IEC TR 61850-90-8

Edition 1.0 2016-04

TECHNICAL REPORT

colour inside

Communication networks and systems for power utility automation –
Part 90-8: Object model for E-mobility

IEC TR 61850-90-8:2016-04(en)

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Communication networks and systems for power utility automation – Part 90-8: Object model for E-mobility

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 90-8: Object model for E-mobility

FOREWORD

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IEC TR 61850-90-8, which is a technical report, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
57/1603/DTR	57/1651/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61850 series, published under the general title *Communication networks and systems for power utility automation*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This part of IEC 61850-90, which is a technical report, describes how current standardization for Electric Road Vehicles (EV) and the Vehicle-to-Grid Communication Interface can be linked to IEC 61850-7-420, which deals with Distributed Energy Resources (DER). This technical report provides necessary background information and proposes an object model for E-Mobility in order to establish an EV plugged into the power grid as DER according to the principles of IEC 61850-7-420. The basic information modeling in IEC 61850 and IEC 61850-7-420 already covers a lot of needs for the E-Mobility domain. Missing parts can be modeled as new logical nodes and data objects, which this technical report defines.

NOTE Editorial Notes on this technical report are summarized in Annex G.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 90-8: Object model for E-mobility

1 Scope

This part of IEC 61850-90, which is a technical report, shows how IEC 61850-7-420 can be used to model the essential parts of the E-Mobility standards related to Electric Vehicles and Electric Vehicle Supply Equipments (IEC 62196, IEC 61851, IEC 15118) and the Power system (IEC 61850-7-420), in order to secure a high level of safety and interoperability.

The namespace of this document is:

- "(TR) IEC 61850-90-8:2015"

The name space "IEC 61850-90-8" is considered as "Transitional" since the model is expected to be included in the next edition of IEC 61850-7-420 [1]. Potential extensions/modifications may happen if/when the model is given International Standard status. The most optimal backward compatibility with the original content will be strived for during this move.

In accordance with the status of the ISO 15118 series and systems determined in IEC 61851-23 and -24, this technical report focuses on EV charging processes only. Discharging processes in order to support grid services are out of scope, but will be adopted when available in future versions of ISO 15118-2 and IEC 61851-1, -23 and -24.

2 Normative references

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

IEC 61850-7-4:2010, *Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object classes*

IEC 61850-7-420:2009, *Communication networks and systems for power utility automation – Part 7-420: Basic communication structure – Distributed energy resources logical nodes*

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

IEC 61851-21-1:–, *Electric vehicle conductive charging system – Part 21-1: Electric vehicle onboard charger EMC requirements for conductive connection to a.c./d.c. supply*[1]

IEC 61851-21-2:–, *Electric vehicle conductive charging system – Part 21-2: EMC requirements for OFF board electric vehicle charging systems*[1]

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[1] To be published.

IEC 61851-23:2014, *Electric vehicle conductive charging system – Part 23: DC electric vehicle charging station*

IEC 61851-24:2014, *Electric vehicle conductive charging system – Part 24: Digital communication between a d.c. EV charging station and an electric vehicle for control of d.c. charging*

IEC 62196-1:2014, *Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 1: General requirements*

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*

IEC 62196-3:2014, *Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 3: Dimensional compatibility and interchangeability requirements for d.c. and a.c./d.c. pin and contact-tube vehicle couplers*

ISO 15118-1:2013, *Road vehicles – Vehicle to grid communication interface – Part 1: General information and use-case definition*

ISO 15118-2:2014, *Road vehicles – Vehicle-to-grid communication interface – Part 2: Network and application protocol requirements*

ISO 15118-3:2015, *Road vehicles – Vehicle-to-grid communication interface communication interface – Part 3: Physical and data link layer requirements*

3 Terms, definitions and acronyms

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

3.1 Terms and definitions

3.1.1
Balance Responsible Party
BRP
party that has a contract proving financial security and identifying balance responsibility with the Imbalance Settlement Responsible of the Market Balance Area entitling the party to operate in the market

Note 1 to entry: This is the only role allowing a party to nominate energy on a wholesale level.

Note 2 to entry: The meaning of the word "balance" in this context signifies that that the quantity contracted to provide or to consume must be equal to the quantity really provided or consumed.

Note 3 to entry: This is equivalent to "Program responsible party" in the Netherlands, "Balance group manager" in Germany and "market agent" in Spain.

[SOURCE: ENTSO-E RM:2014-01]

3.1.2
CHArge de Move
CHAdeMO
Socket, connector and charging system for DC quick charging, equivalent to "move by charge"

3.1.3
Charging Infrastructure Operator
CIO
legal entity that operates and maintains the EVSE

Note 1 to entry: It is not obligatory that there is an operator for the EVSE, but e. g. in case of ID validation or Smart Charging where communication is needed, the responsible entity regarding the communication will be the E-Mobility Infrastructure Operator.

