

**Elektromobilität –
Digitale Kommunikation zwischen einer Gleichstrom-Ladestation und
einem Elektrofahrzeug zur Regelung der Gleichstromladung im
Verbund-Ladesystem; Text in Englisch**

Electromobility –

Digital communication between a d.c. EV charging station and an electric vehicle for control of d.c. charging in the Combined Charging System; Text in English

Électromobilité –

Communication digitale entre la borne de recharge à courant continu et la véhicule électrique pour régler la charge à courant continu dans le système de charge combiné (CCS); Texte en anglais

Zur Erstellung einer DIN SPEC können verschiedene Verfahrensweisen herangezogen werden:
Das vorliegende Dokument wurde nach den Verfahrensregeln einer Vornorm erstellt.

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Foreword

This document has been prepared by Working Group NA 052-01-03-17 AK "Vehicle to grid communication interface (V2G-CI)" of the DIN Standards Committee Road Vehicle Engineering (NAAutomobil).

A DIN SPEC adopted as a Pre-standard is the result of standardization that is not published by DIN as a Standard owing to certain reservations as to its content or owing to the process of its development deviating from that of a standard.

A draft for this DIN SPEC has not been published.

Experiences made with this DIN SPEC are welcome

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Amendments

With regard to DIN SPEC 70121:2012-08, the following amendments have been made:

- a) clause 2: Several normative references have been added;
- b) clause 3: List of terms and definitions has been revised;
- c) previous sub-clause 7.1 (list of use cases) has been deleted;
- d) clause 8: Various subclauses have been revised:
 - 1) subclause 8.3: "HomePlug Green PHY" were added (e.g. „NUM_SOUNDS“ in message „CM_SLAC_PARM.CNF“ has been changed into 0xA, etc.);
 - 2) subclauses 8.3.3 und 8.3.5 have been revised;
 - 3) subclause 8.9: Several use case services have been added.
- e) clause 9: Serveral requirements have been added with the complete section;
- f) cubclause 9.5.2.5. has been added;
- g) annex B has been added.

Previous editions

DIN SPEC 70121: 2012-08

Introduction

The time consumption for electrical vehicles (EVs) charging process is determined by the maximum power, which can be transferred to the EV. The alternating current (AC) charging has a fixed limited voltage (e.g. 400 V in Europe) and therefore an increasing of power supply can only be achieved by higher currents. This approach is limited by the cable weight, because a higher current requires a greater cross section of the copper cable. As the user must be able to connect the EV with the EVSE the charging cable should not be heavier than a typical fuel tube of a filling Station today. A further disadvantage of the AC charging approach is that the rectifier must be placed in the EV. This results in an increase of the overall EV weight and complexity of it as depending on a size of the rectifier, a special liquid cooling system may be required for it. The weight of a rectifier however increases with the power it can handle. These disadvantages can be prevented by using a DC charging approach. In this case the rectifier is placed in the EVSE and the used voltage is limited by the maximum battery voltage (typically 400-800 volt), which is normally higher than the AC voltage.

The drawback of the DC charging solution is that the communication real time requirements on the EV-EVSE interface increases as the rectifier and the battery management system must be able to communicate via this interface. The prevention of an incorrect charging state requires a real time communication, which is tailored to the charging process. The real time requirements depend on the battery system and are subjects of further investigations.

The main aspects of this specification are

- Support of the Combined Charging System based on IEC 61851-23;
- Aligned charging process with SAE J2847/2;
- Ease of integration of SEP2.0 or similar XML based approach for V2G Communications.

1 Scope

This document specifies the DC specific communication between battery electric vehicles (BEV) or plug-in hybrid electric vehicles (PHEV) and the Electric Vehicle Supply Equipment (EVSE, also known as charge spot) as shown in Figure 1. In the following, the BEV and PHEV are also named Electrical Vehicle (EV). Information exchange to other actors is out of scope of DIN SPEC 70121.

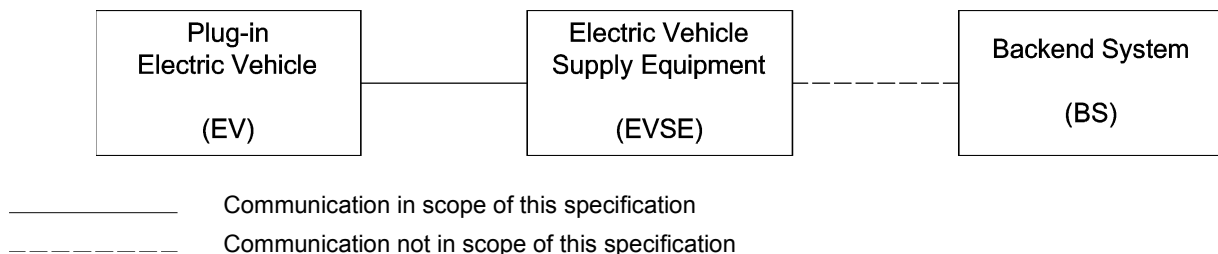


Figure 1 — Communication relationship between EV, EVSE, and BS

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEEE 1901, IEEE Std. 1901-2010, *Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications, 2010*

IEC 61851-1 (Ed. 2.0), *FDIS: Electric vehicle conductive charging system — Part 1: General requirements*

IEC 61851-23 (Ed. 1.0), 69/186/CD:2011-02, *Electric vehicle conductive charging system — Part 23: d.c. electric vehicle charging Station*

IEC 62196-2 (Ed. 1.0), *Plugs, socket-outlets, vehicle connectors and vehicle inlets — Conductive charging of electric vehicles — Part 2: Dimensional compatibility and interchangeability requirements for a.c. pin and contact-tube accessories*

IEC 62196-3, *Plugs, socket-outlets, vehicle connectors and vehicle inlets — Conductive charging of electric vehicles — Part 3: Dimensional compatibility interchangeability requirements for d.c. pin and contact-tube vehicle couplers*

ISO 17409, *Electrically propelled road vehicles — Connection to an external electric power supply — Safety requirements*

HomePlug Green PHY, *HomePlug Green PHY Specification Release Version 1.1.1, 2014 and Errata Sheets*

NOTE Errata content is expected to be published by 11/2013

IETF RFC 768, *User Datagram Protocol (August 1980)*

IETF RFC 793, *Transmission Control Protocol — DARPA Internet Program — Protocol Specification (September 1981)*

IETF RFC 1323, *TCP Extensions for High Performance (May 1992)*

IETF RFC 1624, *Computation of the Internet Checksum via Incremental Update (May 1994)*

IETF RFC 1981, *Path MTU Discovery for IP version 6 (August 1996)*

IETF RFC 2018, *TCP Selective Acknowledgment Options (October 1996)*

IETF RFC 2460, *Internet Protocol, Version 6 (IPv6) Specification (December 1998)*

IETF RFC 2988, *Computing TCP's Retransmission Timer (November 2000)*

IETF RFC 3122, *Extensions to IPv6 Neighbor Discovery for Inverse Discovery Specification (June 2001)*

IETF RFC 3484, *Default Address Selection for Internet Protocol version 6 (IPv6) (February 2003)*

IETF RFC 6582, *The NewReno Modification to TCP's Fast Recovery Algorithm (April 2012)*

4286, *Multicast Router Discovery (December 2005)*

IETF RFC 4291, *IP Version 6 Addressing Architecture (February 2006)*

IETF RFC 4294, *IPv6 Node Requirements (April 2006)*

IETF RFC 4429, *Optimistic Duplicate Address Detection (DAD) for IPv6*

IETF RFC 4443, *Internet Control Message Protocol (ICMP v6) for the Internet Protocol version 6 (IPv6) specification (March 2006)*

IETF RFC 4861, *Neighbour Discovery for IP version 6 (IPv6)*

IETF RFC 4862, *IPv6 Stateless Address Autoconfiguration (September 2007)*

IETF RFC 4884, *Extended ICMP to Support Multi-Part Messages (April 2007)*

IETF RFC 5095, *Deprecation of Type 0 Routing Headers in IPv6 (December 2007)*

IETF RFC 5220, *Problem Statement for Default Address Selection in Multi-Prefix Environments: Operational Issues of RFC 3484 Default Rules (July 2008)*

IETF RFC 5482, *TCP User Timeout Option (March 2009)*

IETF RFC 5681, *TCP Congestion Control (September 2009)*

IETF RFC 5722, *Handling of Overlapping IPv6 Fragments (December 2009)*

IETF RFC 5871, *IANA Allocation Guidelines for the IPv6 Routing Header (May 2010)*

IETF RFC 6298, *Computing TCP's Retransmission Timer (June 2011)*

IETF RFC 6335, *Internet Assigned Numbers Authority (IANA) Procedures for the Management of the Service Name and Transfer Protocol Port Number Registry (August 2011)*

DIN SPEC 91286:2011-11, *Electric mobility — Schemes of identifiers for E-Roaming — Contract ID and Electric Vehicle Supply Equipment ID*

SAE J1772, *SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler*

SAE J2847/2 *Communication between Plug-in Vehicles and Off-Board DC Chargers*

W3C EXI 1.0, *Efficient XML Interchange (EXI) Format 1.0, W3C Recommendation (March 2011)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE In the context of this document, the term EVSE refers to the charging equipment, external to the EV.

3.1

Amplitude map

specifies a transmit power-reduction factor for each subcarrier related to the Tone Map

3.2

Central Coordinator (CCo)

the manager of a HomePlug Green PHY network

3.3

Channel Access Priority (CAP)

a method to prioritize the channel access (see HomePlug Green PHY specification)

3.4

Charging session

time between the beginning (connection of the cable) and the end (disconnection of the cable) of a charging process

3.5

Coexistence

ability of different Green PHY systems to share the same physical media and to function simultaneously

3.6

Communication Media

the physical media carrying the Green PHY signal is given by the cable assembly, which connects the charging infrastructure and the EV

3.7

Communication Setup Timer

timer that monitors the time from plug-in until reception of the SessionSetupRes message by the EV

3.8

Connection coordination

the entity which provides the whole functionality for EV to EVSE Matching and initialization, via the Data Link Control SAP. This entity also controls the relationships between the basic signaling and the upper layers. The entity indicates link status and error information to higher layers. The control of the low-layer communication Network Management parameters is handled over the Data Link Control SAP

3.9

Control Service Access Point (SAP)

Port or logical connection point to a network layer protocol

3.10

CP_EVSE_Function

summary of functionalities according to IEC 61851-1 within the EVSE, e.g. generation Control Pilot duty cycle; control interface; to turn on/off charging power; safety control functions

3.11

CPLT

Control Pilot Line Transmission according to IEC 61851-1 and SAE J1772

3.12

Crosstalk

Capacitive or inductive coupling between two individual electric circuits, each providing a media for a Green PHY network, in a way that the two networks are influenced by each other

3.13

Data Link Control Service Access Point (SAP)

Port or logical connection point between data link and network layer

3.14

DATA SAP

a Service Access Point that defines the interface between Layer 2 and Layer 3 for exchange of V2G related payload

3.15

Electric Vehicle Communication Controller (EVCC)

entity which implements the communication to one or multiple SECCs

3.16

ETH SAP

the Ethernet II-class SAP supports applications using Ethernet II Class packets, including IEEE 802.3 with or without IEEE 802.2 (LLC), IEEE 802.1H (SNAP) extensions, and/or VLAN tagging

3.17

Frame

Message on data link layer level

NOTE A Frame can include a IP-packet in its payload (framing the higher level packet and adding additional information required on data link layer as e.g. synchronization information)

3.18

Global address

IP address with unlimited scope

3.19

Green PHY Bridge

System that allows an EVSE's Green PHY node to communicate on an external network of the EVSE, by converting Green PHY to any other PHY. This bridge acts on OSI-layer 2

3.20

Green PHY module

functional assembly behind each socket outlet (IEC61851-1 case B) or each connector (IEC61851-1 case C) which includes the Green PHY node, and the Connection Coordination functionality

3.21

Green PHY node

device equipped with a HomePlug Green PHY compatible modem chip. It characterises one logical and physical communication device that is attached to a physical media, and is capable of sending, receiving, or forwarding information over a HomePlug Green PHY communication channel

3.22

High-Level Communication (HLC)

High-Level Communication refers to the digital communication used for the exchange of charging parameters e.g. voltage and current. HLC starts with CM_SLAC_PARM.REQ and ends when the TCP connection is closed.

3.23**Initialization**

process of interaction between the EV, the EVSE and an external trigger, beginning from plug-in of the charging cable assembly until the decision for the charging mode to be applied

3.24**Inter System Protocol (ISP)**

enables various Broadband Power Line systems to share power line communication resources in time (time domain multiplex), in frequency (frequency domain multiplex), or both. For more information refer to IEEE 1901.

