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Road vehicles — Vehicle to grid Communication Interface —

Part 3:
Physical and data link layer requirements

Véhicules routiers — Interface de communication entre véhicule et réseau électrique —

Partie 3: Exigences relatives à la couche physique et à la couche liaison de données

ICS 43.120

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Foreword

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ISO/IEC 15118-3 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electric and electronic equipment*.

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

ISO/IEC 15118 consists of the following parts, under the general title *Road vehicles — Vehicle to grid communication interface*:

— *Part 1: Physical General information and use-case definition*

— *Part 2: Network and application protocol requirements*

— *Part 3: Physical layer and Data Link Layer requirements*

Introduction

The pending energy crisis and necessity to reduce greenhouse gas emissions has led the vehicle manufacturers to a very significant effort to reduce the energy consumption of their vehicles. They are presently developing vehicles partly or completed propelled by electric energy. Thus vehicles will reduce the dependency on oil, improve the global energy efficiency and reduce the total CO_2 emissions for road transportation if the electricity is produced from renewable sources. To charge the batteries of such vehicles, specific charging infrastructure is required.

Much of the standardization work on dimensional and electrical specifications of the charging infrastructure and the vehicle interface is already treated in the relevant ISO or IEC groups. However, the question of information transfer between the vehicle and the grid has not been treated sufficiently.

Such communication is beneficial for the optimisation of energy resources and energy production systems as vehicles can recharge at the most economic or most energy-efficient instants.

It is also required to develop efficient and convenient payment systems in order to cover the resulting micro-payments. The necessary communication channel may serve in the future to contribute to the stabilization of the electrical grid as well as to support additional information services required to operate electric vehicles efficiently.

Road vehicles — Vehicle to grid communication interface — Part 3: Physical and data link layer requirements

1 Scope

This part of this International Standard specifies the physical and data link layer for a high level communication, directly between battery electric vehicles (BEV) or plug-in hybrid electric vehicles (PHEV) , and the fixed electrical charging installation (Electric Vehicle Supply Equipment (EVSE)), used in addition to the Basic Signalling, as defined in *[ISO-1]*.

It covers the overall information exchange between all actors involved in the electrical energy exchange. This International Standard is applicable for (manually) connected conductive charging.

Only “*[IEC-1]* modes 3 and 4” EVSEs, with a High Level Communication module, are covered by this standard.

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.

IEC 61851-1:2010, *Electric vehicles conductive charging system – Part 1: General requirements*

IEC 61851-21:2001, *Electric vehicles conductive charging system – Part 21: Electric vehicle requirements for conductive connection to an a.c./d.c. supply*

IEC 62196-2:2011, *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*

DTR TC69-221: *System using a PWM function*

ISO/IEC 15118-1: *Road vehicles – Vehicle to grid communication interface – Part 1: General information and use-case definition*

ISO/IEC 15118-2: *Road vehicles – Vehicle to grid communication interface – Part 2: Network and application protocol requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply in addition to the terms and definitions given in *[ISO-1]*.

3.1
Association
the process to determine the low-layer communication module of the EV and the low-layer communication module of the EVSE, where the EV is physically connected to, in a direct way

NOTE In this document, the term "Association" always refers to "Layer 2 Association".

3.2
Coexistence
the ability of different low-layer communication systems to share the same physical media, and to function simultaneously

3.3
Communication Media
the physical media carrying the low-layer communication signal is given by the cable assembly, which connects the charging infrastructure and the EV

3.4
Communication Node
device equipped with a low-layer communication 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 communication channel

3.5
Connection Coordination
the entity which provides the whole functionality for EV to EVSE association and initialization, via the Data Link Control SAP, described in Clause 6. This entity also controls the relationships between the Basic Signalling 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.

3.6
Crosstalk
a capacitive or inductive coupling between two individual electric circuits, each providing a media for a low-layer communication network, in a way that the two networks are influenced by each other

3.7
Data Link Control SAP
a Service Access Point which defines the interface between the Connection Coordination module and the low-layer communication technology for managing the Link status

3.8
DATA SAP
a Service Access Point that defines the interface between Layer 2 and Layer 3 for exchange of V2G related payload

3.9
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

3.10
Initialization
the process of interaction between the EV, the EVSE and an external trigger, beginning from plug-in of the cable assembly until the decision for the charging mode to be applied

NOTE This process is used for the charging modes 3 and 4, as described in *[IEC-1].*

3.11
IO SAP
the IO Control path interfaces Hardware I/O Control (e.g. control pilot duty cycle) and the control pilot wire

NOTE This entity provides an IO SAP, which is defined in clause 12

3.12
Logical Network
a logical network is defined for the layer 2. This is a set of low-layer communication 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

3.13
Low-layer communication Module
the functional assembly behind each socket outlet or each connector, depending on the type of EV connection (*[IEC-1]*), which includes the communication node and the Connection Coordination functionality

3.14
MAC Address
the MAC Address is a unique identifier assigned to network interfaces for communication on the Data Link Layer

3.15
Nominal Duty Cycle
a 10-96 % duty cycle, according to *[IEC-1]*, generated by the EVSE side

3.16
Pilot Function Controller
the system that manages the control pilot line on the EVSE side, according to *[IEC-1]*

3.17
Shared Bandwidth
in cases where different systems use the same physical media to transmit data, the available bandwidth for each system might be limited, depending on the mechanism used to allocate the total bandwidth

3.18
Signal Coupling
the signal coupling circuit, which described the method of coupling the signal on the communication media

3.19
Supply Equipment Communication Controller (SECC)
entity which implements the communication to one or multiple EVCCs according to *[ISO-2]* and which may be able to interact with secondary actors

3.20
Valid Duty Cycle
this duty cycle is 5 % or 10-96 %, according to *[IEC-1]*, generated by the EVSE

4 Symbols and abbreviated terms

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

DLINK	Data Link
EIM	External Identification Mean
HLE	Higher Layers Entities
ID	Identification
MAC	Media Access Control
SAP	Service Access Point

SE Supply Equipment

5 Conventions

5.1 Definition of OSI based services

[ISO-3] is based on the OSI Service Conventions (ISO/IEC 10731:1994) for the individual layers specified in this document.

5.2 Requirement structure

Each individual requirement included in this document has a unique code, as followed:

"**[V2G3-YXX-ZZ]** Requirement text"

Where "V2G3" represents the *[ISO-3]* set of standards,

Where Y represents the main body (M) / Annexes (Annexes' letter)

Where XX represents the number of the current Clause

Where ZZZ represents the individual requirement number

And where "requirement text" includes the actual text of the requirement.

EXAMPLE **[V2G3-M01-01]** This shall be an example requirement.

5.3 Normative references convention

Each reference to a normative document has a unique code, defined as follow:

[IEC-1] IEC 61851-1

[IEC-21] IEC 61851-21

[IEC-2] IEC 62196-2

[ISO-0] ISO/IEC 15118 series

[ISO-1] ISO/IEC 15118-1

[ISO-2] ISO/IEC 15118-2

[ISO-3] ISO/IEC 15118-3

6 System architecture

6.1 Layers overview

This document is organized along architectural lines, emphasizing the large-scale separation of the system into two parts: the MAC sub layer of the Data Link Layer and the Physical Layer. These layers are intended to correspond closely to the lowest layers of the ISO/IEC Model for Open Systems. Figure 1 shows the relationship of the *[ISO-3]* to the OSI reference model.

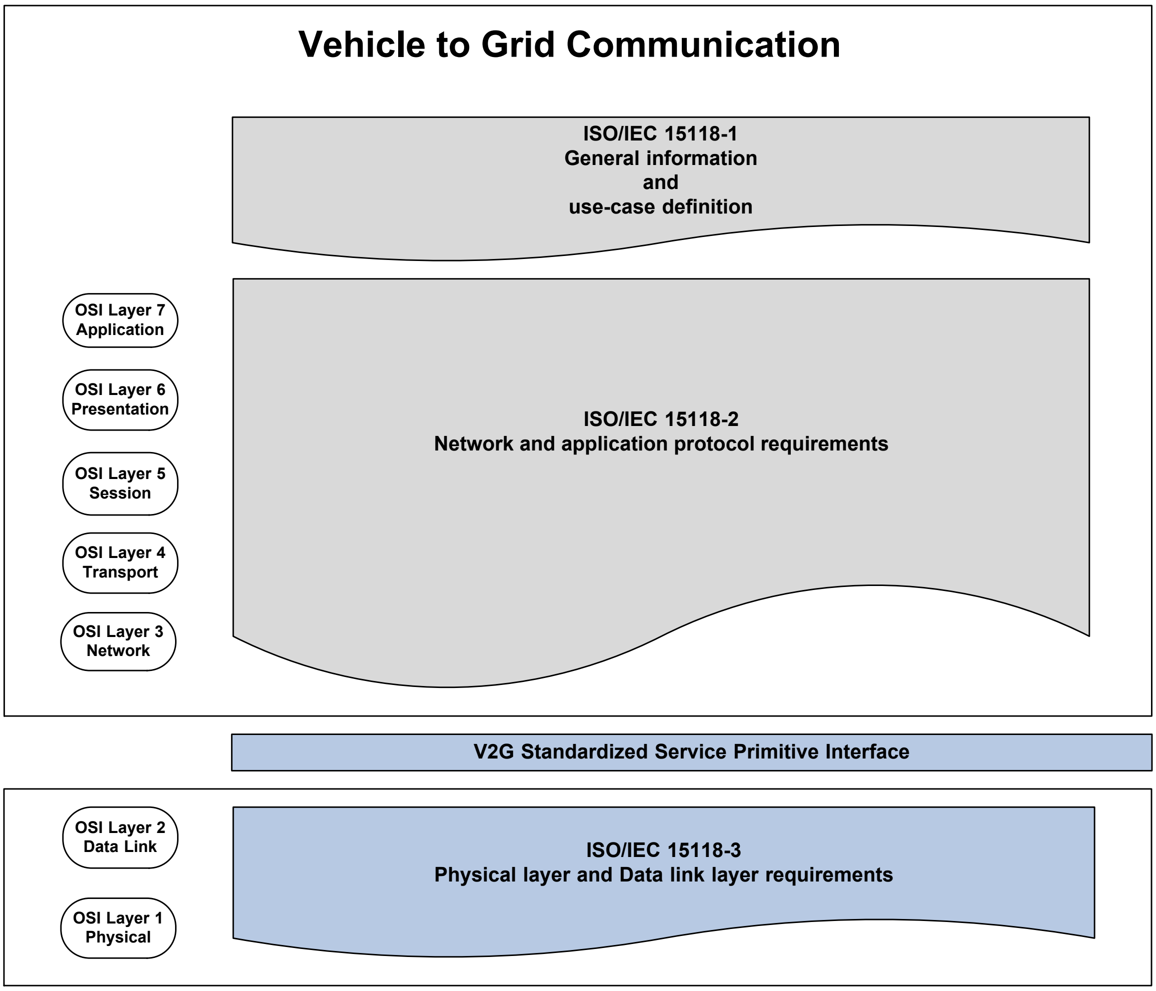

Figure 1 — Overview of *[ISO-0]* in the ISO/IEC OSI reference model

[ISO-3] defined requirements applicable to layer 1 and 2, including V2G Standardized Service Primitive Interface, according to the OSI layered architecture. Layers 3 to 7 are specified in *[ISO-2]*.

Beside the communication related stack on the left and middle of Figure 2, a Hardware Control Path on the right provides triggering and signalling means for *[IEC-1]* related communication.

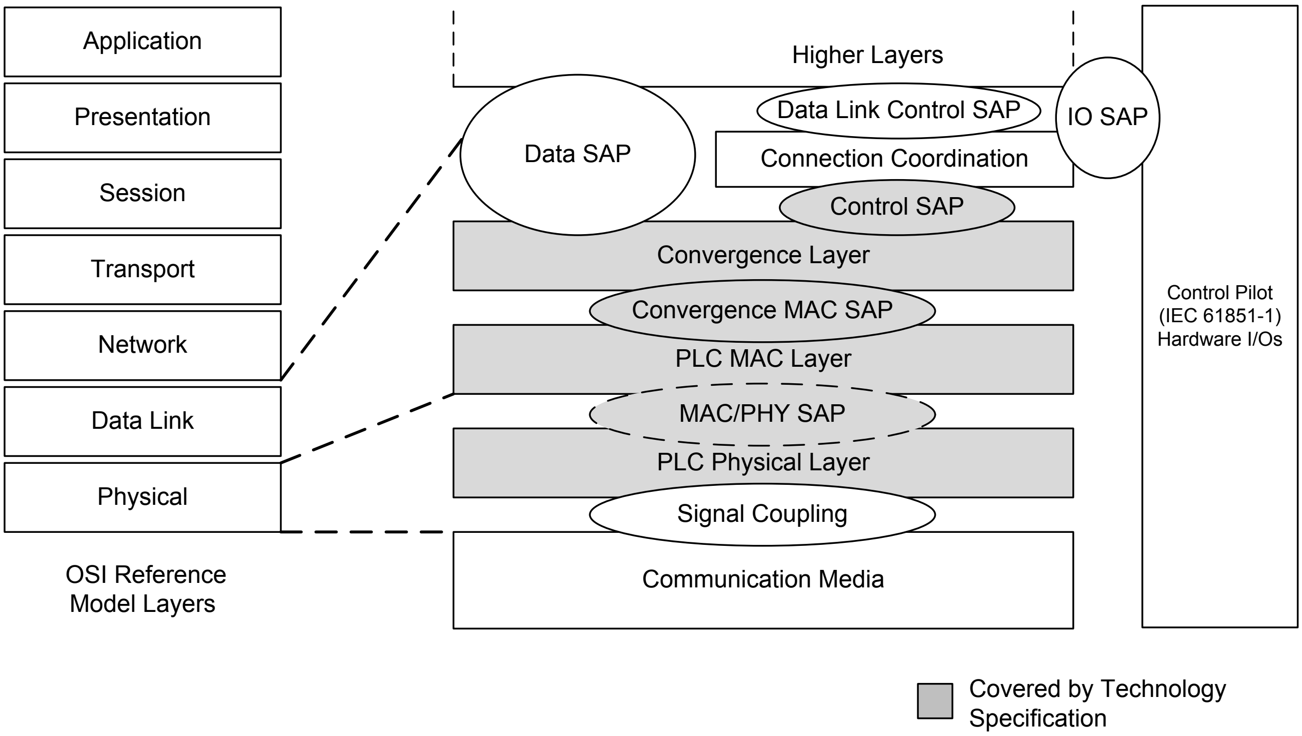

Figure 2 — *[ISO-3]* relationship to the ISO/IEC OSI reference model

6.2 Definition of high level communication and basic signalling

6.2.1 Basic Signalling

[V2G3-M06-01] The Basic Signalling follows *[IEC-1]*. All timings shall be compliant with the *[IEC-1]* Annex A.