Note 2 to entry: This entry corresponds to the Charging Station Operator (CSO or CSIO) in the upcoming IEC TS 62913-2-4[2].

3.1.4
Charging Station
single or multiple EV Supply Equipment(s)

Note 1 to entry: See also EVSE.

3.1.5
Building Energy Management System
BEMS
providers, delivering the systems which facilitate management and control of building facilities, realizing energy saving and increasing comfortability of users of buildings and making full use of the state-of-the-art Information Technology.

[SOURCE: EG3 Deliverable:2011]

3.1.6
Demand Clearing House
DCH
entity for grid negotiation that provides information on the load of the grid

Note 1 to entry: The demand clearing house mediates between two clearing partners – a SECC and the part of the power grid connected to this SECC. Most likely this function will be served by a system operator.

Note 2 to entry: Demand Clearing House and meter operator may exchange information with each other as well as with other actors.

EXAMPLE A DCH typically fulfils following tasks:

- Collect all necessary information from all parts of the power grid, e.g. current or forecasted load of local transformers, distribution grid, power substation, transmission grid, transmission substation, power plants (incl. renewable energies), and predicted charging schedules submitted by EVCCs.A Charging Station represents a single or multiple EV Supply Equipment(s) (see also EVSE).
- Consolidate the collected grid information to a ―grid profile‖ and offer it to SECCs / EVCCs.
- Provide charging schedule proposal for the connected EV to the requesting SECC based on the collected grid profile.
- Inform the SECC as to the necessity for an updated charging schedule if the grid profile has changed.
- On the contrary, the SECC will inform the demand clearing house if the EV's charging schedule has changed.

[SOURCE: ISO 15118-1:2013]

3.1.7
digital communication
digitally encoded information exchanged between an EV charging station and an EV, as well as the method by which it is exchanged

Note 1 to entry:

- 1. CAN based using a dedicated data communication circuit; CAN protocol is given in ISO 11898-1; refer to IEC 61851-24:2014, Annex A and Annex B for specific implementation details;

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2 Under consideration.

- 2. Powerline Communication (Homeplug Green PHY TM) over the control pilot line; refer to IEC 61851-24:2014, Annex C for specific implementation details.

3.1.8
Distribution System Operator
DSO
natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity, according to Article 2.6 of the Directive

Note 1 to entry: Moreover, the DSO is responsible for regional grid access and grid stability, integration of renewables at the distribution level and regional load balancing.

[SOURCE: EG3 Deliverable:2011]

3.1.9
E-Mobility Clearing House
entity mediating between two clearing partners to provide validation services for roaming regarding contracts of different E-Mobility Service Providers

Note 1 to entry: The E-Mobility clearing house's purpose is to:

- collect all necessary contract information like Contract ID, E-Mobility Service Provider (EMSP), communication path to E-Mobility Service Provider, roaming fees, begin- and end-date of contract, etc.
- provide SECC with confirmation that an E-Mobility Service Provider (EMSP) will pay for a given Contract ID (authentication of valid contract) and transfer a corresponding Service Detail Record (SDR) after each charging session to the corresponding E-Mobility Service Provider (EMSP).

Note 2 to entry: E-Mobility Clearing House, E-Mobility Service Provider (EMSP) and Meter Operator (MO) may exchange information with each other as well as other actors.

3.1.10
E-Mobility Customer
legal entity being associated to an E-Mobility Service Provider

Note 1 to entry: The E-Mobility Customer may be bound to an E-Mobility Service Provider by the legal means of a contract.

3.1.11
E-Mobility Infrastructure Producer
legal entity that manufactures E-Mobility infrastructure components (e. g. EVSEs)

3.1.12
E-Mobility Infrastructure Owner
legal entity that owns E-Mobility infrastructure (e.g. EVSEs)

3.1.13
E-Mobility Service Provider
EMSP
legal entity that provides services to the Electric Vehicle User (EVU) related to the operation of an EV

Note 1 to entry: This definition is also considered in the upcoming IEC TS 62913-4[3].

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3 Under consideration.

3.1.14
Electric Energy Meter
EEM
equipment to measure electrical energy by integrating power with respect to time, which complies with IEC 62052-11 and IEC 62053-21, IEC 62053-52

Note 1 to entry: Some use cases need the amount of electric energy measured by the electric energy meter and communicated through the SECC to the EVCC, while other scenarios do not need a separate electric energy meter. The EV may get this information and use it according to the intentions of the OEM.