3.25**IO Service Access Point (SAP)**

IO control path interfaces hardware I/O control (e.g. Control Pilot duty cycle) and the Control Pilot wire

3.26**IP-Address**

IP-layer identifier for an interface or a set of interfaces

3.27**Link-layer address**

Link-layer identifier for an interface (e.g. Ethernet address)

3.28**Link-local address**

IP address with link-only scope that can be used to reach neighbouring nodes attached to the same link

3.29**Logical Network**

Network defined solely on OSI-layer 2. This is a set of Green PHY Stations, which possess the same network key. Only members of the same logical network are able to exchange encrypted payload data and are visible for each other on higher layers. Different logical networks may exist on the same physical media at the same time and are typically used for network segmentation

3.30**MAC Address**

unique identifier assigned to network interfaces for communication on the data link layer

3.31**Management Message Entry (MME)**

are messages exchanged between Green PHY nodes or a Green PHY node and higher layers for control purposes

3.32**Matching**

the process to determine the Green PHY node of the EV and the Green PHY node of the EVSE that are physically directly connected to one another via the charging cable assembly. The Matching process starts with CM_SLAC_PARM.REQ and ends with CM_SLAC_MATCH.CNF

3.33**Maximum Transfer Unit (MTU)**

maximum size of the data link layer that can be utilized by the network layer

3.34**Message set**

set of mandatory V2G messages and parameters for the EVCC or SECC covering one or multiple use case elements

3.35

Message timer

Timer that monitors the exchange of a pair of request/response messages

3.36

Network segment

collection of devices that can exchange data on data link layer level directly via data link addresses

EXAMPLE Ethernet: All devices which can see each other via MAC Addresses).

3.37

Network segment size

Number of devices that are handled in one network segment

3.38

Node

Device that is part of a communication network

EXAMPLE A device implementing IPv6 in an IP network.

3.39

Performance time

non-functional timing requirement defining the time a V2G entity should not exceed when executing or processing certain functionality

3.40

PHY

connects a link layer device to a physical medium. Layer 1 in Open Systems Interconnection model (OSI model)

3.41

Pilot Function Controller

System that manages the Control Pilot Line on the EVSE side, according to IEC 61851-1

3.42

Profile

Group of mandatory and optional message sets covering a set of similar charging scenarios for a specific identification means

3.43

QPSK Modulation

a phase modulation technique that transmits two bits in four modulation states (Quadrature Phase Shift Keying)

3.44

Ready to Charge Timer

Timer that monitors the time from plug-in until the first power delivery message

3.45

Ready to Charge Time

Device or piece of software used in an implementation for measuring time. Depending on the specific use case a timer is also used to trigger certain system events

3.46

Request-Response Message Pair

request message transmitted between sender and receiver and its corresponding response message that is invoked by the request message in the receiver

3.47**Request-Response Message Sequence**

sequence of one or more Request-Response Message Pairs

3.48**ROBO mode**

a communication mode, which uses QPSK only for carrier modulation within the orthogonal frequency division multiplexing (OFDM) to achieve higher robustness in transmission. The ROBO mode can be set to three different performance levels: Mini-ROBO, Standard ROBO and High Speed ROBO. Refer to the HomePlug Green PHY specification for details

3.49**SDP Client**

V2G entity that uses the SDP server to retrieve configuration information about the SECC being able to access the SECC

3.50**SDP Server**

V2G entity providing configuration information for accessing the SECC

3.51**Sequence Timer**

Timer that monitors a Response-Request Message Sequence

3.52**Shared bandwidth**

in cases where different systems use the same physical media to transmit data, they share the available bandwidth depending on a mechanism used to allocate the total bandwidth. The resulting allocation is shared bandwidth.

3.53**Signal Coupling**

Circuit that describes the method of coupling the Green PHY signal to the communication media

3.54**Signal Level Attenuation Characterization (SLAC)**

a protocol to measure the signal strength of a signal between HomePlug Green PHY nodes (used for Matching)

3.55**Signal Strength Measurement**

Signal strength measurement between CM_START_ATTEN_CHAR.IND and CM_ATTEN_CHAR.RSP messages

3.56**Supply Equipment Communication Controller (SECC)**

the entity which implements the communication to one or multiple EVCCs and which may be able to interact with secondary actors

3.57**TCP_DATA**

Socket/interface for data transfer based on TCP connection

3.58**Timeout**

specific time a V2G entity monitors the communication system for a certain event to occur. If the specified time is exceeded, the respective V2G entity initiates the related error handling

3.59

Timer

Device or piece of software used in an implementation for measuring time. Depending on the specific use case a timer is used to trigger certain system events as well

3.60

Tone Mask

the set of OFDM carriers or „tones“ that can be used in a given regulatory jurisdiction or given application

3.61

V2G Communication Session

a semi-permanent interactive information interchange between two specific V2G entities for exchanging V2G messages in a connection-oriented communication

3.62

V2G Entity

primary or secondary actor participating in the V2G communication

3.63

V2G Message

message exchanged on application layer

3.64

V2GTP Entity

V2G entity supporting the V2G transfer protocol

3.65

Virtual network segment

Network segment that is not defined by the physical communication range of the physical and data link layer but by additional mechanisms

NOTE A Virtual network segment shows the same behaviour with respect to the networks segment size for higher layers. Because multiple virtual network segments may coexist in (e.g. in a shared media) the available communication capacity may be different to a network segment that is defined by the physical communication range. The available physical capacity is shared between all virtual network segments.

4 Symbols and abbreviated terms

For the purposes of this document, the following abbreviations apply.

AFE	Analog Front End
BEV	Battery Electric Vehicle
CAP	Channel Access Priority
CCo	Central Coordinator
CP	Control Pilot
CPL	Control Pilot Line
CPLT	Control Pilot Line Transmission
DLINK	Data Link
EV	Electric Vehicle
EVCC	Electric Vehicle Communication Controller
EVSE	Electric Vehicle Supply Equipment
EXI	Efficient XML Interchange
$f_{\text{NMK}}(x)$	Function to derive the Network Management Key from a given string x, according to the HomePlug Green PHY specification.
HLC	High-Level Communication
HLE	Higher Layers Entities
HPGP	HomePlug Green PHY
ID	Identification
IP	Internet Protocol
ISP	Inter System Protocol
LC	Link Control (control and status of the Green PHY link)
MAC	Media Access Control
MME	Management Message Entry
MNBC	Multi-Network Broadcast
NACK	Negative Acknowledgement
NEK	Network Encryption Key
NMK	Network Management Key

NWP	Network Password
OEM	Original Equipment Manufacturer
PE	Protective Conductor
PDU	Protocol Data Unit
PHEV	Plug-in Hybrid Vehicle
PLC	Power Line Communication
PnC	Plug and Charge
PSD	Power Spectrum Density
PWM	Pulse Wide Modulation
QPSK	Quadrature Phase Shift Keying
RESS	Rechargeable Electric Storage System
RF	Radio Frequency
RFC	Request for comments
SAML	Security Assertions Markup Language
SAP	Service Access Point
SDP	SECC Discovery Protocol
SDU	Service Data Unit
SE	Supply Equipment
SECC	Supply Equipment Communication Controller
SLAC	Signal Level Attenuation Characterization
SLAAC	Stateless address auto configuration
SNR	Signal to noise ratio
TCP	Transmission Control Protocol
TSO	Transmission System Operator
V2G	Vehicle-to-Grid Communication
V2G CI	Vehicle-to-Grid Communication Interface
V2GTP	V2G Transfer Protocol
V2GTPPT_EXI	V2G Transfer Protocol Payload Type for EXI messages
UDP	User Datagram Protocol
XML	Extensible Markup Language

5 Relation to other standards

The digital communication between an EV and an EVSE defined in DIN SPEC 70121 is based on an early unpublished version of the ISO/IEC 15118 series of documents. As the ISO/IEC 15118 series has since undergone further development, there are now technical differences between DIN SPEC 70121 and the ISO/IEC 15118 series.

The assumptions on DC electric vehicle charging Station in this document are based on the definitions in IEC 61851-23. The basic signaling is based on the definitions in IEC 61851-1.

6 Conventions

The conventions described in the following subclauses are applied by this document.

6.1 Definition of OSI based services

This document is based on the conventions discussed in the OSI Service Conventions (refer to ISO 10731) as they apply for the individual layers specified in this document.

This document describes requirements applicable to layer 1 - 7 according to the OSI layered architecture.

6.2 Requirement structure

6.2.1 Requirement format

This document uses a requirement structure i.e. a unique number identifies each individual requirement included in this clause. This requirement structure allows for easier requirement tracking and test case specification. The following formats are used:

"[V2G-DC-xyz]" requirement text where:

- "V2G-DC" represents the DIN SPEC 70121;
- "xyz" represents the individual requirement number and;
- "requirement text" represents the actual text of the requirement.

EXAMPLE **[V2G-DC-001]** This shall be an example

6.2.2 Applicability

This clause specifies the requirements to be implemented by the EV and the EVSE in order to allow communication between both entities. Usually the requirements of this standard are implemented by one vehicle entity and additionally at least by one EVSE entity depending on the EVSE network architecture.

The requirements of this specification will refer to as "The EV shall implement..." implying that the vehicle communication entity shall implement the required functionality if not explicitly stated otherwise.

The requirements of this specification will refer to as "The EVSE shall implement..." implying that at least one EVSE entity shall implement the required functionality if not explicitly stated otherwise.

The requirements of this specification will refer to as "The V2G entities shall implement..." implying that all V2G entities involved in the V2G communication shall implement the required functionality if not explicitly stated otherwise.

[V2G-DC-001] The EV shall implement all mandatory requirements defined in this document for an EV.

[V2G-DC-002] The EVSE shall implement all mandatory requirements defined in this document for an EVSE.

6.2.3 Usage of RFC references

When RFCs are referenced all “must/ must not” requirements are mandatory.

[V2G-DC-003] If a referenced RFC has been updated by one or several RFC, the update is fully applicable for this standard.

[V2G-DC-004] If an update or part of an update applicable to an RFC referenced herein is not compatible with the original RFC or the implementation described by this standard the update shall not apply.

6.3 Notation used for XML schema diagrams

This standard makes use of XML as a description format for V2G messages. For details with regards to the XML schema diagram notation used in this document refer to Altova XMLSpy Manual.

Allowing for an easy way to distinguish the types used for the XML schema definitions in this document, the following naming conventions apply:

- complex type use capitalized first letters;
- simple types use non capitalized first letters.

7 DC Charging System Architecture

7.1 System schematics of DC charging system

This document assumes a DC charging system as specified in IEC 61851-23, Annex C. For further details, please refer to IEC 61851-23.

7.2 Pilot function

This specification assumes the charging mode 4 as defined in IEC 61851-1. Mode 4 is used for DC charging. The Pilot Function is based on a PWM conforming to IEC 61851-1, Annex A. For further details, please refer to IEC 61851-1.

7.3 Communication Stack

Figure 2 shows the communication stack for DC charging according to DIN SPEC 70121.

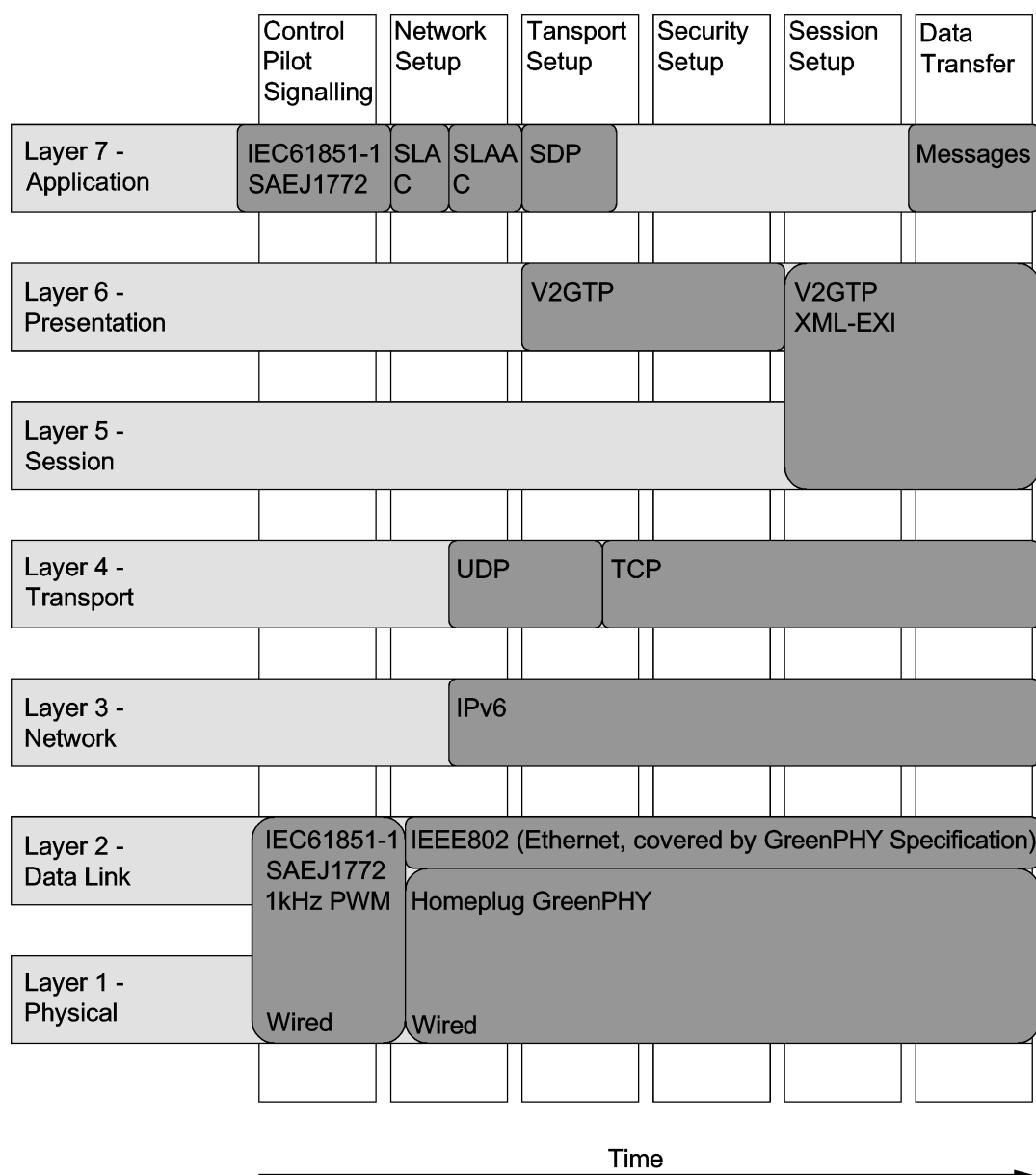


Figure 2 — Protocol stack for DC charging control without security

8 EV-EVSE Communication

8.1 Basic requirements for V2G Communication

8.1.1 General information and definitions

After establishing a physical connection, an IP based session has to be established. Within this session, messages are transferred between EV and EVSE. Communication is needed for controlling a battery charging session and the interaction between EV and EVSE.