Such a charging process uses the bidirectional signalling according to *[IEC-1]*, indicating EV related information via control pilot states and EVSE related information via the duty cycle of the control pilot signal.

6.2.2 High level communication

[V2G3-M06-02] The HLC shall be used in addition to the Basic Signalling in order to enable a bidirectional communication and offer additional features.

[V2G3-M06-03] The sequence of the data exchange within the HLC based charging session shall be done in accordance to the *[ISO-2]* communication protocol.

It can be split into 2 periods:

— The Period 1 prepares the settings to initiate a communication channel. It covers the messages of *[ISO-2]* SDP, Session Setup, ChargeParameterDiscovery and PowerDelivery (start) (List not exhaustive).

— The Charging Loop

NOTE The detailed descriptions are given in the clause 7.

Secretary's NOTE Should we ask the upper layers to inform the layer 2 that the "Period 1" (communication channel settings) is finished? Up to that period, the layer 2 may have to do action with the S2, and has to keep the control of the PWM. After that trigger, we can leave without the PWM.

[V2G3-M06-04] In case of HLC based charging, the PWM duty cycle shall not change due to dynamically changed grid information. Those dynamically changed grid limitations shall be provided through the *[ISO-0]* communication channel.

6.3 Identification requirements

The initialization phase depends on, whether identification "ID from EV" or EIM is required, as described in *[ISO-1]*, use-cases D1, D2, D3 and D4.

[V2G3-M06-05] When an ID is required, the EVSE shall provide an "ID from EV" and/or EIM means.

Any payment included in a package (parking fee, in a flat rate…) is considered as "No ID required" (since the energy is paid for by means totally independent of the EVSE).

NOTE 1 The need for authentication can be externally triggered.

NOTE 2 The "ID required" covers only the ID for operating purposes, and does not cover all the identification linked to the "security" as described in the *[ISO-2]*.

NOTE 3 The feature "Plug and Charge" is called "ID from EV", using the message set of *[ISO-2]*.

NOTE 4 At a public accessible EVSE, with only “ID from EV”, there might be a fallback solution, to allow any EV, to be able to charge.

[V2G3-M06-06] If the duty cycle is set to 5 %, the EVCC may launch an "ID recognition" from the EV (Use-case D1 and D2 of *[ISO-1]*). According to the EV's answer, the SECC may decide to allow the charge or not.

6.4 System requirements

6.4.1 Overview

This Clause defines the requirements on the triggering of the EVSE and the EV immediately after the plug-in of the cable assembly: sequence specifying when and how the contract ID is recognized, when to launch the Association process (at the MAC level), and how to decide to use Basic Signalling or HLC.

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

6.4.2 EVSE

[V2G3-M06-07] If the EVSE sets a 5 % duty cycle, and the "ID from EV" is passed, the charging loop shall be launched.

6.4.2.1 Control pilot requirements

[V2G3-M06-08] Each EVSE outlet has its own dedicated Pilot Function controller.

The complete asynchronous process and the sequences are described in clause 7.

[V2G3-M06-09] After a positive EIM, the EVSE shall provide a nominal duty cycle as soon as the EVSE is ready to supply energy.

NOTE 1 This nominal duty cycle may trigger the EV to launch a Basic Signalling charge.

NOTE 2 After establishment of digital communication and ID recognition, the EVSE may switch at any time between a 5 % duty cycle and a nominal duty cycle.

[V2G3-M06-10] The B1 state shall be at least T_conn_osci_on.

NOTE This will allow the system to have time to react to a transition B2 – B1 – B2.

6.4.2.2 Low-layer communication requirements

The *[ISO-1]* Annex A describes different architectures.

The Association process is designed for working between the low-layer communication module locally assigned to each socket-outlet, on the EVSE side, and the EVCC.

NOTE 1 The complete Association process description is given in Clause 9.

NOTE 2 *[ISO-3]* highly recommends to build a point to point architecture (1 low-layer communication module on EVSE side, and 1 low-layer communication module per EV).

[V2G3-M06-11] The case of charging station enclosures with multiple socket-outlets or attached cables, and only one low-layer communication module managing the complete station shall behave as an individual low-layer communication module for each outlet.

6.4.3 EV

6.4.3.1 Control pilot requirements

On seeing a nominal duty cycle, the EV may launch the charge at any time.

[V2G3-M06-12] In the HLC mode, in case of a nominal duty cycle, the vehicle shall choose between the two following ways, to determine the maximum charge current, defined by the EVSE:

— By calculating the minimum of the maximum current given by the duty cycle and the maximum charge current given by using the low-layer communication messages.

— By following the low-layer communication messages only.

NOTE If a nominal duty cycle is set, it is recommended to keep it as the maximum current capacity of the charging station, and let the high level communication messages dynamically adjust the available max current.

6.4.3.2 Low-layer communication requirements

[V2G3-M06-13] The trigger for launching the association process shall be the availability of a control pilot, independently of the oscillator (Bx, Cx, Dx, or F).

[V2G3-M06-14] The EV shall decide to launch the Association process whenever it wants, according to the requirement [V2G3-M06-13].

[V2G3-M06-15] The EV shall always try to charge in the HLC mode, as soon as the Association process is successful, even if the control pilot duty cycle is indicating a nominal value.

[V2G3-M06-16] The EV shall charge in the Basic Signalling mode, if the Association process has failed and the control pilot indicates a nominal duty cycle.

[V2G3-M06-17] An EV shall always be capable to switch from a HLC mode to a Basic Signalling mode, if an error occurs on the *[ISO-0]* communication, even if a HLC mode is already launched.

[V2G3-M06-18] During an Association process, a change in the duty cycle shall not terminate / interrupt the Association process on EV side.

6.5 Configuration of a low-layer communication module

Coexistence mechanisms are technology dependant and are not defined in this standard.

7 Connection coordination

This Clause describes the behaviour of the system, at different phases of a charging session, between a plug-in and a plug-out.

7.1 Overview

Secretary's NOTE To be added a Figure that includes all phases of a charging session, witch a reference to each sub-clauses.

7.2 Plug-in phase

This phase covers the plug-in up to the beginning of the charge.

[V2G3-M07-01] Before beginning the plug-in sequence, all parameters and timers shall be reset to default values.

Secretary's NOTE Consistency with timers and sequences shall be checked with *[ISO-2]* before IS.

7.2.1 EVSE side

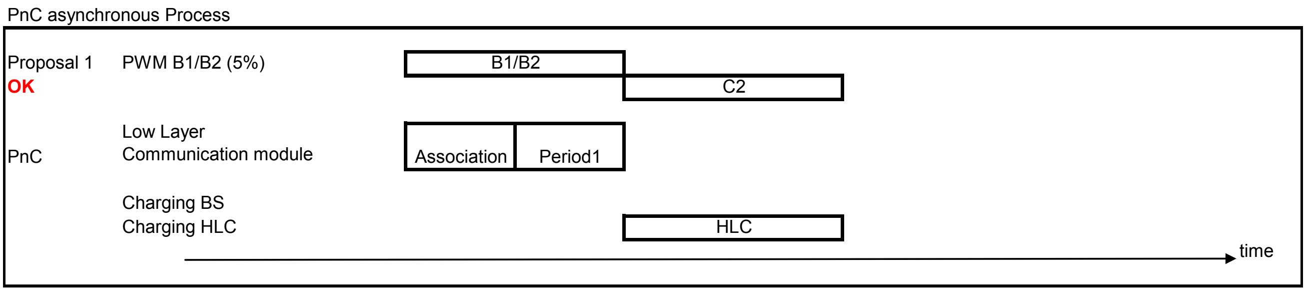

Figure 3 — Asynchronous process: PnC

Secretary's NOTE Title to be updated, according to next secretary's note and CD13b-JP-YK2.

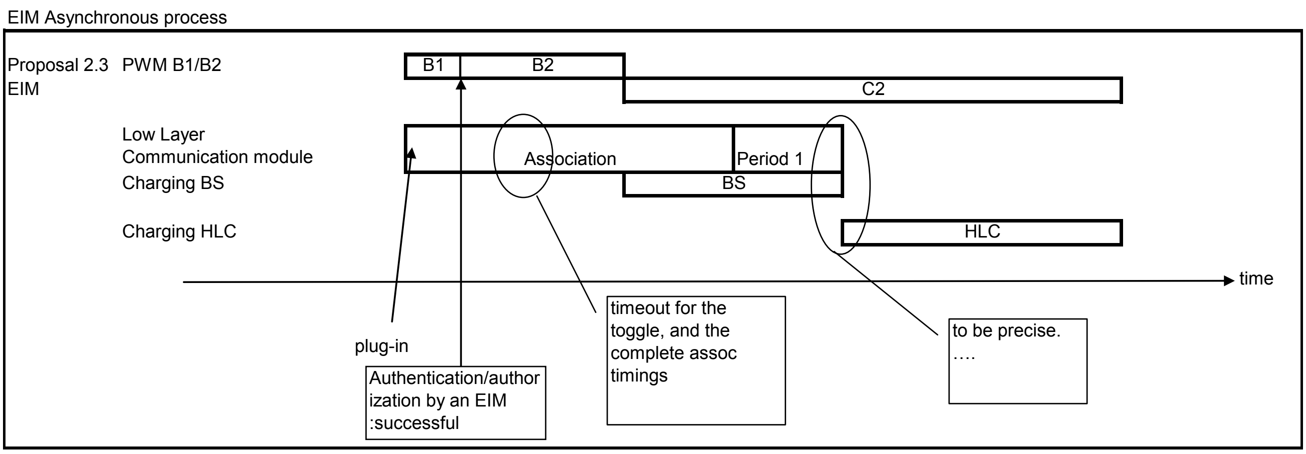

Figure 4 — Asynchronous process: EIM

Secretary's NOTE While in EIM, the process is asynchronous, since EIM can happen at any time, for the PnC, the process seems to be synchronous… which changes nothing except the title of Figure 3. This note shall be deleted before IS.

[V2G3-M07-02] After successful detection of the plug-in of a cable assembly, the low-layer communication module shall be ready for communication in less than T_conn_max_comm.

[V2G3-M08-03] During a plug-in phasis, the EVSE shall only apply a voltage to the control pilot, when the low-layer communication module is ready for communication. The EVSE is free to switch on/off the DC voltage on the control pilot, but before applying the DC voltage, the low-layer communication module has to be ready for communication.

Due to the fact that the initialization process is asynchronous, an EVSE should be prepared to receive an EIM identification, if offered, at any time.

NOTE 1 The EIM sequence is compliant with the use-case A2 from *[ISO-1]*.

NOTE 2 If the EVSE implements the P'nC sequence without any fall back solution, the charging will not happen if the EV doesn't implement an EVCC.

According to the *[ISO-2]* profile implemented, each EVSE will decide to implement or not an EIM as a fallback solution to be able to handle all kind of cars, or just the EV equipped with the "Plug and Charge" profile.

Secretary's NOTE Should we change the term "profile" by "identification mode".

7.2.2 EV side

NOTE 1 When detecting a nominal duty cycle, the EV is allowed to begin the charge, according to the Basic Signalling mode.

NOTE 2 The EV will choose between beginning the charge or waits for the low-layer communication channel.

[V2G3-M07-04] The EV may switch at any time between a Basic Signalling mode and a HLC mode (see Figure 3 and Figure 4).

[V2G3-M07-05] The EV shall relaunch the Association process C_conn_max_assoc times in series within a plug-in and a plug-out phasis. After C_conn_max_assoc unsuccessful trials, the EV shall stay in the Basic Signaling mode.

7.3 Initialization phase

[V2G3-M07-06] When the Association process is successful and if the Plug-and-Charge profile is implemented, the Application layer via High Level Communication shall launched the ID recognition.

Secretary's NOTE All steps between Association process and the ID recognition is described in [ISO-2].

[V2G3-M07-07] According to that ID recognition, the EVSE shall decide to authorize the charge or to not authorize the charge.

7.4 Loss of communication

This clause covers the situation where the low-layer communication link is lost while the charging session was happening (C2 state), i.e. between a plug-in and a plug-out.

7.4.1 EVSE side

[V2G3-M07-08] If the EVSE receives the signal to start the Association process, the EVSE shall turn on the oscillator if not already on.

[V2G3-M07-09] When leaving any sequence at state E or F, the EVSE shall turn off the oscillator at least T_conn_osci_on.

NOTE This will create a transition X1 -> X2, that will force the EV to re-launch the association process, if needed.

[V2G3-M07-10] With receiving a D-Link_Termination.request from HLE with RESETUP = Yes, the communication node shall leave the logical network within T_assoc_leave, and shall be ready for a new Association process.

7.4.2 EV side

In case the EVSE has turned off the oscillator, the EV will open its switch S2, to reach the state B1. A lack of communication will thus imply a stop of charging (transition Cx -> C1/B1).

[V2G3-M07-11] When detecting a transition B1-> B2, the EV,shall relaunch the Association process if it is in an unassociated state.

[V2G3-M07-12] If EV detects loss of communication, the EV shall decide either to charge on Basic Signalling mode, or to stop the charge.

[V2G3-M07-13] While relaunching the Association process, the EV is allowed to go on charging in the Basic Signaling mode, if the EVSE sets a nominal duty cycle.

