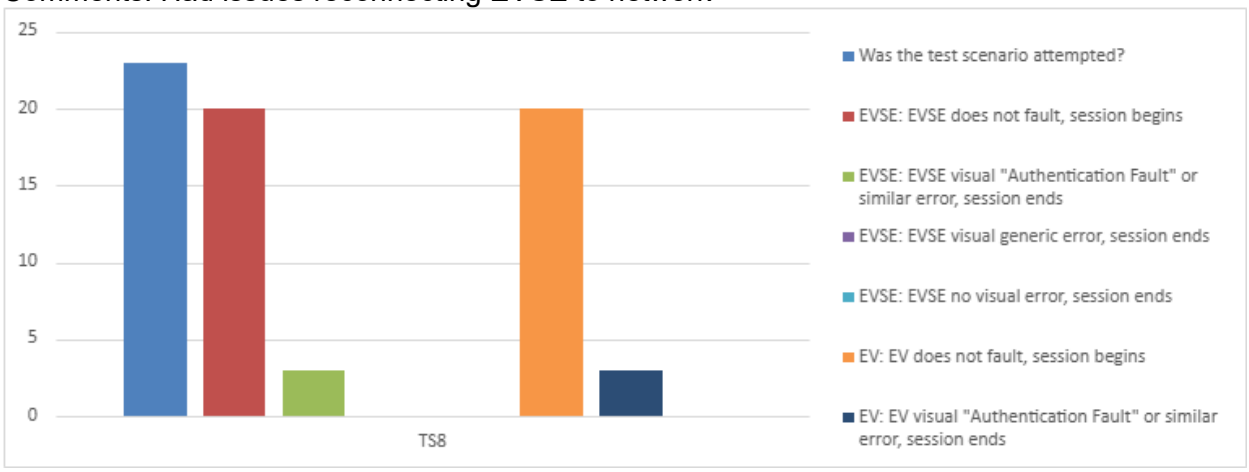


Figure 31: Test Scenario 8 results

3.3.9 Test Scenario 9

TS 9, “Pause & Resume Manually Curtail EVSE to Zero Current during PT” had a medium attempt rate and a high success rate and an average duration of 4.7 minutes, which is significantly longer than most other tests. This test has multiple pass criteria that are mutually exclusive. 18 of the teams did not give a fault and returned to full power. Manually curtailing the current made teams go through the backend of their system to prepare for this test, hence the longer average time. The summary of this TS and testing outcomes/comments can be seen below.

Comments: Vehicle didn't respond to 'wakeup' on resume

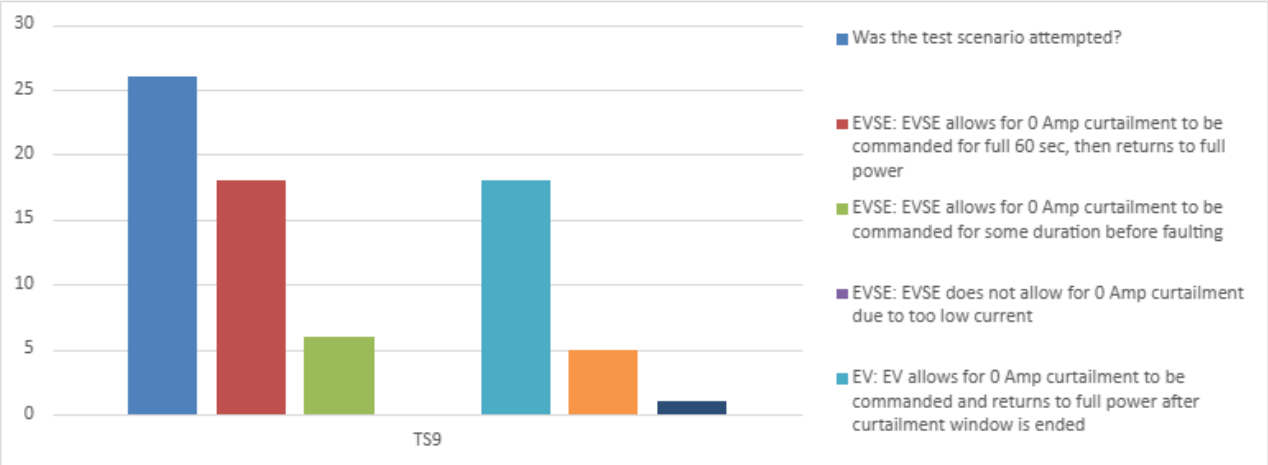


Figure 32: Test Scenario 9 results

3.3.10 Test Scenario 10

TS 10, “Pause & Resume Activating a "Pause" during PT during Charge Scheduling” had a very low attempt rate and a very high success rate. This test was one of the most difficult due to Charge Scheduling not being implemented on most EVSE’s. This test has multiple pass criteria that are mutually exclusive. All 4 of the teams that attempted this test received the highest pass criteria. The summary of this TS and testing outcomes/comments can be seen below.

Comments: Not many attempts due to charge scheduling.

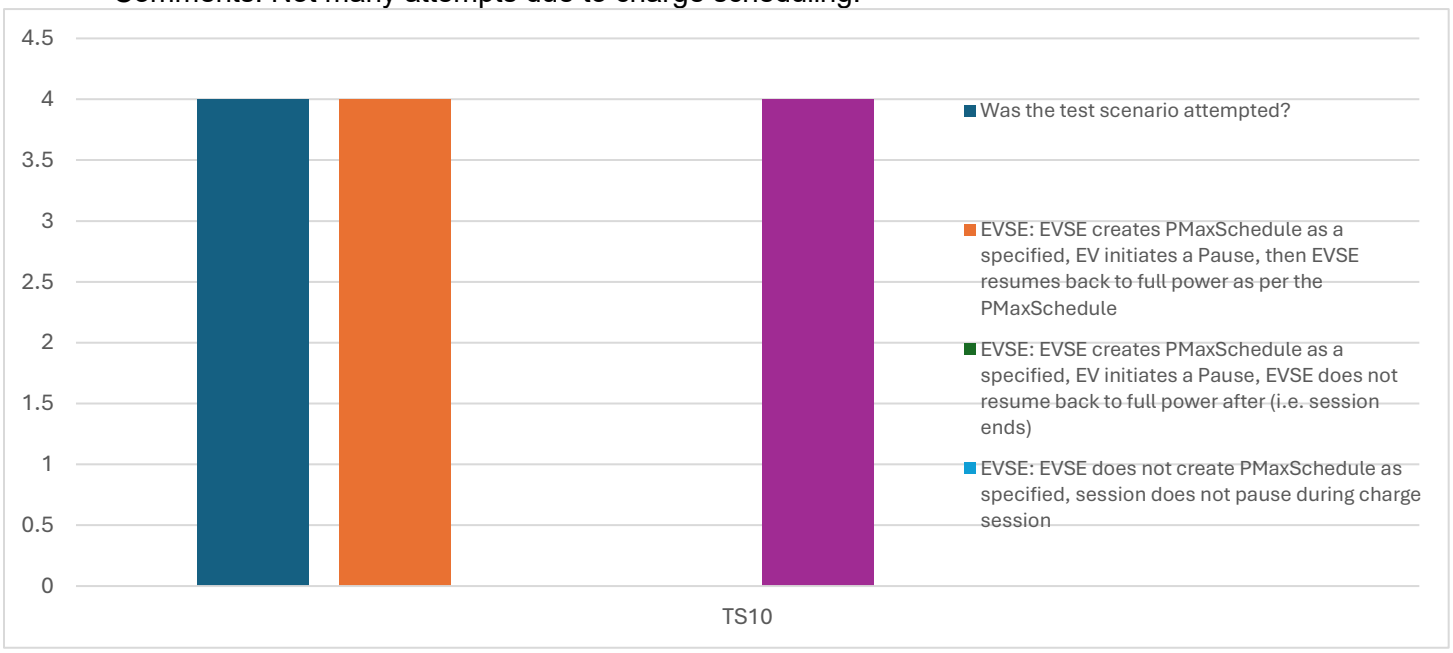


Figure 33: Test Scenario 10 results

3.3.11 Test Scenario 11

TS 11, “Plug & Charge Valid EV & EVSE Certificates”, had a medium attempt rate and a medium success rate with an average duration of 4.5 minutes. This test has passing criteria along with stretch goals. 6 out of the 10 teams that attempted got the highest pass criteria while 4 teams were able to get the stretch goal of using the CharIN provided certificate. The summary of this TS and testing outcomes/comments can be seen below.

Comments: Teams tend to use DIN when testing

Figure 34: Test Scenario 11 results

3.3.12 Test Scenario 12

TS 12, “Plug & Charge Expired EV Contract Certificate”, had a low attempt rate and a low success rate. This test has pass criteria that are mutually exclusive along with stretch goals. 2 out of the 5 teams that attempted got the highest possible score and stretch goals by prompting users to use EIM and using the CharIN certificate. The summary of this TS and testing outcomes/comments can be seen below.

Comments: Not many teams wanted to attempt

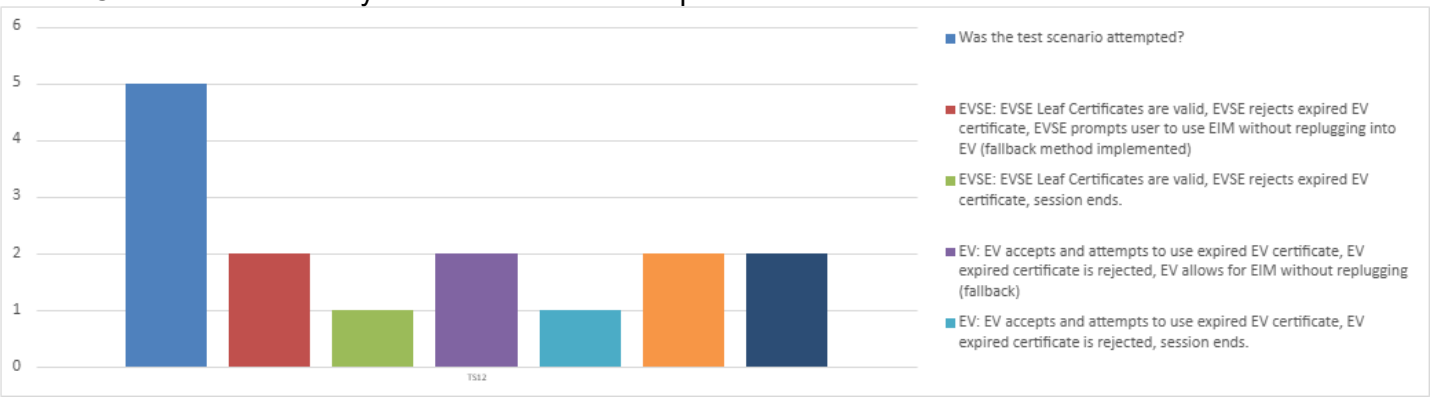


Figure 35: Test Scenario 12 results

3.3.13 Test Scenario 13

TS 13, “Adapter Plug-In to Connector First”, had a high attempt rate and a high success rate with an average duration of 2.0 Minutes. This test has a single pass criterion and one stretch goal. All 15 out of 15 teams that attempted got the highest score by getting the session to begin. No team was able to get the stretch goal of the eSDP recognizing the adapter. The summary of this TS and testing outcomes/comments can be seen below.
Comments: Not all teams have access to an adapter