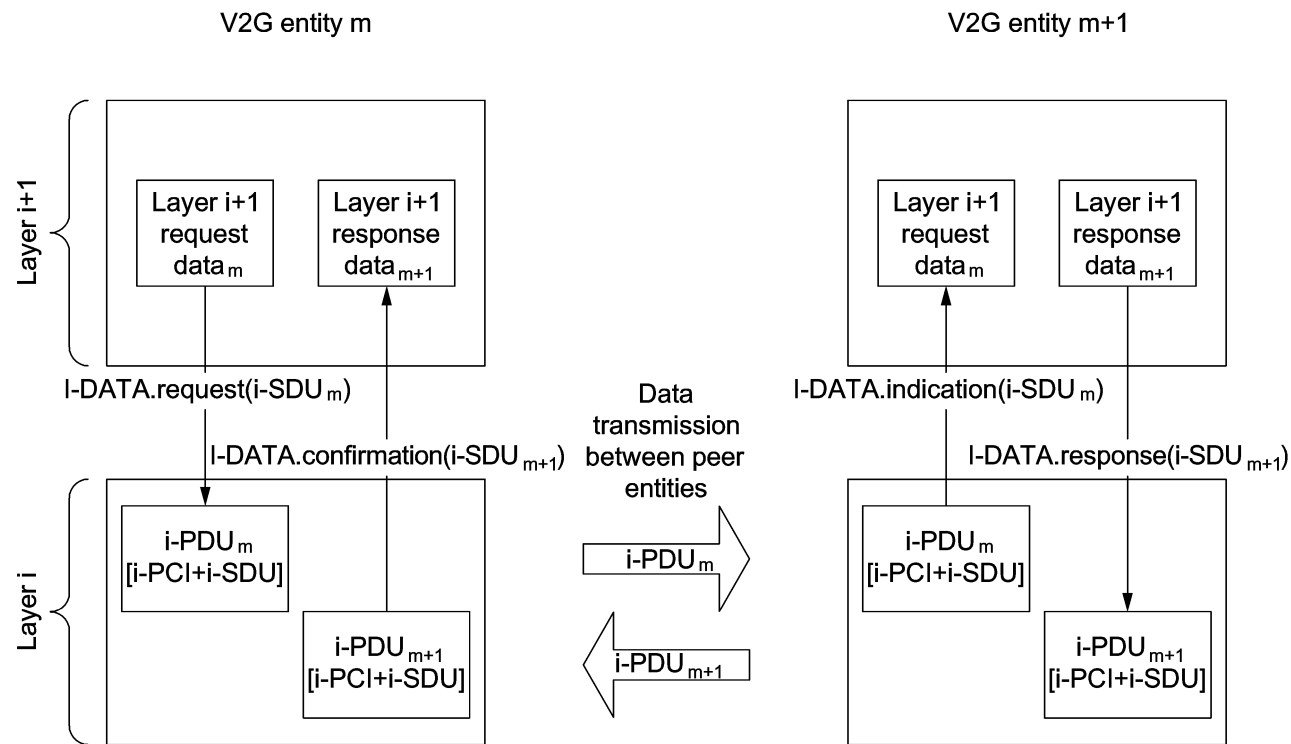
8.2 Service primitive concept of OSI layered architecture

8.2.1 Overview

This subclause explains how the OSI layered architecture applies within DIN SPEC 70121. It is intended to provide simple means for describing the interfaces between the individual communication protocol layers required by DIN SPEC 70121 and furthermore allows for defining timing requirements more precisely.

Services are specified by describing the service primitives and parameters that characterize a service. This is an abstract definition of services and does not force a particular implementation.

Figure 3 depicts a simplified view of OSI layer interaction sufficient to understand the OSI layered architecture principles for the context of DIN SPEC 70121.



Key
PDU_x: Protocol Data Unit of network entity x
PCI: Protocol Control Information
SDU_x: Service Data Unit of network entity x

Figure 3 — OSI layered architecture principles

When a layer $i+1$ instance of V2G entity m exchanges data with a layer $i+1$ instance of V2G entity $m+1$ each instance uses services of an instance of layer i . A service is defined as a set of service primitives.

8.2.2 Syntax of service primitives

Service primitives are described with the following syntax:

[Initial of layer]-[NAME].[primitive type](parameter list)

whereas [initial of layer] is one out of the following seven:

[Physical, Data Link, Network, Transport, Session, Presentation, Application]

whereas [NAME] is the name of the primitive

EXAMPLE Typical examples for [Name] are CONNECT, DISCONNECT, DATA.

whereas [primitive type] is one out of the following four:

[request, indication, response, confirmation]

whereas (parameter list) includes a list of parameters separated by comma the user of the service is supposed to provide when using the respective service primitive; optional parameters are marked with brackets "[.]"

NOTE In this document, the primitive type ".indication" always indicates an event asynchronously to the upper layer.

8.3 Physical and Data Link Layer

8.3.1 System architecture

8.3.1.1 High-Level communication and basic signaling

8.3.1.1.1 Basic signaling

[V2G-DC-005] The basic signaling follows IEC 61851-1. All the timings shall be compliant with IEC 61851-1, Annex A.

During the charging process, a bidirectional signaling according to IEC 61851-1 is used to indicate EV-related information via CP states and EVSE-related information via the CP duty cycle.

[V2G-DC-006] For DC charging according to DIN SPEC 70121, Mode 4 according to IEC 61851-1 shall be used.

[V2G-DC-560] For DC charging according to DIN SPEC 70121, the EV shall apply CP State C or D during the energy transfer and CP State B otherwise, unless an error condition occurring at any point in time requires changing to CP State B. For more details, please refer to clause 9.7.4.1.4, in particular [V2G-DC-501] and [V2G-DC-502].

[V2G-DC-561] An EVSE that supports only DC charging according to DIN SPEC 70121 on a connector shall apply a CP duty cycle of 5 % on this connector after detection of CP State B, so that the High-Level Communication can start, and until High-Level Communication stops, unless an error condition requires applying a different CP duty cycle or CP voltage.

NOTE 1 An EVSE that supports also other charging types than DC charging according to DIN SPEC 70121 on a connector may, in accordance with the specification of those charging types, apply other CP duty cycles, including 100 %, on this connector until it sends a ChargeParameterDiscoveryRes message with ResponseCode equal to "OK". Please refer to [V2G-DC-671].

NOTE 2 According to IEC 61851-23, if the SECC detects CP State A or an unexpected CP State B, it carries out, without any delay, an “EVSE-initiated emergency shutdown”, which includes turning off the CP oscillator, if it is turned on, and a fast reduction of the output current. For details, please refer to IEC 61851-23.

8.3.1.1.2 High-Level Communication (HLC)

High-Level Communication in DC charging is used for exchange of charging parameters e.g. voltage and current.

[V2G-DC-008] The HLC shall be used in addition to the basic signaling in order to enable a bidirectional communication for charging control.

[V2G-DC-485] This data link is performed via the Power Line Communication technology HomePlug Green PHY according to the HomePlug Green PHY specification.

8.3.1.2 Identification requirements

Identification (e.g. payment option) is out of scope of DIN SPEC 70121.

8.3.1.3 System requirements

8.3.1.3.1 Overview

This chapter describes startup of EV and EVSE after the plug-in of the charging cable.

This chapter also defines how the EVSE and the EV shall be designed for properly triggering the process of Matching and initialization.

8.3.1.3.2 EVSE architecture

8.3.1.3.2.1 Control pilot and Green PHY communication requirements

[V2G-DC-471] Each EVSE connector shall have its own dedicated Pilot Function controller.

[V2G-DC-562] Each EVSE connector shall have its own dedicated Green PHY node.

The MAC Matching is done between the Green PHY node locally assigned to each connector of the EVSE and the Green PHY node on the EV side.

NOTE 1 The present document only describes point to point relationship between the Green PHY nodes on EV and EVSE sides.

NOTE 2 Only “IEC 61851-1 Mode 4” EVSEs, that include an HLC module, are in the scope of DIN SPEC 70121.

8.3.1.4 Configuration of a Green PHY node

This section is a summary of some key points of the HomePlug Green PHY technology according to the HomePlug Green PHY specification which this standard requires.

The Physical Layer of the HomePlug Green PHY technology is fully described in the HomePlug Green PHY specification.

8.3.1.4.1 ROBO modes and data rate

The HomePlug Green PHY Technology uses three robust ("ROBO") modes of communication for:

- Beacon, data broadcast, and multicast communication
- Session setup
- Exchange of Management Messages
- Data messages

All ROBO Modes use QPSK modulation. This mechanism introduces redundancy by a factor that depends on the type of ROBO Mode.

Table 1 — ROBO Modes and PHY Data Rate

ROBO Mode	Number of Copies	PHY Rate (Default Tone Mask)
MINI-ROBO_AV	5	3.7716 Mbps
STD-ROBO_AV	4	4.9226 Mbps
HS-ROBO_AV	2	9.8452 Mbps

8.3.1.4.2 Shared bandwidth mechanisms

Coexistence mechanisms with other HomePlug technologies are addressed in the specifications HomePlug Green PHY and IEEE 1901.

8.3.1.4.2.1 Inter System Protocol (ISP)

HomePlug Green PHY implements the ISP as a coexistence mechanism. The ISP, defined by IEEE 1901, allows coexistence between devices that implement non-interoperable protocols. Using ISP, 1901 access, 1901 wavelet, 1901 FFT, LRWBS and ITU-T G.hn devices are able to coexist.

[V2G-DC-021] The Green PHY node on the EVSE side shall be capable to detect the zero cross of the AC line cycle to support coexistence functionality. Zero cross detection is optional for the Green PHY node on the EV side.

8.3.1.4.2.2 Coexistence with HomePlug AV technologies

In addition to the coexistence mechanisms with other HomePlug technologies, there is a specificity regarding the HomePlug AV technology.

In some cases with a fully loaded HomePlug AV network, the HomePlug Green PHY network may be limited to 7 % in time. This might affect the average data rate.

8.3.2 Connection coordination

8.3.2.1 Plug-in phase

This phase covers the period of time after plug-in of the charge cable assembly.

[V2G-DC-507] After the EVSE detects CP State B, the EVSE's Green PHY node shall be ready for communication in less than T_conn_max_comm.

[V2G-DC-564] An EVSE that supports only DC charging according to DIN SPEC 70121 on a connector shall apply a CP duty cycle of 5 % on this connector no later than 1s after its Green PHY node is ready for communication.

[V2G-DC-733] An EVSE that supports only DC charging according to DIN SPEC 70121 on a connector shall apply a CP duty cycle of 100 % (with $V_g=12\text{ V}$ constant voltage, according to IEC 61851-1) on this connector if its Green PHY node is not ready for communication, unless an error condition requires applying a different CP duty cycle or CP voltage.

8.3.3 EV – EVSE Matching process

8.3.3.1 Overview

Crosstalk of Green PHY signals on several charge cables could lead to an incorrect pairing of an EVCC and a SECC. For a successful charging process, a correct pairing between the EV and the connector of the EVSE plugged into this EV is indispensable. This pairing is achieved by the Matching process. After the Matching process in layer 1 and 2, upper layers are able to proceed with their binding process.

If an EVCC or a SECC is not member of a Green PHY logical network, it is in “Unmatched” state.

When the connector is being plugged into the EV's inlet, the EVCC and SECC are initially in the "Unmatched" state.

In the following chapter, the term “Matching” refers to “Layer 2 Matching”.

NOTE This standard covers a point-to-point Matching.

Despite Matching is mandatory at layer 2, it is also mandatory for higher layers.

8.3.3.2 Initialization of the Matching process

The first phase of the Matching process is called Initialization of the Matching process. During this phase, the node is configured in order to enhance the Matching process.

