Whitepaper
of Charging Interface Initiative e.V.

CharIN Conformance Test Systems (CCTS) Specification

V1.0

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1. Abbreviations

ACD	Automatic Connection Device
BPT	Bidirectional Power Transfer
CCS	Combined Charging System
CCTS	CharIN CCS Test System
CP	Control Pilot
DIN	German Institute for Standardization
DUT	Device under Test
EIM	External Identification Means (External payment)
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
HL-COM	High Level Communication
HPGP	HomePlug Green PHY
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LL-COM	Low Level Communication
PE	Protective Earth
PLC	Power Line Communication
PnC	Plug and Charge
PWM	Pulse Width Modulation
SAE	Society of Automotive Engineers
SUT	System under Test
TLS	Transport Layer Security
WPT	Wireless Power Transfer
XML	Extensible Markup Language

2. Relevant Standards & Documents

The following standards are considered for CCTS specification:

• DIN SPEC 70121:2014	DC Communication
• IEC 61851-23 Ed1:2014	DC Charging Stations
• IEC 61851-1 Ed3:2017	Charging System General Requirements
• ISO 17409 Ed1:2015	Safety for Electric Vehicles
• IEC 62196-3 Ed1:2014	DC Inlet and coupler
• DIN SPEC 70122 Ed1:2018	Communication Testcases
• DIN VDE V 0122-2-300:2016-04	Conformance Test Spec. IEC 61851-23, Annex CC

In addition, the following CharIN documents are considered for CCTS specification:

- CharIN "Implementation Guide to DIN SPEC 70121:2014"
- CharIN "IEC 61851-23:2014 – Implementation guide for system C"
- CharIN "DC CCS Power Classes V6, 2018-06-24"
- CharIN "Test Cases for DIN SPEC 70121:2014 Implementation Guide"
- CharIN "Test Cases for system C in IEC 61851-1/-23"

3. Introduction

3.1. Scope

This document specifies the requirements of a test device, that is able to test the conformance of EV/EVSE CCS charging interfaces. This test device is being referred to as CharIN CCS Test System (short: CCTS) from here on. The specification describes a modular system approach, allowing a CCTS implementation to only cover parts of it, in order to be able to test a specific subset of the overall product conformance. This shall enable CCTS vendors to follow this CharIN e.V. specification and build a device, that is specialized for a certain area of conformance test (e.g., High Level Communication) while being fully compatible to other CCTS implementations that cover the same or more requirements. All CCTS requirements specified in this document build a minimum functionality which is necessary to execute the specified test cases.

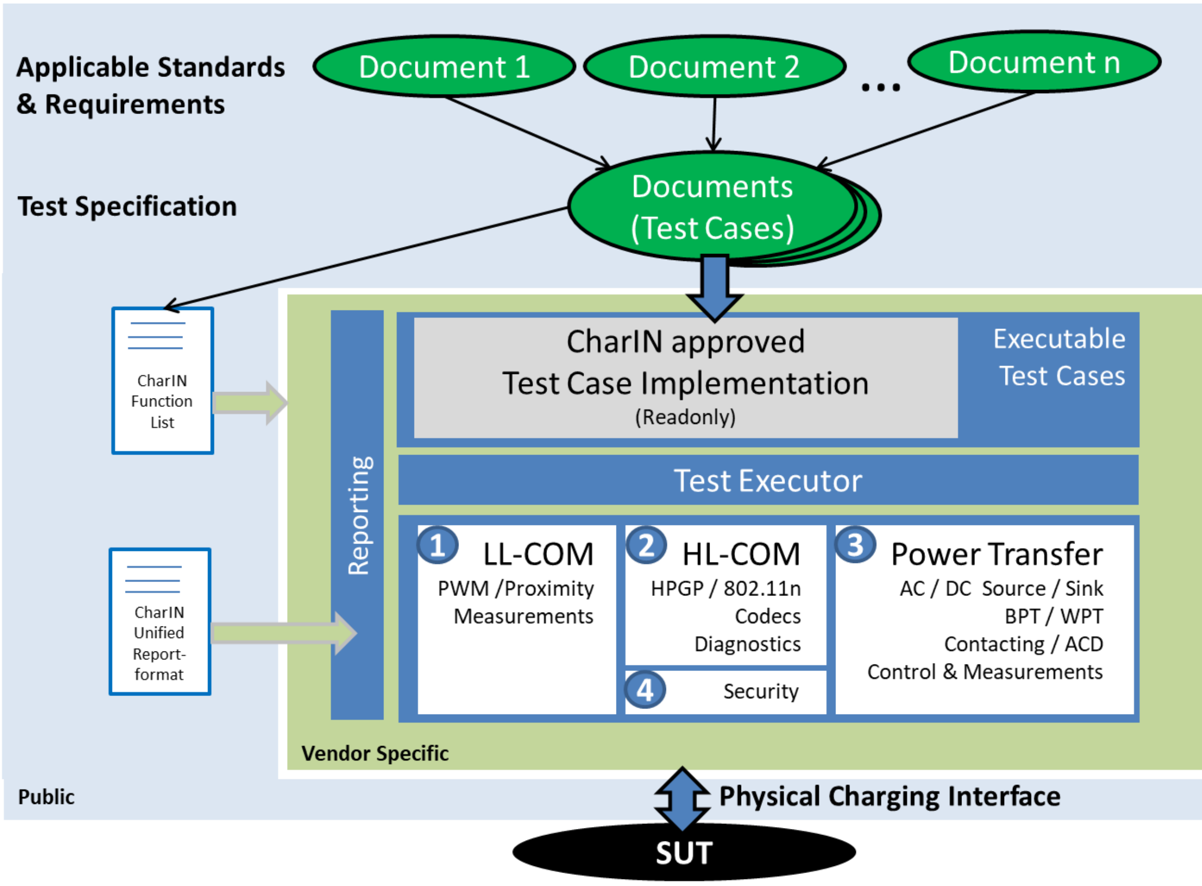
All requirements are derived from the given standards of the Combined Charging System (short: CCS). The following matrix shows the relevance of the main feature for each currently relevant CCTS configuration according to CCS steps.