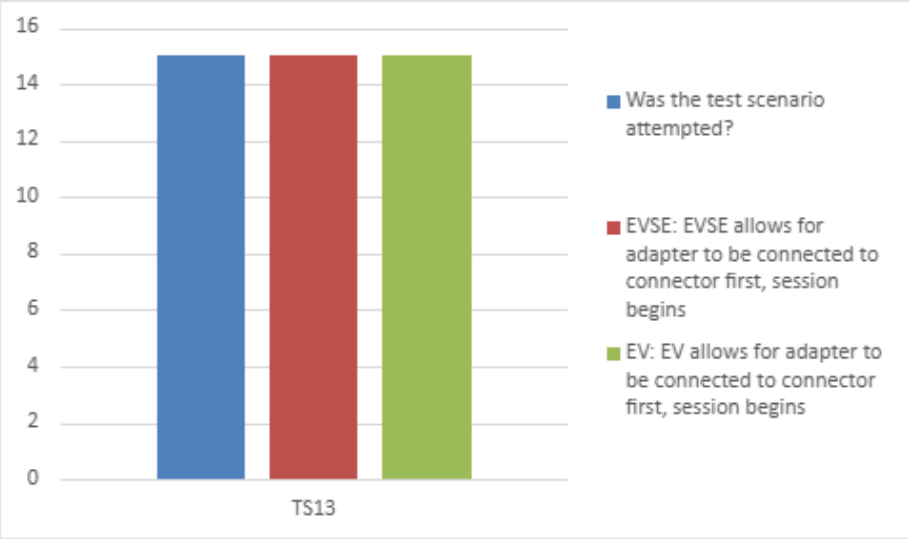


Figure 36: Test Scenario 13 results

3.3.14 Test Scenario 14

TS 14, “Adapter Plug-In to Vehicle First”, had a high attempt rate and a lower success rate with an average duration of 1.0 Minute. This test has a single pass criterion and one stretch goal. 7/14 EVSE and 8/14 EV teams attempted the test and scored by getting the session to begin. No team was able to get the stretch goal of the eSDP recognizing the adapter. The summary of this TS and testing outcomes/comments can be seen below.
Comments: Some teams disagreed with the test purpose

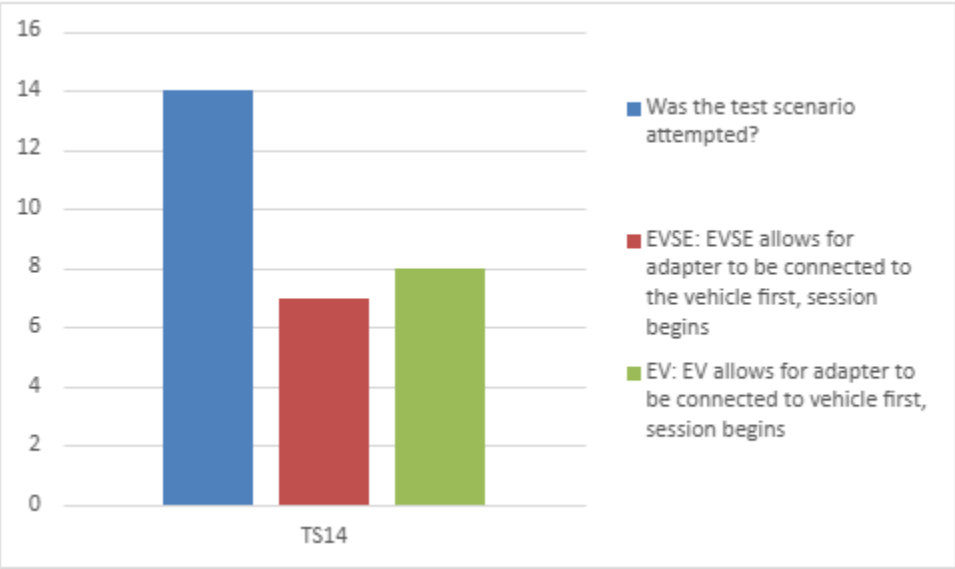


Figure 37: Test Scenario 14 results

3.3.15 Test Scenario 15

TS 15, “V2G EVSE Spoof-Matches EV Current Request over HLC, but commands -5 Amps”, had a low attempt rate but a high success rate. This test has two passing criteria that are mutually exclusive. 4 out of 5 teams attempted the test and scored by getting the session to begin. Almost all teams were able to get back to full power after allowing for -5 amps. The summary of this TS and testing outcomes/comments can be seen below.
Comments: Most teams did not attempt V2G

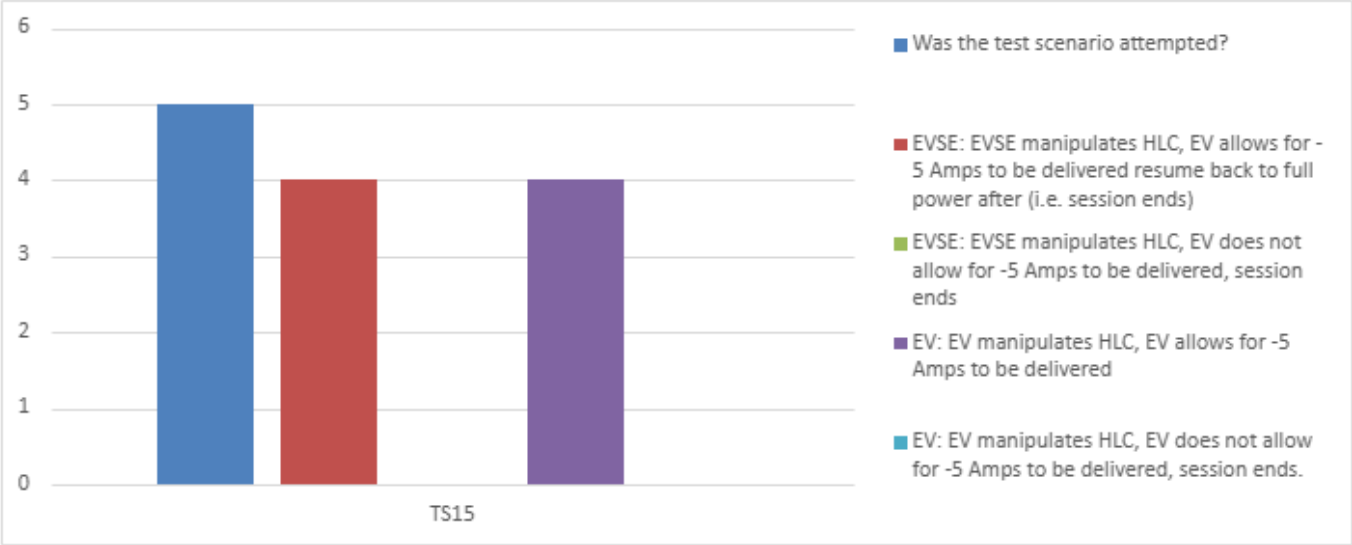


Figure 38: Test Scenario 15 results

3.3.16 Test Scenario 16

TS 16, “V2G Dynamic BPT using ISO 15118-20, Command -5 Amps” had a very low attempt rate but a high success rate since just one team attempted and passed. This test has two passing criteria that are mutually exclusive. The team attempted the test using ISO 15118-20 and scored by getting the session to begin. Most teams did not have ISO 15118-20 implemented to do this test. The summary of this TS and testing outcomes/comments can be seen below.
Comments: Most teams did not attempt V2G

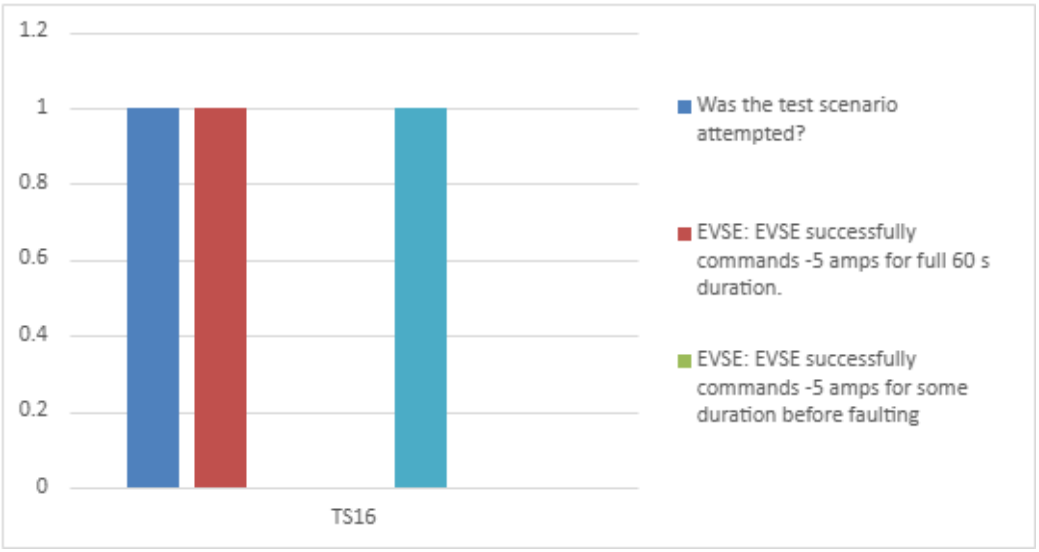


Figure 39: Test Scenario 16 results

3.4 Feedback and Future Recommendations

This section of the report summarizes feedback and recommendations from participants of the ACM ChargeX PTP at CharIN Testival held in May 2025. The feedback was collected through separate surveys conducted by both ACM and CharIN to assess the effectiveness, relevance, and organization of the prescribed testing effort within the broader interoperability event. The analysis covers participation, gamification, moderator roles, test case satisfaction, and future interest. Results from both the surveys, 'ACM ChargeX PTP Feedback Survey' by ACM (hereby addressed as ACM survey) and 'Testival NA 2025 Feedback Survey – PTP ChargeX & ACM' by CharIN (hereby addressed as CharIN survey) are included in this section.

3.4.1 Participation Overview

According to the ACM survey, a significant portion of respondents had prior experience with ChargeX PTP. As shown in Figure 40, 30% participated in November 2024, 20% in June 2024 (North America), and another 20% in both. This implies a substantial number of returning participants.

According to the CharIN survey, for the Testival NA 2025, motivations for prescribed testing were primarily to support data collection activities to benefit the industry (81.25%) and prior participation (50%), as seen in Figure 41. Figure 39 shows how attendees participated in various CharIN Testival activities. The ChargeX Award ceremony, and end-to-end testing administered by ChargeX were more active than in previous events.