[V2G-DC-014] Each Green PHY node shall provide a method to exchange authorized frequencies to be used for the communication in order to be in line with frequency restrictions. A Green PHY node shall respect the spectrum limitation sent by the counterpart node.

NOTE All EVSEs should be able to update the set of frequencies to be used according to future legislative regulations.

[V2G-DC-018] The Green PHY node on the EV side shall be configured to never become the CCo.

Note: This could be done with the APCM_SET_CCo.REQ primitive as defined in the HomePlug Green PHY specification.

[V2G-DC-019] The Green PHY node on the EVSE side shall be configured to always be the CCo.

Note: This could be done with the APCM_SET_CCo.REQ primitive as defined in the HomePlug Green PHY specification.

[V2G-DC-020] Any SLAC related message transmitted shall be sent with CAP3 priority to speed up the Matching process.

[V2G-DC-024] A SLAC request shall only be responded by an EVSE's Green PHY node if all of the following conditions are fulfilled:

- The EVSE is connected to an EV, detected by the CP state

- The EVSE is in “Unmatched” state.

8.3.3.3 Discovery of the connected Green PHY node on EVSE side

During the discovery process, the EV determines which EVSE is directly connected to its charge cord.

The method is based on a measurement of the Green PHY signal strength. The EV will discover all the EVSE Green PHY nodes in range. On the basis of a signal strength measurement for each Green PHY node, the EV decides to which node it is directly connected.

[V2G-DC-029] The Green PHY nodes on EVSE and EV side shall be compliant with the unsecured SLAC protocol defined in the HomePlug Green PHY specification.

[V2G-DC-030] Measurement of the signal strength on EVSE side shall be done according to the HomePlug Green PHY Signal Level Attenuation Characterisation (SLAC).

[V2G-DC-031] Only the EV shall send SLAC requests

[V2G-DC-032] Only the EVSE shall answer to SLAC requests

In case of two or more EVs plug-in at the same time and there is crosstalk the EVSEs must answer all SLAC requests, not only the first one.

[V2G-DC-568] The SECC shall be able to process and answer 5 SLAC requests in parallel.

[V2G-DC-034] The SLAC method shall be concluded by:

- EVSE_FOUND,
- EVSE_POTENTIALLY_FOUND, or
- EVSE_NOT_FOUND.

NOTE The use of EVSE_POTENTIALLY_FOUND is optional.

[V2G-DC-035] Each EV Green PHY node shall consider the status “EVSE_POTENTIALLY_FOUND” as “EVSE_FOUND” or as “EVSE_NOT_FOUND”.

[V2G-DC-569] The ATTEN_PROFILE within the message CM_ATTEN_CHAR.IND shall be calculated by arithmetic mean of the ATTEN_PROFILE of the CM_ATTEN_PROFILE.IND of previous M-SOUNDS corrected by the attenuation of the receive path AttnRxEVSE as described in chapter 8.3.7.4.1

[V2G-DC-570] The Average_Attenuation used for the Matching decision shall be calculated by the arithmetic mean of all groups in the CM_ATTEN_CHAR.IND.

[V2G-DC-038] According to the result of the SLAC process, the Green PHY node on the EV side shall send its decision using the respective messages:

- If EV_Discovering_Status = EVSE_FOUND, the EV Green PHY node shall inform the EVSE that they are connected, and shall start to set up the logical network. The EV Green PHY node shall use the CM_SLAC_MATCH message.

- If EV_Discovering_Status = EVSE_POTENTIALLY_FOUND, the EV Green PHY node shall inform the most probable EVSE that it will start a Validation process by using CM_VALIDATE messages
- If EV_Discovering_Status = EVSE_NOT_FOUND, the Green PHY node shall inform HLE that Matching is not possible using the primitive D-LINK_READY.indication(DLINKSTATUS = no Link) and keep the Green PHY node in the "Unmatched" state.

NOTE: Attenuation measurement is based on the PSD values of the NorthAmerican carrier and spectral mask of the Green PHY specification. - 50 dBm/Hz will give 0 dB attenuation during SLAC measurement

As soon as the Green PHY node on the EV side is active, it may start to discover its connected EVSE.

During this process, the EV shall send broadcast requests only. The EVSE measures the attenuation of this signal for different groups of frequencies, and answers to the EV. When the EV receives the results, it has to decide whether or not the received message was sent by a physically connected EVSE.

In case of doubt, the Green PHY node on EV side may re-launch a SLAC process and/or ask the EVSE for a Validation step.

Figure 4 gives an overview of the discovery process from EV side. It shows the sequence to follow, from the discovery of the other Green PHY nodes to the start of the communication.

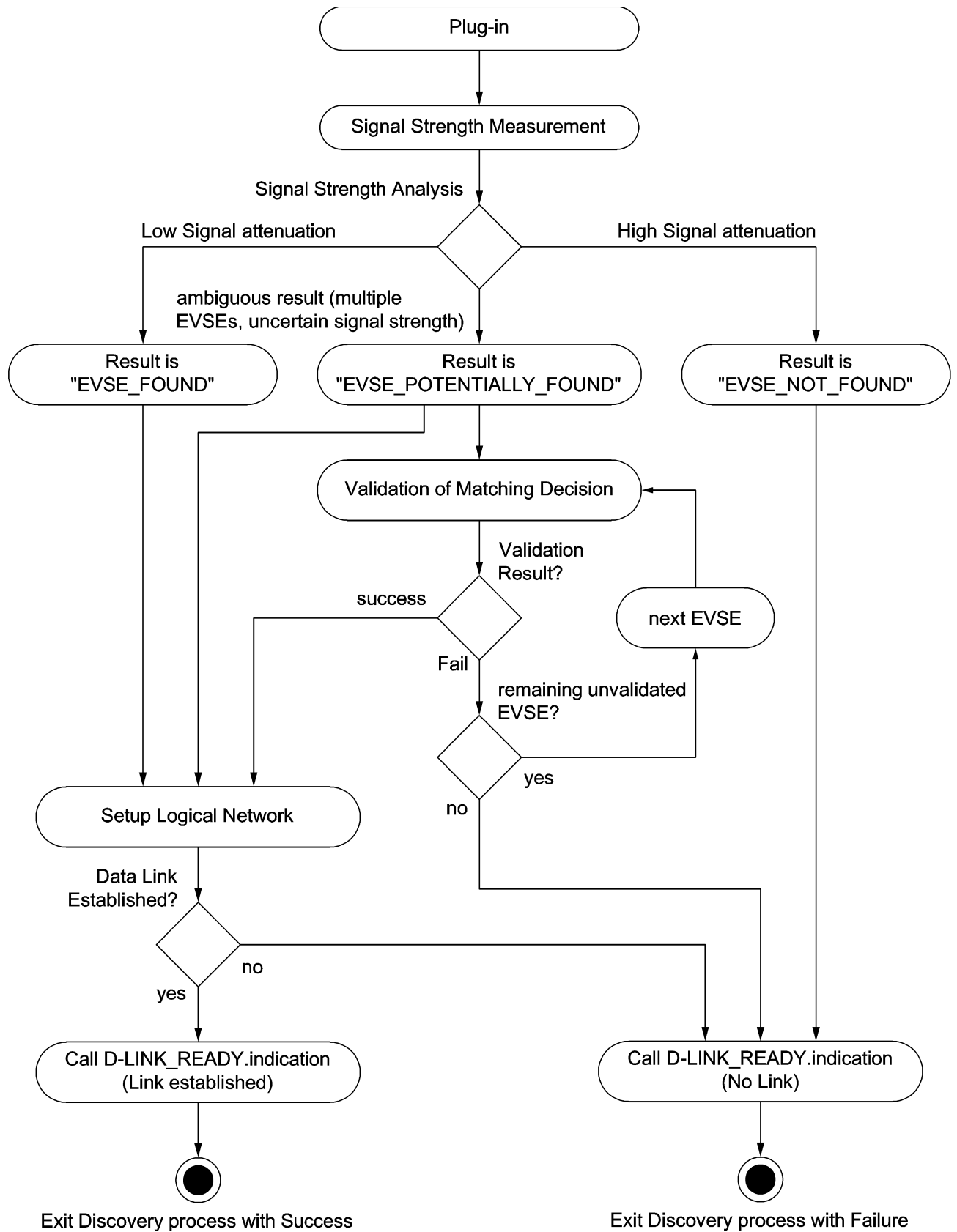


Figure 4 — EVSE Discovery process from EV side

Figure 5 shows a high-level overview of the Matching process. The default state of a Green PHY node at plug-in is "Unmatched". A CP state change from CP state A, B with 100 % CP duty cycle, E or F to B with 5 % CP duty cycle triggers the Matching process (state "Matching" in Figure 5) which determines the correct EV-EVSE pairing by a signal strength measurement. The Matching process may also start at different times (not shown in Figure 5). A successful Matching process leads to the state "Matched".

[V2G-DC-751] Any transition from the state "Matching" to state "matched" or "Unmatched" shall trigger a call of the primitive D-LINK_READY.indication to indicate a successful or failed Data-Link setup.

[V2G-DC-752] A failure during the Matching process, a loss of the Control Pilot or a request from HLE shall lead to a reset to state "Unmatched".

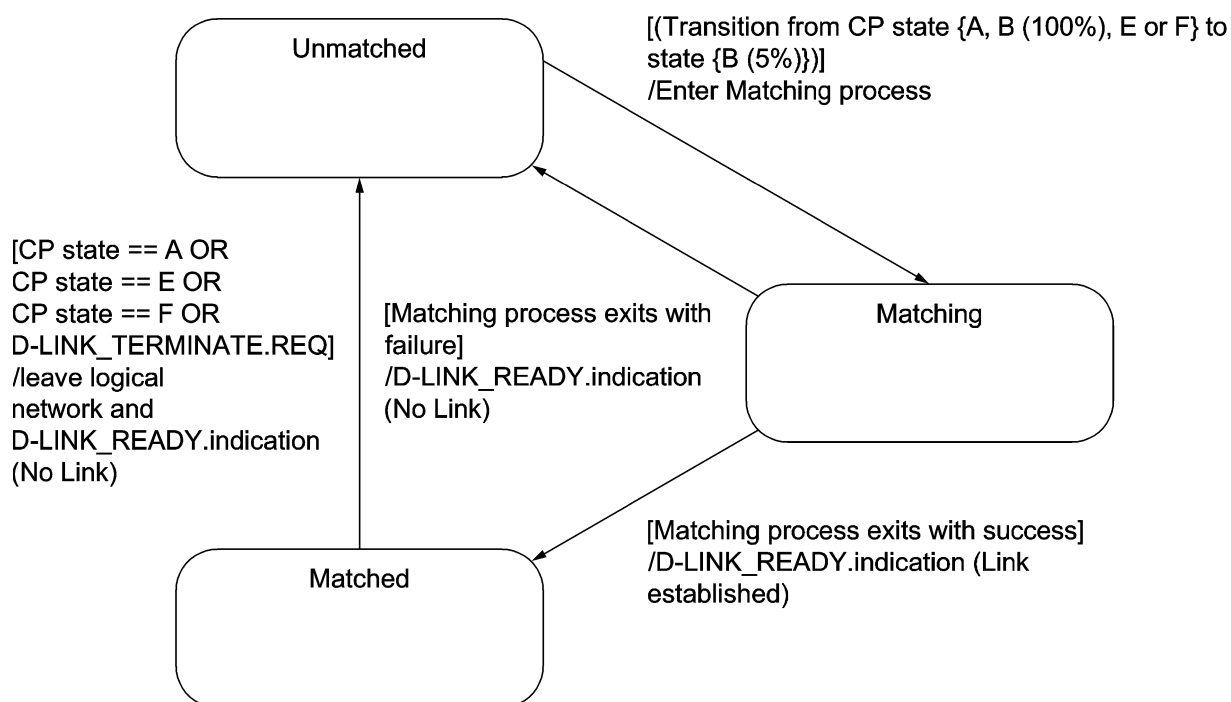


Figure 5 — Matching state machine

8.3.3.3.1 Matching process sequence diagram with SLAC messages

[V2G-DC-571] The Matching process is based on the messages defined in the HomePlug Green PHY specification.

Figure 6 gives the complete sequence chart of the Matching process. It shows the sequence to follow, from the discovery of the other Green PHY nodes to the start of the communication.