NOTE The Association process after a loss of communication, is exactly the same as during a plug-in phasis. If previously associated and not plugged out, the Validation step can be skipped.

[V2G3-M07-14] With receiving a D-Link_Termination.request from HLE with RESETUP = Yes, the communication node shall leave the logical network within T_assoc_leave and relaunch the Association process during at least T_conn_resetup.

7.5 Wake-up phase

[V2G3-M07-15] The EVSE shall wake up the EV and relaunch the Association process by creating a transition B1 -> B2, if needed.

NOTE This sequence will awake the EV, if the EV was sleeping.

[V2G3-M07-16] During a sleeping phasis (EV or EVSE side), the EVSE shall not turn off the +12V supply, in order to keep alive the pilot line.

[V2G3-M07-17] During a sleeping phasis, the EVSE may decide to turn off its low-layer communication module.

[V2G3-M07-18] The EVSE shall not asleep its low-layer communication module, if the oscillator is on.

[V2G3-M07-19] The wake-up of the low-layer communication module on EVSE side shall happen only through a toggle on the pilot line.

An EV shall wake-up on detecting a transition B1-> B2, according to *[IEC-1]*.

[V2G3-M07-20] Depending on the implementation, the EV shall relaunch the Association process either systematically, or if the system is not assured that the cable assembly was never physically disconnected.

[V2G3-M07-21] An EV may decide to wake-up an EVSE, while being at a B1 state, by creating one single toggle B1->C1-> B1, as defined in 9.4.

[V2G3-M07-22] In case of a EVSE awoken by the EV, (Requirement [V2G3-M07-21]), the Association process shall not be launched by the EV before T_conn_assoc_start after the transition C1->B1.

[V2G3-M07-23] In case of an EVSE awoken by the EV ((Requirement [V2G3-M07-21]), the low-layer communication module shall ready maximum T_conn_assoc_start after the transition C1->B1.

[V2G3-M07-24] In case of a B2->B1-> B2 transition, the time at B1 shall be at least T_time_B1 seconds.

7.6 Plug-out phase (with hint)

This phase supposes that the customer gave a hint to the system that he wants to leave.

NOTE With detecting the plug out, the D-LINK_TERMINATE.request shall be sent to lower layers. The description how to proceed with D-LINK_TERMINATE.request is defined in sub-clause 9.6.

[V2G3-M07-25] For a unexpected loss of communication, requirement [V2G3-M09-25] shall be taken into account.

[V2G3-M07-26] With a type 1 connector, if the customer pushes S3, but doesn't plug-out, the system may relaunch at any time the communication automatically.

NOTE This requirement doesn’t imply to relaunch the identification, if not needed.

[V2G3-M07-27] With a type 2 connector, if the customer unlocks, but don't plug-out, the system may relaunch the communication automatically and will relock the connector.

[V2G3-M07-28] If control pilot line is interrupted, then the trigger of the Association process is reset to the beginning.

7.7 State change

[V2G3-M07-29] If needed, a transition from state F, D, or C to B should re-initiate a HLC, if the time at the F, D or C state before the transition to B is more than T_conn_init_HLC.

NOTE The support of an automatic F -> B trigger is up to the EVSE manufacturer.

7.8 Error handling

NOTE Clause empty for the moment, it will be updated during the work of Connection Cycle sub-group.

8 Timings and constants

This clause summarizes all timings used in the Main body of this standard.

[V2G3-M08-01] All low-layer communication devices shall comply with Table 1.

Table 1 — Timing and constant values

Parameter	Description	Min	Typical	Max	Unit
C_assoc_retry	Number of retries of the Signal Strength Measurement			3	nbr
C_conn_max_assoc	Number of retries of Association sequence	3			nbr
C_vald_nb_toggles	Number of BCB Toggles	1		3	nbr
T_assoc_leave	Maximum time to close the logical network			1	s
T_assoc_max_ssm	Duration of the Signal Strength Measurement			3	s
T_conn_assoc_start	Time before launching an association, after a toggle B1->C1-> B1	6			s
T_conn_init_HLC	Minimum B state duration after a state F, D or C	200			ms
T_conn_max_comm	Maximum time of low-layer communication module availability after Proximity pin detection			1	s
T_conn_osci_on	Minimum time to turn on the oscillator after entering B1 state	5			s
T_conn_resetup	Time to resetup the Association process after a loss of communication	1			min
T_conn_type1	Time to wait before relaunching communication for Type 1 connector	10			s
T_conn_type2	Time to wait before relaunching communication for Type 2 connector	10			s
T_time_B1					
T_vald_detect_time	Time to detect a variation of the state on EVSE side			200	ms
T_vald_state_duration	Duration of each state B or C within the BCB Toggle	200		400	ms
T_vald_toggle	Duration of the BCB Toggle sequence	600		2800	ms

[V2G3-M08-02] Any successful Association process shall reset all parameters, all the timers and reset the retry_counter.

9 Association EV – EVSE process

9.1 Overview

A unique association between the EV and a specific charge coupler of the supply equipment is necessary. After this Association process in layers 1 and 2, upper layers are able to proceed their binding process. Interfaces related to Data Link status are defined in clause 12. Depending on the communication signal paths, the Association process depends on the infrastructure topology.

Under some technical conditions, the Association process may render ambiguous results. In this case, an additional validation method based on a signalling via the control pilot line may be necessary to confirm the association.

Figure 5 gives a generic overview of the Association process. The full description is given in the corresponding annex.

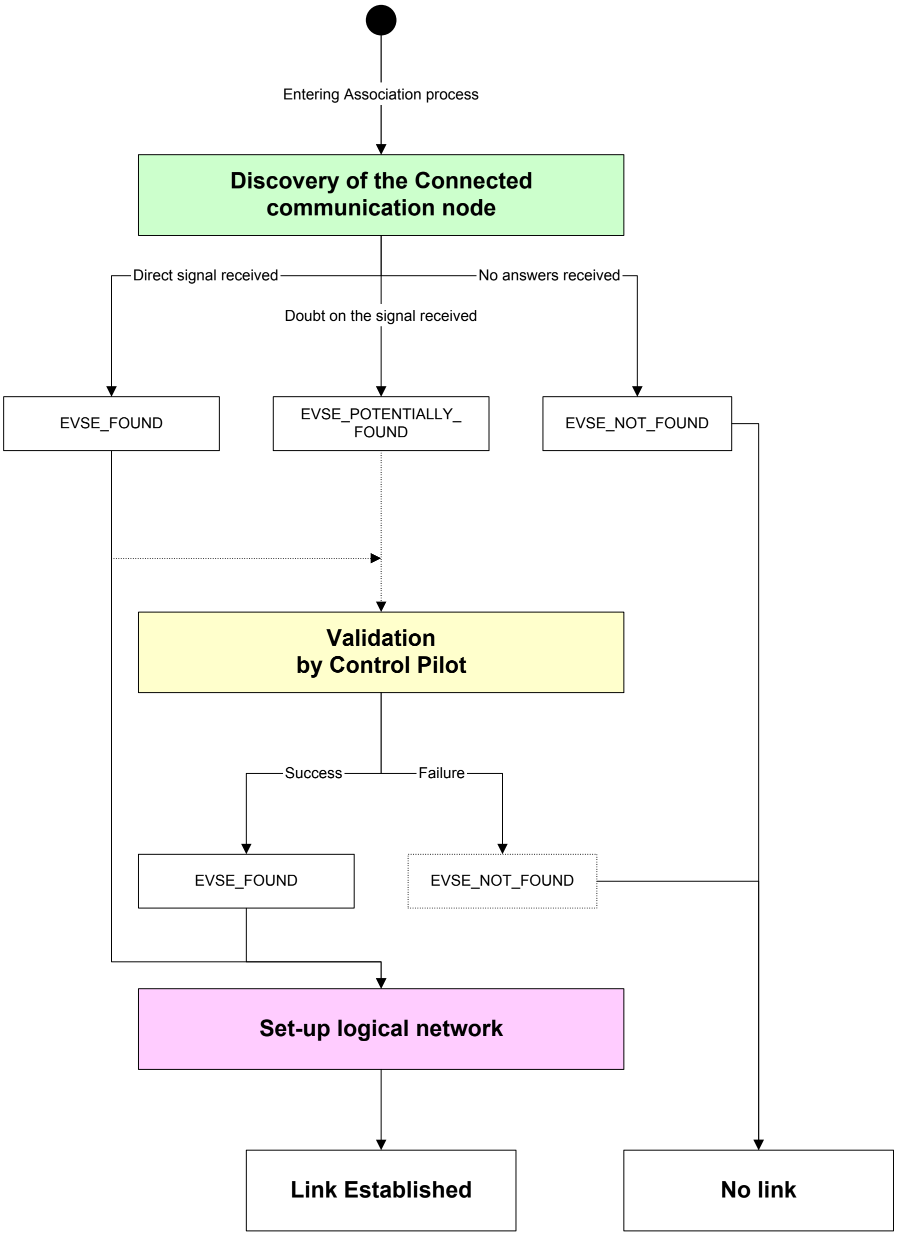

Figure 5 — EV Point of View

9.2 Initialization of association process

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

[V2G3-M09-01] Each communication node shall provide a method to exchange authorized frequencies to be used, to be in line with frequency restrictions. A communication 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.

9.3 Discovery of the connected low-layer communication module

During the discovery process, the EV determines which EVSE is directly connected to its cable assembly.

The method is based on a measurement of the signal strength. The EV will discover all the communication nodes in range, measure and compare signal strengths and will choose the communication nodes. See the corresponding annex for more details.

[V2G3-M09-02] All *[ISO-3]* communication nodes in the network shall be compliant with a method of measurement based on the signal strength.

[V2G3-M09-03] Only EV communication nodes shall send requests based on this signal strength method.

[V2G3-M09-04] Only EVSE communication nodes shall answer to the requests based on this signal strength measurement.

[V2G3-M09-05] The nominal procedure of signal strength measurement shall be operated in less than T_assoc_max_ssm.

[V2G3-M09-06] The signal strength measurement shall be concluded by:

- EVSE Found
- EVSE Potentially Found
- No EVSE Found

NOTE The exact usage of the terms "EVSE Found", "EVSE Potentially Found" and "No EVSE Found" are in the corresponding annexes.

[V2G3-M09-07] According to the use-cases, each OEM may consider the status “EVSE Potentially Found” as “EVSE Found” or “No EVSE Found”.

[V2G3-M09-08] According to the use-cases, each OEM may consider the status “EVSE Found” or “EVSE Potentially Found” as only “EVSE Potentially Found”. In this case, the Validation of the Association shall be considered as mandatory.

NOTE In the following cases, it is recommended to consider the "EVSE Potentially Found":

- For DC station
- When the energy flow is charged to the customer, within the use-case "Identification from the EV" (*[ISO-1]* use-case D1/D2).

[V2G3-M09-09] The EV shall retry the signal strength measurement C_assoc_retry time before considering the Association process as definitively failed.

9.4 Validation of matching decision

The Validation of matching decision is a method to validate the signal strength measurement via an additional independent path, based on the hardwired control pilot line.

If a Validation of matching decision is required to confirm that the EV is connected to the right low-layer communication module, the following requirements are considered as mandatory.

After the signal strength measurement, the EV can decide on the basis of the results to request the EVSE for an additional validation. As soon as the EVSE is ready to detect the control pilot line, the EV sends a random timer value to the EVSE T_vald_toggle. After sending the message, the EV switches the control pilot state in the sequence B-C-B. This switching sequence is called BCB-Toggle in the following.

According to 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 and to perform the Validation process, or to skip it.

During the time T_vald_toggle, the EV performs multiple BCB toggles. The number of toggles is chosen randomly in the available time.

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

[V2G3-M09-10] Both EVs and EVSEs shall be compliant with a method to validate the EV-EVSE connection, based on the signal sequence "EV signal to the EVSE" defined in *[IEC-1]* Annex A.

[V2G3-M09-11] In accordance with *[IEC-1]*, the EV shall perform a "BCB Toggle" defined in Figure 6.

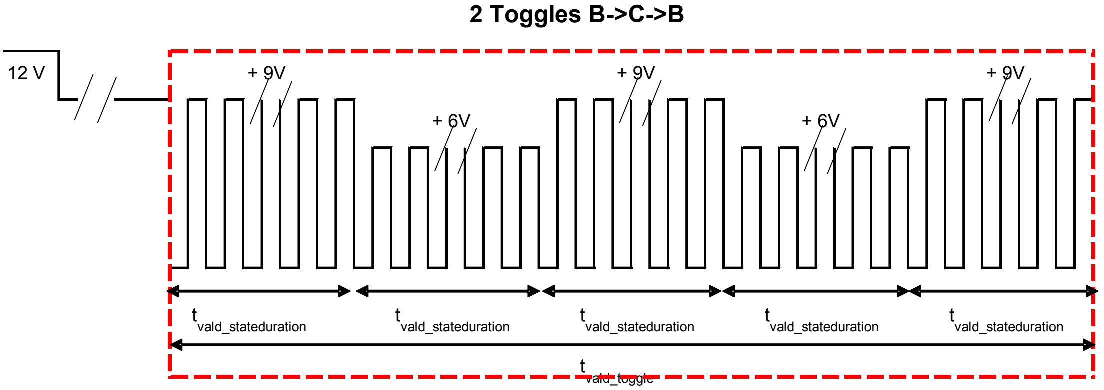

Figure 6 — Example of toggle sequence with 2 toggles

[V2G3-M09-12] If the EV status is "EVSE Found", the Validation step is optional.

[V2G3-M09-13] If the EV status is "EVSE Potentially Found", the EV shall start the Validation process. According to the grid architecture, the EVSE can inform the EV that it is allowed to abort the Validation step. In such a case the EV has the option to abort the validation.

[V2G3-M09-14] The EVSE shall be able to detect a state variation on the control pilot line within T_vald_detect_time.

[V2G3-M09-15] The duration of each state during the toggle sequence is defined as T_vald_state_duration.