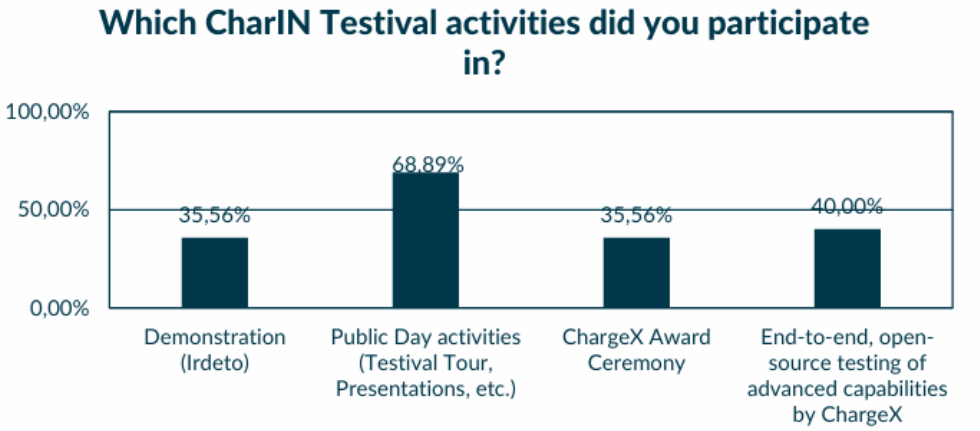


Figure 40: CharIN Survey results for participation activities at CharIn Testival NA 2025 at ACM

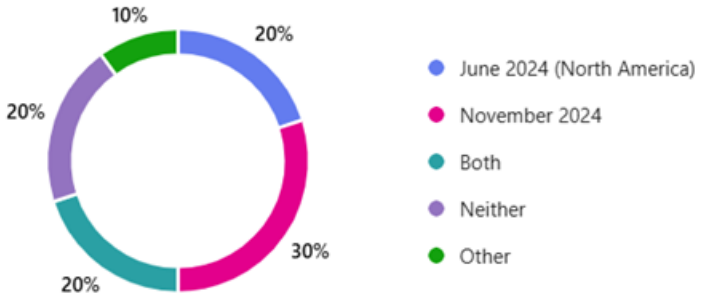


Figure 41: ACM Survey results for participation in ChargeX PTP in prior CharIn Testivals

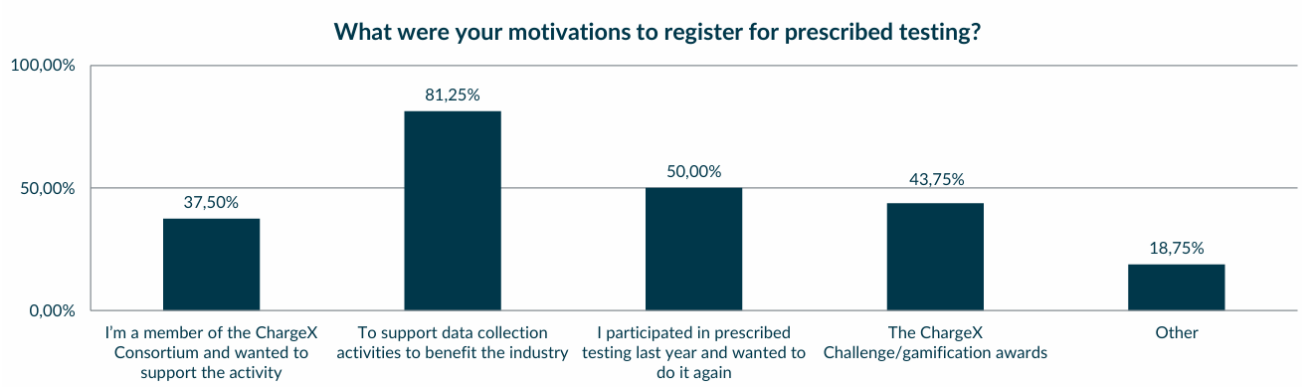


Figure 42: CharIN Survey results for motivation to participate in PTP

Responses from 'Other' in Figure 41, include having a detailed list of Interoperability tests that are understood by all participants to make testing a lot quicker and easier, having more visual details of the Challenge gamification throughout, allotting more time to PTPs or giving more preference to Adhoc testing, treating testing partner's goals first and treat the prescribed testing as a stretch goal since figuring out known issues or trying an advanced function is a higher priority for the participants than collecting a points for basic tests which are known to pass.

3.4.2 Testing experience and Logistics

Many participants found value in the testing sessions for identifying issues more efficiently than in internal setups. Nevertheless, logistical concerns such as time limitations, late setup by some vendors, and incomplete early communication, particularly regarding PKI and ChargeX documents, impacted effectiveness. Multiple participants noted that pairing with non-participating partners hindered data collection and test execution. Suggestions included adding 30 minutes for each test slot and encouraging pre-selection of partners based on mutual intent to complete prescribed tests.

3.4.3 Role of Moderators

According to the ACM Survey, moderators were generally seen as helpful. 56% of respondents considered them "Necessary and helpful," while 44% found them "Helpful but not necessary" as shown in Figure 42. A comment noted that the moderator room was hidden, limiting off-the-cuff conversations.

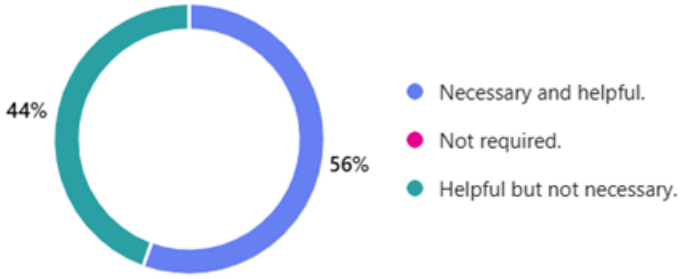


Figure 43: ACM Survey results for Role of Moderators in PTP

3.4.4 Gamification & Awards

The gamification approach received mixed responses. While some found it engaging and beneficial for industry involvement, others questioned its alignment with varying testing goals and product maturity levels. Respondents recommended refining the scoring mechanism to reflect test complexity and relevance. Feedback also emphasized the importance of moderators, particularly for providing clarity and maintaining structure.

The gamification (test scoring) and award approach received largely positive feedback, with 78% of respondents finding it "Fair and encouraging" as seen in Figure 43. However, there were suggestions for different approaches, with 30% preferring "Only Day-2 for test scoring/gamification" and another 30% suggesting "Only selected tests under test scoring/gamification" as shown in Figure 44. One comment highlighted that test scoring should be weighed based on difficulty.

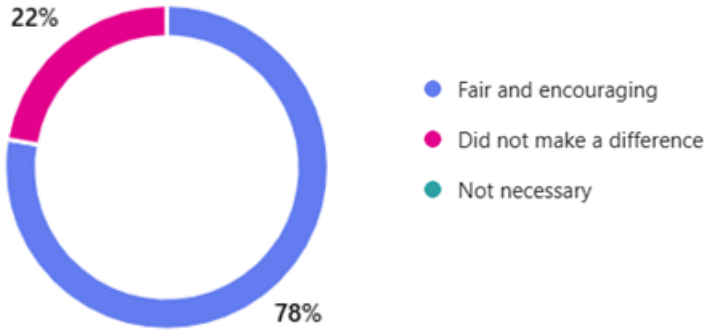


Figure 44: ACM Survey results for opinion on the gamification test scoring and award approach

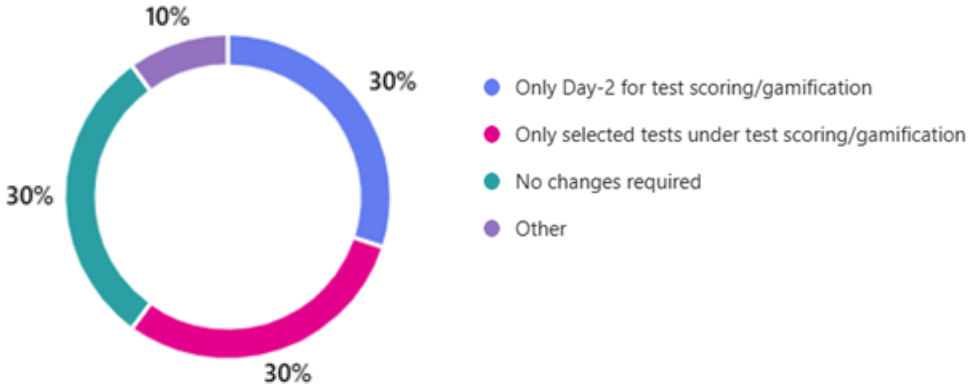


Figure 45: ACM Survey results for approach to gamification

3.4.5 Test Content & Time Allocation

Feedback from the ACM survey showcased divided opinions on the sufficiency of time allocated for testing. While some requested additional time, others advocated reducing the number of required tests. Several participants suggested customizing or simplifying the existing test list to reflect test equipment providers' capabilities or the maturity level of participating systems. A subset of respondents emphasized the need to tailor tests to evolving interoperability challenges.

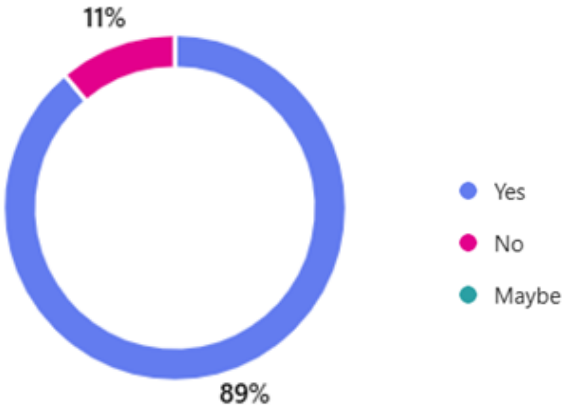


Figure 46. ACM survey results for if the pre-Testival briefing timely and helpful

The pre-Testival briefing was overwhelmingly deemed timely and helpful, with 89% responding 'Yes'. Regarding the time provided for prescribed tests, 56% found it "Just right," while 33% felt it was "Not sufficient"

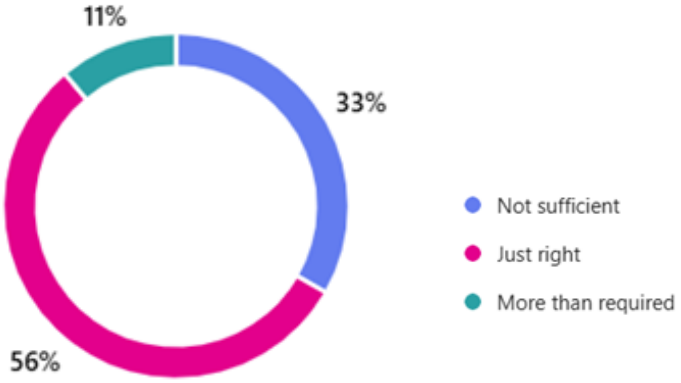


Figure 47. ACM survey results for if the time provided for PTPs satisfactory

3.4.6 Future Participation and Recommendations

There is general interest in continued involvement in future ChargeX PTP events. Some participants, however, expressed hesitancy depending on factors such as test design, equipment needs, and scheduling flexibility. To increase engagement, participants proposed enhanced clarity in expectations, early sharing of documentation, and a more collaborative pairing strategy during scheduling.

A strong majority (67%) expressed interest in participating in future ACM ChargeX PTPs, with 33% responding "Maybe" as seen in Figure 47. For those who chose "Maybe," location (43%) and cost (29%) were the most important factors for participation as shown in Figure 48.

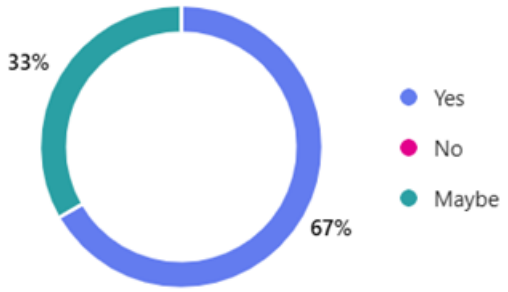


Figure 48. ACM survey results for interest in participating in future ACM ChargeX PTP

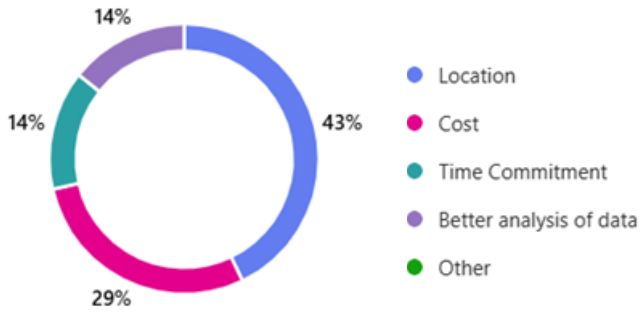


Figure 49. ACM survey results for factors concerning future participation in future ACM ChargeX PTP

Overall, the feedback indicates a positive experience, with participants valuing the opportunity to find and solve issues. Key areas for improvement include:

- Refining the gamification approach to align with diverse tester priorities, and inclusion of more specific tests that align with the EV/EVSE pairings.
- Ensuring better visibility and accessibility for moderators
- Considering adjustments to test case lists and time allocation based on participant feedback.
- Better time management for and by PTP participants for trouble shooting, Adhoc testing and prescribed testing.
- Having test partners select ahead of time if they want to participate for each individual slot since the decision to participate in PTP can change based on the maturity of the EV, EVSE, or test system, before each test slot.
- Weighing test scores based on difficulty of the test features.
- Refining the gamification approach to enable participants to prioritize their individual testing improves PTP participation since the PTP test goals might or might not align with different testers priorities.