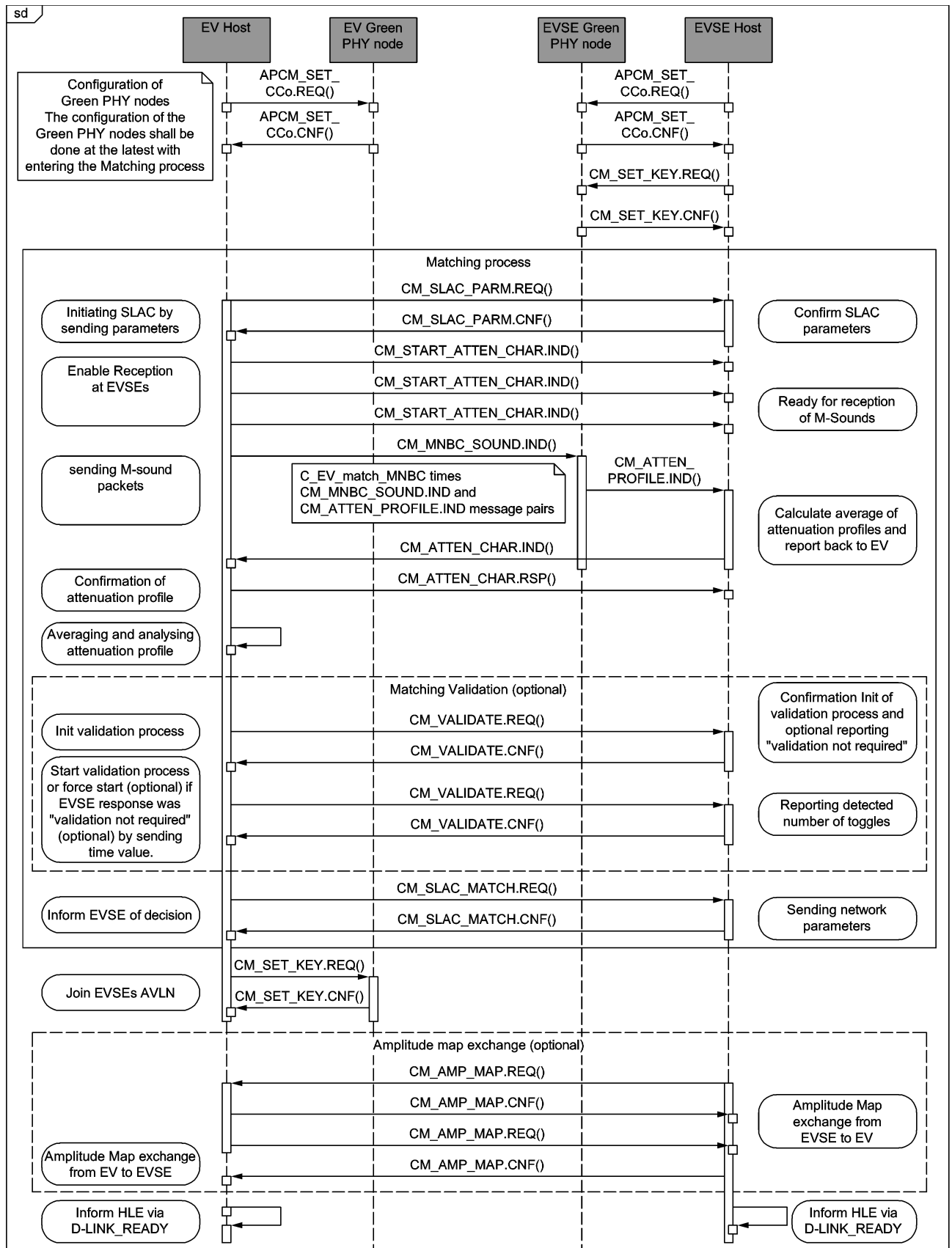


Figure 6 — Sequence chart of HomePlug Green PHY Matching process

8.3.3.3.2 MME Content for SLAC

HomePlug Green PHY provides management messages for data exchange between the Central Coordinator (EVSE) and Stations (EV).

[V2G-DC-042] For the SLAC process, the Green PHY nodes shall use the following set of MMEs of the HomePlug Green PHY specification. The parameters to be used within the MMEs are defined in Table 2

[V2G-DC-572] The Ethernet destination MAC Address field shall be filled either as broadcast or unicast, as defined in Table 2.

NOTE: All SLAC messages are sent in multi-network broadcast (MNBC) even if the the destination MAC Address is unicast. See Annex B for details.

[V2G-DC-573] EVCC and SECC shall check the destination MAC Address for received SLAC messages. Messages that are defined as Unicast according to Table 2, Table 4, Table 5, Table 6 and Table 7 shall only be accepted if the destination MAC Address equals the entities address. Messages that are defined as Broadcast according to Table 2, Table 4 Table 5, Table 6 and Table 7 shall also be accepted as unicast messages

[V2G-DC-574] The EVSE shall generate a random NMK after power-on and after every plug-out of an EV, and it shall use this random NMK for setting up a logical network.

NOTE NMK and NID should be generated after plug-out instead of plug-in to save time for Data Link setup.

[V2G-DC-575] The EVSE shall generate the NID out of the NMK as defined in the HomePlug Green PHY specification and shall use it for setting up a logical network.

[V2G-DC-734] For setting up a logical network the message CM_SET_KEY.REQ shall be used with the generated NMK and NID.

[V2G-DC-735] On EVSE side, the message CM_SET_KEY shall be send after power on and after every plug out.

[V2G-DC-576] For NID generation, Security Level=0b00 shall be used.

Table 2 — SLAC MME parameter values

MME	Field	Octet No.	Field Size (Octets)	Value	Definition
CM_MNBC_SOUND.IND Ethernet Broadcast	APPLICATION_TYPE	0	1	0x00	EV-EVSE Matching
	SECURITY_TYPE	1	1	0x00	No Security
	MSVarField	-	-	-	M-Sound Variable Field See definition below

Table 2 (continued)

MME	Field	Octet No.	Field Size (Octets)	Value	Definition
MSVarField of CM_MNBC_SOUND.IND	SenderID	0-16	17	Filled with 0x00	
	Cnt	17	1	Variable	Countdown counter for number of Sounds remaining
	RunID	18-25	8	-	Random identifier created by the EV which initiates the SLAC process. This value shall be the same as the one sent in the CM_SLAC_PARM.REQ message by this sender.
	RSVD	26-33	8	Filled with 0x00	-
	Rnd	34-49	16	Variable	Random Value
CM_SLAC_PARM.REQ Ethernet Broadcast	APPLICATION_TYPE	0	1	0x00	EV-EVSE Matching
	SECURITY_TYPE	1	1	0x00	No Security
	RunID	2-9	8	Variable	Random Run Identifier of sender
CM_SLAC_PARM.CNF Ethernet Unicast	M-SOUND_TARGET	0-5	6	0xFFFFFFFFFF	Request sent in broadcast
	NUM_SOUNDS	6	1	0x0A	Number of M-Sounds to be transmitted by the EV GP Station during the SLAC process
	Time_Out	7	1	0x06	Timeout for transmission of M-Sound MPDUs in multiple of 100ms 0x00 = 0ms 0x01 = 100ms 0x02 = 200ms...
	RESP_TYPE	8	1	0x01	Send to another GP STA (EV)
	FORWARDING_STA	9-14	6	MAC Address of the EV HLE	Station which the measurement results shall be sent to
	APPLICATION_TYPE	15	1	0x00	Application Type 0x00 : PEV-EVSE Association 0x01-0xFF: Reserved

Table 2 (continued)

MME	Field	Octet No.	Field Size (Octets)	Value	Definition
CM_SLAC_PARM.CNF Ethernet Unicast	SECURITY_TYPE	16	1	0x00	Security in M-Sound Messages 0x00: No Security 0x01: Public Key Signature 0x02-0xFF: Reserved
	RunID	17-24	8	variable	Run identifier of sender
CM_START_ATTEN_CHA R.IND Ethernet Broadcast	APPLICATION_TYPE	0	1	0x00	EV-EVSE Matching
	SECURITY_TYPE	1	1	0x00	No Security
	ACVarField	-	-	-	Attenuation Characteristics Variable Fields See definition below
ACVarField of CM_START_ATTEN_CHA R.IND	NUM_SOUNDS	0	1	0x0A	Number of M-Sounds transmitted by the GP Station during the SLAC process
	Time_Out	1	1	0x06	Timeout for transmission of M-Sound MPDUs in multiple of 100ms 0x00 = 0ms 0x01 = 100ms 0x02 = 200ms...
	RESP_TYPE	2	1	0x01	Send to another GP STA (EV)
	FORWARDING_STA	3-8	6	MAC Address of the EV HLE	Station which the measurement results shall be sent to
	RunID	9-16	8	variable	Random identifier created by the EV which initiates the SLAC process

Table 2 (continued)

MME	Field	Octet No.	Field Size (Octets)	Value	Definition
CM_ATTEN_PROFILE.IND	EV MAC	0-5	6	variable	EV MAC Address
	NumGroups	0	1	variable	Number of Groups (=N) 0x00=0 Octets 0x01=1 Octet ...
	RSVD	7	1	-	Reserved
	AAG[1]	8	1	variable	Average Attenuation of Group -1 0x00=0dB 0x01=1dB ...
CM_ATTEN_PROFILE.IND	...				
	AAG[N]	-	1	variable	Average Attenuation of Group – N 0x00=0 Octets 0x01=1 Octet ...
CM_ATTEN_CHAR.IND Ethernet Unicast	APPLICATION_TYPE	0	1	0x00	EV-EVSE Matching
	SECURITY_TYPE	1	1	0x00	No Security
	ACVarField	-	-	-	Attenuation Characteristics Variable Fields See definition below
ACVarField of CM_ATTEN_CHAR.IND	SOURCE_ADDRESS	0-5	6	variable	MAC Address of the EV which initiates the SLAC process
	RunID	6-13	8	variable	Random identifier created by the EV which initiates the SLAC process
	SOURCE_ID	14-30	17	0x00	-
	RESP_ID	31-47	17	0x00	-
	NumSounds	48	1	variable	Number of M-Sounds used to generate the ATTEN_PROFILE
	ATTEN_PROFILE	-	Var.	-	Signal Level Attenuation see definition below

Table 2 (continued)

MME	Field	Octet No.	Field Size (Octets)	Value	Definition
ATTEN_PROFILE of CM_ATTEN_CHAR.IND	NumGroups	6	1	Variable	Number of Groups (=N) 0x00 = 0 Octets 0x01 = 1 Octet and so on
	AAG[1]	-	1	Variable	Average Attenuation of Group – 1 0x00 = 0 dB 0x01 = 1 dB 0x02 = 2 dB and so on
	...				
ATTEN_PROFILE of CM_ATTEN_CHAR.IND	AAG[N]	-	1	Variable	Average Attenuation of Group – N 0x00 = 0 dB 0x01 = 1 dB 0x02 = 2 dB and so on
CM_ATTEN_CHAR.RSP Ethernet Unicast	APPLICATION_TYPE	0	1	0x00	EV-EVSE Matching
	SECURITY_TYPE	1	1	0x00	No Security
	ACVarField	-	-	-	Attenuation Characteristics Variable Fields See definition below
ACVarField of CM_ATTEN_CHAR.RSP	SOURCE_ADDRESS	0-5	6	6 Bytes	MAC Address of the EV which initiates the SLAC process
	RunID	6-13	8	8 Bytes	Random identifier created by the EV which initiates the SLAC process
	SOURCE_ID	14-30	17	0x00	-
	RESP_ID	31-47	17	0x00	-
	Result	48	1	0x00	Success
CM_SLAC_MATCH.REQ Ethernet Unicast	APPLICATION_TYPE	0	1	0x00	EV-EVSE Matching
	SECURITY_TYPE	1	1	0x00	No Security
	MVFLength	2-3	2	0x3E	MatchVarField Length
	MatchVarField	-	-	-	Field described below

Table 2 (continued)

MME	Field	Octet No.	Field Size (Octets)	Value	Definition
MatchVarField of CM_SLAC_MATCH.REQ	EV ID	0-16	17	0x00	-
	EV MAC	17-22	6	-	EV MAC Address
	EVSE ID	23-39	17	0x00	-
	EVSE MAC	40-45	6	-	EVSE MAC Address
	RunID	46-53	8	-	Identifier given in the CM_START_ATTEN_CH AR.IND message
	RSVD	54-61	8	-	-
CM_SLAC_MATCH.CNF Ethernet Unicast	APPLICATION_TYPE	0	1	0x00	EV-EVSE Matching
	SECURITY_TYPE	1	1	0x00	No Security
CM_SLAC_MATCH.CNF Ethernet Unicast	MVFLength	2-3	2	0x56	MatchVarField Length
	MatchVarField	-	-	-	This field is described below
MatchVarField of CM_SLAC_MATCH.CNF	EV ID	0-16	17	0x00	-
	EV MAC	17-22	6	-	EV MAC Address
	EVSE ID	23-39	17	0x00	-
	EVSE MAC	40-45	6	-	EVSE MAC Address
	RunID	46-53	8	-	Random identifier created by the EV which initiates the SLAC process. This value shall be the same as the one sent in the CM_SLAC_PRAM.REQ message by this sender.
	RSVD	54-61	8	-	-
	NID	62-68	7	NID calculated from the random NMK that will be set	Network ID given by the CCo (EVSE)
	RSVD	69	1	-	-
	NMK	70-85	16	Random value	Private NMK of the EVSE (random value)

Table 2 (continued)

MME	Field	Octet No.	Field Size (Octets)	Value	Definition
CM_SET_KEY.REQ Unicast to local Green PHY Node	Key Type	0	1	0x01	Fixed value to indicate "NMK"
	My Nonce	1-4	4	0x00000000	Fixed value, encrypted payload not used
	Your Nonce	5-8	4	0x00000000	Fixed value, encrypted payload not used
	PID	9	1	0x04	Fixed value to indicate "HLE protocol"
	PRN	10-11	2	0x0000	Fixed value, encrypted payload not used
	PMN	12	1	0x00	Fixed value, encrypted payload not used
	CCo Capability	13	1	variable	CCo Capability according to the Station role.
	NID	14-20	7	variable	54 LSBs contain the NID 2 MSBs = 0b00
	NewEKS	21	1	0x01	Fixed value to indicate "NMK"
	NewKey	22-37	16	variable	NMK

[V2G-DC-577] Based on the signal attenuation read by the "CM_ATTEN_CHAR.IND" message, the EV_Discovering_Status is defined by the following table.