[V2G3-M09-16] Both EV and EVSE shall use the same set of messages to exchange the number of toggles, using the messages defined in dedicated annexes.

[V2G3-M09-17] The EVSE shall answer positively to only one EV request for Validation if it receives multiple requests. The EVSE shall answer with a negative state otherwise.

[V2G3-M09-18] The EV shall choose a timer value T_vald_toggle.

[V2G3-M09-19] The EV shall perform C_vald_nb_toggles BCB toggle(s) during the Validation step, and shall adjust the T_vald_toggle in coherence with the number of BCB Toggles.

[V2G3-M09-20] The control pilot duty cycle has no impact on the Validation step.

[V2G3-M09-21] Since the communication node on EV side concludes the signal strength measurement, the communication node on EV side shall also conclude this mechanism. This method shall be concluded by:

- EVSE Found
- No EVSE Found

NOTE At this stage, the Validation is physically performed with the control pilot line. The "EVSE Potentially Found" state is not possible.

9.5 Set-up a logical network

According to the low-layer communication technology, a logical network may have to be built in order to enhance the communication.

[V2G3-M09-22] As soon as the EV has successfully joined the Logical Network of the EVSE both entities are in the status "associated". The communication node shall inform HLE via the D-LINK_READY.indication = Link established, that HLE's binding process can begin.

9.6 Leave the logical network

[V2G3-M09-23] With receiving a D-Link_Termination.request from HLE, the communication node shall leave the logical network within T_assoc_leave. All parameters related to the current link shall be set to the default value and shall change to the status "Unassociated".

[V2G3-M09-24] When the low-layer communication module leaves the Logical Network, it shall inform HLE via the D-LINK_READY.indication = no Link.

9.7 Error handling

[V2G3-M09-25] In the following cases, the communication node shall leave the logical network within T_assoc_leave. All parameters related to the current link shall be set to the default value and shall change to the status "Unassociated".

- The state A is detected on EVSE side
- The state E is detected on EV side

NOTE Additional errors are defined in the corresponding annexes.

10 EMC requirements

Requirements are defined in *[IEC-21]*.

Technology related EMC requirements are defined in the corresponding annex.

11 Signal coupling

The signal coupling, as well as additional requirements regarding the physical layer, the MAC layer and the interface with the network layer are defined within the corresponding annex.

12 Layer 2 interfaces

12.1 Overview

The purpose of all primitives defined in this clause is for explanation and for definition of a unique terminology within the document. This terminology is not implementation relevant.

As shown in Figure 2, the definition of the Data Link Layer provides two interfaces to higher layers:

- The Data SAP is the interface between the communication technology and the layer 3 (e.g. IPv6);
- The Data Link Control SAP provides link status information, error information, control functionality and is located between the Connection Coordination and higher layers;
- The Control SAP provides the minimum set of control functionalities to guarantee interaction between convergence layer and the Connection Coordination.

12.2 IO-control

The hardware IO Control Service Primitives provides methods for controlling, triggering and signalling interaction between the high-level digital communication and the Connection Coordination to the *[IEC-1]* Basic Signalling.

This interface is primarily accessed by higher layers and the Connection Coordination module to trigger on status changes and influence the status indicated via the control pilot.

Table The IO-CPSTATE.indication notifies higher layers about a change in the current control pilot state. This indication shall be sent on any change of the control pilot status.

Table 2 — IO-CPSTATE.indication

Primitive	IO-CPSTATE.indication
Entity to support	EV,
Parameter Name	Description
CPState	State of control pilot (A, B, C, D, E, F)

IO-GET_CPDUTYCYCLE.confirmation confirms the IO-SET_ CPDUTYCYCLE.request request by sending the current duty cycle within the parameter CPDUTYCYCLE.

Table 3 — IO-GET_ CPDUTYCYCLE.confirmation

Primitive	IO-GET_ CPDUTYCYCLE.confirmation
Entity to support	EV, EVSE
Parameter Name	Description
CPDUTYCYCLE	Duty cycle value of the control pilot (0 – 100 %)

The IO-CPDTYCYCLE.indication notifies a change of the current control pilot duty cycle to higher layers. This indication shall only be sent, when the value change is greater than 2 % within 500 ms.

Table 4 — IO-GET_CPDUTYCYCLE.indication

Primitive	IO-GET_CPDUTYCYCLE.indication
Entity to support	EVSE
Parameter Name	Description
CPDUTYCYCLE	Duty cycle value of the control pilot (0 - 100%)

12.3 Data SAP

The Data SAP interfaces higher layer data to a low-layer communication technologies Data Link Layer.

12.4 Data Link Control SAP to layer 3

These primitives are defined according to *[ISO-2]* document.

[V2G3-M12-01] The D-LINK_READY.indication shall inform higher layers a change of communication link status. This indication shall be sent with any change link status. The values of the DLINKSTATUS are independent of the states of the control pilot signal.

Table 5 — D-LINK_READY.indication

Primitive	D-LINK_READY.indication
Entity to support	EV, EVSE
Parameter Name	Description
DLINKSTATUS	Status of communication link: — No link — Link established

[V2G3-M12-02] The D-LINK_TERMINATE.request shall force lower layers to terminate the association. This indication should be sent in case of a communication error on upper layers, which require a re-setup of the connection or to terminate the connection before quitting the charge session.

Table 6 — D-LINK_TERMINATE.request

Primitive	D-LINK_TERMINATE.request
Entity to support	EV, EVSE
Parameter Name	Description
RESETUP	No – Terminate and keep unassociated until unplug Yes – Terminate and re-associate immediately

[V2G3-M12-03] The D-LINK_TERMINATE.confirmation shall confirm a D-LINK_TERMINATE.request.

Table 7 — D-LINK_TERMINATE.confimation

Primitive	D-LINK_TERMINATE.confimation
Entity to support	EV, EVSE
Parameter Name	Description
RESETUP	No – Terminate and keep unassociated until unplug Yes – Terminate and re-associate immediately

Annex A
(normative)

HomePlug GreenPHY on Control Pilot line

A.1 Scope

This part describes all requirements for the HomePlug GreenPHY Technology on control pilot line. All requirements of this clause are mandatory.

If not specifically indicated, both generic and technology-dependant requirements are mandatory.

A.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 *Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications, release version of 2011*

HomePlug GreenPHY Specification, release version 1.1, 2012

A.3 Terms and definitions

For the purposes of this document, the following terms and definitions apply in addition to the terms and definitions given in the clause 3.

A.3.1
Amplitude Map
he Amplitude Map specifies a transmit power-reduction factor for each subcarrier related to the Tone Mask

A.3.2
Central Coordinator
the central coordinator is the manager of a HomePlug GreenPHY network

A.3.3
Channel Access Priority
the CAP is a method to prioritize the channel access (See *[HPGP]*)

A.3.4
Inter System Protocol
the intersystem Protocol enables various Broadband Power Line systems to share power line communication resources in tine (time domain multiplex), in frequency (frequency domain multiplex), or both. For more information, refer to *[IEEE]*

A.3.5
Management Message Entry
MMEs are messages exchanged between PLC nodes or a PLC node and higher layers for control purposes

A.3.6
QPSK Modulation
a phase modulation technique that transmits two bits in four modulation states

A.3.7
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

A.3.8
Signal Level Attenuation Characterization
the SLAC is a protocol to measure the signal strength of a signal between HomePlug GreenPHY stations

A.3.9
Tone Mask
the Tone Mask defines the set of tones and maximum transmission power that can be used in a given regulatory jurisdiction or given application

A.4 Symbols and abbreviated terms

CAP Channel Access Priority

CCo Central Coordinator

HPGP HomePlug GreenPHY

ISP Intersystem Protocol

MME Management Message Entry

PE Protective Earth

PLC Power Line Communication

QPSK Quadrature Phase Shift Keying

SLAC Signal Level Attenuation Characterization

A.5 Convention

All conventions are described in the clause 5 of this standard, and are used in all annexes.

A.5.1 Normative references convention

In addition to the normative references defined in the sub-clause 5.3, the following references to normative document are used in this annex:

[IEEE] IEEE 1901

[HPGP] HomePlug GreenPHY Specification.

A.6 System architecture

A.6.1 Layers overview

The "Figure 2 — *[ISO-3]* relationship to the ISO/IEC OSI reference model" gives an overview of the structure.

As shown in the "Figure 2 — *[ISO-3]* relationship to the ISO/IEC OSI reference model", the definition of the Data Link Layer provides two interfaces to higher layers, the ETH SAP and the Data Link Control SAP.

A.6.1.1 Communication Media

In this annex, the Communication Media block is the control pilot line (*[IEC-1]*, Annex A).

A.6.1.2 Data SAP

The Data SAP is the ETH SAP. The ETH SAP is completely covered by the *[HPGP]*.

Due to the Convergence Layer, the Data Link Layer of HomePlug GreenPHY provides an Ethernet II-class SAP to higher layers.

This 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.

The Data Link Control SAP indicates link status and error information to higher layers and is provided by the Connection Coordination entity.

A.6.1.3 Signal coupling

The signal coupling interface is described in the clause A.11 of this annex.

A.6.1.4 MAC/PHY Stack

The coloured entities represent the whole HomePlug GreenPHY MAC and PHY layer and are covered by *[HPGP]*. The Convergence Layer adapts the generic HomePlug GreenPHY MAC to an IEEE 802.3 Ethernet II-class interface via the ETH SAP. The Control SAP provides a control interface to access HomePlug GreenPHY specific data and configuration for Network management, including encryption key management, SLAC services and link status information.

A.6.1.5 Connection coordination

There are no additional requirements for the technology.

A.6.2 Definition of high level communication and basic signalling

There are no additional requirements for the technology.

A.6.3 Identification requirements

There are no additional requirements for the technology.

A.6.4 System requirements

[V2G3-A06-01] This standard takes only into account a signal coupling, operating on a point to point basis with only one PLC module on EVSE side connected to one PLC module on EV side.

[V2G3-A06-02] EVSE systems that have multiple EV modems connected to one central EVSE modem shall operate with vehicles that have been designed to operate in one to one configurations.

A.6.5 Configuration of a PLC module

This sub-clause is a summary of some key points of HomePlug GreenPHY technology that this standard requires.

The Physical Layer of the HomePlug GreenPHY technology is fully described in the *[HPGP]*.

A.6.5.1 Shared bandwidth mechanisms

NOTE Coexistence mechanisms with other HomePlug technologies are addressed in *[HPGP]*.

A.6.5.1.1 ISP

[HPGP] implements the ISP as a coexistence mechanism. The ISP, defined by *[IEEE]*, 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.

[V2G3-A06-03] The PLC module 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 PLC node on the EV side.

NOTE Coexistence mechanisms with other technologies, covered by *[IEEE]*, are a requirement in *[HPGP]*.

A.6.5.1.2 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, in case of coexistence with a fully loaded HomePlug AV, the HomePlug GreenPHY may be limited to 7 % in time. This can affect the data rate.

A.7 Connection coordination

There are no additional requirements for the technology.

A.8 Timings and constants

This clause summarizes all timings used in this annex.

[V2G3-A08-01] All PLC devices shall comply with Table A.1.

Table A.1 — Timing and constant values

Parameter	Description	Min	Typical	Max	Unit
C_assoc_MNBC	Number of M-Sounds sent for the SLAC	8	10	16	
C_assoc_signalattn_direct				10	dB
C_assoc_signalattn_indirect		20			dB
T_assoc_alive				2	s
T_assoc_join				4	s
T_Assoc_MNBC_Timeout	Time out used for SLAC	-	600	1000	ms
T_assoc_response				200	ms
T_assoc_session_max	Maximum time between CM_ATTN_CHAR.RSP and either CM_VALD_CPLT.REQ, either CM_SLAC_MATCH.REQ			3	s

A.9 Association EV – EVSE process

[V2G3-A09-01] The Association process is based on the messages defined in the *[HPGP]*.

Figure A.1 outlines the complete sequence of the association process. It shows the sequence to follow, from the discovery of the other PLC modules to the start of the nominal communication.