Appendix – ChargeX PTP Document

Authors

Sam Thurston – Argonne National Laboratory (ANL)

Sally Glass – Idaho National Laboratory (INL)

Contributors

The authors gratefully acknowledge the invaluable contribution of industry participants in the ChargeX Consortium.

Acknowledgments

The National Charging Experience Consortium (ChargeX Consortium) is a collaborative effort between Argonne National Laboratory, Idaho National Laboratory, National Renewable Energy Laboratory, electric vehicle charging industry experts, consumer advocates, and other stakeholders.

Version History

Date	Changes	Author
09.01.2024	Altered June 2024 test program document to create November test program document. Updated location, prescribed duration, gamification rules, etc.	Sam Thurston
09.15.2024	Updated cover page logo, changed name to ChargeX Challenge, minor edits throughout	Sally Glass
09.30.2024	Added in more detail on gamification, point system, etc.	Sam Thurston
10.14.2024	After test scenarios were reviewed and finalized by EAB and ChargeX's Testing TF, tabular versions were created and added in to this document. Further detail on awards & outcomes added, as well as full test scenario description in appendix.	Sam Thurston
03.10.2025	Altered November 2024 PTP document to create May 2025 PTP document. Updated event structure changes and test scenarios.	Sam Thurston
04.25.2025	Detailed test scenarios added in for TS1-TS16 along with recommended HLC communications for executing advanced test scenarios	Sam Thurston

Scope of Document

This document details the conditions for the optional prescribed testing program (PTP) implemented during the CharIN May 2025 Testival at American Center for Mobility (ACM) in Ann Arbor, MI.

General Description

An optional prescribed testing program (PTP) proposed by the ChargeX Consortium was handed off to the CharIN May 2025 event host, the American Center for Mobility (ACM), to be offered

during the testival. Prescribed tests for this Testival were chosen based on industry feedback through ChargeX Testing Task Force meetings. During the first two days of testing, each 90-minute test slot will have a portion of that will be dedicated to prescribed testing for those who have opted-in to the program and wish to participate, with the remaining time dedicated to free time (i.e. “ad hoc” time). Further details on prescribed testing program rules & structure, test cases, moderator details, data sharing sensitivities, etc. may be shared with testers closer to the event.

For more information, contact ChargeX Testing TF Lead Sam Thurston(sthurston@anl.gov) and/or ACM representative Sushanta Das(sushanta.das@acmwillowrun.org)

Testing Conditions

The following outlines all details surrounding testing purposes, setup, structure, rebates, etc.

Goals

- To nurture a hybrid interoperability testing experience between adhoc and prescribed testing.
- To prove industry hand-off, in that prescribed testing can be managed and executed by industry.
- To reflect industry-desirable test cases based on feedback throughout Testing TF meetings.
- To encourage the testing of advanced charging features such as authentication types, authentication methods, ISO 15118-2 & ISO 15118-20 implementations, Plug&Charge capabilities, seamless retry, MREC implementations, Adapters, V2G, etc.
- To spark friendly competition through a gamified testing approach, rewarding participants for their testing achievements.
- To provide a well-structured prescribed testing approach with technical details decisions based on industry input and previous prescribed testing experiences.
- To collect anonymous comparable results through the outcomes of prescribed testing, and to benchmark the technological advancements & common issues of pre-production equipment /software from those participating in this program.

Test Participants

- This event targets manufacturers and CPOs of EVs and EVSEs capable of AC level 2 or DC fast charging attending the CharIN Testival who have opted to participate in the prescribed testing program.
- Every participating company shall provide staff who can set up, configure, and execute test scenarios according to the test program and categorize potentially found interoperability issues according to the test reporting template.

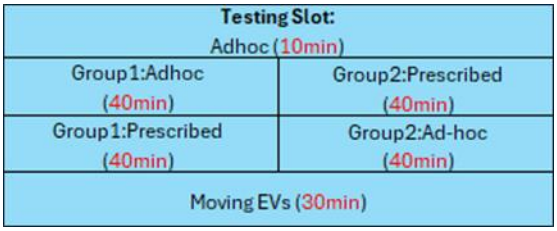
Test Process

- Tests will be conducted in test pairings based on a test schedule that is derived through CharIN’s technical matchmaking system. This matchmaking is based on registration information and prescribed testing program signup that will be provided by each participating company before the event. Matchmaking will be performed by CharIN prior to the event.
- During each test slot, the registered participants will be testing in parallel to one another. Test pairings will change in the Round Robin procedure between test slots according to the provided test schedule.
- An ACM moderator will be assigned to each test pairing during the prescribed testing period to relieve the testers from additional duties such as recording results, relaying test case steps & setup details, providing clarification, etc.
- The time breakdown between ad hoc & prescribed testing is as follows:
    - 50-minutes ad hoc, 40-minutes prescribed, 30-minutes to move EVs
- If the number of EV & EVSE pairings exceeds 8 during any test slot, a two-group structure will be followed. Pairings will be designated as either “Group 1” or “Group 2” for each specific timeslot.

This is done to minimize the necessary moderator work force for staff. The time breakdown between ad hoc testing and prescribed testing for the two groups is as follows, and can also be seen in Figure 1:

- Group 1: 10-minutes ad hoc, then 40-minutes prescribed, then 40-minutes ad hoc
- Group 2: 10-minutes ad hoc, then 40-minutes ad hoc, then 40-minutes prescribed

- Testers should aim to complete as many included test scenarios during the prescribed testing period as possible if they have the technical capabilities to do so.



Gamification Guidelines

- This event contains a gamification approach to test scenario completion, meaning that points will be designated for attempting and meeting specifically defined pass criteria for each test scenario. Further details can be found below on this gamification approach to prescribed testing:
- Testers will receive points as a pairing, not as individual testers. EV and EVSE pairings must work together to meet test pass criteria successfully, with a moderator presenting tracking results.
- Points are separated into the following 4 categories:
  - Attempt points: Points awarded for attempting a test scenario.
  - EVSE pass criteria points: Points awarded for EVSE meeting pass criteria; multiple pass criteria are listed increasing in points with increased complexity.
  - EV pass criteria points: Points awarded for EV meeting pass criteria; multiple pass criteria are listed increasing in points with increased complexity.
  - Stretch goal pass criteria points: Points awarded for additional “stretch goal” pass criteria, may be specific to either EV or EVSE. These pass criteria go above and beyond EV & EVSE pass criteria and are worth high points.
- Multiple attempts for a single test can be made, however only the best performing attempt overall score (Attempt+EVSE+EV+SG) will be used for that scenario. It is recommended that the number of attempts per scenario does not exceed three, if more than three it should be noted by moderators.

Test Report Submission

Each test couple is required to work with their assigned moderator to submit a test report until the end of each prescribed testing period according to the method provided by the moderator team.

Test Scenarios

The test scenarios are designed to be completed in any order, with tabular details surrounding the test case description. Test pairings will decide together which tests they would like to attempt from the provided list of scenarios. Further details around testing setup and conditions may be provided if necessary closer to the event date. This prescribed test program includes the following 16 test scenarios seen in Table 1 along with correlating points. “Min” is the number of points for attempting that scenario, “Max” is the best possible points for achieving EV and EVSE pass criteria, “Max+SG” is for additional Stretch Goal points additionally available to be added on top of “Max”. More details on the pass criteria, setup, etc. is defined for each test scenario in Section D.

Test Name	Min	Max	Max+SG
TS1: Auth. Types: Authenticate-first using DIN 70121 or J1772	2	6	--
TS2: Auth. Types: Authenticate-first using ISO 15118-2	2	8	--
TS3: Auth. Types: Authenticate-first using ISO 15118-20	2	14	--
TS4: Fault Stops: Disconnect Pilot @EVSE or @EV during PT	3	9	14
TS5: Fault Stops: Press Latch during Session Initialization (SI)	3	9	--
TS6: Fault Stops: Press EVSE emergency stop during PT, attempt to unplug cable from EV	3	11	16
TS7: Fault Stops: Disconnect network connection, then attempt Authentication	3	9	14
TS8: Fault Stops: Disconnect all network connections during PT	3	9	14
TS9: Pause & Resume: Manually Curtail EVSE to Zero Current during PT	4	14	--
TS10: Pause & Resume: Activating a "Pause" during PT using Charge Scheduling	7	21	--
TS11: PnC: Valid EV & EVSE Certificates	5	13	17
TS12: PnC: Expired EV Contract Certificate – session terminates and/or fallback to EIM	5	15	19
TS13: Adapters: Plug-In to Connector First	3	11	15
TS14: Adapters: Plug-In to Vehicle First	3	11	15
TS15: V2G: EVSE Spoof-matches EV Current Request over HLC, but commands -5Amps	6	16	--
TS16: V2G: Dynamic Bi-directional Power Transfer using ISO15118-20, command -5Amps	8	24	--

Awards and Outcomes

ACM will work with CharIN to coordinate an awards ceremony to recognize the achievements and efforts of those who participated in this PTP. This awards ceremony is designed to be in good spirits with rewards that may include ribbons, certificates, trophies, swag/merch, etc. Not all awards will be given solely on meeting pass criteria, some may be based on individual efforts, pairing efforts, number of attempts, striving for more challenging tests, etc.