Table 3 — EV_Discovering_Status definition

Status	Average_Attenuation		Description
	From	To	
EVSE_FOUND	-	C_EV_match_signal attn_direct	The EVSE is identified without any doubt
EVSE_POTENTIALLY_FOUND	C_EV_match_signal attn_direct	C_EV_match_signal attn_indirect	One or several EVSEs are identified. The next step of the Matching process will allow deciding if the most probable candidate is the connected EVSE.
EVSE_NOT_FOUND	C_EV_match_signal attn_indirect	-	No direct connected EVSE is found

NOTE: Attenuation measurement is based on the PSD values of the NorthAmerican carrier and spectral mask of the Green PHY specification. -50dBm/Hz will give 0dB attenuation during SLAC measurement

8.3.3.4 Validation of the Matching EV - EVSE

The Validation of the Matching decision is a method to validate the results of the signal strength measurement via an additional independent path, based on the hardwired Control Pilot line.

After the signal strength measurement and based on the results thereof, the EV may decide to request from the EVSE to perform an additional Validation. As soon as the EVSE is ready to detect the CPL, the EV sends a random timer value to the EVSE (TP_EV_vald_toggle). After sending the message, the EV switches the CP State in the sequence B-C-B. This switching sequence is called BCB-Toggle in the following.

Depending on the EVSE architecture, the EVSE can answer to the request by a "not required" state. This is just a recommendation from the EVSE, the EV decides either to follow the EVSE recommendation and to skip the Validation or to continue the process and to perform the Validation process.

During the time TP_EV_vald_toggle, the EV performs multiple B-C-B toggles. The number of toggles (C_vald_nb_toggles) is chosen randomly in the available time.

At the end of the timer, the EVSE sends a Green PHY message with the number of toggles seen on the line and waits for the decision value.

If the result of the SLAC process is "EVSE_POTENTIALLY_FOUND", a Validation step via the CPLT is optional.

This step allows the use of the CP states to assure the physical link between EV and EVSE.

[V2G-DC-043] The EV may support Validation of the Matching decision according to the signal sequence in Figure 7

[V2G-DC-736] The EVSE shall support Validation of the Matching decision according to the signal sequence in Figure 7.

[V2G-DC-056] The EV may perform a "BCB-Toggle" as defined in Figure 7.

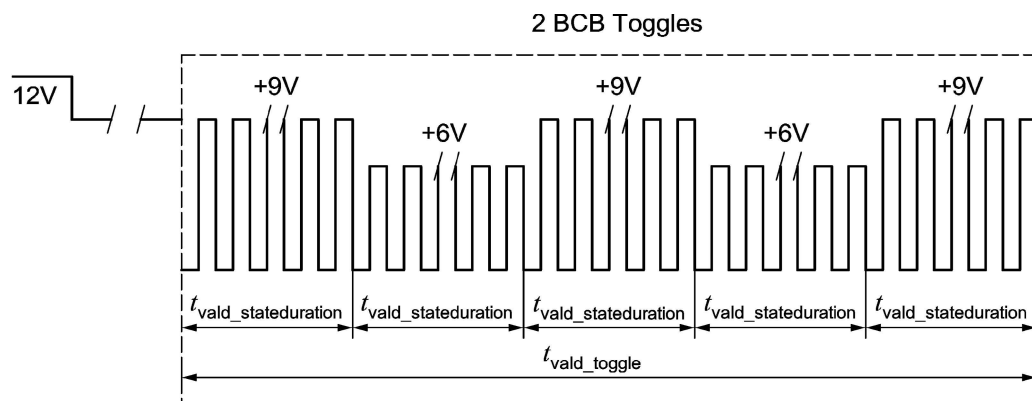


Figure 7 — Example of toggle sequence with 2 toggles

[V2G-DC-051] If the EV_Discovering_Status is "EVSE_POTENTIALLY_FOUND", the EV may start the Validation process. Depending on the grid architecture, the EVSE may inform the EV that it is allowed to abort the Validation step. The EV may decide to abort this step.

[V2G-DC-053] The EVSE shall be able to detect a variation of the CP State within $T_{\text{vald_detect_time}}$.

[V2G-DC-520] The duration of each CP State during the BCB toggle sequence is defined by $T_{\text{vald_state_duration}}$.

- [V2G-DC-578]** The EVSE shall support a set of messages to exchange the number of BCB toggles, using the messages CM_VALIDATE.REQ/CNF.
- [V2G-DC-737]** If the EV implements Validation of the Matching, the EV shall support a set of messages to exchange the number of BCB toggles, using the messages CM_VALIDATE.REQ/CNF.
- [V2G-DC-579]** In case an EVSE receives a Validation request while it is still in a Validation step with another EV, it shall give a negative response to this incoming request.
- [V2G-DC-058]** If the EV uses Validation of the Matching, the EV shall perform C_vald_nb_toggles BCB toggle(s) during the Validation step, and shall adjust the TP_EV_vald_toggle according to the number of BCB toggles.
- [V2G-DC-521]** The CP duty cycle shall have no impact on the Validation step, neither on EVSE side nor on EV side.
- [V2G-DC-049]** Since the Green PHY node on EV side concludes the signal strength measurement, the Green PHY node on EV side shall also conclude Validation of the Matching, if it is used. The Validation shall be concluded by:
- EVSE_FOUND, or
 - EVSE_NOT_FOUND.
- NOTE** At this stage, the Validation is physically performed with the CPL. The "EVSE_POTENTIALLY_FOUND" status is not possible.
- [V2G-DC-523]** According to the EVSE architecture, the EVSE can decide to answer to a CM_VALIDATE.REQ with "Not_Required" in CM_VALIDATE.CNF result field. In this case, the EV shall decide:
- Either to continue the Validation process by resending the request CM_VALIDATE.REQ.
 - Or to skip the Validation process, by informing the EVSE of the decision using the CM_SLAC_MATCH.REQ.
- [V2G-DC-524]** Both EV and EVSE shall comply with the sequence diagram defined in Figure 6.
- [V2G-DC-525]** If the EV uses Validation of the Matching, both EV and EVSE shall use the CM_VALIDATE messages to exchange the toggle related values, using the parameters defined in the Table 4.
- [V2G-DC-580]** If the EV uses Validation of the Matching, the Ethernet destination MAC Address field shall be filled as unicast as defined in the Table 4.

Table 4 — MME parameters for Validation, first request-response

MME	Field	Octet No.	Field Size (Octets)	Value	Definition
CM_VALIDATE.REQ Ethernet Unicast	Signal Type	0	1	0x00	Fixed value to indicate “EV S2 toggles on Control Pilot line”
	VRVarField	-	-	-	Validate request variable field See definition below
VRVarField of CM_VALIDATE.REQ	Timer	0	1	0x00	Fixed value In the first VALIDATE request-response exchange the timer field shall be set to zero.
	Result	1	1	0x01	Fixed value In the first VALIDATE request-response exchange, the result field shall be set to 0x01 = “Ready”.
CM_VALIDATE.CNF Ethernet Unicast	SignalType	0	1	0x00	Fixed value to indicate “EV S2 toggles on Control Pilot line”
	VCVarFiled	-	-	-	Validate confirm variable field
VCVarField of CM_VALIDATE.CNF	ToggleNum	0	1	0x00	Fixed value In the first VALIDATE request-response exchange the ToggleNum field shall be set to zero.
	Result	1	1	Var.	Result code: 0x00 = Not Ready 0x01 = Ready 0x02 = Success 0x03 = Failure 0x04 = Not Required 0x05-0xFF = Reserved

For the first VALIDATE request-response exchange, the result field shall be filled as follows:

The EV shall set the result field of the CM_VALIDATE.REQ with 0x01, to indicate that a Validation process starts.

The EVSE shall set the result field of the CM_VALIDATE.CNF to:

- “Ready” to confirm the readiness for a Validation process
- “Not Ready” to indicate that it is busy and temporarily not able to perform a Validation (an immediate retry with the step 1 CM_VALIDATE.REQ by the EV is reasonable).
- “Success” shall not be used
- “Not required” to indicate that a Validation is not required

Table 5 — MME parameters for Validation, second request-response

MME	Field	Octet No.	Field Size (Octets)	Value	Definition
CM_VALIDATE.REQ Ethernet Unicast	Signal Type	0	1	0x00	Fixed value to indicate “EV S2 toggles on Control Pilot line”
	VRVarField	-	-	-	Validate request variable field See definition below
VRVarField of CM_VALIDATE.REQ	Timer	0	1	Var.	Variable value indicating the time duration while the EVSE shall listen to BCB-toggles (TT_EVSE_vald_toggle): 0x00 = 100 ms 0x01 = 200 ms
	Result	1	1	0x01	Fixed value In the second VALIDATE request-response exchange, the result field shall be set to 0x01 = “Ready”.
CM_VALIDATE.CNF Ethernet Unicast	SignalType	0	1	0x00	Fixed value to indicate “EV S2 toggles on Control Pilot line”
	VCVarFiled	-	-	-	Validate confirm variable field
VCVarField of CM_VALIDATE.CNF	ToggleNum	0	1	Var.	This value contains the number of BC-edges detected by the EVSE during TT_EVSE_vald_toggle
	Result	1	1	Var.	Result code: 0x00 = Not Ready 0x01 = Ready 0x02 = Success 0x03 = Failure 0x04 = Not Required 0x05-0xFF = Reserved

For the second VALIDATE request-response exchange, the result field shall be filled as follows:

The EV shall set the result field of the CM_VALIDATE.REQ with 0x01, to indicate that a toggle process starts.

The EVSE shall set the result field of the CM_VALIDATE.CNF to:

- “Success” to confirm that the toggle process is done with success and the result field contains valid data
- “Failure” to indicate that the toggle process could not be finished with success and the result field contains no valid data.

8.3.3.5 Set-up a logical network

After the correct pairing between EV and EVSE was determined by the Matching process, the EV joins the logical network of the EVSE. Therefore, the broadcast domain is reduced to the Green PHY nodes physically directly connected.

8.3.3.5.1 Requirements

- [V2G-DC-059]** The EV Green PHY node shall try to join the logical network only if the EV_Discovering_Status is "EVSE_FOUND".
- [V2G-DC-060]** In order to create the Logical Network both EV and EVSE shall use the "CM_SLAC_MATCH" MMEs defined in the HomePlug Green PHY specification using sequences defined in Figure 6.
- [V2G-DC-061]** As soon as the EV has successfully joined the logical network of the EVSE both entities are in the state "matched". The Green PHY node of both EV and EVSE shall inform HLE via the D-LINK_READY.indication(DLINKSTATUS = Link established) that HLE's binding process can begin.
- [V2G-DC-581]** In "matched" state no further SLAC messages other than CM_AMP_MAP.REQ and CM_AMP_MAP.CNF shall be send or processed.

8.3.3.5.2 Amplitude map exchange

The amplitude map exchange is an optional function to request the counterpart Green PHY node to reduce the transmission power for certain carriers. The requesting device sends a CM_AMP_MAP.REQ command, which has to be confirmed by the counterpart node by a CM_AMP_MAP.CNF message.

The transmission power limitation request is related to the PSD at EVs/EVSEs inlet/connector.

The CM_AMP_MAP.REQ MME has two different functions, depending on the source/destination of the message:

- A CM_AMP_MAP.REQ sent from one host to another host via the Green PHY Link is designated to transmit the requested transmission power per carrier to the destination host to be included in its amplitude map calculation. This message does not have any direct influence on the Green PHY node transmission power, its only used for information exchange
- A CM_AMP_MAP.REQ sent from one host to the local Green PHY chip causes the Green PHY chip to modify its transmission power.

All transmission power values within the CM_AMP_MAP MMEs are related to a reference value of -50 dBm/Hz. The resolution of AMDATA is -2 dB, so that a AMDATA value of 0b0011 means a value -6 dB.

Example for request of a transmission power limitation

(For simplification within this example its total number of carriers is fictitiously set to 6)

Assumption:

EVSE requests a limitation of the power of carriers 2 and 3 to -78 dBm/Hz, while the other carriers keep unaffected. The EV has no limitation request to the EVSE.

- The EVSE sends a CM_AMP_MAP.REQ to the EV host MAC Address with the following values:
 {0,14,14,0,0,0}
 AMDATA[0] = 0x00
- AMDATA[1] = 0x0E
 AMDATA[2] = 0x0E
 AMDATA[3] = 0x00
 AMDATA[4] = 0x00
 AMDATA[5] = 0x00

Related to the reference of -50 dBm/Hz the requested value of -78 dBm/Hz leads to the difference of -28 dB which in turn leads to a raw value of 14 (0xE) for 2dB resolution.