Step	CCTS Configuration	LL-COM (1)	HL-COM (2)		Power Transfer (3)				Security (4)
		PWM/ Proximity	HPGP	802.11n	AC	DC	BPT	WPT	TLS/XML-Signature
	AC with PWM only	X			X				
CCS Basic	EIM with Communication only	X	X						
CCS Basic	EIM with Power Transfer	X	X		X	X			
CCS Extended	PnC Communication only	X	X						X
CCS Extended	PnC with Power Transfer	X	X		X	X			X
CCS Extended	Bidirectional Power Transfer (BPT)	X	X		X	X	X		X
CCS Advanced	Wireless Power Transfer (WPT)	X		X				X	X
CCS Advanced	Automatic Connection Device (ACD)	X	X	X	X	X		X	X

For instance, when being used in early development stage, a CCTS setup may cover only communication and ignore power. At the same time, a manufacturer of only AC EV supply equipment will never need DC features for testing. On the other side, for a full CCS certification of an EV/EVSE product, the CCTS needs to provide all necessary features, to perform all conformance relevant test cases (including power and safety tests).

4. System Architecture

The following illustration visualizes all external interfaces as well as the most important function blocks of a CCTS.



The CCTS architecture basically has two parts, a public part and a vendor specific part.

The **public part** consists, besides of the to be implemented standards and specifications, of the CharIN function list and the CharIN unified test format which will be explained later in this chapter. The description and documentation of the public part contains no vendor specific elements and was created and will be maintained by the Vendor Team within the Focus Group Conformance & Interop.

The central element of the **vendor specific part** is the test executor. The test executer executes the test cases which are implemented also with a vendor specific tool. The test executer also controls the different blocks which are numbered from 1 to 4. It is not mandatory for a CCTS to provide all blocks. Which blocks are relevant are dependent on the System under Test (SUT) and can be seen in the matrix which is shown earlier in this document. The CCTS is connected to the SUT with a physical charging interface, which is described later in this document. Also, this interface is a modular part of the CCTS and dependent on the SUT. The CCTS generates a test report which content is specified as “CharIN Unified Test Report Format”.

The detailed documentation for the vendor specific part will be available from every Vendor based on the exact architecture and configuration of the individual test system.

4.1. Low Level Communication (LL-COM)

This part of the CCTS shall be able to stimulate and measure the PWM signal on the control pilot (CP). Also the proximity pilot (PP) shall be stimulated and measured with this part of the CCTS.

The exact functions of this low-level communication part of the CCTS can be seen in the “CharIN function list”.

4.2. High Level Communication (HL-COM)

This part of the CCTS shall be able to provide PLC communication which is necessary for DIN70122 and ISO15118.

The exact functions of this high-level communication part of the CCTS can be seen in the “CharIN function list”.

4.3. Power Transfer

This part of the CCTS shall be able to source current if the SUT is an EV or sink current if the SUT is an EVSE. The maximum power capacity of the CCTS is not a fixed value. It is dependent on the SUT respectively the DC power classes which are defined by CharIN.

The exact functions of this power transfer part of the CCTS can be seen in the “CharIN function list”.

4.4. Security

For testing a SUT which features ISO15118 PnC mode it is necessary that the CCTS is capable of handling TLS (e.g., setting up a TLS connection).

The exact functions of this security part of the CCTS can be seen in the “CharIN function list”.

4.5. CharIN Function List

In the ”CharIN function list” all necessary functions are defined which a CCTS has to provide to be able to cover the relevant standards.

The functions will be grouped within the following categories:

- Function block
    - LL-COM
    - HL-COM
    - Power Transfer

- Security
- Detail
- HPGP
- MSG
- Codec
- Security
- PWM
- Proximity
- AC
- DC

- SUT
  - EV
  - EVSE
  - EV&EVSE

If applicable every function contains in addition an electrical specification in which parameters like range, accuracy and resolution are specified.

4.6. CharIN Unified Test Report Format

In the first step the goal is to have a test report which is comparable manually, to have an automatically comparable format will be the future goal. For the moment only the content of the test report will be defined, not the file format or representation. But the file format should be a common readable format e.g., Excel CSV.

Like the entire CCTS specification, only the minimum requirement for a test report will be defined. It is up to the single Vendor to offer more information in the test report. A distinction is made between the header content, which is available only once per test report and the test cases content which is available for each test case.

Header content:

- Start date / time
- Stop date / time
- Tester / Operator / Login name
- Test Setup
  - Vendor
  - Version of Test Execution Software
  - Version of Test Package (optional, waiting for Versioning of CharIN)
  - Used Hardware / Revision

- Variants (Used PICS / PIXIT)

Test case content:

- Executed testcase (ID / Name)
- Version of Test Cases
- Point of first fail
- Test Verdict (Pass / Fail / Inconclusive)
- Expected values / Actual values (in case of fail) (needs to be defined in preparation of IOP event)

4.7. Standard test setup

This chapter aims to provide an overview for an electric circuit of the test system and the DUT. Tests systems fulfills several testing functionalities, nevertheless, core functions required for the CharIN tests of DC CCS DUTs are shown on the figures within this chapter. The depicted circuit is not a strict technical requirement for the test system and may differ between different vendors. Any electric circuit that fulfills the same functions and specifications listed within this document can be used as an EV or EVSE emulator.

i. Overview of an EV-emulator test setup

Figure 1 shows the circuit diagram of an EV-emulator with a DC EVSE as a DUT.