Test Setup, Procedures & Results Tracking

Section A: EVSE Meta Data *complete once per EVSE equipment*

QA1: Specify Equipment Type ..... (EVSE)

QA2: Select level of charging available:
- AC Charging ..... (Yes / No)
- DC Charging ..... (Yes / No)

QA3: Select charging handle types available:
- J1772 ..... (Yes / No)
- CHAdeMO ..... (Yes / No)
- CCS Type 1 ..... (Yes / No)
- CCS Type 2 ..... (Yes / No)
- NACS ..... (Yes / No)
- SAE J3400 ..... (Yes / No)

QA4: Select Product stage ..... (Prototype / Pre-Production / Series Production / Not Scheduled)

QA5: Select common implemented protocols available for testing:
- DIN SPEC 70121:2014 OR SAE J2931/4 2014-10 & SAE J2847-2 2015-04 ..... (Yes / No)
- ISO/IS 15118-2:2014 & ISO/IS 15118-3:2015 ..... (Yes / No)
- ISO/IS 15118-20:2022 & ISO/IS 15118-3:2015 ..... (Yes / No)

QA6: Select supported ISO/IEC 15118-2 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QA7: Select supported ISO/IEC 15118-20 authentication types available:
- External Identification Means (EIM) ..... (Yes / No)
- Plug&Charge ..... (Yes / No)

QA8: Select supported ISO/IEC 15118-20 transport protocols:
- TCP (for testing only) ..... (Yes / No)
- TLS 1.2 (for testing only) ..... (Yes / No)
- TLS 1.3 (standard) ..... (Yes / No)

QA9: Select EIM types available:
- Credit Card INSERT ..... (Yes / No)
- Credit Card TAP ..... (Yes / No)
- RFID ..... (Yes / No)
- App ..... (Yes / No)
- Other EIM _____ / No)

Section B: EV Meta Data *complete once per EV equipment*

QB1: Specify Equipment Type.....(EV)

QB2: Select level of charging available:
- AC Charging.....(Yes / No)
- DC Charging.....(Yes / No)

QB3: Select charging inlet types available:
- J1772.....(Yes / No)
- CHAdeMO.....(Yes / No)
- CCS Type 1.....(Yes / No)
- CCS Type 2.....(Yes / No)
- NACS.....(Yes / No)
- SAE J3400.....(Yes / No)

QB4: Select Product stage..... (Prototype / Pre-Production / Series Production / Not Scheduled)

QB5: Select common implemented protocols available for testing:
- DIN SPEC 70121:2014 OR SAE J2931/4 2014-10 & SAE J2847-2 2015-04.....(Yes / No)
- ISO/IS 15118-2:2014 & ISO/IS 15118-3:2015.....(Yes / No)
- ISO/IS 15118-20:2022 & ISO/IS 15118-3:2015.....(Yes / No)

QB6: Select supported ISO/IEC 15118-2 authentication types available:
- External Identification Means (EIM).....(Yes / No)
- Plug&Charge.....(Yes / No)

QB7: Select supported ISO/IEC 15118-20 authentication types available:
- External Identification Means (EIM).....(Yes / No)
- Plug&Charge.....(Yes / No)

QB8: Select supported ISO/IEC 15118-20 transport protocols:
- TCP (for testing only).....(Yes / No)
- TLS 1.2 (for testing only).....(Yes / No)
- TLS 1.3 (standard).....(Yes / No)

Section C: Test Slot Meta Data *complete every Test Slot*

Pre-test data

QA1: Test Slot Number _____

QA2: Moderator Name _____

QA3: Prescribed Testing Start Time _____

QA4: EVSE enrolled in Prescribed Testing ..... (Yes / No)

QA5: EV enrolled in Prescribed Testing ..... (Yes / No)

QA6: The following has been reviewed with testers ..... (Yes / No)

- List of test scenarios
    - Desired or possible tests for testing pair (recommend all 8 is possible)
    - Remind how long per test that equates to (30min ÷ #tests)
- Structure of test scenarios:
    - Test purpose, preconditions, steps, pass criteria, results tracking, etc.
- EVSE Meta Data collected.
- EV Meta Data collected.
- Even if tests have already been completed in adhoc, instruct to re-perform them now during prescribed testing (time taken to complete, are steps accurate, feedback on pass criteria, etc).
- Any additional open questions

QA7: Which tests desired/possible ..... (TS1 / TS2 / TS3 / TS4 / TS5 / TS6 / TS7 / TS8)

- Float moderator will go around to each pairing at start of session to record who is attempting PnC testing. He will let Hubject team know which require expired EV certificates and will begin issuing

Post-test data

QA8: Number of tests attempted _____

QA9: Which tests attempted (circle) ..... (TS1 / TS2 / TS3 / TS4 / TS5 / TS6 / TS7 / TS8)

QA10: Any outstanding issues _____

QA11: Tester1 comments _____

_____

QA12: Tester2 comments _____

_____

QA13: Moderator comments _____

_____

_____

Section D: Test Scenarios Detailed

Test Scenario 1:

Test Scenario 1: Authenticate-first using DIN 70121 or J1772						
Test Identifier:	Test Scenario 1					
Test Name:	Authenticate-first using DIN 70121 or J1772					
Test Type:	Intentional Charging					
Test Category:	Authentication Types, Methods & Timeouts					
Purpose:	- To ensure "Authenticate-first" option is available - To ensure different authentication types are available and accepted - To ensure specified HLC protocol is accepted					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, HLC Protocol Used					
Intended MRECs/Errors:	None					
Possible MRECs/Errors:	"HLC Not Supported"					
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Authenticate				
	HLC Protocol:	**DIN 70121 / J1772**				
	Involved Systems:	EV, EVSE				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Provide **'Authentication Type'**				
	4	Within 30 seconds, Plug-In EV				
	5	Observe session initialization into power transfer				
	6	Terminate charge session 30 - 60 seconds into power transfer				
	7	Unplug EV				
Pass Criteria: **(Check box if met)**			**A1**	**A2**	**A3**	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**2pt**
	#1 EVSE: Charge started utilizing specified **'HLC Protocol'**		☐	☐	☐	**2pt**
	#1 EV: Charge started utilizing specified **'HLC Protocol'**		☐	☐	☐	**2pt**
	Total Points					
Comments						

Test Scenario 2:

Test Scenario 2: Authenticate-first using ISO 15118-2						
Test Identifier:	Test Scenario 2					
Test Name:	Authenticate-first using ISO 15118-2					
Test Type:	Intentional Charging					
Test Category:	Authentication Types, Methods & Timeouts					
Purpose:	- To ensure "Authenticate-first" option is available - To ensure different authentication types are available and accepted - To ensure specified HLC protocol is accepted					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, HLC Protocol Used					
Intended MRECs/Errors:	None					
Possible MRECs/Errors:	"HLC Not Supported"					
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Authenticate				
	HLC Protocol:	**ISO 15118-2**				
	Involved Systems:	EV, EVSE				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Provide **'Authentication Type'**				
	4	Within 30 seconds, Plug-In EV				
	5	Observe session initialization into power transfer				
	6	Terminate charge session 30 - 60 seconds into power transfer				
	7	Unplug EV				
Pass Criteria: (Check box if met)			**A1**	**A2**	**A3**	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**2pt**
	#1 EVSE: Charge started utilizing specified **'HLC Protocol'**		☐	☐	☐	**3pt**
	#1 EV: Charge started utilizing specified **'HLC Protocol'**		☐	☐	☐	**3pt**
	Total Points					
Comments						

Test Scenario 3:

Test Scenario 3: Authenticate-first using ISO 15118-20						
Test Identifier:	Test Scenario 3					
Test Name:	Authenticate-first using ISO 15118-20					
Test Type:	Intentional Charging					
Test Category:	Authentication Types, Methods & Timeouts					
Purpose:	- To ensure "Authenticate-first" option is available - To ensure different authentication types are available and accepted - To ensure specified HLC protocol is accepted					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, HLC Protocol Used					
Intended MRECs/Errors:	None					
Possible MRECs/Errors:	"HLC Not Supported"					
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Authenticate				
	HLC Protocol:	**ISO 15118-20**				
	Involved Systems:	EV, EVSE				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Provide **'Authentication Type'**				
	4	Within 30 seconds, Plug-In EV				
	5	Observe session initialization into power transfer				
	6	Terminate charge session 30 - 60 seconds into power transfer				
	7	Unplug EV				
Pass Criteria: **(Check box if met)**			**A1**	**A2**	**A3**	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**2pt**
	#1 EVSE: Charge started utilizing specified **'HLC Protocol'**		☐	☐	☐	**6pt**
	#1 EV: Charge started utilizing specified **'HLC Protocol'**		☐	☐	☐	**6pt**
	Total Points					
Comments						

Test Scenario 4:

Test Scenario 4: Disconnect Pilot @EVSE or @EV during Power Transfer (PT)						
Test Identifier:	Test Scenario 4					
Test Name:	Disconnect Pilot @EVSE or @EV during PT					
Test Type:	Intentional Faults					
Test Category:	Power Transfer (PT) Tests					
Purpose:	- To emulate a lost Pilot signal during an active charge session - To ensure EV and EVSE systems detect lost Pilot and react appropriately					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response					
Intended MRECs/Errors:	"PilotFault"					
Possible MRECs/Errors:						
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Authenticate				
	HLC Protocol:	DIN 70121 / J1772, ISO 15118-2, or ISO 15118-20				
	Involved Systems:	EV, EVSE				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Provide **'Authentication Type'**				
	4	Within 30 seconds, Plug-In EV				
	5	Observe session initialization into power transfer				
	6	Disconnect Pilot signal at EVSE or EV 30-60 seconds into power transfer				
	7	If session does not fault/end, manually terminate charge session				
	8	Unplug EV				
Pass Criteria: **(Check box if met)**			**A1**	**A2**	**A3**	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**3pt**
	#3 EVSE: EVSE visual "Pilot" error, session ends		☐	☐	☐	**3pt**
	#2 EVSE: EVSE visual generic error, session ends		☐	☐	☐	**2pt**
	#1 EVSE: EVSE no visual error, session ends		☐	☐	☐	**1pt**
	#3 EV: EV visual "Pilot" error, session ends		☐	☐	☐	**3pt**
	#2 EV: EV visual generic error, session ends		☐	☐	☐	**2pt**
	#1 EV: EV no visual error, session ends		☐	☐	☐	**1pt**
	Stretch Goal: EVSE "PilotFault" MREC thrown		☐	☐	☐	**5pt**
	Total Points					
Comments						

Test Scenario 5:

Test Scenario 5: Press Latch during Session Initialization (SI)						
Test Identifier:	Test Scenario 5					
Test Name:	Latch Press during Session Initialization (SI)					
Test Type:	Intentional Faults					
Test Category:	Session Initialization (SI) Tests					
Purpose:	- To emulate an EV driver pressing connector latch during session initialization - To witness EV and EVSE systems behavior when attempting latch press during SI					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response					
Intended MRECs/Errors:	"ConnectorLockFailure", "ProximityFailure"					
Possible MRECs/Errors:						
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Authenticate				
	HLC Protocol:	DIN 70121 / J1772, ISO 15118-2, or ISO 15118-20				
	Involved Systems:	EV, EVSE				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Provide **'Authentication Type'**				
	4	Within 30 seconds, Plug-In EV				
	5	Within 5-10 seconds of plug-in, press connector latch				
	6	If session does not fault/end upon latch press, manually terminate charge session during PT				
	7	Unplug EV				
Pass Criteria: **(Check box if met)**			A1	A2	A3	**Points**
	Start Time:					**--**
	End Time:					**--**
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**3pt**
	#4 EVSE: EVSE Latch cannot be pressed during SI		☐	☐	☐	**3pt**
	#3 EVSE: EVSE visual "Connector Lock" error, session ends		☐	☐	☐	**3pt**
	#2 EVSE: EVSE visual generic error, session ends		☐	☐	☐	**2pt**
	#1 EVSE: EVSE no visual error, session ends		☐	☐	☐	**1pt**
	#4 EV: EV does not allow Latch to be pressed during SI		☐	☐	☐	**3pt**
	#3 EV: EV visual "Connector Lock" error, session ends		☐	☐	☐	**3pt**
	#2 EV: EV visual generic error, session ends		☐	☐	☐	**2pt**
	#1 EV: EV no visual error, session ends		☐	☐	☐	**1pt**
	Total Points					
Comments						

Test Scenario 6:

Test Scenario 6: Press EVSE Emergency Stop during PT then Attempt Unplug from EV						
Test Identifier:	Test Scenario 6					
Test Name:	Press EVSE Emergency Stop during PT then Attempt Unplug from EV					
Test Type:	Intentional Faults					
Test Category:	Power Transfer (PT) Tests					
Purpose:	- To emulate a loss of power event to the EVSE - To ensure EV driver can unplug vehicle in the event of total EVSE power loss					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response					
Intended MRECs/Errors:	"EmergencyStop", "PowerLoss"					
Possible MRECs/Errors:						
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Authenticate				
	HLC Protocol:	DIN 70121 / J1772, ISO 15118-2, or ISO 15118-20				
	Involved Systems:	EV, EVSE				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Provide **'Authentication Type'**				
	4	Within 30 seconds, Plug-In EV				
	5	Observe session initialization into power transfer				
	6	Within 30 seconds of PT, press EVSE emergency stop to disconnect input power to EVSE				
	7	Attempt to unplug EV				
	8	If unable to unplug EV, restore power to EVSE				
	9	Unplug EV				
Pass Criteria: **(Check box if met)**			A1	A2	A3	Points
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	3pt
	#4 EVSE: EVSE allows connector to be unplugged after EVSE power loss		☐	☐	☐	1pt
	#3 EVSE: EVSE visual "EmergencyStop" or similar error, session ends		☐	☐	☐	3pt
	#2 EVSE: EVSE visual generic error, session ends		☐	☐	☐	2pt
	#1 EVSE: EVSE no visual error, session ends		☐	☐	☐	1pt
	#4 EV: EV allows connector to be unplugged after EVSE power loss		☐	☐	☐	1pt
	#3 EV: EV visual "ConnectorLock" error, session ends		☐	☐	☐	3pt
	#2 EV: EV visual generic error, session ends		☐	☐	☐	2pt
	#1 EV: EV no visual error, session ends		☐	☐	☐	1pt
	Stretch Goal: EVSE "EmergencyStop" MREC is thrown		☐	☐	☐	5pt
	Total Points					
Comments						

Test Scenario 7:

Test Scenario 7: Disconnect all Network Connections then Attempt Authentication						
Test Identifier:	Test Scenario 7					
Test Name:	Disconnect all Network Connections then Attempt Authentication					
Test Type:	Intentional Faults					
Test Category:	Session Initialization (SI) Tests					
Purpose:	- To emulate a loss of network connection prior to payment - To test if EVSE will allow session to authenticate without any network connection					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response					
Intended MRECs/Errors:	"NoInternet", "AuthenticationFault"					
Possible MRECs/Errors:						
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	~~* Plug&Charge~~ * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Plug-In				
	HLC Protocol:	DIN 70121 / J1772, ISO 15118-2, or ISO 15118-20				
	Involved Systems:	EV, EVSE				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Plug-in vehicle				
	4	Disconnect all network connections from EVSE (Wi-Fi, Ethernet, and LTE)				
	5	If fault occurs, end test				
	6	If no immediate fault, Provide **'Authentication Type'**				
	7	If no further fault, terminate session 30-60 seconds into power transfer				
	8	Unplug EV				
Pass Criteria: **(Check box if met)**			A1	A2	A3	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**3pt**
	#4 EVSE: EVSE does not fault, session begins		☐	☐	☐	**3pt**
	#3 EVSE: EVSE visual "AuthenticationFault" or similar error, session ends		☐	☐	☐	**3pt**
	#2 EVSE: EVSE visual generic error, session ends		☐	☐	☐	**2pt**
	#1 EVSE: EVSE no visual error, session ends		☐	☐	☐	**1pt**
	#4 EV: EV does not fault, session begins		☐	☐	☐	**3pt**
	#3 EV: EV visual "AuthenticationFault" or similar error, session ends		☐	☐	☐	**3pt**
	#2 EV: EV visual generic error, session ends		☐	☐	☐	**2pt**
	#1 EV: EV no visual error, session ends		☐	☐	☐	**1pt**
	Stretch Goal: EVSE "NoInternet" MREC is thrown		☐	☐	☐	**5pt**
	Total Points					
Comments						

Test Scenario 8:

Test Scenario 8: Disconnect all Network Connections during Power Transfer (PT)						
Test Identifier:	Test Scenario 8					
Test Name:	Disconnect all Network Connections during Power Transfer (PT)					
Test Type:	Intentional Faults					
Test Category:	Power Transfer (PT) Tests					
Purpose:	- To emulate a loss of network connection during power transfer - To test if EVSE will allow power trasnfer to continue without any network connection					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response					
Intended MRECs/Errors:	"NoInternet", "AuthenticationFault"					
Possible MRECs/Errors:						
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Plug-In				
	HLC Protocol:	DIN 70121 / J1772, ISO 15118-2, or ISO 15118-20				
	Involved Systems:	EV, EVSE				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Plug-in vehicle				
	4	Within 30 seconds Provide **'Authentication Type'**				
	5	Observe session initialization into power transfer				
	6	Disconnect all network connections from EVSE (Wi-Fi, Ethernet, and LTE)				
	8	If no fault, terminate session 30-60 seconds into power transfer				
	9	Unplug EV				
Pass Criteria: **(Check box if met)**			**A1**	**A2**	**A3**	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**3pt**
	#4 EVSE: EVSE does not fault, session continues		☐	☐	☐	**3pt**
	#3 EVSE: EVSE visual "AuthenticationFault" or similar error, session ends		☐	☐	☐	**3pt**
	#2 EVSE: EVSE visual generic error, session ends		☐	☐	☐	**2pt**
	#1 EVSE: EVSE no visual error, session ends		☐	☐	☐	**1pt**
	#4 EV: EV does not fault, session continues		☐	☐	☐	**3pt**
	#3 EV: EV visual "AuthenticationFault" error, session ends		☐	☐	☐	**3pt**
	#2 EV: EV visual generic error, session ends		☐	☐	☐	**2pt**
	#1 EV: EV no visual error, session ends		☐	☐	☐	**1pt**
	Stretch Goal: EVSE "NoInternet" MREC is thrown		☐	☐	☐	**5pt**
	Total Points					
Comments						

Test Scenario 9:

Test Scenario 9: Pause&Resume Manually Curtail EVSE to Zero Current during PT						
Test Identifier:	Test Scenario 9					
Test Name:	Pause&Resume Manually Curtail EVSE to Zero Current during PT					
Test Type:	Intentional Charging					
Test Category:	Pause&Resume					
Purpose:	- To emulate a workaround approach to pause&resume by EVSE limiting to zero current - To test if EV will allow for extremely low current without ending charge session (i.e. performance check)					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, CSMS/EVSE curtailment command					
Intended MRECs/Errors:	None					
Possible MRECs/Errors:	EV Performance Check Failure @ low current					
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Plug-In				
	HLC Protocol:	DIN 70121 / J1772, ISO 15118-2, or ISO 15118-20				
	Involved Systems:	EV, EVSE				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Plug-in vehicle				
	4	Within 30 seconds Provide **'Authentication Type'**				
	5	Observe session initialization into power transfer				
	6	After 30 seconds of power transfer, curtail EVSE current to 0Amp for 60seconds via "EVSE available current" or via OCPP curtailment command				
	7	Remove EVSE curtailment and allow charge session to return to full power				
	8	After 30 seconds, terminate charge session				
	9	Unplug EV				
Pass Criteria: **(Check box if met)**			A1	A2	A3	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**4pt**
	#3 EVSE: EVSE allows for 0Amp curtailment to be commanded for full 60sec, then returns to full power		☐	☐	☐	**5pt**
	#2 EVSE: EVSE allows for 0Amp curtailment to be commanded for some duration before faulting		☐	☐	☐	**3pt**
	#1 EVSE: EVSE does not allow for 0amp curtailment due to too low current		☐	☐	☐	**2pt**
	#3 EV: EV allows for 0Amp curtailment to be commanded and returns to full power after curtailment window is ended		☐	☐	☐	**5pt**
	#2 EV: EV allows for 0Amp curtailment to be commanded for some duration before faulting		☐	☐	☐	**3pt**
	#1 EV: EV does not allow for 0amp curtailment due to too low current		☐	☐	☐	**2pt**
	Total Points					
Comments						

Test Scenario 10:

Test Scenario 10: Pause&Resume Activating a "Pause" during PT using Charge Scheduling		
Test Identifier:	Test Scenario 10	
Test Name:	Pause&Resume Activating a "Pause" during PT using Charge Scheduling	
Test Type:	Intentional Charging	
Test Category:	Pause&Resume	
Purpose:	- To test functionality of ISO 15118-2 Pause&Resume charging feature	
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, HLC Message Sequence	
Intended MRECs/Errors:	None	
Possible MRECs/Errors:	InvalidSequence	
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)	
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM
	Plug-In or Authenticate First:	Plug-In
	HLC Protocol:	ISO 15118-2, or ISO 15118-20
	Involved Systems:	EV, EVSE
	EV HMI charge scheduling values:	*EVChargeParameter* includes; EAmount: 10kWh, Duration: 3600 (1 hour)
	EVSE charge scheduling values:	*PMaxScheduleEntry* ; [0] start: 0, PMax: "nonzero" W [1] start: 30, PMax: 0 W [2] start: 90, Pmax: "nonzero" W
	Charge Scheduling:	* EV must have AC charge scheduling feature for AC charging * EV must have DC charge scheduling feature for DC charging

Steps:		
	1	Set EVSE HLC highest priority to **'HLC Protocol'**
	2	Set EVSE authentication option to **'Authentication Type'**
	3	Set **'EV HMI charging schedule values'**
	4	Set **'EVSE charge availability' values'**
	5	Plug-in vehicle
	6	Within 30 seconds Provide **'Authentication Type'**
	7	Observe session initialization HLC Messaging and record EV '*PowerDeliveryReq > ChargingProfile'*
	8	Observe power transfer, observe '*SessionStopReq: 'Pause"* 30 seconds into power transfer
	9	Observe full power charge session begin 60 seconds after *'Pause'*
	10	After 30 seconds of full power transfer, terminate charge session
	11	Unplug EV

Pass Criteria: **(Check box if met)**		A1	A2	A3	Points
	Start Time:				--
	End Time:				--
	ATTEMPT: Test scenario was attempted	☐	☐	☐	7pt
	#3 EVSE: EVSE creates *PMaxSchedule* as specified, EV initiates a *Pause,* then EVSE resumes back to full power as per the *PMaxSchedule*	☐	☐	☐	7pt
	#2 EVSE: EVSE creates *PMaxSchedule* as specified, EV initiates a *Pause,* EVSE does not resume back to full power after (i.e. session ends)	☐	☐	☐	2pt
	#1 EVSE: EVSE does not create *PMaxSchedule* as specified, session does not pause during charge session	☐	☐	☐	1pt
	#4 EV: EV communicates *EVChargeParameter,* and creates *ChargingProfile* that initiates a *Pause* , then resumes back to full power as per the EVSE *PMaxSchedule*	☐	☐	☐	7pt
	#3 EV: EV communicates *EVChargeParameter,* but creates *ChargingProfile* that does not initiate a *Pause,* session begins	☐	☐	☐	4pt
	#2 EV: EV communicates *EVChargeParameter,* but does not create *ChargingProfile* , session begins	☐	☐	☐	2pt
	#1 EV: EV does not communicate *EVChargeParameter,* session still begins	☐	☐	☐	1pt
	Total Points				

Comments	

ISO 15118-2:2013 or ISO 15118-2:2015

TS10: Generalized HLC Messaging for Charge Scheduling Pause&Resume

SupportedAppProtocol:

```
EV: "supportedAppProtocolReq":
>AppProtocol
>>[0]
        ProtocolNamespace: urn:din:70121:2012:MsgDef\0
        ...
        SchemaID: 10
        Priority: 3
>>[1]
        ProtocolNamespace: urn:iso:15118:2:2013:MsgDef\0
        ...
        SchemaID: 20
        Priority: 2
>>[2]
        ProtocolNamespace: urn:iso:15118:2:2015:MsgDef\0
        ...
        SchemaID: 30
        Priority: 1
```

```
EVSE: "supportedAppProtocolRes":
        ResponseCode: Success
        SchemaID: 30
```