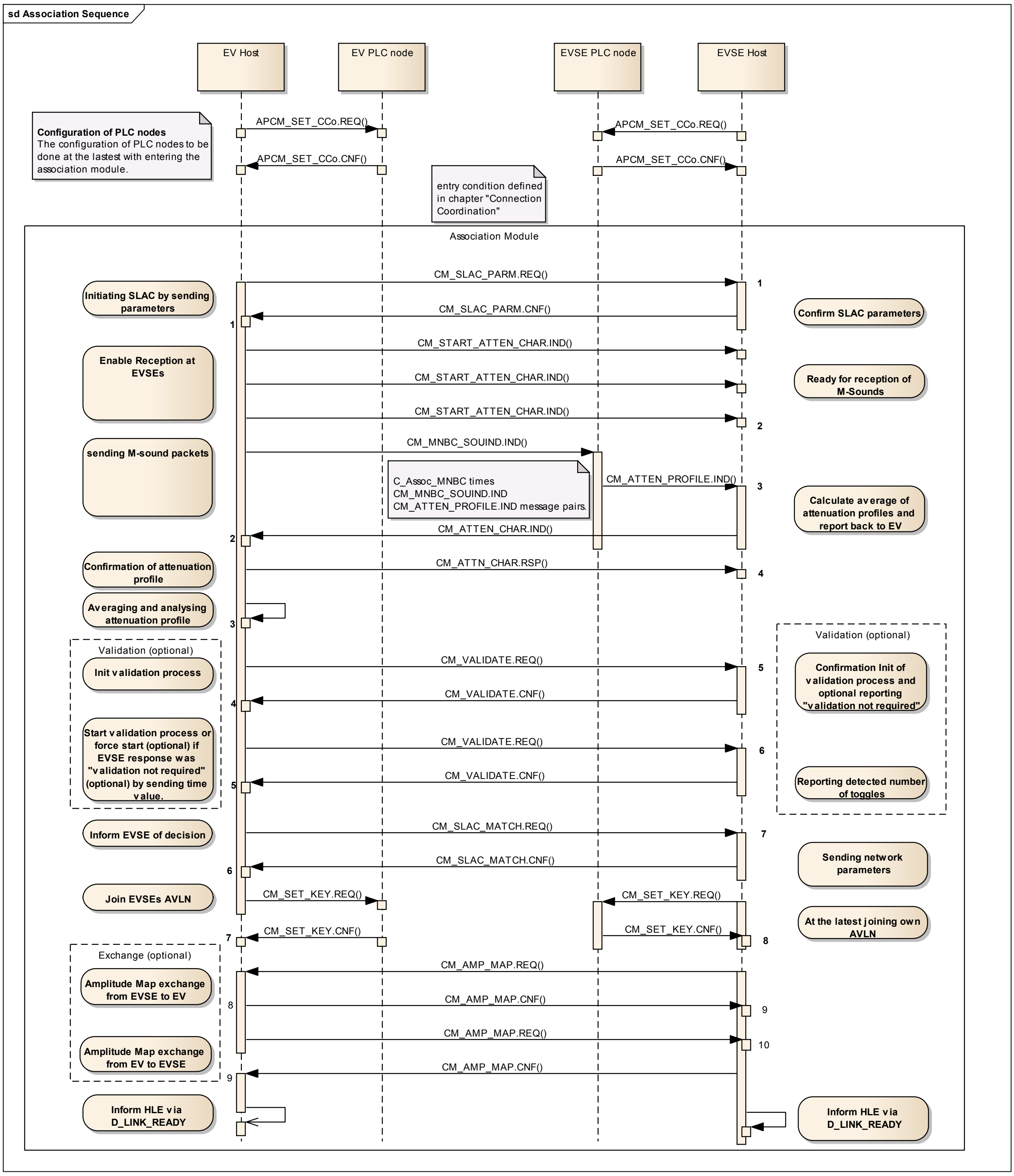

Figure A.1 — Sequence chart of HomePlug GreenPHY association process

Secretary's NOTE The association process is based on a proposal (draft version of HomePlug 1.1, final document still to be released by HomePlug Alliance). This note will be deleted when the final specification is available.

A.9.1 Initialization of association process

A.9.1.1 Requirements

[V2G3-A09-02] The PLC node on the EV side shall be configured in order to never become the CCo. Therefore, the APCM_SET_CCo.REQ primitive defined in clause “Control SAP Service” of the *[HPGP]* shall be used with the parameters defined in A.9.1.2.

[V2G3-A09-03] The PLC node on the EVSE side shall be configured in order to always be the CCo. Therefore, the APCM_SET_CCo.REQ primitive defined in clause “Control SAP Service” of the *[HPGP]*, shall be used with the parameters defined in A.9.1.2.

[V2G3-A09-04] To speed up the Association process, the PLC node shall be configured to use CAP3 priority for all frames related to the Association process.

[V2G3-A09-05] A SLAC request shall only be responded by EVSEs PLC node if all the following conditions are fulfilled:

— The EVSE is connected to an EV, detected by a plugged charge cord

— The EVSE is in "Unassociated state"

[V2G3-A09-06] The PLC node on the EV side shall never answer to a SLAC request.

A.9.1.2 MME Content

As defined in the requirement [V2G3-A09-02], the APCM_SET_CCo.REQ primitive should be used using the following parameters:

Table A.2 — APCM_SET_CCo.REQ

MME	Parameter	Value
APCM_SET_CCo.Req	SET_CCo_Mode	"Never a CCo"

As defined in the requirement [V2G3-A09-03], the APCM_SET_CCo.REQ primitive should be used using the following parameters:

Table A.3 — APCM_SET_CCo.REQ

MME	Parameter	Value
APCM_SET_CCo.Req	SET_CCo_Mode	"Always a CCo"

A.9.2 Discovery of the connected PLC node

A.9.2.1 Description of the step

At the beginning of the Connection Coordination phase, the EV has to determine which counterpart nodes are available and which one is the right one to connect to. Therefore, the EVSE measures the attenuation of the signal coming from the EV via multicast for different groups of frequencies. When the EV receives the results, it decides if the received message comes from the connected EVSE.

As soon as the PLC module on the EV side enters the Association process, it needs to discover its connected EVSE.

The Signal Strength Measurement method to be used is the SLAC defined in the *[HPGP]*. According to the result, an additional validation using the hard-wired control pilot line may be required.

A.9.2.2 Requirements

[V2G3-A09-07] The PLC node shall be compliant with the SLAC messages defined in the *[HPGP]*.

[V2G3-A09-08] The PLC node on the EV side shall be compliant with the sequence diagram of the "Figure A.1 — Sequence chart of HomePlug GreenPHY association process".

[V2G3-A09-09] 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 A.11.4.1.

[V2G3-A09-10] The Average_Attenuation used for matching decision shall be calculated by the arithmetic mean of all groups in the CM_ATTEN_CHAR.IND.

Secretary's NOTE PT4/Association has decided to use the arithmetic mean of all groups. Investigations are in progress to check if it is the best way to compute the data.

[V2G3-A09-11] According to the result of the SLAC process, the PLC node on the EV side shall send its decision using the relevant messages:

- If EV_Discovering_Status = EVSE_FOUND, the PLC node shall inform the EVSE that they are connected, and start to join the logical network. The PLC node shall use the CM_SLAC_MATCH messages, as described in the requirement [V2G3-A09-23] in A.9.4.3.
- If EV_Discovering_Status = EVSE_POTENTIALLY_FOUND, the PLC node shall inform the most probable EVSE that it will start a Validation process, using the CM_VALD_CPLT messages, as described in the requirement [V2G3-A09-20], in A.9.3.3.
- If EV_Discovering_Status = EVSE_NOT_FOUND, the PLC node shall inform HLE that association is not possible using the primitive D-LINK_READY.indication with the status "no Link" and keep the PLC node in the "Unassociated" state.

A.9.2.3 MME Content

[V2G3-A09-12] For the SLAC process, the PLC nodes shall use the following set of MMEs. The parameters to be used within the MMEs are defined in Table A.4.

[V2G3-A09-13] The Ethernet Destination MAC Address field shall be filled either as Broadcast or Unicast, as defined in Table A.4.

Table A.4 — MMEs parameters definition for SLAC

MME	Field	Value	Definition
CM_MNBC_SOUND.IND Broadcast	APPLICATION_TYPE	0x00	PEV-EVSE Association
	SECURITY_TYPE	0x00	No Security
	MSVarField	-	M-Sound Variable Field See definition below
MSVarField of CM_MNBC_SOUND.IND	SenderID	17 Bytes	Not used in *[ISO-3]*
	Cnt	1 Byte	Countdown counter for number of Sounds remaining
	RunID	8 Bytes	This value shall be the same as the one sent in the CM_START_ATTEN_CHAR.IND message by this sender.
	RSVD	8 Bytes	Not used in *[ISO-3]*
	Rnd	16 Bytes	Random Value
CM_SLAC_PARM.REQ Broadcast	APPLICATION_TYPE	0x00	PEV-EVSE Association
	SECURITY_TYPE	0x00	No Security
	RunID	8 Bytes	Random Run Identifier of sender
CM_SLAC_PARM.CNF Unicast	M-SOUND_TARGET	0xFFFFFFFFFFFF	Request send in broadcast
	NUM_SOUNDS	C_Assoc_MNBC	Number of M-Sounds transmitted by the GP station during the SLAC process
	Time_Out	T_Assoc_MNBC_Timeout	Timeout
	RESP_TYPE	0x00	HLE usage
	FORWARDING_STA	0x00	No station
CM_START_ATTEN_CHAR.IND Broadcast	APPLICATION_TYPE	0x00	PEV-EVSE Association
	SECURITY_TYPE	0x00	No Security
	ACVarField	-	Attenuation Characteristics Variable Fields See definition below
ACVarField of CM_START_ATTEN_CHAR.IND	NUM_SOUNDS	C_Assoc_MNBC	Number of M-Sounds transmitted by the GP station during the SLAC process
	Time_Out	T_Assoc_MNBC_Timeout	Timeout

	RESP_TYPE	0x00	HLE usage
	FORWARDING_STA	0x00	Not used
	RunID	8 Bytes	Random identifier created by the EV which initiates the SLAC process
CM_ATTEN_CHAR.IND Unicast	APPLICATION_TYPE	0x00	PEV-EVSE Association
	SECURITY_TYPE	0x00	No Security
	ACVarField	-	Attenuation Characteristics Variable Fields See definition below
ACVarField of CM_ATTEN_CHAR.IND	SOURCE_ADDRESS	6 Bytes	MAC Address of the EV which initiates the SLAC process
	RunID	8 Bytes	Random identifier created by the EV which initiates the SLAC process
	SOURCE_ID	0x00	Not used in unsecured SLAC
	RESP_ID	0x00	Not used in unsecured SLAC
	NumSounds	1 Byte	Number of M-Sounds used to generate the ATTEN_PROFILE
	ATTEN_PROFILE	-	Signal Level Attenuation (Field format in Table ”ATTEN_PROFILE” of HomePlug GreenPHY specification)
CM_ATTEN_CHAR.RSP Unicast	APPLICATION_TYPE	0x00	PEV-EVSE Association
	SECURITY_TYPE	0x00	No Security
	ACVarField	-	Attenuation Characteristics Variable Fields See definition below
ACVarField of CM_ATTEN_CHAR.RSP	SOURCE_ADDRESS	6 Bytes	MAC Address of the EV which initiates the SLAC process
	RunID	8 Bytes	Random identifier created by the EV which initiates the SLAC process
	SOURCE_ID	0x00	Not used in unsecured SLAC
	RESP_ID	0x00	Not used in unsecured SLAC
	Result	0x00	Success

[V2G3-A09-14] Based on the signal attenuation read by the "CM_ATTEN_CHAR.RSP" Message, the EV_Discovery_Status is defined by the following Table A.5:

Table A.5 — EV_Discovering_Status definition

Status	Average_Attenuation		Description
	From	To	
EVSE_FOUND	-	C_assoc_signalattn _direct	The EVSE is identified without any doubt
EVSE_POTENTIALLY _FOUND	C_assoc_signalattn _direct	C_assoc_signalattn _indirect	One or several EVSEs are identified. The next step of the Association process will allow deciding if the most probable candidate is the connected EVSE.
EVSE_NOT_FOUND	C_assoc_signalattn _indirect	-	No direct connected EVSE is found

A.9.3 Validation of matching decision

A.9.3.1 Description of the step

The Validation of matching decision is a method to validate the SLAC based Association determination via an additional independent path, based on the hardwired control pilot line.

The main process is described in the sub-clause 9.4.

A.9.3.2 Requirements

[V2G3-A09-15] If the EV_Discovering_Status is “EVSE_FOUND”', the Validation step is optional.

[V2G3-A09-16] If the EV_Discovering_Status is “EVSE_POTENTIALLY_FOUND”, a confirmation with control pilot duty cycle shall be used.

[V2G3-A09-17] The EVSE shall answer to a CM_VALIDATE.REQ with a "Ready" state to only one EV request for Validation if it receives multiple requests. The EVSE shall answer with "Not_Ready" state otherwise.

[V2G3-A09-18] According to the EVSE Architecture, the EVSE can decide to answer with "Not_Required" state. In this case, the EV shall decide:

— Either to continue the Validation process, by resending the request CM_VALIDATE.REQ.

— Either to skip the Validation process, by informing the EVSE of the decision, using the CM_SLAC_MATCH.REQ.

[V2G3-A09-19] Both EV and EVSE shall comply with the sequence diagrams defined in Figure A.1.

A.9.3.3 MME content

[V2G3-A09-20] Both EV and EVSE shall use the CM_VALIDATE messages to exchange the toggle related values, using the parameters defined in the section A.9.3.3.

[V2G3-A09-21] The Ethernet Destination MAC Address field shall be filled either as Broadcast or Unicast, as defined in the Table A.6.

Table A.6 — MMEs parameters definition for Validation

MME	Field	Size	Values
CM_VALIDATE.REQ Broadcast	Signal Type	0x00	PEV S2 toggles on control pilot line
	VRVarField	-	Validate Request Variable Field See definition below
VRVarField of CM_VALIDATE.REQ	Timer	1 Byte	Time during the EVSE has to hear the control pilot line, in ms: 0x00 = 100 ms 0x01 = 200 ms
	Result	1 Byte	Result code: 0x00 = Not Ready 0x01 = Ready 0x02 = Success 0x03 = Failure 0x04 = Not Required
CM_VALIDATE.CNF Unicast	SignalType	0x00	PEV S2 toggles on control pilot line
	VCVarFiled	-	Validate Confirm Variable Field
VCVarField of CM_VALIDATE.CNF	ToggleNum	1 Byte	Number of detected Toggle sequences: 0x00 = 0 0x01 = 1 … and so on
	Result	1 Byte	Result code: 0x00 = Not Ready 0x01 = Ready 0x02 = Success 0x03 = Failure 0x04 = Not Required

A.9.4 Joining the logical network

A.9.4.1 Description of the step

After the right Association between EV and EVSE was determined, the EV joins the logical network of the EVSE. Therefore, the broadcast domain is reduced to the PLC nodes directly connected.

A.9.4.2 Requirements

[V2G3-A09-22] The PLC node shall try to join the Logical Network only if the EV_Discovering_status is EV_FOUND

[V2G3-A09-23] In order to create the Logical Network both EV and EVSE have to use the "CM_SLAC_MATCH" MMEs defined in the *[HPGP]* messages, using sequences defined in "Figure A.1 — Sequence chart of HomePlug GreenPHY association process".

[V2G3-A09-24] At any time an EVSE switches to a private logical network by sending a CM_SLAC_MATCH.CNF MME. The NID shall be set per random value, to assure a unique logical network.

[V2G3-A09-25] In the case that a PLC node requires additional carriers to be notched, it shall send the amplitude map to the remote PLC node as soon as the logical network is set up. Therefore the sequence described in Figure A.1 and sub-clause A.9.4.3 for detailed primitives shall be used. The amplitude map for further communication shall be the intersection of the PLC node's local amplitude and the received amplitude map from the remote PLC node.