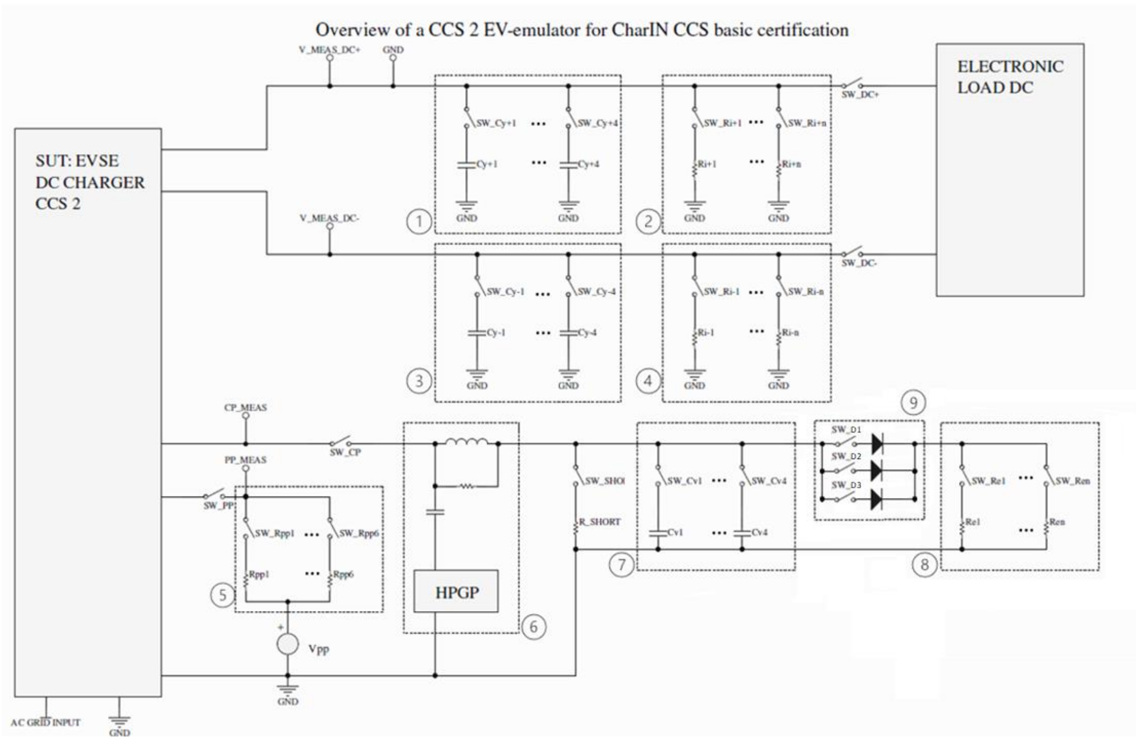


Figure 1. Overview of an EV-emulator

Table 1. Overview of EV-emulator components

Groupe number	Description	Reference	Values	Accuracy
1	Capacitance test of DC+	F-03-03-05: HV_FIU_set_Cy+_PE	0; 500; 1000; 2000 (nF)	10%
2	Insulation test of DC+	F-03-03-03: HV_FIU_set_Cy+_PE	1K, 20k; 49.9k; 97.6k; 154k; 182k; 205k; 309k; 650k 1M; >25M (Ω)	2%
3	Capacitance test of DC-	F-03-03-06: HV_FIU_set_Cy-_PE	0; 500; 1000; 2000 (nF)	10%
4	Insulation test of DC-	F-03-03-04: HV_FIU_set_Cy+_PE	1K, 20k; 49.9k; 97.6k; 154k; 182k; 205k; 309k; 650k 1M; >25M (Ω)	2%
5	Proximity Pilot resistance test	F-02-03-01: PP _EVSE_set_Resistance	fixed: [100; 150; 220; 480 (R6+R7); 680; 1500] +/- var: 0...100	1%
6	Circuit for HPGP modem	Refer to ISO 15118-3:2015	NA	NA
7	Control Pilot capacitance test	F-02-02-23: CP_EV_set_Capacitance	low / 1500 /2400 / 3900 (pF)	5%
8	Control Pilot S2 resistance test	F-02-02-29: CP_EV_set_Resistance_Re	780 ... 3k (Ω)	0.1%
9*	Diode voltage drop test	F-02-02-27: CP_EV_set_Voltage_Diode	0.55; 0.7; 0.85 (V)	5%

For detailed info of the values shown in table 1, see chapter 8 and each specific test case.

ii. Definition of data acquisition

Data acquisition rate is defined following the criteria of minimum rate of 1 kHz. This value is required as a general characteristic of the tests system to fulfill all the required test cases detailed on Chapter 8 Functional Requirements.

Chapter 5.4 Performance & Response time as 1kHz as default settings for measurements. Nevertheless, it may change depending on the specific needs of each test case and the sensed value".

In accordance with the CharIN-TC_IEC61851-1_-23_V.1.0.0_CCSBasic, the values that can be measured are divided within:

- Filtered Values: Those values considered as filtered are acquired with a low pass filter and received with a sampling rate of 100Hz.

- Average Values: Some cases the filtered values require to be process under an arithmetic mean and then compared with the expected results. Through the CCTS Specification, those parameters are referred as "average values".

Within this document version, CharIN CCTS Specification V.1.0, it is not expected to have greater acquisition times than 100 Hz as it none of the test cases of the Chapter 8 Functional Requirements specify this. Future tests cases developed by CharIN may require higher rates.