ChargeParameterDiscovery:

```
EV: "ChargeParameterDiscoveryReq": #This will need to be programmed by EV
>DC_EVChargeParameter              #for ACL2 use "AC_EVChargeParameter"
        DepartureTime   6600       #11 hours from plug-in on HMI
        EAmount
                Multiplier      0       #20kWh energy needed
                Unit            Wh
                Value           20000
        EVMaxVoltage
                ...             ____ V  #Based on EV limits
        EVMaxCurrent
                ...             ____ A  #Based on EV limits
        EVMinCurrent
                ...             0    A
>RequestedEnergyTransferMode
        DC_extended                #for ACL2 use "AC_single_phase_core"
>MaxEntriesSAScheduleTuple
        32                      #Number of allowable tuples for scheduling
```

```
EVSE: "ChargeParameterDiscoveryRes":    #Programmed by EVSE
>SAScheduleList
>>SAScheduleTuple
>>>PMaxSchedule
>>>>PMaxScheduleEntry
>>>>>[0]
        RelativeTimeInterval            #20kW @ beginning
                start           0
        PMax
                Multiplier      0
                Unit            W
                Value           20000
>>>>>[1]
        RelativeTimeInterval            #0kW @ 30sec
                start           30
        PMax
                Multiplier      0
                Unit            W
                Value           0
>>>>>[2]
        RelativeTimeInterval            #20kW @ 90sec
                start           90
        PMax
                Multiplier      0
                Unit            W
                Value           20000
```

PowerDelivery:

```
EV: "PowerDeliveryReq": #Ex. response determined by the EV BMS CPDRes
>ChargingProfile
>>ProfileEntry (0)
        ChargingProfileEntryStart       0
        ChargingProfileEntryMaxPower    20000W
>>ProfileEntry (1)
        ChargingProfileEntryStart       30  #EV should initiate "Pause"
        ChargingProfileEntryMaxPower    0W
>>ProfileEntry (2)
        ChargingProfileEntryStart       90
        ChargingProfileEntryMaxPower    20000W
>>ChargeProgress        Start
>>SASScheduleTupleID    1
```

```
EVSE: "PowerDeliveryRes":
>ResponseCode: OK
```

SessionStop:

```
EV: "SessionStopReq":
>SessionID: ...
>ChargingSession: Pause
```

```
EVSE: "SessionStopRes":
>SessionID: ...
>ResponseCode: OK
```

Test Scenario 11:

Test Scenario 11: Plug&Charge Valid EV & EVSE Certificates						
Test Identifier:	Test Scenario 11					
Test Name:	Plug&Charge Valid EV & EVSE Certificates					
Test Type:	Intentional Charging					
Test Category:	Plug&Charge					
Purpose:	- To test functionality of ISO 15118-2/20 Plug&Charge using valid certificates					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, HLC Message Sequence, PKI Provider					
Intended MRECs/Errors:	None					
Possible MRECs/Errors:	InvalidToken, InvalidPayment					
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug & Charge ~~* Credit Card INSERT~~ ~~* Credit Card TAP~~ ~~* RFID~~ ~~* App~~ ~~* Other EIM~~				
	Plug-In or Authenticate First:	Plug-In				
	HLC Protocol:	ISO 15118-2, or ISO 15118-20				
	Involved Systems:	EV, EVSE, PKI Provider				
	PKI Certificate Source	Private Certificate, CharIN Sponsor Provided Certificate				
Steps:	**1**	Ensure EV Contract certificate is valid, sourced by **'PKI Certificate Source'**				
	2	Ensure EVSE Leaf certificate is valid, sourced by **'PKI Certificate Source'**				
	3	Set EVSE HLC highest priority to **'HLC Protocol'**				
	4	Set EVSE authentication option to **'Authentication Type'**				
	5	Plug-in vehicle				
	6	Observe session initialization into power transfer				
	7	Terminate charge session 30-60s into power transfer				
	8	Unplug EV				
Pass Criteria: **(Check box if met)**			A1	A2	A3	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**5pt**
	#1 EVSE: EVSE Leaf certificates are valid, EVSE accepts valid EV certificates, session begins		☐	☐	☐	**4pt**
	#1 EV: EV accepts & uses valid EV certificates, session begins		☐	☐	☐	**4pt**
	Stretch Goal A: EVSE uses valid CharIN Provided certificates as **'Certificate Type'**		☐	☐	☐	**2pt**
	Stretch Goal B: EV uses valid CharIN Provided certificates as **'Certificate Type'**		☐	☐	☐	**2pt**
	Total Points					
Comments						

Test Scenario 12:

Test Scenario 12: Plug&Charge Expired EV Contract Certificate						
Test Identifier:	Test Scenario 12					
Test Name:	Plug&Charge Expired EV Contract Certificate					
Test Type:	Intentional Fault					
Test Category:	Plug&Charge					
Purpose:	- To test ISO 15118-2/20 Plug&Charge using expired certificates - To test fallback methods/alternatives when Plug&Charge fails due to expired EV certificates					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, HLC Message Sequence, PKI Provider					
Intended MRECs/Errors:	None					
Possible MRECs/Errors:	InvalidToken, InvalidPayment					
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug & Charge ~~* Credit Card INSERT~~ ~~* Credit Card TAP~~ ~~* RFID~~ ~~* App~~ ~~* Other EIM~~				
	Plug-In or Authenticate First:	Plug-In				
	HLC Protocol:	ISO 15118-2, or ISO 15118-20				
	Involved Systems:	EV, EVSE, PKI Provider				
	PKI Certificate Source	Private Certificate, CharIN Sponsor Provided Certificate				
Steps:	**1**	Ensure EV Contract certificate is expired, sourced by **'PKI Certificate Source'**				
	2	Ensure EVSE Leaf certificate is valid, sourced by **'PKI Certificate Source'**				
	3	Set EVSE HLC highest priority to **'HLC Protocol'**				
	4	Set EVSE authentication option to **'Authentication Type'**				
	5	Plug-in vehicle				
	6	Observe session initialization failure due to expired certificates				
	7	If fallback method prompts user for different EIM, provide such authentication and observe session initialization into power transfer				
	8	Terminate charge session 30-60s into power transfer				
	9	Unplug EV				
Pass Criteria: **(Check box if met)**			A1	A2	A3	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**5pt**
	#2 EVSE: EVSE Leaf certificates are valid, EVSE rejects expired EV certificate, EVSE prompts user to use other EIM without replugging into EV (fallback method implemented)		☐	☐	☐	**5pt**
	#1 EVSE: EVSE Leaf certificates are valid, EVSE rejects expired EV certificate, session ends.		☐	☐	☐	**4pt**
	#2 EV: EV accepts and attempts to use expired EV certificate, EV expired certificate is rejected, EV allows for EIM without replugging (fallback		☐	☐	☐	**5pt**
	#1 EV: EV accepts and attempts to use expired EV certificate, EV expired certificate is rejected, session ends.		☐	☐	☐	**4pt**
	Stretch Goal A: EVSE uses valid CharIN Provided certificates as **'Certificate Type'**		☐	☐	☐	**2pt**
	Stretch Goal B: EV uses valid CharIN Provided certificates as **'Certificate Type'**		☐	☐	☐	**2pt**
	Total Points					
Comments						

Test Scenario 13:

Test Scenario 13: Adapter Plug-In to Connector First						
Test Identifier:	Test Scenario 13					
Test Name:	Adapter Plug-In to Connector First					
Test Type:	Intentional Charging					
Test Category:	Adapter Testing					
Purpose:	- To test interoperability of adapters - To ensure different sequence methods of using adapters is accepted					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response					
Intended MRECs/Errors:	None					
Possible MRECs/Errors:	InvalidSequence					
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Authenticate first				
	HLC Protocol:	DIN 70121, J1772, ISO 15118-2, or ISO 15118-20				
	Involved Systems:	EV, EVSE, Adapters				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Provide **'Authentication Type'**				
	4	Plug adapter into EVSE connector first				
	5	Within 30seconds, Plug-in adapter to vehicle				
	6	Observe session initialization into power transfer				
	7	After 30 seconds, terminate charge session				
	8	Unplug EV				
Pass Criteria: **(Check box if met)**			A1	A2	A3	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**3pt**
	#1 EVSE: EVSE allows for adapter to be connected to connector first, session begins		☐	☐	☐	**4pt**
	#1 EV: EV allows for adapter to be connected to connector first, session begins		☐	☐	☐	**4pt**
	Stretch Goal: eSDP recognizes adapter is being used		☐	☐	☐	**4pt**
	Total Points					
Comments						

Test Scenario 14:

Test Scenario 14: Adapter Plug-In to Vehicle First						
Test Identifier:	Test Scenario 14					
Test Name:	Adapter Plug-In to Vehicle First					
Test Type:	Intentional Charging					
Test Category:	Adapter Testing					
Purpose:	- To test interoperability of adapters - To ensure different sequence methods of using adapters is accepted					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response					
Intended MRECs/Errors:	None					
Possible MRECs/Errors:	InvalidSequence					
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Authenticate first				
	HLC Protocol:	DIN 70121, J1772, ISO 15118-2, or ISO 15118-20				
	Involved Systems:	EV, EVSE, Adapters				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Provide **'Authentication Type'**				
	4	Plug adapter into vehicle inlet first				
	5	Within 30seconds, Plug-in connector to adapter				
	6	Observe session initialization into power transfer				
	7	After 30 seconds, terminate charge session				
	8	Unplug EV				
Pass Criteria: **(Check box if met)**			A1	A2	A3	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**3pt**
	#1 EVSE: EVSE allows for adapter to be connected to vehicle first, session begins		☐	☐	☐	**4pt**
	#1 EV: EV allows for adapter to be connected to vehicle first, session begins		☐	☐	☐	**4pt**
	Stretch Goal: eSDP recognizes adapter is being used		☐	☐	☐	**4pt**
	Total Points					
Comments						

Test Scenario 15:

Test Scenario 15: V2G EVSE Spoof-Matches EV Current Request over HLC, but Commands -5Amps						
Test Identifier:	Test Scenario 15					
Test Name:	V2G EVSE Spoof-Matches EV Current Request over HLC, but Commands -5Amps					
Test Type:	Intentional Charging					
Test Category:	Vehicle-2-Grid					
Purpose:	- To emulate a workaround approach to V2G by manipulating *CurrendDemandRes* communicated to EV by EVSE and what is actually the current commanded by EVSE - To test for vulnerabilities in EV charge session monitoring (i.e. if negative current can be achieved in this method)					
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, CSMS/EVSE curtailment command					
Intended MRECs/Errors:	None					
Possible MRECs/Errors:	Performance Check failuire, Invalid messaging					
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)					
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM				
	Plug-In or Authenticate First:	Plug-In				
	HLC Protocol:	DIN 70121				
	Involved Systems:	EV, EVSE				
Steps:	**1**	Set EVSE HLC highest priority to **'HLC Protocol'**				
	2	Set EVSE authentication option to **'Authentication Type'**				
	3	Plug-in vehicle				
	4	Within 30 seconds Provide **'Authentication Type'**				
	5	Observe session initialization into power transfer				
	6	Ensure EV continuously sends (over HLC) *CurrentDemandReq > EV Target Current* as intended without alterations.				
	7	Ensure EVSE continuously responds (over HLC) with *CurrentDemandRes > EVSE Present Current* matching the EV requested target current.				
	8	After HLC handshake, ensure EVSE does not internally command the communicated *EVSE Present Current* , and instead commands -5Amps.				
	9	If no fault occurs, after 60 seconds terminate charge session				
	10	Unplug EV				
Pass Criteria: **(Check box if met)**			**A1**	**A2**	**A3**	**Points**
	Start Time:					--
	End Time:					--
	ATTEMPT: Test scenario was attempted		☐	☐	☐	**6pt**
	#2 EVSE: EVSE manipulates HLC, EV allows for -5Amps to be delivered		☐	☐	☐	**5pt**
	#1 EVSE: EVSE manipulates HLC, EV does not allow for -5Amps to be delivered, session ends		☐	☐	☐	**3pt**
	#2 EV: EV manipulates HLC, EV allows for -5Amps to be delivered		☐	☐	☐	**5pt**
	#1 EV: EV manipulates HLC, EV does not allow for -5Amps to be delivered, session ends		☐	☐	☐	**3pt**
	Total Points					
Comments						