[V2G3-A09-26] As long no exchange of an amplitude map is trigger by one of the PLC nodes, a default Amplitude map shall be used.

NOTE The EVSE shall guarantee the conformity to 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.

A.9.4.3 MME content

[V2G3-A09-27] The Ethernet Destination MAC Address field shall be filled as Unicast, as defined in the Table A.7.

Table A.7 — MMEs parameters definition for Logical Network

MME	Field	Value	Definition
CM_SLAC_MATCH.REQ	APPLICATION_TYPE	0x00	PEV-EVSE Association
	SECURITY_TYPE	0x00	No Security
	MVFLength	2 Bytes	MatchVarField Length
	MatchVarField	-	This field is described below
MatchVarField of CM_SLAC_MATCH.REQ	PEV ID	17 Bytes	Not used in *[ISO-3]*
	PEV MAC	6 Bytes	PEV MAC Address
	EVSE ID	17 Bytes	Not used in *[ISO-3]*
	EVSE MAC	6 Bytes	EVSE MAC Address
	RunID	8 Bytes	Identifier given in the CM_START_ATTEN_CHAR.IND message
	RSVD	8 Bytes	Not used in *[ISO-3]*
CM_SLAC_MATCH.CNF	APPLICATION_TYPE	0x00	PEV-EVSE Association
	SECURITY_TYPE	0x00	No Security
	MVFLength	2 Bytes	MatchVarField Length
	MatchVarField	-	This field is described below
MatchVarField of CM_SLAC_MATCH.CNF	PEV ID	17 Bytes	Not used in *[ISO-3]*
	PEV MAC	6 Bytes	PEV MAC Address
	EVSE ID	17 Bytes	Not used in *[ISO-3]*
	EVSE MAC	6 Bytes	EVSE MAC Address
	RunID	8 Bytes	Identifier given in the CM_START_ATTEN_CHAR.IND message
	RSVD	8 Bytes	Not used in *[ISO-3]*
	NID	8 Bytes	Network ID given by the CCo (EVSE)
	NMK	0x00	Private NMK of the EVSE (random value)

To exchange an Amplitude map, the EVSE shall use the "CM_AMP_MAP.REQ" primitive defined in clause 11.5.12 of the *[HPGP]*. The content depends on the carriers to be used.

To confirm an amplitude mask exchange, the EV shall use the "CM_AMP_MAP.CNF" primitive defined in sub-clause 11.5.13 of the *[HPGP]*. The content is shown in the following Table A.8:

Table A.8 — MMEs parameters definition for Amplitude Map exchange

MME	Field	Value	Definition
CM_AMP_MAP.REQ	AMLEN	2 Bytes	Number of entries
	AMDATA[0]	4 Bytes	Amplitude Map Data: First unmasked carrier
	AMDATA[n]	4 Bytes	Amplitude Map Data: [n] unmasked carrier
CM_AMP_MAP.CNF	ResType	1 Byte	Response Type: 0x00 = Success 0x01 = Failure

A.9.5 Leave the logical network

This sub-clause allows speeding up a disconnection / reconnection of another car. This sub-clause avoids that the CCo of the Logical Network needs several minutes to discover that the car has left the network.

[V2G3-A09-28] With receiving a D-Link_Termination.request from HLE, the PLC node shall leave the logical network and reset the NMK. PLC node shall follow the clause “Leaving an AVLN” defined in the *[HPGP]*.

A.9.6 Error handling

[V2G3-A09-29] The number of SLAC process retries is limited to C_assoc_retry. A retry is considered as one full process of SLAC, including the two sub steps.

[V2G3-A09-30] The EV shall react to the potential EVSE with either a CM_VALD_CPLT.REQ or a CM_SLAC_MATCH.REQ message within T_assoc_session_max after receiving a CM_ATTN_CHAR.RSP response. Otherwise, the EVSE is allowed to timeout the association session with the certain EV.

The following table defines error cases during the Association process. Every error case is mapped to an Error Handling procedure. The numbering of the steps is related to Figure A.1.

Table A.9 — Error Handling

Point of Error	Error cases	Error Handling Procedure
EVSE / EV	Node receives request message with a non-valid message content	EHP_01 (No answer)
EVSE / EV	Node receives response message with a non-valid message content	EHP_02 (Resend request, counter)
EVSE / EV	Node does not receive confirmation message within T_assoc_response	EHP_02 (Resend request, counter)
EVSE / EV	Node does not detect any message flow for T_assoc_alive	EHP_03 (Initiate restart, counter)
EV	No matching EVSE in "Analyse Attenuation Profile"	EHP_03 (Initiate restart, counter)
EV, step 7	EV is not able to join the logical network within T_assoc_join	EHP_03 (initiate restart, counter)
EVSE	Timeout, no EV joins the EVSE's logical network	EHP_04(resend matching confirmation, counter)

[V2G3-A09-31] In error handling procedure EHP_01, the node shall not answer to the last request. Error will be solved by timeout.

[V2G3-A09-32] In error handling procedure EHP_02, the node shall resend the last request. The number of retries per message type is limited to C_assoc_rerequ = 3. The retry counter shall be reset, as soon as a valid response follows a retry.

[V2G3-A09-33] In error handling procedure EHP_03, the node shall leave the Association process module returning a failure message to the connection cycle module.

[V2G3-A09-34] In error handling procedure EHP_04, the node shall resend the matching confirmation. The number of retries per message type is limited to C_assoc_rematch = 3.

A.10 EMC requirements

[V2G3-A10-01] All PLC nodes shall notch out the carriers listed in Table A.10 in the tone mask.

Table A.10 — Notched carriers

HomePlug GeenPHY Carrier
0 - 85
140 - 167
215 - 225
283 - 302
410 - 419
570 - 591
737 - 748
857 - 882
1016 - 1027
1144 - 1535

A.11 Signal coupling

A.11.1 Overview

This clause defines the requirements that have to be fulfilled, in order to inject HomePlug GreenPHY signals into the control pilot line to enable bidirectional HomePlug GreenPHY communication between one EVSE and one EV.

The HomePlug GreenPHY signals on the control pilot line are compliant with *[HPGP]* except the signal coupling, signal levels and carrier usage.

As PLC signal's coupling is directly linked to the control pilot, the schematic in *[IEC-1]* Annex A specification is basis for definitions regarding the control pilot signal.

To enable PLC injection, the path from EVSE's output to EV's input should not be considered as capacitive only, as it is sufficient for the low frequency control pilot signal. For high frequency PLC, the path should be considered as a transmission line. To take the high frequency into account, the control pilot circuit and the component values have to be specified more detailed.

For the control pilot line, the additional capacity of the PLC coupling circuit has to be considered. For the PLC signal, the partitioning of the capacitive load of the EV, EVSE and the charge cord is important and is detailed in this clause.

A.11.2 General drawing for PLC injection

[V2G3-A11-01] All technical requirements described in this clause assume to have a dedicated pair of PLC chips implemented for the couple (EVSE, EV), linked by a control pilot wire. Figure A.2 depicts an implementation of parallel injection and gives definitions used further.

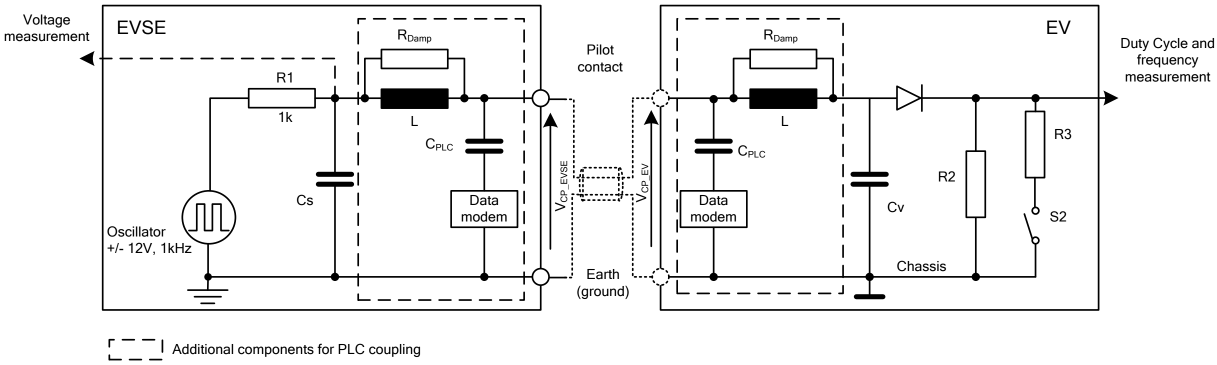

Figure A.2 — Implementation of parallel injection

NOTE 1 Different topologies like point-to-multipoint are not covered and may require adaptations.

NOTE 2 The coupling drawing is valid for cases A, B and C, as defined in the *[IEC-1]*.

NOTE 3 The coupling capacitors are equivalent components, which can be implemented with more than one component, for example 2 capacitors, as soon as the requirements about values given in the table below is fulfilled.

NOTE 4 L and R_{Damp} associated with capacitors, form low pas filters, which enable the normal working of the control pilot line and the PLC communication at the same time. They enable to affect low frequency signals to the control pilot line and high frequency ones to the PLC. R_{Damp} resistors limit resonance effects of RLC filters thus constituted.

[V2G3-A11-02] In case of parallel injection, the PLC signal shall be coupled between the control pilot wire and the PE (Protective Earth) wire.

[V2G3-A11-03] In case of parallel injection, the PLC injection circuit on EVSE side shall be wired to the control pilot and the PE. Additional components, such as EMC or ESD protection, should not affect the PLC signals.

[V2G3-A11-04] In case of parallel injection, the PLC injection circuit on EV side shall be wired to the control pilot line and the ground. Additional components, such as EMC or ESD protection, should not affect the PLC signals.

[V2G3-A11-05] PLC shall work with any duty cycle and level applied to the control pilot line.

[V2G3-A11-06] A proper formatting of the control pilot raw signal shall be implemented on EVSE side, to assure *[IEC-1]* compliancy in presence of an additional PLC signal.

NOTE 5 The *[ISO-3]* highly recommends to apply at least a 1^{st} order low pass filter with a cut-off frequency of 100 kHz to 200 kHz for measurements on the control pilot signal (e.g. duty cycle or amplitude), not to disturb the measurement by high frequency PLC signals.

A.11.3 Signal requirements for PLC injection

The following table gives requirements that physical signals shall comply with, in order to enable PLC injection into the control pilot line, according to previous requirements.

NOTE The PLC signal shall be added to control pilot signal on the control pilot line. The resulting signal should be the algebraic sum of PWM control pilot signal and of the PLC signals.

[V2G3-A11-07] The control pilot line and the PE wires shall be considered as a transmission line for the PLC signal; as defined in Table A.11.

Table A.11 — Definition of electrical characteristics

Parameter	Conditions and Comments	Min	Typ	Max	Unit	Note
Length of the cable assembly				10	m	
C_{PLC}	See definition above	-	1.35		nF	4,5
R_{Damp}	See definition above	-	220	1 k	Ω	5
L	See definition above	-	220		µH	4,5
C_S	See definition in *[IEC-1]*				pF	2,4
C_V	See definition in *[IEC-1]*				pF	2,4
Power Spectral Density of PLC signals at V_{CP_EVSE} and V_{CP_EV} Measurement method defined in A.11.4.2	From 1.8 to 30 MHz, RBW=9 kHz on 50 Ω. All carriers	-77 TBC	-75	-73	dBm/ Hz	Sec Note
Peak-Peak Voltage of PLC signals at V_{CP_EVSE} and V_{CP_EV}	Control pilot signal steady at high or low level – 1 PLC actually emitting at a time (peak to peak) – EV connected to the EVSE with the cable assembly. Measured at max PSD level of PLC with example of injection circuit given below.	-	1.3		Vpp	3,4
Conducted PLC Crosstalk from control pilot line to the Mains (via power supply) (measured between any live or neutral wire and PE/CP)	From 2 MHz to 28 MHz			-40	dB	

NOTE 1 Any capacity on the control pilot line which is directly connected between the control pilot line and ground should be as small as possible, not to attenuate the PLC signal in an excessive way. Most of the capacitive load should be separated from the high frequency PLC with the inductor L.

NOTE 2 At given impedance, the maximum peak to peak amplitude is directly linked to the PSD also defined in the table. For the purpose of limiting the impact of the high frequency PLC signal on the control pilot line, a simplification from definition in frequency domain to a peak to peak voltage is sufficient.

NOTE 3 The maximum values are defined by *[IEC-1]* Annex A.

NOTE 4 These parameters are to consider with parallel injection only, as defined in Figure A.2.

NOTE 5 An important source of crosstalk is the following: the PLC signal crosstalks from the control pilot line to the Mains via the cable assembly, then, is conducted by Mains connection to another cable assembly, and crosstalks again to the other control pilot line.

Secretary's Note The min value of PSD of PLC signals still to be confirmed.

A.11.4 Signal transmission path and signal measurement

This sub-clause defines a typical transmission path for the PLC signal. This includes PSDs, attenuations and measurement procedures. Especially the SLAC method for measuring the signal strength needs a well-defined power level for signal transmission.

A.11.4.1 Typical transmission path

Figure A.3 shows the transmission path for the PLC signal with example values for attenuations and PSDs. All PSD and attenuation values are intended as a list of values over carrier groups, single values in the following description are given for simplification only. The attenuations are assumed as example values as follows:

— AttnRxEV is the insertion loss of the receiving path between the PLC transceiver and the charge coupler on EV side. In the example, a value of 5 dB is assumed (e.g. through to transformers, lines, coupling components);

— AttnTxEV is the insertion loss of the transmitting path between the PLC transceiver and the charge coupler on EV side. In the example, a value of 4 dB is assumed (e.g. through to transformers, lines, coupling components);

— AttnRxEVSE is the insertion loss of the receiving path between the PLC transceiver and the charge coupler on EVSE side. In the example, a value of 3 dB is assumed (e.g. through to transformers, lines, coupling components);

— AttnTxEVSE is the insertion loss of the transmitting path between the PLC transceiver and the charge coupler on EVSE side. In the example, a value of 5 dB is assumed (e.g. through to transformers, lines, coupling components);

— AttnCord is the insertion loss of the charge cord itself.