The acquisition of the PWM of the CP requires a low pass filter to detect maximum expected fall and rise time of the signal (1 – 10 µs) while filtering out the PLC and other noises above 1 MHz CharIN recommends using a 160 kHz low pass filter.

5. General Requirements

In the following, general requirements for the CCTS are introduced and described. As mentioned before, these requirements are intended to build the minimum required functionality for the CCTS.

With reference to the system architecture defined in chapter 4, the CCTS is logically divided into four function blocks. Every function block itself shall be capable of the whole specified functionality (for details see functional requirements in chapter 6). This shall ensure a common architecture between all CCTS vendor implementations, and hence enable hybrid setups integrating single function blocks from different vendors to one CCTS conform test system.

5.1. Calibration

Every CCTS shall be calibrated properly. This is required for accurate measurement of all relevant values, like HV voltage and current or CP voltage. Additionally, this ensures consistency between all available CCTS implementations. As one result of the calibration process, the measurement error of the CCTS can be determined and, if reasonable, minimized. This may lead to a more conclusive building of verdicts within test case execution (see chapter 4.3).

For a CCTS the set and get values shall be as specified in the test cases. The tests performed by a CCTS shall be carried out.

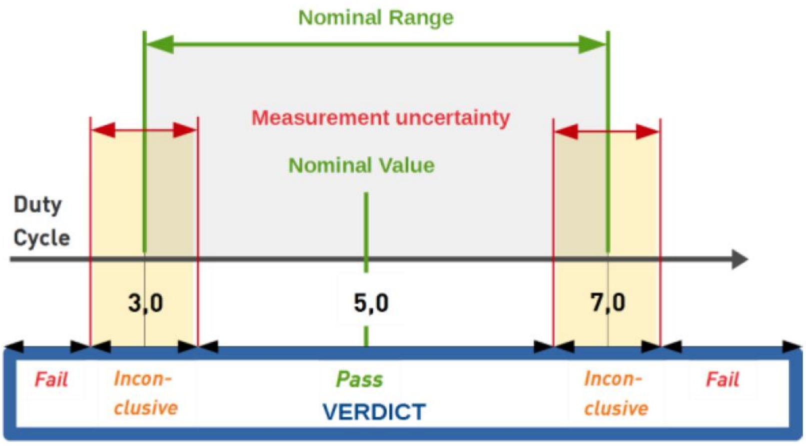
- Nominal laboratory conditions 20 °C ±5 °C
- Nominal laboratory pressure between 0.6 to 1.2 atm.
- Nominal relative humidity between 20% to 80%.

5.2. System Integration & Contacting

In case of testing a full EV or EVSE product, electro-mechanical connection to the System under test shall be realized with the respective CCS connector/inlet. These can be found in chapter 5.4.

5.3. Conclusive Verdict Building

To get a reliable verdict for specified test cases, each CCTS vendor shall consider the actual measurement accuracy / uncertainty of his test system, when building the respective verdict. This shall be done by giving the verdict “inconclusive”, when the measurements of expected results (e.g., CP voltage or duty cycle, HV voltage or current) are within the range of the measurement uncertainty. The following example visualizes this approach by reference to the Duty Cycle D_N = 5% as the indicator for high level communication. In case the measurement of the actual Duty Cycle D_N is close to normative thresholds ($D_{N,min}$ = 3%, $D_{N,max}$ = 7%) and within the respective CCTS measurement uncertainty, the verdict “inconclusive” may be given.



In case the measurement uncertainty of the CCTS implementation is negligible in relation to measurement and tolerance range, an inconclusive verdict may be obsolete.

5.4. Performance & Response time

To ensure sufficient evaluation of the DUT behavior, the CCTS shall be implemented as a test system with real-time functionality. This includes execution of and measurement according to required functions (see chapter 5) in an adequate time. The most time critical system response of applicable DUTs is assumed to be the shutdown of an EVSE for DC charging. This shutdown event shall occur consequent to several possible actions like

- exceedance of EVSE output voltage above maximum voltage limit send by EV (Error shutdown according to IEC 61851-23 Ed.2, chapter 6.3.1.106, table 103) or
- a CP state transition from state C to A appears (Emergency shutdown according to IEC 61851-23 Ed.2, chapter CC.4.3).

In both exemplary cases, the EVSE shall react within a time of 10 ms. To evaluate and analyze this behavior properly, the CCTS shall perform actions and measurements on a time base of approximately 1 ms, so with a resolution 10 times higher than the DUT's behavior. In addition to this real-time functionality, the CCTS shall also be deterministic. This shall ensure, that evaluation of several iterations of test case execution with the same DUT lead to consistent results.

5.5. PSD Calibration

A complete PLC modem calibration in frequency domain by means of a power spectrum density (PSD) according to DIN SPEC 70121 (chapter 8.3.7.4.3) or ISO 15118-3 (A.11.4.2) are no mandatory part of the CCTS. Instead, it is recommended to use the specific measurement setup according to figure 17, resp. figure A.12.

6. Functional Requirements

One main part of the CCTS specification is the definition and categorization of functions. The categorization is based on the introduced function blocks (see chapter 3) and supplemented by associated details. This chapter focuses on the definition of the respective functions. Every comprehensive CCTS implementation shall support these functions. In case of partially implementation of an CCTS the respective functions of the corresponding function blocks shall be supported completely.