- The EV host compares the received values with its default PSD at the inlet, which are assumed to be {-75, -75, -77, -77, -75, -75} dBm/Hz. For carriers 2 and 3 the requested values are less than the default ones:
- Carrier 1: -75 dBm/Hz < -50 dBm/Hz: ok
- Carrier 2: -75 dBm/Hz < -78 dBm/Hz: n.ok. deviation: 3 dBm/Hz
- Carrier 3: -77 dBm/Hz < -78 dBm/Hz: n.ok. deviation: 1 dBm/Hz
- Carrier 4: -77 dBm/Hz < -50 dBm/Hz: ok
- Carrier 5: -75 dBm/Hz < -50 dBm/Hz: ok
- Carrier 6: -75 dBm/Hz < -50 dBm/Hz: ok

The carriers 2 and 3 have to be reduced in power by 3 dBm/Hz and 1 dBm/Hz respectively.

- The EV host confirms the CM_AMP_MAP.REQ with a corresponding CM_AMP_MAP.CNF
- Based on the calculated attenuation values for the carriers 2 and 3 the EV host subtract these values from the default Green PHY chip setting and writes them to the Green PHY chip using the CM_AMP_MAP.REQ and its local destination address.

[V2G-DC-064] In the case that a Green PHY node requires additional carriers to be notched, it shall send the amplitude map to the remote Green PHY node as soon as the logical network is set up. Therefore the sequence described in Figure 6 and subclause 8.3.3.5.2 for detailed primitives shall be used. The amplitude map for further communication shall be the intersection of the amplitude map of the local Green PHY node and the received amplitude map from the remote Green PHY node.

[V2G-DC-582] As long as no exchange of an amplitude map is triggered by one of the Green PHY nodes, the default Amplitude map of Green PHY specification v1.1 shall be used.

NOTE The EVSE shall guarantee the conformity on local legislation on authorized / forbidden frequencies, in the frequency band 2 – 30 MHz. By this mechanism, the EV will always comply with the local legislation. The EVSE should be able to be reconfigured to future evolution of restrictions

[V2G-DC-583] The Ethernet destination MAC Address field shall be filled as unicast, as defined in Table 6 and Table 7.

[V2G-DC-584] To exchange an amplitude map, the "CM_AMP_MAP.REQ" message of the HomePlug Green PHY specification shall be used. The content is shown in Table 6.

[V2G-DC-585] To confirm an amplitude map exchange, the "CM_AMP_MAP.CNF" message of the HomePlug Green PHY specification shall be used. The content is shown in Table 7.

To exchange an amplitude map, the Green PHY node may use the "CM_AMP_MAP.REQ" message defined in the HomePlug Green PHY specification. The content depends on the carriers to be used.

Table 6 — CM_AMP_MAP.REQ parameters

MME	Field	Oct. Num.	Field Size (Bits)	Value	Definition
CM_AMP_MAP.REQ Ethernet Unicast	AMLEN	0-1	16	Var.	Number of amplitude data Entries – n 0x00=zero 0x01=one ...and so on
	AMDATA[0]	2	4	Var.	Amplitude map data: first unmasked carrier
	AMDATA[n]	n	4	Var.	Amplitude map data: [n] unmasked carrier

To confirm an Amplitude Map exchange, the Green PHY node shall use the "CM_AMP_MAP.CNF" message defined in the HomePlug Green PHY specification. The content is shown in Table 7.

Table 7 — CM_AMP_MAP.CNF parameters

MME	Field	Oct. Num.	Field Size (Bits)	Value	Definition
CM_AMP_MAP.CNF Ethernet Unicast	ResType	0	8	Var.	Response type: 0x00 = Success 0x01 = Failure

8.3.3.6 Leave the logical network

This section allows speeding up a disconnection / reconnection of another EV. This sub section avoids that the CCo of the logical network needs several minutes to discover that the EV has left the network.

[V2G-DC-065] With receiving a D-Link_TERMINATE.request from HLE, the Green PHY node shall leave the logical network within T_match_leave. All parameters related to the current link shall be set to the default value and the Green PHY node shall change to the state "Unmatched".

[V2G-DC-527] When the Green PHY node leaves the logical network, it shall inform HLE via the D-LINK_READY.indication(DLINKSTATUS = no Link).

[V2G-DC-526] In the following cases, the Green PHY node shall leave the logical network within T_match_leave. All parameters related to the current link shall be set to the default value and the Green PHY node shall change to the state "Unmatched".

- The EVSE detects CP State A, E or F according to IEC 61851-1
- The EV detects CP State A, E or F according to IEC 61851-1

8.3.4 Timings, parameters and error handling

This section summarizes all Physical and Data Link Layer timings used in DIN SPEC 70121.

The following naming convention for timers is used in the Physical and Data Link Layer chapter. Timers are named according to this scheme:

TP_{EV/EVSE}_NAME = [X; Y] {s/ms}

TT_{EV/EVSE}_NAME = Y {s/ms}

Where the leading T stands for TIMER, followed by:

T for TIMEOUT

P for PERFORMANCE

X for MINIMUM TIME

Y for MAXIMUM TIME

EV/EVSE specifies on which side the timer is running. When nothing specific is specified, timer runs on both sides.

EXAMPLE

"TP_EV_match_MNBC_interval = [10; 20] ms" is a Performance Timer on the EV side for the interval between transmitted M-SOUNDS with a minimum time of 10 ms and a maximum time of 20 ms.

"TT_EV_match_response = 200 ms" is a Timeout Timer on the EV side which counts the time between an EV request and the anticipated response by the EVSE with a timeout value of 200 ms.

Difference between performance and timeout timer:

A performance timer on the EVSE side for example shall reach a value larger than the minimum time specified for this timer before the EVSE triggers the event associated with it (e.g. sending a specific message) but the EVSE shall trigger the event before the maximum time value specified for this timer is reached. If the maximum time value is exceeded, this does not constitute a critical error and no action has to be taken, but this shall normally not happen. A timeout timer on the opposite side (EV) is associated with the same event and shall trigger an error handling procedure if it reaches its maximum value specified. In a performance timer/ timeout timer pair, the maximum value of the timeout timer shall always be defined higher than the one of the performance timer (at least by twice the maximum possible message propagation time on the power line, but usually more).

[V2G-DC-586] All Green PHY nodes shall comply with Figure 8 below



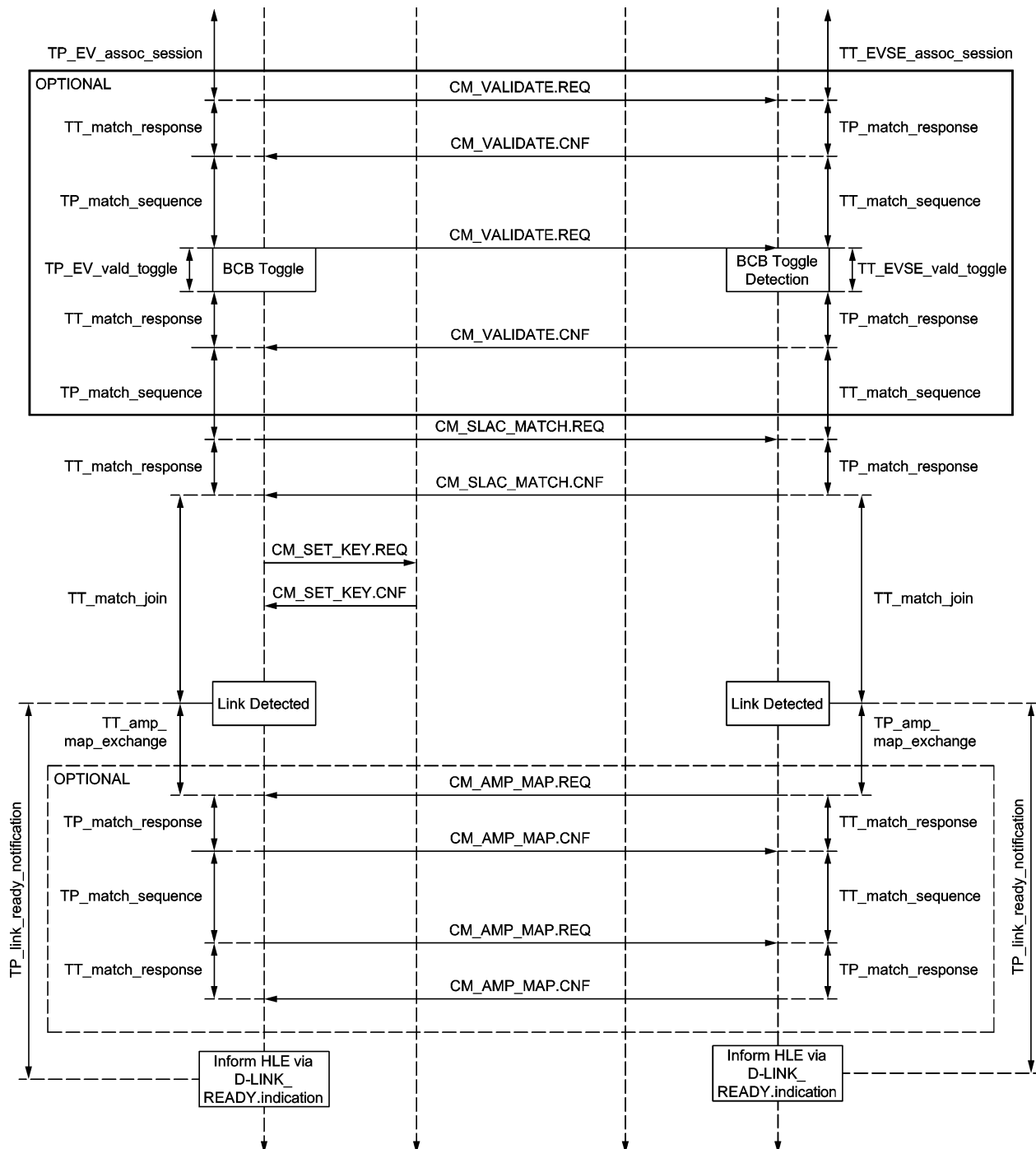


Figure 8 —Matching Timing Sequence Chart

[V2G-DC-519] All Green PHY nodes shall comply with Table 8.

Table 8 — Timings and Paramters

Parameter	Description	Min	Typical	Max	Unit
TP_EV_SLAC_init	Time between detection of CP State B with 5% duty cycle or wake-up and sending CM_SLAC_PARM.REQ by the EV			10	s
TT_EVSE_SLAC_init	Time the EVSE waits for receiving CM_SLAC_PARM.REQ after the EVSE detects CP state B with 5 % CP duty cycle	20			s
C_EV_match_retry	Number of retries of the corresponding message within the Matching process			2	nbr
TP_match_sequence	General performance time for subsequent requests after a response to previous request has been received			100	ms
TP_match_response	General performance time for a response to a request			100	ms
TT_match_response	Time that the EV/EVSE shall wait for a response from the EVSE/EV			200	ms
TT_match_sequence	Time that the EVSE/EV shall wait for a request from the EV/EVSE			400	ms
TT_EVSE_match_session	Maximum time from CM_ATTEN_CHAR.RSP received and the reception of either CM_VALIDATE.REQ or CM_SLAC_MATCH.REQ			10	s
TP_EV_match_session	Performance time for the EV to start Validation or SLAC_MATCH after sending CM_ATTEN_CHAR.RSP			500	ms
TT_match_join	Maximum time between CM_SLAC_MATCH.CNF and link establishment. If there is no link after this timeout expires, the EV retries the Matching process and the EVSE resets its state machine.			12	s
TT_amp_map_exchange	Timeout timer that runs on both EV and EVSE side after link is detected. If an EV or EVSE does not want to start an AMP MAP exchange and no request is received by the other side within the timeout value of this timer, then it is to be assumed that no AMP MAP exchange will take place and a D-LINK_READY.indication notification shall be send to the HLE			200	ms
TP_amp_map_exchange	Performance timer for the start of an AMP MAP exchange. Either the EV or the EVSE shall send a CM_AMP_MAP.REQ within the max value of this timer after link is detected in order to trigger an AMP MAP exchange			100	ms

Table 8 (continued)

TP_link_ready_notification	Performance timer from Data Link detected to HLE information with D_LINK_READY primitive	0,2		1	s
C_vald_nb_toggles	Number of BCB toggles	1		3	nbr
T_vald_state_duration	Duration of each CP State B or C within the BCB toggle	200		400	ms
TP_EV_vald_toggle	Duration of BCB toggle sequence	600		3500	ms
TT_EVSE_vald_toggle	Timeout timer for the EVSE to stop monitoring CP for BCB toggle. Value is received in CM_VALIDATE.REQ			3500	ms
T_vald_detect_time	Time to detect a variation of the CP state on EVSE side			200	ms
TP_EV_batch_msg_interval	Interval between two CM_START_ATTEN_CHAR.IND or CM_MNBC_SOUND.IND messages	20		50	ms
C_EV_match_MNBC	Numer of M-Sounds sent for the SLAC	-	10	-	nbr
TT_EVSE_match_MNBC	Timeout on the EVSE side that triggers the calculation of the average attenuation profile	600	-	600	ms
TP_EVSE_avg_atten_calc	Performance time for the EVSE to calculate the average attenuation profile after reception of all M-SOUNDS or after TT_EVSE_match_MNBC has expired			100	ms
TT_EV_atten_results	Time the EV shall wait for CM_ATTEN_CHAR.IND messages from EVSEs. Timer starts with the sending of the first CM_START_ATTEN_CHAR.IND			1200	ms
C_EV_match_signalattn_direct	Limit for signal strength measurement for direct connected EVSE		10		dB
C_EV_match_signalattn_indirect	Limit for signal strength measurement if no direct connected EVSE is found		20		dB
T_match_leave	Maximum time to leave the logical network (e.g. after D-LINK_TERMINATE.request)			1	s
C_EV_start_atten_char_inds	Number of CM_START_ATTEN_CHAR.IND messages to be sent		3		nbr
T_conn_max_comm	Time after plug-in (detection of CP state B or Proximity pin) until the Green PHY node shall be ready for communication.			8	s

8.3.5 Error handling

The following subclauses defines the error handling for the Matching process.