IEC DIN 70121:2012

TS15: Generalized HLC Messaging for DIN 70121 Bi-directional Power Transfer

<table>
<tr>
<td><u>SupportedAppProtocol</u>:

```
EV: "supportedAppProtocolReq":
>AppProtocol
>>[0]
        ProtocolNamespace: urn:din:70121:2012:MsgDef\0
        ...
        SchemaID: 10
        Priority: 3
>>[1]
        ProtocolNamespace: urn:iso:15118:2:2013:MsgDef\0
        ...
        SchemaID: 20
        Priority: 2
>>[2]
        ProtocolNamespace: urn:iso:15118:2:2015:MsgDef\0
        ...
        SchemaID: 30
        Priority: 1
```

</td>
<td>

```
EVSE: "supportedAppProtocolRes":        #DIN 70121 chosen
        ResponseCode: Success
        SchemaID: 10
```

</td>
</tr>
<tr>
<td><u>CurrentDemand:</u>

```
EV: "CurrentDemandReq":
>CurrentDemandReq
>>DC_EVStatus ...
>>>EVTargetVoltage ...
>>>EVTargetCurrent             [EV Target Current (derived): "EV_Value"]
>>>EVMaximumVoltageLimit ...                                  #^Positive value requested by EV
>>>EVMaximumCurrentLimit ...
>>>RemainingTimeToFullSOC ...
>>>RemainingTimeToBulkSOC ...
```

continuous loop during PT</td>
<td>

```
EVSE: "CurrentDemandRes":
>CurrentDemandRes
       [ResponseCode: OK (0)]
>>DC_EVSEStatus ...
>>>EVSEPresentVoltage ...
>>>EVSEPresentCurrent          [EVSE Present Current (derived): "EV_Value"]
>>>EVSECurrentLimitAchieved ...                                  #^Matches requested EV value
>>>EVSEVoltageLimitAchieved ...
>>>EVSEPowerLimitAchieved ...
>>>EVSEMaximumVoltageLimit ...
>>>EVSEMaximumCurrentLimit ...
>>>EVSEMaximumPowerLimit ...
```

continuous loop during PT</td>
</tr>
</table>

Test Scenario 16:

Test Scenario 16: V2G Dynamic BPT using ISO 15118-20, Command -5Amps		
Test Identifier:	Test Scenario 16	
Test Name:	V2G Dynamic BPT using ISO 15118-20, Command -5Amps	
Test Type:	Intentional Charging	
Test Category:	Vehicle-2-Grid	
Purpose:	- To test ISO 15118-20 V2G Dynamic Bidirectional Power Transfer charging feature - To test charge scheduling capabilities within Dynamic BPT	
Observed Metrics:	Session initialization stages, EV UI response, EVSE UI response, HLC Messaging	
Intended MRECs/Errors:	None	
Possible MRECs/Errors:	MessageSequenceFailure, Other failure	
Recorded Test Results:	* Pass Criteria Met * Point of failure (if applicable)	
Pre-Test Conditions:	Authentication Type (*choose):	* Plug&Charge * Credit Card INSERT * Credit Card TAP * RFID * App * Other EIM
	Plug-In or Authenticate First:	Plug-In
	HLC Protocol:	ISO 15118-2:2015, ISO 15118-20
	EV ServiceIDs:	*ServiceDiscovery:* [0]: ServiceID:2, [1] ServiceID:17
	EV Charge Parameters:	*ChargeParameterDiscoveryReq:* EVMinimumEnergyRequest: -5000W EVMaximumDischargePower: -10000W EVMaximumDischargeCurrent: -10A EVMinimumSOC: 5%
	EVSE Charge Parameters:	*ChargeParameterDiscoveryRes:* EVSEMaximumDischargePower: -10000W EVSEMaximumDischargeCurrent: -10A
	EV Bidirectional Control:	*DC_BidirectionalControlReq:* EVTargetCurrent: 'value' EVMaximumDischargeCurrent: -10A EVMaximumDischargePower: -10000W
	EVSE Bidirectional Control:	*DC_BidirectionalControlRes:* EVSEPresentCurrent: -5A
	Involved Systems:	EV, EVSE

Steps:		
	1	Set EVSE HLC highest priority to **'HLC Protocol'**
	2	Set EVSE authentication option to **'Authentication Type'**
	3	Set EV available service IDs to **'EV ServiceIDs'**
	4	Set EV charge parameters to include **'EV Charge Parameters'** values
	4	Set EVSE charge parameters to include **'EVSE Charge Parameters'** values
	5	Plug-in vehicle
	6	Within 30 seconds Provide **'Authentication Type'**
	7	Observe session initialization into power transfer
	8	Ensure EV continuously sends (over HLC) **'EV Bidirectional Control'**
	9	Ensure EVSE continuously responds (over HLC) with **'EVSE Bidirectional Control'**
	10	If no fault occurs, after 60 seconds terminate charge session
	11	Unplug EV

Pass Criteria: **(Check box if met)**		A1	A2	A3	Points
	Start Time:				--
	End Time:				--
	ATTEMPT: Test scenario was attempted	☐	☐	☐	8pt
	#3 EVSE: EVSE successfully commands -5amps for full 60s duration	☐	☐	☐	8pt
	#2 EVSE: EVSE successfully commands -5amps for some duration before faulting	☐	☐	☐	6pt
	#1 EVSE: EVSE communicates the prescribed HLC sequence, but bidirectional power flow does not occur	☐	☐	☐	3pt
	#3 EV: EV successfully allows for -5amps for full 60s duration	☐	☐	☐	8pt
	#2 EV: EV successfully allows for -5amps for some duration before faulting	☐	☐	☐	6pt
	#1 EV: EV communicates the prescribed HLC sequence, but bidirectional power flow does not occur	☐	☐	☐	3pt
	Total Points				

Comments	

ISO 15118-2:2015

TS16: Generalized HLC Messaging for Dynamic Bidirectional Power Transfer (DBPT)

SupportedAppProtocol:

```
EV: "supportedAppProtocolReq":
>AppProtocol
>>[0]
        ProtocolNamespace: urn:din:70121:2012:MsgDef\0
        ...
        SchemaID: 10
        Priority: 3
>>[1]
        ProtocolNamespace: urn:iso:15118:2:2013:MsgDef\0
        ...
        SchemaID: 20
        Priority: 2
>>[2]
        ProtocolNamespace: urn:iso:15118:2:2015:MsgDef\0
        ...
        SchemaID: 30
        Priority: 1
```

```
EVSE: "supportedAppProtocolRes":
        ResponseCode: Success
        SchemaID: 30
```

ServiceDiscovery:

```
EV: "ServiceDiscoveryRequest":
>SupportedServiceIDs
>>ServiceID
>>>[0]
       [ServiceID: 2]          #DC_Charging, "1" for AC_Charging
>>>[1]
       [ServiceID: 17]         #DC_BPT, "16" for AC_BPT
```

```
EVSE: "ServiceDiscoveryResponse":
>PaymentOptionList
>>PaymentOption
>>>[0]
       [PaymentOption: External Payment (1)]
>EnergyTransferServiceList
>>Service
>>>[0]
       [ServiceID: 2]
       [FreeService: 1]
>>>[1]
       [ServiceID: 17]
       [FreeService: 1]
```

PaymentServiceSelection:

```
EV: "PaymentServiceSelectionReq":
>PaymentServiceSelectionReq
       [SelectedPaymentOption: ExternalPayment (1)]
>>SelectedEnergyTransferService
       [ServiceID: 17]
       [ParameterSetID: 1]
```

```
EVSE: "PaymentServiceSelectionRes":
>PaymentServiceSelectionRes
        [ResponseCode: OK (0)]
```

ChargeParameterDiscovery:

```
EV: "ChargeParameterDiscoveryReq":
>DC_EVBidirectionalParameter          #for ACL2 use "AC_EVBidirectionalParameter"
>>DepartureTime              [DepartureTime: 0]
>>EVMaximumChargePower ..
>>EVMinimumChargePower ...
>>EVMaximumChargeCurrent ...
>>EVMinimumChargeCurrent ...
>>EVMaximumVoltage ...
>>EVTargetEnergyRequest ...
>>EVMaximumEnergyRequest ...
>>EVMinimumEnergyRequest       [Value: -5000]          #Set to -5kWh
>>TargetSOC                    [TargetSOC: 100]
>>BulkSOC                      [BulkSOC: 80]
>>EVMaximumDischargePower      [Value: -10000]         #Set to -10kW
>>EVMinimumDischargePower      [Value: 0]
>>EVMaximumDischargeCurrent    [Value: -10]            #Set to -10Amps
>>EVMinimumDischargeCurrent    [Value: 0]
>>EVMinumumVoltage ...
>>MinimumSOC                   [Value: 5]
```

```
EVSE: "ChargeParameterDiscoveryRes":
>DC_EVSEBidirectionalParameter          #for ACL2 use "AC_EVBidirectionalParameter"
       [ResponseCode: OK (0)]
       [EVSEProcessing: Finished (0)]
>>EVSEMaximumChargePower ...
>>EVSEMaximumChargeCurrent ...
>>EVSEMinimumChargeCurrent ...
>>EVSEMaximumVoltage ...
>>EVSEMinumumVoltage ...
>>EVSECurrentRegulationTolerance ...
>>EVSEPeakCurrentRipple ...
>>EVSEEnergyToBeDelivered ...
>>EVSEMaximumDischargePower    [Value: -10000]         #Set to -10kW
>>EVSEMaximumDischargeCurrent  [Value: -10]            #Set to -10Amps
>>EVSEMinimumDischargeCurrent  [Value: 0]
```

DC_BidirectionalControl:

```
EV: "DC_BidirectionalControlReq":
>DC_BidirectionalControlReq
>>EVTargetEnergyRequest ...
>>EVMaximumEnergyRequest ...
>>EVMinimumEnergyRequest ...
>>DisplayParameters
>>EVTargetCurrent             [EV Target Current: 'value']
>>EVMaximumVoltage ...
>>EVMinumumVoltage ...
>>EVMaximumChargeCurrent ...
>>EVMaximumDischargeCurrent   [Value: -10]            #Set to -10Amps
>>EVMaximumChargePower ..
>>EVMaximumDischargePower     [Value: -10000]         #Set to -10kW
```

continuous loop during PT

```
EVSE: "DC_BidirectionalControlRes":
>DC_BidirectionalControlRes
       [ResponseCode: OK (0)]
>>EVSEPresentCurrent          [EVSE Present Current (derived): -5] #command -5amps
>>EVSEPresentVoltage ...
>>EVSEPowerLimitAchieved ...
>>EVSECurrentLimitAchieved ...
>>EVSEVoltageLimitAchieved ...
>>EVSEMaximumChargePower ...
>>EVSEMaximumDischargePower ...
>>EVSEMaximumChargeCurrent ...
>>EVSEMaximumDischargeCurrent ...
>>EVSEMaximumVoltage ...
>>EVSEMinumumVoltage ...
```

continuous loop during PT