6.1. Templates for Functions

ID	**Unique number of function** **F-XX-YY-ZZ** **[XX := Function Block | YY := Detail |ZZ := Counter]**
Name	Name of function
Description	Description of function
Function Block	Function Block of CCTS system architecture [LL-COM | HL-COM | Power Transfer | Security]
Detail	Detail with reference to Function Block [HPGP | MSG | Codec | Security | PWM | Proximity | AC | DC]
SUT / DUT	System or Device under Test [EV | EVSE | EVSE&EV]
Standards	Reference to applicable standard(s)
CharIN documents	Reference to applicable CharIN document(s)

ID	**Unique number of function** **F-XX-YY-ZZ** **[XX := Function Block | YY := Detail |ZZ := Counter]**
Name	Name of function
Description	Description of function
Function Block	Function Block of CCTS system architecture [LL-COM | HL-COM | Power Transfer | Security]

Detail	Detail with reference to Function Block [HPGP | MSG | Codec | Security | PWM | Proximity | AC | DC]
SUT / DUT	System or Device under Test [EV | EVSE | EVSE&EV]
Standards	Reference to applicable standard(s)
CharIN documents	Reference to applicable CharIN document(s)
Parameter	Parameter value types for set-functions
Return	Return value types for get-functions
Unit	Unit for parameter or return value
Range	Range of parameter or return value
Resolution	Resolution of parameter or return value
Accuracy	Accuracy of parameter or return value
Bandwidth (get) / slew rate (set)	More detailed specification of measurement and stimulation
Additional Requirements	Additional requirements for measurement and stimulation
Normative requirement	Reference to applicable requirement(s) in standard(s)

6.2. List of Functions w/o Electrical Specification

ID	**F-01-01-01**
Name	Send MMEs
Description	Send MMEs to PLC-Chip
Function Block	HL-COM
Detail	HPGP
SUT / DUT	EVSE&EV

Standards	DIN SPEC 70121:2014:2014 ISO 15118-3:2015
CharIN documents	-

ID	**F-01-01-02**
Name	Receive MMEs
Description	Receive MMEs from PLC-Chip
Function Block	HL-COM
Detail	HPGP
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-3:2015
CharIN documents	-

ID	**F-01-01-03**
Name	Classify detected EVSE
Description	Classify EVSEs into groups (EVSE found, EVSE not found, EVSE potentially found)
Function Block	HL-COM
Detail	HPGP
SUT / DUT	EVSE
Standards	DIN SPEC 70121:2014:2014 ISO 15118-3:2015
CharIN documents	-

ID	**F-01-01-04**
Name	Get Link Status

Description	Get link status from PLC-Chip
Function Block	HL-COM
Detail	HPGP
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-3:2015
CharIN documents	-

ID	**F-01-01-05**
Name	Set amplitude map
Description	Set prescaler for amplitude map of PLC-chip as part of the SLAC process
Function Block	HL-COM
Detail	HPGP
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-3:2015
CharIN documents	-

ID	**F-01-01-06**
Name	Set PLC mode
Description	Set PLC chip to EV or EVSE
Function Block	HL-COM
Detail	HPGP
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-3:2015

CharIN documents	-

ID	**F-01-02-01**
Name	Encode_SLAC
Description	Encode SLAC messages
Function Block	HL-COM
Detail	Codec
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-3:2015
CharIN documents	-

ID	**F-01-02-02**
Name	Decode_SLAC
Description	Decode SLAC messages
Function Block	HL-COM
Detail	Codec
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-3:2015
CharIN documents	-

ID	**F-01-02-03**
Name	Encode_EXI_Stream
Description	Encode Test-Data/Messages into corresponding EXI streams
Function Block	HL-COM

Detail	Codec
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-2:2014
CharIN documents	-

ID	**F-01-02-04**
Name	Decode_EXI_Stream
Description	Decode EXI streams into Test-Data/Messages
Function Block	HL-COM
Detail	Codec
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-2:2014
CharIN documents	-

ID	**F-01-02-05**
Name	Encode_SDP
Description	Encode Test-Data/Messages into corresponding SDP requests/responses
Function Block	HL-COM
Detail	Codec
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-2:2014
CharIN documents	-

ID	**F-01-02-06**
Name	Decode_SDP
Description	Decode SDP requests/responses into Test-Data/Messages
Function Block	HL-COM
Detail	Codec
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-2:2014
CharIN documents	-

ID	**F-01-02-07**
Name	Encode_V2GTP
Description	Encode Test-Data/Messages into corresponding V2GTP envelopes
Function Block	HL-COM
Detail	Codec
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-2:2014
CharIN documents	-

ID	**F-01-02-08**
Name	Decode_V2GTP
Description	Decode V2GTP envelopes into Test-Data/Messages
Function Block	HL-COM
Detail	Codec
SUT / DUT	EVSE&EV

Standards	DIN SPEC 70121:2014:2014 ISO 15118-2:2014
CharIN documents	-

ID	**F-01-03-01**
Name	Send_SDP_MSG
Description	Send the encoded SDP requests through UDP messages to the SUT
Function Block	HL-COM
Detail	Msg
SUT / DUT	EVSE/EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-2:2014
CharIN documents	-

ID	**F-01-03-02**
Name	Receive_SDP_MSG
Description	Receive the encoded SDP requests through UDP messages from the SUT
Function Block	HL-COM
Detail	Msg
SUT / DUT	EVSE/EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-2:2014
CharIN documents	-

ID	**F-01-03-03**
Name	Send _V2G_MSG

CHARIN

Description	Send the encoded V2G messages through a TCP or TLS connection to the SUT
Function Block	HL-COM
Detail	Msg
SUT / DUT	EVSE/EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-2:2014
CharIN documents	-

ID	**F-01-03-04**
Name	Receive_V2G_MSG
Description	Receive the encoded V2G messages through a TCP or TLS connection from the SUT
Function Block	HL-COM
Detail	Msg
SUT / DUT	EVSE/EV
Standards	DIN SPEC 70121:2014:2014 ISO 15118-2:2014
CharIN documents	-