Prerequisites:

Max(timer_name) is the maximum value a timer is allowed to reach before a timeout occurs according to the Summary of Timers and Constraints

Min(timer_name) is the minimum value that a timer shall reach before an action bound to this timer is performed

8.3.5.1 Error handling for signal strength measurement parameter exchange

Before the signal strength measurement starts, the EV broadcasts the parameters to be used for the following signal strength measurement sequence by means of the message CM_SLAC_PARM.REQ. Any “Unmatched” EVSE that receives the parameter exchange broadcast sends a response to the EV by means of the message CM_SLAC_PARM.CNF.

8.3.5.1.1 Sequence chart

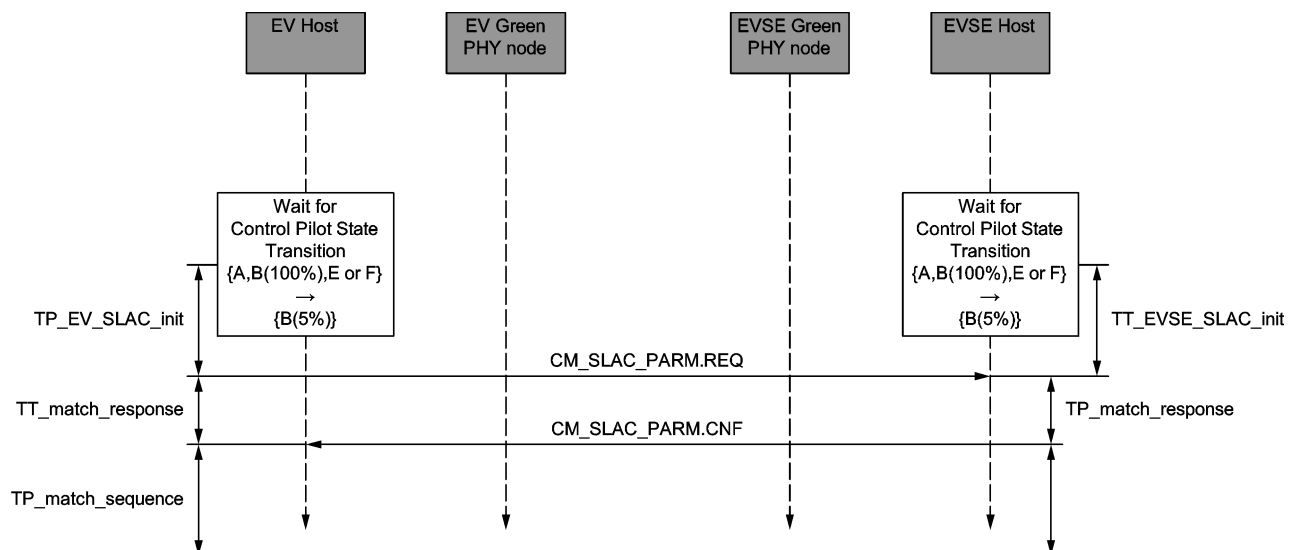


Figure 9 — CM_SLAC_PARM.REQ/CNF sequence chart

8.3.5.1.2 Requirements for EV side

- [V2G-DC-587]** If not in state “matched”, the EV shall send at least one CM_SLAC_PARM.REQ before the timer TP_EV_SLAC_init expires.
- [V2G-DC-588]** The start condition of the timer TP_EV_SLAC_init shall be CP State B with a CP duty cycle of 5 %.
- [V2G-DC-589]** In the SLAC parameter exchange phase, the EV shall send a CM_SLAC_PARM.REQ and wait for the maximum value of TT_match_response for CM_SLAC_PARM.CNFs from potential EVSEs.
- [V2G-DC-590]** The start condition of TT_match_response shall be the transmission of CM_SLAC_PARM.REQ

[V2G-DC-591] If the EV receives a CM_SLAC_PARM.CNF with invalid content, it shall be ignored. Content which deviate from the MME definition in Table 2 is invalid.

[V2G-DC-592] If no valid CM_SLAC_PARM.CNF arrives at the EV when TT_match_response expires, the EV shall retransmit the request and wait again for TT_match_response. The total number of retries is given by C_EV_match_retry. If C_EV_match_retry is reached, the Matching process shall be considered as FAILED.

8.3.5.1.3 Requirements for EVSE side

[V2G-DC-593] If not in state “matched”, and as long as the timer TT_EVSE_SLAC_init is not expired, the EVSE shall answer to valid CM_SLAC_PARM.REQs.

[V2G-DC-594] The start condition of the timer TT_EVSE_SLAC_init shall be CP State B with a CP duty cycle of 5 %

[V2G-DC-596] If the EVSE receives a CM_SLAC_PARM.REQ with invalid content, the EVSE shall ignore it and shall not stop the timeout timer TT_EVSE_SLAC_init. Content which deviate from the MME definition in Table 2 is invalid.

[V2G-DC-597] When receiving a CM_SLAC_PARM.REQ, the EVSE shall answer by sending a CM_SLAC_PARM.CNF response within TP_match_response.

[V2G-DC-598] If during a Matching process the EVSE receives a CM_SLAC_PARM.REQ from the EV which participates in the ongoing Matching process, the EVSE shall restart its state machine and reply to this request because it shall be considered as a new retry by the EV.

8.3.5.2 Error handling for Signal Strength measurement

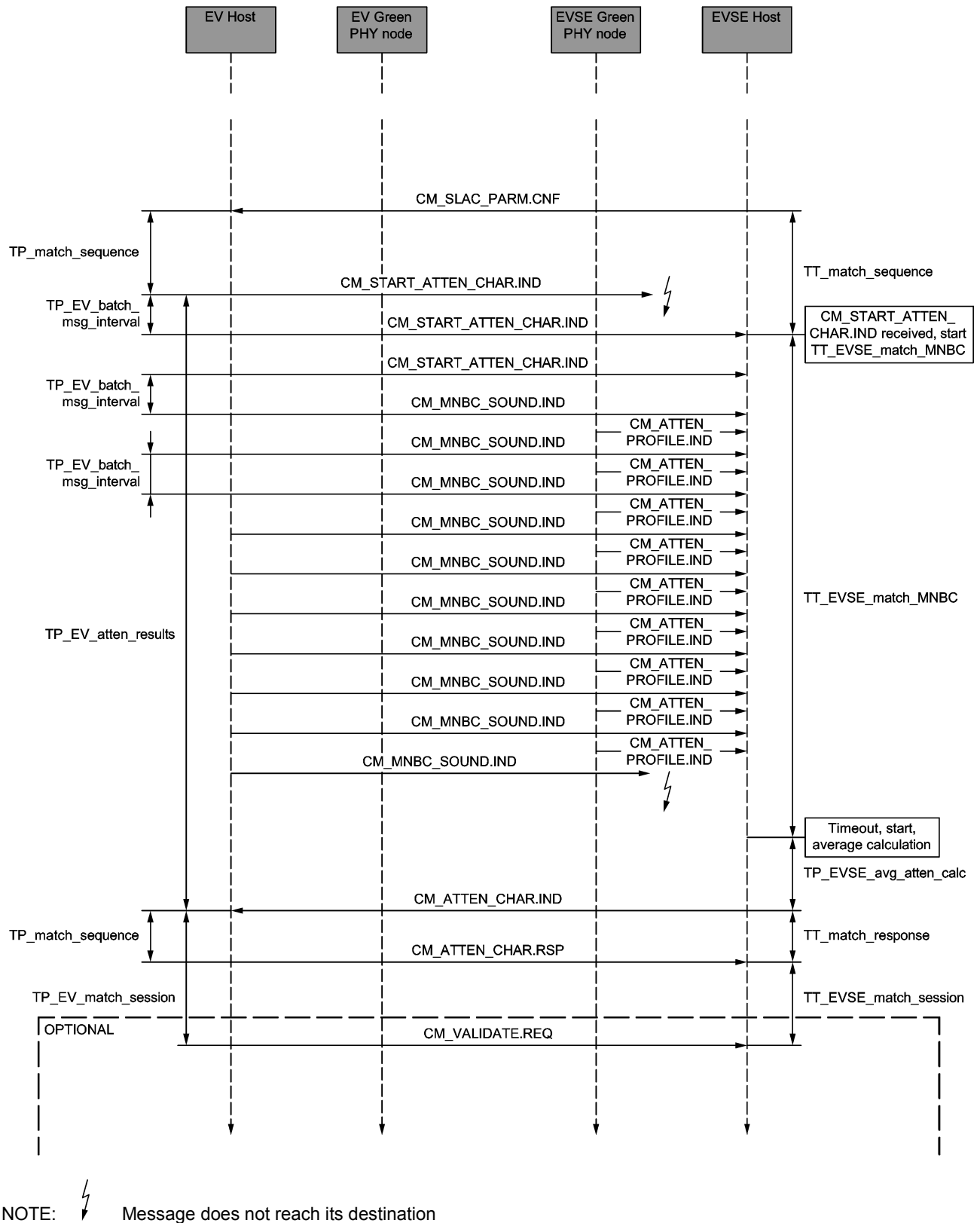


Figure 10 —Signal Strength measurement Sequence Chart

8.3.5.2.1 Requirements for EV side

- [V2G-DC-674]** With receiving a CM_SLAC_PARM.CNF the EV shall start the timer TP_match_sequence. When the TP_match_sequence timer expires, the EV shall send a sequence of C_EV_start_atten_char_inds CM_START_ATTEN_CHAR.IND messages.
- [V2G-DC-675]** The time duration between consecutive CM_START_ATTEN_CHAR.IND messages shall be TP_EV_batch_msg_interval.
- [V2G-DC-676]** After sending the last message of the CM_START_ATTEN_CHAR.IND message sequence, the EV shall wait for TP_EV_batch_msg_interval before starting the CM_MNBC_SOUND.IND message sequence.
- [V2G-DC-677]** Within CM_MNBC_SOUND.IND message sequence the EV shall transmit the CM_MNBC_SOUND.IND message C_EV_match_MNBC times. With each message, the counter field "cnt" shall be decremented.
- [V2G-DC-678]** The time duration between consecutive CM_MNBC_SOUND.IND messages is defined to TP_EV_batch_msg_interval.
- [V2G-DC-679]** The EV shall start the timeout timer TT_EV_atten_results when sending the first CM_START_ATTEN_CHAR.IND.
- [V2G-DC-680]** While the timer TT_EV_atten_results is running, the EV shall process incoming CM_ATTEN_CHAR.IND messages. If the CM_ATTEN_CHAR.IND messages from all EVSEs are received, which were recognized during the parameter exchange, the EV is allowed to stop the TT_EV_atten_results timer and continue the Matching process. To be able to service also EVSEs which were not received during the parameter exchange the EV may wait for incoming CM_ATTEN_CHAR.IND messages until the TT_EV_atten_results timer expires before continuing the Matching process.
- [V2G-DC-681]** If no CM_ATTEN_CHAR.IND is received before TT_EV_atten_results expires, the Matching process shall be considered as FAILED.
- [V2G-DC-682]** If a CM_ATTEN_CHAR.IND is received and its origin is an EVSE that has not sent a CM_SLAC_PARM.CNF before, the message shall be processed and not ignored.
- [V2G-DC-683]** If the TT_EV_atten_results timer expires and not all anticipated responses are received, the EV shall continue the Matching process.
- [V2G-DC-684]** If the EV receives a CM_ATTEN_CHAR.IND with invalid content, it shall be ignored. Content which deviate from the MME definition in Table 2 is invalid.
- [V2G-DC-685]** If the NUM_SOUNDS field in a CM_ATTEN_CHAR.IND is zero, then the ATTEN_PROFILE has no significance and the whole messages shall be ignored. It is up to the EV to decide what number of M-SOUNDS used for the attenuation profile is sufficient for its decision (i.e. whether to discard CM_ATTEN_CHAR.IND if NUM_SOUNDS is less than C_EV_match_MNBC).
- [V2G-DC-686]** On reception of CM_ATTEN_CHAR.IND, the EV shall answer by sending the CM_ATTEN_CHAR.RSP within TP_match_sequence.
- [V2G-DC-687]** After sending a CM_ATTEN_CHAR.RSP, the EV shall continue the Matching process with the found and/or potentially found EVSEs by sending either a CM_SLAC_MATCH.REQ to the selected EVSE or a CM_VALIDATE.REQ to one of the potential EVSEs within TP_EV_match_session.