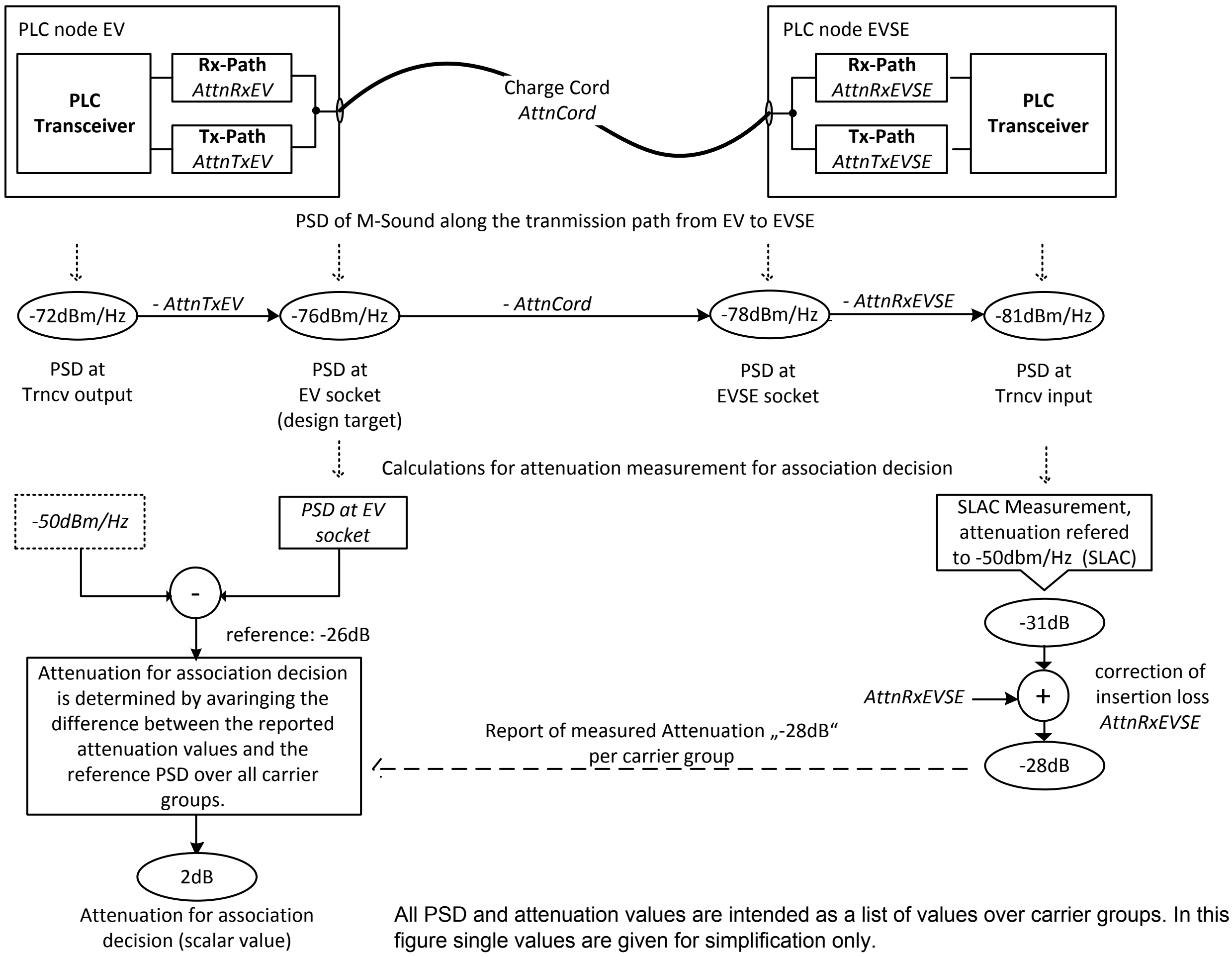

Figure A.3 — PLC-Transmission path example with SLAC relevant attenuations and calculations

In the example the design target is to achieve a PSD at the inlet of device of -76 dBm/Hz over the PLC spectrum. Due to insertion losses in the transmission path (AttnTxEV), the output power of the transceiver (-72 dBm/Hz) has to be higher to compensate the attenuation AttnTxEV. The way of measuring the PSD for the transmission path is given in A.11.4.2.

The charge cord attenuates the PLC signal by AttnCord, which leads in the example to a PSD at the counterpart socket-outlet of -78 dBm/Hz. Within the EVSE, the PLC signal is also affected by an insertion loss (AttnRxEVSE) of the Rx path from the socket-outlet to the transceiver.

Calibration and Correction

Rx-Path on EVSE side:

The PLC module on EV side does not know the value of AttnRxEVSE. Since this value has an impact on the SLAC measurement, the EVSE has to correct the measurement values by AttnRxEVSE before reporting the values back to the EV.

Tx-Path:

Any PLC module has to comply with the transmission power given by the PSD range in “Table A.9”. The measurement procedure to be used is given in A.11.4.2.

Beside the requirement for all PLC-nodes to comply with the defined PSD values, on EV side the exact knowledge of the PSD at the inlet is required as a reference for reported attenuation profiles from EVSEs. Any received attenuation profile from an EVSE has to be compared against the reference value given by the Tx-PSD at the inlet minus the -50dBm/Hz reference defined for the SLAC measurement.

A.11.4.2 Conditions of measurement

In the following, a measurement setup and procedure is defined to determine the electrical characteristic of the transmitted signal of a V2G-device in frequency domain by means of a power spectrum density (PSD). The numeric values for the PSD is defined in Table A.11 and assures a comparable signal characteristic within a certain tolerance range across V2G devices.

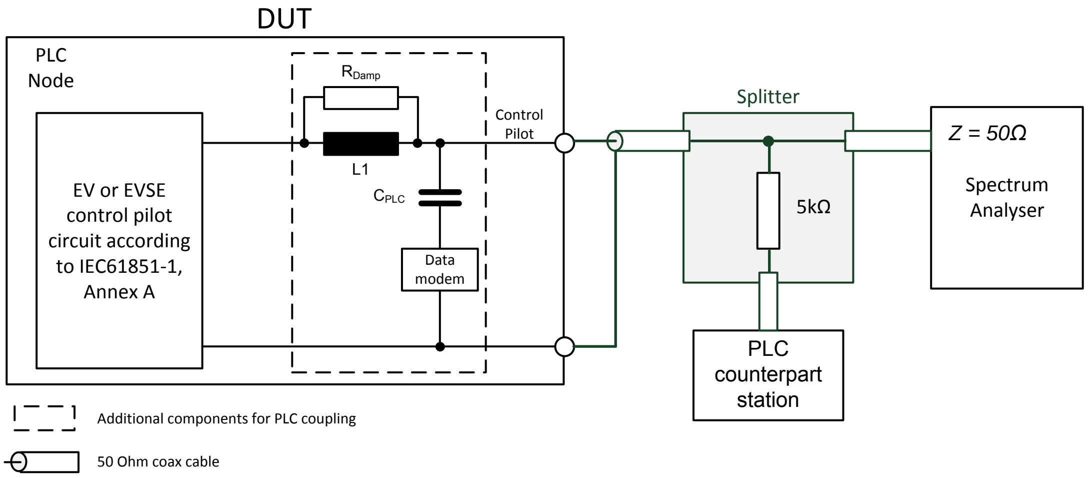

Figure A.4 — Measurement setup

The process defined in this clause assumes a 50 Ω load between the control pilot terminal and the ground/earth conductor. All output voltages are specified as the voltage measured at the control pilot and ground terminals of the PLC node.

[V2G3-A11-08] Measurements shall be made by using equipment confirming to CISPR16 specifications with a resolution bandwidth of 9 kHz.

[V2G3-A11-09] A PLC counterpart station shall be connected to the DUT, to allow data communication during the measurement. The counterpart station shall be separated by a 5 kΩ resistor not to have an impact of the stations input impedance on the measurement.

[V2G3-A11-10] The PLC counterpart station shall comply with *[ISO-3]* regarding coupling circuit and transmission power.

[V2G3-A11-11] A spectrum analyser with a 50 Ω input impedance shall be connected to the communication line.

[V2G3-A11-12] All passive components in the signal path shall be 50 Ω compliant parts and their insertion loss shall be taken into account.

[V2G3-A11-13] During the whole measurement process, the DUT shall transmit with at least 20 % of the maximum data rate.

[V2G3-A11-14] The measurement shall be compliant to the following procedure:

- The input attenuator of the spectrum analyser should be set in a proper way to avoid overloading the measurement device;

- The instrument should be set to measure the peak power in a 9 kHz resolution bandwidth (dBm / 9 kHz);
- Record the whole carrier band from 1.8 to 30 MHz with a hold time of at least 10 ms per sample point;
- Determine the spectrum analyser's equivalent noise power bandwidth for the 9 kHz filter;
- Calculate the power spectrum density for the DUT by taking the values obtained in step 3 and subtracting 10 log (equivalent noise power bandwidth / 1 Hz).

NOTE The transmission power should be adapted via the PLC chip prescaler to fit into the defined PSD limits.

A.11.5 Injection drawing

Based on the signal and signal path specification above, the following clauses give an implementation example for the PLC injection on the control pilot line.

The following schematic shows an implementation example based on the generic circuit in Figure A.5.

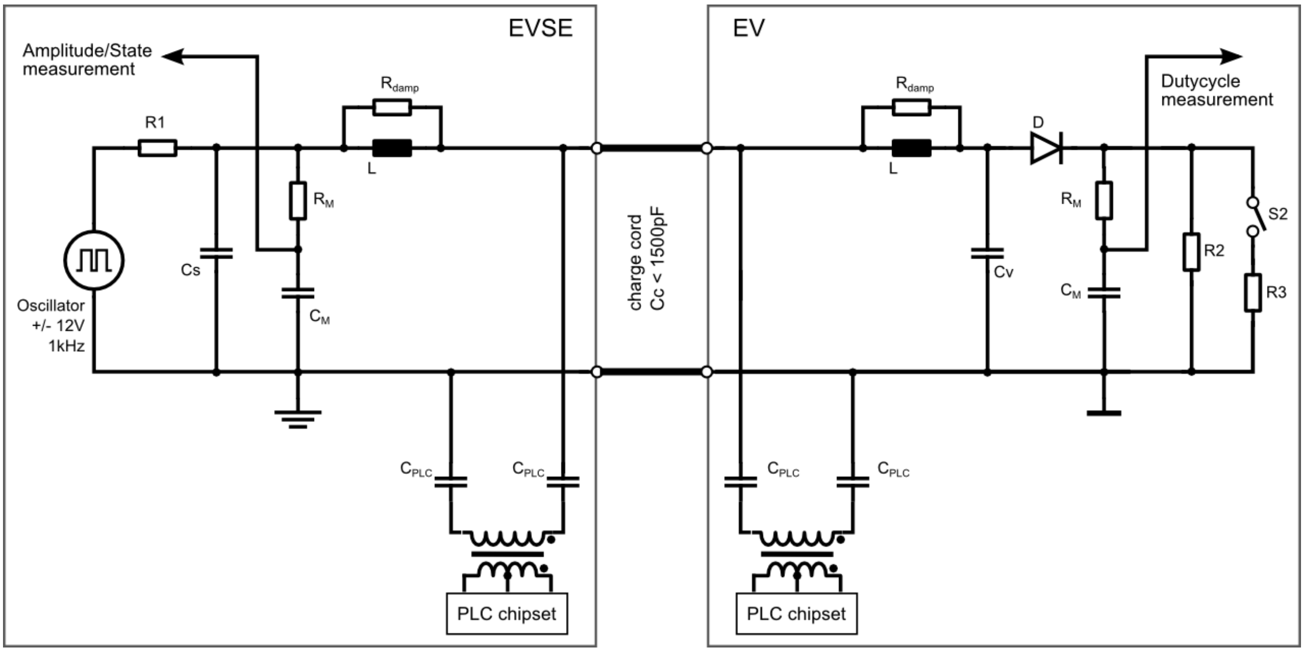

Figure A.5 — Implementation example with a PLC coupling transformer

For the implementation example in Figure A.5, the components values defined in Table A.12 should be applied.

Table A.12 — Components values of Implementation example

Component	Value
R_1	*[IEC-1]*
R_2	*[IEC-1]*
R_3	*[IEC-1]*
R_M	10 kΩ
C_M	100 pF
C_V	*[IEC-1]*
C_S	*[IEC-1]*
C_{PLC}	2.7 nF
T1 / *T2*	Example: 1:1:1 Coupling transformer (Depends on the chips and the TX / RX band-pass filter)
D	*[IEC-1]*
L	220 µH

A.12 Layer 2 interfaces

A.12.1 IO control

There are no additional requirements for the technology.

A.12.2 Data Link Data SAP

The Ethernet II-class SAP includes following service primitives, defined in the *[HPGP]*:

— ETH_SEND.REQ

— ETH_SEND.CNF

— ETH_RECEIVE.IND

A.12.3 Data Link Control SAP to layer 3

There are no additional requirements for this technology.

Annex B
(informative)

G3 on CPLT

NOTE Annex C has not been prepared by the project team responsible for the development of this document. The decision to mark this annex normative will be taken after the end of the testing period of the technologies.

B.1 Scope

This part describes all requirements for the G3 technology on CPLT. All requirements defined in this section are mandatory as soon as this annex is deployed.

B.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.

ITU G.9955, Annexes A and D

ITU G.9956, Annex A

B.3 Terms and definitions

For the purposes of this document, the following terms and definitions apply in addition to the terms and definitions given in the clause 3.

B.3.1
G3-PLC MAC
ITU G.9956, Annex A

B.3.2
G3-PLC PHY
ITU G.9955, Annexes A and D

B.4 Symbols and abbreviated terms

ERDF	Electricité et Réseau de France
FCC	Federal Communications Commission

B.5 Conventions

There are no specificities.