ID	**F-01-03-05**
Name	TCP_Port_Control_Connect
Description	Setup a TCP connection
Function Block	HL-COM
Detail	Msg
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014

CharIN documents	-

ID	**F-01-03-06**
Name	TCP_Port_Control_Disconnect
Description	Disconnect TCP port
Function Block	HL-COM
Detail	Msg
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014
CharIN documents	-

ID	**F-01-03-07**
Name	TCP_Port_Control_Status
Description	Control receiving information / status on a given TCP connection (disconnection handling)
Function Block	HL-COM
Detail	Msg
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014:2014
CharIN documents	-

ID	**F-02-01-01**
Name	BCB Toggle Execute
Description	Execute defined number of toggles between StateB and State C
Function Block	LL_COM
Detail	HPGP
SUT / DUT	EVSE

Standards	DIN SPEC 70121:2014:2014 ISO 15118-3:2015
CharIN documents	-

ID	**F-04-01-01**
Name	ST_Init
Description	System inizialization
Function Block	System
Detail	-
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014
CharIN documents	-

ID	**F-04-01-02**
Name	ST_Reset
Description	System reset
Function Block	System
Detail	-
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014
CharIN documents	-

ID	**F-04-01-03**
Name	ST_Timer_Start
Description	Start of System timer
Function Block	System

Detail	-
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014
CharIN documents	-

ID	**F-04-01-04**
Name	ST_Timer_Stop
Description	Stop of System timer
Function Block	System
Detail	-
SUT / DUT	EVSE&EV
Standards	DIN SPEC 70121:2014
CharIN documents	-

6.3. List of Functions w/ Electrical Specification

ID	**F-02-02-15**
Name	CP_EV_get_Voltage_positive
Description	Get the CP peak voltageControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014

	ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	-
Return	voltage
Unit	Volt(V)
Range	0 ... 13.5
Resolution	0.01
Accuracy	± 0.02
Bandwidth (get) / slew rate (set)	-
Additional Requirements	low pass filter designed to detect maximum expected fall and rise time of PWM signal (1-10µs) while filtering out PLC signal and other noise above 1MHz (recommended 160 kHz low pass first order)
Normative requirement	IEC 61851-1:2017 , Table A.4

ID	**F-02-02-16**
Name	CP_EV_get_Frequency
Description	Get the measured PWM frequencyControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014

	ISO 15118-3:2015
CharIN documents	-
Parameter	-
Return	frequency
Unit	Hertz(Hz)
Range	0; 980...1020
Resolution	0.1
Accuracy	± 0.1
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	IEC 61851-1:2017 , Table A.2

ID	**F-02-02-17**
Name	CP_EV_set_Resistance_R2
Description	Set R2 resistance for the corresponding state (including resistor tolerances)ControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015 ISO 15118-3:2015

CharIN documents	-
Parameter	resistance
Return	-
Unit	Ohm(Ω)
Range	261…1339
Resolution	1.0
Accuracy	0.1%
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	IEC 61851-1:2017 , Table A.3

ID	**F-02-02-18**
Name	CP_EV_set_Resistance_R3
Description	Set R3 resistance for the corresponding state (including resistor tolerances)ControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015 ISO 15118-3:2015
CharIN documents	-

Parameter	resistance
Return	-
Unit	Ohm(Ω)
Range	2658...2822
Resolution	1.0
Accuracy	0.1%
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	IEC 61851-1:2017 , Table A.3

ID	**F-02-02-19**
Name	CP_EV_get_State
Description	Identify PWM state based on U pos voltage and oscillator stateControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015 ISO 15118-3:2015
CharIN documents	-
Parameter	-

Return	state
Unit	Enum
Range	A1; A2; B1; B2; C1; C2; D1; D2; E; F; Invalid
Resolution	-
Accuracy	-
Bandwidth (get) / slew rate (set)	-
Additional Requirements	- If test case requires testing of extended CP voltage range, please use F-02-02-01 - CCTS shall extend state detection to intermediate amplitude levels, as permitted by table A4 of IE 61851-1 Ed.3 Example: state Cx detection = 4.50..7.499 V
Normative requirement	IEC 61851-1:2017 , Table A.4

ID	**F-02-02-20**
Name	CP_EV_get_Dutycycle
Description	Get the measured PWM duty cycleControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015 ISO 15118-3:2015
CharIN documents	-
Parameter	-

Return	dutycycle
Unit	percent(%)
Range	0; 2...98; 100
Resolution	0.1
Accuracy	± 0.2 (resp. ±2µs)
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	IEC 61851-1:2017 , Table A.7, A.8

ID	**F-02-02-21**
Name	CP_EV_get_Rise_time
Description	Get the rise time of the PWM signalsControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	-
Return	rise_time

Unit	Time(µs)
Range	1...30.0
Resolution	0.1
Accuracy	1.0
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	IEC 61851-1:2017 , Table A.11

ID	**F-02-02-22**
Name	CP_EV_get_Fall_time
Description	Get the fall time of the PWM signalsControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	-
Return	fall_time
Unit	Time(µs)

Range	1...30.0
Resolution	0.1
Accuracy	1.0
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	IEC 61851-1:2017 , Table A.11

ID	**F-02-02-23**
Name	CP_EV_set_Capacitance
Description	Set or adjust the capacitance of the CP circuitControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	capacitance
Return	-
Unit	Farad(pF)
Range	low / 1500 /2400 / 3900

Resolution	-
Accuracy	± 5%
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	IEC 61851-1:2017 , Table A.3

ID	**F-02-02-24**
Name	CP_EV_set_Short_Circuit
Description	Inject a CP-PE short circuit in order to trigger EVSE shutdown reactionControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	circuit_status
Return	-
Unit	Bool
Range	0; 1 (with <10 Ω)
Resolution	1

Accuracy	1
Bandwidth (get) / slew rate (set)	-
Additional Requirements	Shortcircuit to be performed with a maximum 10Ohm resistor. The goal is to reach <1V on the CP at the vehicle connector of the SUT (= state E)
Normative requirement	IEC 61851-1:2017 , Annex A, Figure A.8 IEC 61851-1:2017 , Test A.4.9

ID	**F-02-02-25**
Name	CP_EV_set_Open_Circuit
Description	Disconnect CP line in order to simulate "unplugging connector"ControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	circuit_status
Return	-
Unit	Bool
Range	0; 1
Resolution	1

Accuracy	1
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	-

ID	**F-02-02-27**
Name	CP_EV_set_Voltage_Diode
Description	Set Diode voltage drop (tolerances) in order to check behaviour of EVSEControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	voltage
Return	-
Unit	Volt(V)
Range	0.55; 0.7; 0.85
Resolution	0,15
Accuracy	± 5%

Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	IEC 61851-1:2017 , Table A.3

ID	**F-02-02-28**
Name	CP_EV_get_Voltage_negative
Description	Get the CP peak voltageControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	-
Return	voltage
Unit	Volt(V)
Range	-13.5...0.0
Resolution	0.01
Accuracy	± 0.02
Bandwidth (get) / slew rate (set)	-

Additional Requirements	low pass filter designed to detect maximum expected fall and rise time of PWM signal (1-10µs) while filtering out PLC signal and other noise above 1MHz (recommended 160 kHz low pass first order)
Normative requirement	IEC 61851-1:2017 , Table A.4

ID	**F-02-02-29**
Name	CP_EV_set_Resistance_Re
Description	Set Re resistance for the corresponding state (including resistor tolerances and pararell)ControlPilot amplitude
Function Block	LL_COM
Detail	PWM
SUT / DUT	EVSE
Standards	IEC 61851-1 Ed. 3 SAE J1772 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015 ISO 15118-3:2015
CharIN documents	-
Parameter	resistance
Return	-
Unit	Ohm(Ω)
Range	780,,,3000
Resolution	1.0
Accuracy	0.1%
Bandwidth (get) / slew rate (set)	-

Additional Requirements	-
Normative requirement	IEC 61851-1:2017 , Table A.3

ID	**F-02-03-01**
Name	PP_EVSE_set_Resistance
Description	Set or adjust the Resistance of the ProximityPilot within the EV connectorControlPilot amplitude
Function Block	LL_COM
Detail	Proximity
SUT / DUT	EV
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	resistance
Return	-
Unit	Ohm(Ω)
Range	fixed: [100; 150; 220; 480 (R6+R7); 680; 1500] +/- var: 0…100
Resolution	1
Accuracy	1%
Bandwidth (get) / slew rate (set)	-

Additional Requirements	-
Normative requirement	IEC 61851-1:2017 , Table B.1, B.2

ID	**F-02-03-02**
Name	PP_EVSE_Measure_Resistance
Description	Measure the resistance of the ProximityPilot within the EVSE connectorControlPilot amplitude
Function Block	LL_COM
Detail	Proximity
SUT / DUT	EV
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	-
Return	resistance
Unit	Ohm(Ω)
Range	0…4600
Resolution	10
Accuracy	± 2%
Bandwidth (get) / slew rate (set)	-

Additional Requirements	-
Normative requirement	-

ID	**F-02-03-03**
Name	PP_EVSE_set_Short_Circuit
Description	Inject a PP-PE short circuit in order to trigger EV shutdown reactionControlPilot amplitude
Function Block	LL_COM
Detail	Proximity
SUT / DUT	EV
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	circuit_status
Return	-
Unit	Bool
Range	0; 1
Resolution	1
Accuracy	1
Bandwidth (get) / slew rate (set)	-

Additional Requirements	-
Normative requirement	-

ID	**F-02-03-04**
Name	PP_EVSE_set_Open_Circuit
Description	Disconnect PP line in order to simulate "unplugging connector"ControlPilot amplitude
Function Block	LL_COM
Detail	Proximity
SUT / DUT	EV
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	circuit_status
Return	-
Unit	Bool
Range	0; 1
Resolution	1
Accuracy	1
Bandwidth (get) / slew rate (set)	-

Additional Requirements	-
Normative requirement	-

ID	**F-03-02-01**
Name	HV_measure_DC_U
Description	Measure DC voltageControlPilot amplitude
Function Block	Power Transfer
Detail	DC
SUT / DUT	EVSE&EV
Standards	IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	-
Return	voltage
Unit	Volt(V)
Range	0...1000
Resolution	1
Accuracy	±1V offset ± 0.2 % of value
Bandwidth (get) / slew rate (set)	1 kHz
Additional Requirements	Note: For Load Dump tests Data Adquisition rate higher than 1 kHz might be required.

Normative requirement	IEC 61851-23 Ed.2 chapter 101.2.1.2.2

ID	**F-03-02-02**
Name	HV_measure_DC_I
Description	Measure DC currentControlPilot amplitude
Function Block	Power Transfer
Detail	DC
SUT / DUT	EVSE&EV
Standards	IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	-
Return	current
Unit	Ampere(A)
Range	0…500 (Maximum is depending on power class DC5, DC10, DC20, FC50, HPC150, HPC250, HPC350)
Resolution	0.1
Accuracy	± 0.1A offset ± 0.25 % of value
Bandwidth (get) / slew rate (set)	1kHz
Additional Requirements	Note: For Inrush Current tests Data Adquisition rate higher than 1 kHz might be required.