B.6 Software Architecture

B.6.1 Specific overview for G3 Technology

This sub-clause is organized along architectural lines, emphasizing the large-scale separation of the system into two parts: the Media Access Control (MAC) sub layer of the Data Link Layer and the Physical Layer. These layers are intended to correspond closely to the lowest layers of the ISO/IEC Model for Open Systems.

Figure B.1 shows the relationship of the ISO/IEC 15118 physical and data link layer to the OSI reference model.

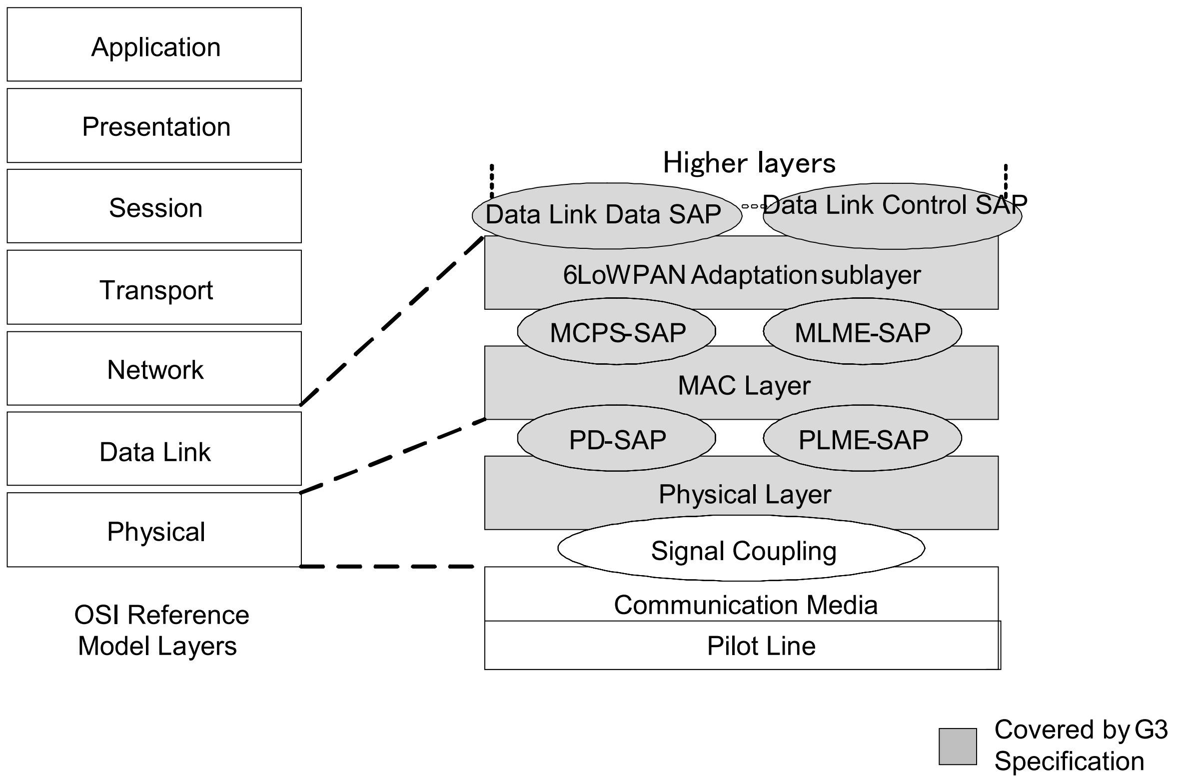

Figure B.1 — ISO/IEC 15118 Physical and Data Link Layer relationship to the ISO/IEC OSI reference model

B.6.2 Entity overview

B.6.2.1 Communication media

The physical media carrying the PLC signal is defined given by the cable assembly, which connects the power outlet and the EV.

B.6.2.2 Signal coupling

The signal coupling interface is defined in B.11 and describes the method of coupling the low frequency PLC signal on the communication media.

B.6.2.3 PLC physical, MAC and convergences layers

The grey colour entities represent the whole Data Link and Physical layer, and are covered by the G3-PLC PHY and G3-PLC MAC specifications.

B.7 Definition of high level communication and basic signalling

There are no additional requirements for this technology.

B.8 Triggering

There are no additional requirements for this technology.

NOTE This technology does not require specific signals from the EVSE as it is a point-to-point technology that does not require association at the physical layer.

B.9 Association EV – EVSE procedure

B.9.1 Overview

The G3 PLC technology on CPLT is a point-to-point communication link that does not require specific association procedures for the physical link.

NOTE Association requires bi-directional information exchange. The low frequency of the G3 technology and the low signal levels used on the CPLT render transfer to the Mains impossible. It has been demonstrated that crosstalk from Mains to Pilot wire was detected above 11 V. This exceeds the allowed signal level.

B.9.2 Configuration of the PLC node

[V2G3-B09-01] The PLC node shall be configured in order to use the key “ISOIEC_15118-3” (TBD).

[V2G3-B09-02] The PLC node shall be configured in order to use the FCC frequency band

NOTE 1 There is no need to exchange the frequencies used for communication, since the use of the FCC frequency band on a medium (the pilot wire) which is decoupled from the Mains is not restricted.

NOTE 2 Additional identifier may be added in the beacons to specify conformity to ISO/IEC 15118.

B.9.3 Discovery of the connected PLC module

[V2G3-B09-03] The “Discovery of the connected PLC module” macro bloc is not needed for G3 technology.

NOTE The G3 PLC technology supports channel estimation features which allow each G3 PLC communication node to set up a neighbour table. The neighbour table gathers a list of essential parameters for each neighbour, including the Link Quality Indicator (LQI) which is based on SNR measurements. It is possible to define a threshold under which a note would not be considered as a neighbour and will have to be disassociated, but this feature is not considered as necessary given the fact that the G3 PLC allows the establishment of a point to point link between and EVSE and the physically connected EV.

B.9.4 Validation of the Identification of the PLC EVSE

[V2G3-B09-04] The validation of the Identification of the PLC module on the EVSE side is not relevant for G3 technology.

NOTE 1 The Validation of the Identification is not applicable for G3 technology.

NOTE 2 In addition, it is possible to configure the PLC node to avoid any communication with a G3 PLC signal under a predefined value.

B.9.5 Set-up a logical network: 6LoWPAN Association procedure

The bootstrap of a private network using a public key between the EV and the EVSE shall be conformant to the following procedure:

— EVSE verifies the public key received from EV via the received beacons

— After verification, EVSE assigns a group key to the EV

— If not verified, EVSE denies EV Association

B.10 EMC requirements

No specific EMC requirements are specified in this standard.

B.11 Signal Coupling

[V2G3-B11-01] The coupling circuit shown in Figure B.2 shall be used on the EVSE and the vehicle.

R_1, C_1, C_2, R_2, R_3, S_1 are indicated for information only and values as defined in IEC 61851-1 Annex A shall be assumed to be already installed in the EVSE or EV. T2 represents the cable assembly between the EVSE and EV.

Lx1, Lx2, Rx1, and Rx2 are inserted in series with the pilot wire as shown on the Figure B.2.

[V2G3-B11-02] Values of the inductances Lx1 (1 000 µH) Lx2 (1 000 µH), Rx1 (680 Ω), Rx2 (680 Ω) and coupling capacitors Cx1 (500 pF), Cx2 (500 pF) are mandatory. Rx3 (1 kΩ) and Rx4 (1 kΩ) are indicated as possible values of internal impedance of the transmitter. They are destined to limit the variation of the signal voltage on the pilot wire.

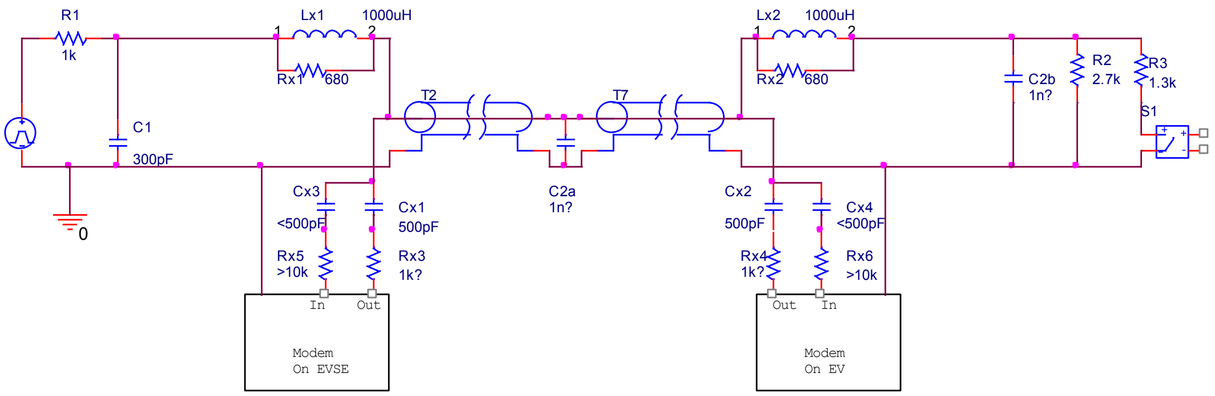

Figure B.2 — Coupling circuit for G3 technology on Pilot wire

[V2G3-B11-03] The values of the coupling components as shown in Table B.1 are mandatory both on the EV and on the EVSE sides.

Table B.1 — Coupling components values

Group	Function	Mandatory values
A1, A2	Series impedance designed to avoid short circuiting of the High frequency high level data carrier by EVSE or EV capacitors to ground	Lx1, Lx2 = 1 000 mH Rx1, Rx2 typically 680 Ω
B1, B2	Transmission Matching impedance for high frequency signals	Circuit not implemented
C1, C2	Common mode rejection	Circuit not implemented
D1, D2	Capacitive Coupling circuit Rx3, Rx4 = source resistance of HF output Rx5, Rx6 = optional input impedance of modem	- Cx1, Cx2 = 500 pF - Rx5, Rx6 > 10 kΩ - Cx5, Cx6 = 500 pF

[V2G3-B11-04] The PLC transmission devices shall limit the signal voltage on the pilot wire to 0.5 V RMS.

NOTE 1 Further decoupling circuits may be added to the pilot wire circuit.

NOTE 2 Additional filtering components may be added to the EVSE power lines to improve reliability for specific environments.

[V2G3-B11-05] The signal voltage of the PLC transmission devices shall be at least on the pilot wire to 0.2 V RMS.

B.12 Layer 2 interfaces

B.12.1 Specific overview for G3 PLC technology

As shown in Figure B.3, the G3 PLC technology covers both physical and data link layers and is based on a fully standardized PHY/MAC and 6LoWPAN stack.

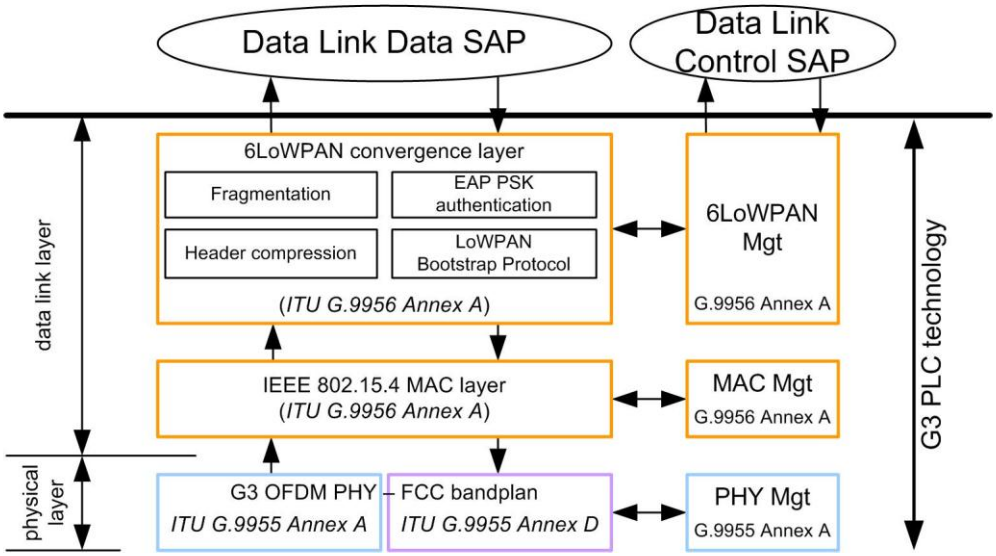

Figure B.3 — G3 PLC communication stack

The physical layer relies on an OFDM modulation operating in the FCC band. Channel estimation features enable the system to automatically adjust the modulation scheme to the channel conditions. Annexes A and D of ITU G.9955 international standard specifies the G3 physical layer.

The G3 MAC sub layer is based on the IEEE 802.15.4 MAC standard CSMA/CA access method, quality of service, encryption, are the main features specified in Annex A of ITU G.9956. In addition, the 6LoWPAN convergence layer guarantees the support of IPv6 but also of authentication mechanisms during the network association phase which is totally managed by the lower layers. The usage which is made of RFC 4944 is fully described in Annex A of the ITU G.9956 standard.

NOTE If RFC 4944 specifies the compression of IPv6 (RFC 2460) and UDP (RFC 768) headers, IPv6 packets composed TCP (RFC 793) payloads and TCP plain headers are supported.

B.12.2 Data Link Data SAP

The interface to the higher layers consists in a set of generic primitives allowing the access to the lower layers in order to exchange data over the channel. The primitives are defined as follows:

— DATA-LINK_SEND.REQ: This primitive allows the higher layers to hand over to the lower layers the data to be transmitted over the medium.

- DATA-LINK_SEND.CNF: This primitive indicated to the higher layers whether or not the transmission was successful.
- DATA-LINK_RECEIVE.IND: This primitive informs higher layers that new data has been received.

B.12.3 Data Link Control SAP

There are no additional requirements for this technology.

All generic requirements are mandatory.