Normative requirement	IEC 61851-23 Ed.2 Annex CC.6.3

ID	**F-03-02-03**
Name	HV_measure_DC_P
Description	Measure DC powerControlPilot amplitude
Function Block	Power Transfer
Detail	DC
SUT / DUT	EVSE&EV
Standards	IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	-
Return	power
Unit	Watt(W)
Range	0...350000 (Maximum is depending on power class DC5, DC10, DC20, FC50, HPC150, HPC250, HPC350)
Resolution	1
Accuracy	± 100Watt ± 0.6 % of value
Bandwidth (get) / slew rate (set)	—
Additional Requirements	-

Normative requirement	-

ID	**F-03-02-05**
Name	HV_source_set_U_DC
Description	Control DC power source: Set DC output voltageControlPilot amplitude
Function Block	Power Transfer
Detail	DC
SUT / DUT	EVSE&EV
Standards	IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	voltage
Return	-
Unit	Volt(V)
Range	0...1000
Resolution	1
Accuracy	±1.5V offset ± 0.5 % of value
Bandwidth (get) / slew rate (set)	250V/s
Additional Requirements	-

Normative requirement	IEC 61851-23 Ed.2 chapter 101.2.1.2.2 slew rate: Minimum requirement in IEC 61851-23

ID	**F-03-02-09**
Name	HV_set_DC_relays
Description	-ControlPilot amplitude
Function Block	Power Transfer
Detail	DC
SUT / DUT	EVSE&EV
Standards	IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	circuit_status
Return	-
Unit	Bool
Range	0; 1
Resolution	1
Accuracy	1
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	-

ID	**F-03-03-03**
Name	HV_FIU_set_DC+_PE_resistance
Description	Failure insertion: Isolation resistance between DC+ and PE before & during operationControlPilot amplitude
Function Block	Power Transfer
Detail	FIU
SUT / DUT	EVSE
Standards	IEC 61851-23 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	IEC 61851-23:2014 – Implementation guide for system C
Parameter	resistance
Return	-
Unit	Ohm(Ω)
Range	1K, 20k; 49.9k; 97.6k; 154k; 182k; 205k; 309k; 650k 1M; >25M
Resolution	discrete steps
Accuracy	2%
Bandwidth (get) / slew rate (set)	-
Additional Requirements	Note: Power consumption shall be taken into an account depending on DC voltage and Power values as well as assimetrical or simmetrical short
Normative requirement	-

ID	**F-03-03-04**
Name	HV_FIU_set_DC-_PE_resistance
Description	Failure insertion: Isolation resistance between DC- and PE before & during operationControlPilot amplitude
Function Block	Power Transfer
Detail	FIU
SUT / DUT	EVSE
Standards	IEC 61851-23 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	IEC 61851-23:2014 – Implementation guide for system C
Parameter	resistance
Return	-
Unit	Ohm(Ω)
Range	1K, 20k; 49.9k; 97.6k; 154k; 182k; 205k; 309k; 650k 1M; >25M
Resolution	discrete steps
Accuracy	2%
Bandwidth (get) / slew rate (set)	-
Additional Requirements	Note: Power consumption shall be taken into an account depending on DC voltage and Power values as well as assimetrical or simmetrical short
Normative requirement	-

ID	**F-03-03-05**
Name	HV_FIU_set_Cy+_PE
Description	Failure insertion: Y-capacitance between DC+ and PE before & during operationControlPilot amplitude
Function Block	Power Transfer
Detail	FIU
SUT / DUT	EVSE
Standards	IEC 61851-23 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	IEC 61851-23:2014 – Implementation guide for system C
Parameter	capacitance
Return	-
Unit	nF
Range	0; 500; 1000; 2000
Resolution	-
Accuracy	10%
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	-

ID	F-03-03-06
Name	HV_FIU_set_Cy-_PE
Description	Failure insertion: Y-capacitance between DC- and PE before & during operationControlPilot amplitude
Function Block	Power Transfer
Detail	FIU
SUT / DUT	EVSE
Standards	IEC 61851-23 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	IEC 61851-23:2014 – Implementation guide for system C
Parameter	capacitance
Return	-
Unit	nF
Range	0; 500; 1000; 2000
Resolution	-
Accuracy	10%
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	-

ID	F-03-03-07

Name	HV_FIU_set_DC_Open_Circuit
Description	Failure insertion: Open circuit for DC+ and DC- during operationControlPilot amplitude
Function Block	-
Detail	-
SUT / DUT	-
Standards	IEC 61851-1 Ed. 3 SAE J1772 IEC 61851-23 DIN SPEC 70121:2014 ISO 15118-2:2014 ISO 15118-3:2015
CharIN documents	-
Parameter	circuit_status
Return	-
Unit	Bool
Range	0; 1
Resolution	1
Accuracy	1
Bandwidth (get) / slew rate (set)	-
Additional Requirements	-
Normative requirement	-

6.4. Connectivity / Interfaces

Region	Power Transfer		SUT / DUT		CCTS Interface
	AC	DC	EV	EVSE	
Europe	X		X		Type 2 AC plug
	X			X	Type 2 CCS inlet / Type 2 AC inlet
		X	X		Type 2 CCS plug
		X		X	Type 2 CCS inlet
North America Korea Japan (AC only?)	X		X		Type 1 AC plug
	X			X	Type 1 CCS inlet / Type 1 AC inlet
		X	X		Type 1 CCS plug
		X		X	Type 2 CCS inlet

7. Non-Functional Requirements

7.1. Safety

This item will be specified in a later version.

7.2. Mechanical design (IP class, weight, dimensions)

This item will be specified in a later version.

7.3. Power Supply

This item will be specified in a later version.

8. Reference

This document was created by the Vendor Team of the Focus Group Conformance & Interoperability of the CharIN association.

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