Note 2 to entry: The EEM may be operated by a Metering Operator.

[SOURCE: ISO 15118-1:2013]

3.1.15
Electric Vehicle
EV
any vehicle propelled by an electric motor drawing current from a rechargeable storage battery or from other portable energy storage devices (rechargeable, using energy from a source off the vehicle such as a residential or public electric service), which is manufactured primarily for use on public streets, roads or highways

[SOURCE: ISO 15118-1:2013]

3.1.16
Electric Vehicle Communication Controller
EVCC
embedded system, within the vehicle, that implements the communication between the vehicle and the SECC in order to support specific functions

Note 1 to entry: Such specific function could be e.g. controlling in- and output channels, encryption, or data transfer between vehicle and SECC.

[SOURCE: ISO 15118-1:2013]

3.1.17
Electric Vehicle Manufacturer
OEM
legal entity responsible for all the technologies inside the EV also in relation to the data communication

Note 1 to entry: This is commonly known as OEM (Original Equipment Manufacturer).

3.1.18
Electric Vehicle Supply Equipment
EVSE
conductors, including the phase(s), neutral and protective earth conductors, the EV couplers, attached plugs, and all other accessories, devices, power outlets or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the EV and allowing communication between them as necessary

Note 1 to entry: For the purposes of this document, it is assumed that an EVSE may host multiple outlets each being managed according to IEC 61851-1 Annex A.

[SOURCE: ISO 15118-1:2013]

3.1.19
Electric Vehicle User
EVU
person or legal entity using the vehicle and providing information about driving needs and consequently influences charging patterns

Note 1 to entry: Driving needs such as range and time of availability are necessary to achieve the most appropriate charging scenario.

Note 2 to entry: There shall be a relationship/association between the EVU and the E-Mobility Customer (EC). However, the exact nature of this relationship/association depends on the underlying business models and use cases.

[SOURCE: ISO 15118-1:2013]

3.1.20
Electricity Provider
EP
body of secondary actor to provide electricity

3.1.21
Energy Market
commodity markets that deal specifically with the trade and supply of energy (purchase and sale of energy products)

Note 1 to entry: Energy market may refer to an electricity market, but can also refer to other sources of energy.

Note 2 to entry: It typically describes a wholesale market for energy producers and energy retailers. Other participants in the wholesale energy market include financial intermediaries, energy traders and large consumers.

3.1.22
energy Supplier
retailer
entity that offers contracts for supply of energy to a consumer (the supply contract)

Note 1 to entry: Within this role the energy Supplier will initiate DSM activities.

Note 2 to entry: In some countries referred to as Retailer.

3.1.23
High Level Communication
HLC
bidirectional digital communication using protocol and messages specified in ISO 15118-2 and physical and data link layer specified in ISO 15118-3

Note 1 to entry: High-level communication in ISO 15118 is compliant to the term digital communication in SAE J1772/2836/2847/2931.

[SOURCE:ISO 15118-1:2013]

3.1.24
Meter Operator
MO
party responsible for installing, maintaining, testing, certifying and decommissioning physical meters

[SOURCE: ENTSO-E RM:2014-01]

3.1.25
Power Outlet
part of a plug and socket-outlet intended to be installed with the fixed wiring

Note 1 to entry: All power outlets shall have the pilot function.

[SOURCE: ISO 15118-1:2013]

3.1.26
Primary Actor
PA
role involved directly in the charging process

[SOURCE: ISO 15118-1:2013]

3.1.27
Secondary Actor
SA
role involved indirectly in the charging process

Note 1 to entry: Secondary actors may exchange information between each other.

Note 2 to entry: Secondary actors could also be a single entity.

[SOURCE: ISO 15118-1:2013]

3.1.28
Service Detail Record
SDR
data package of a charge or service related session with all necessary information that an E-Mobility Service Provider needs for billing or for informing the customer about the session

Note 1 to entry: Some data may be sent from EVSE. Some data originally be owned by E-Mobility Clearing House. Some data may be created at E-Mobility Clearing House. Some record to be sent to E-Mobility Service Provider for billing or informing their customers.

[SOURCE: ISO 15118-1:2013]

3.1.29
Supply Equipment Communication Controller
SECC
entity which implements the communication to one or multiple EVCCs according to ISO 15118-2 and which may be able to interact with secondary actors

Note 1 to entry: Further details regarding possible architectures are given in Annex A.

Note 2 to entry: Functions of a supply equipment communication controller could be controlling in- and output channels, encryption of data, or data transfer between vehicle and SECC.

[SOURCE: ISO 15118-1:2013]

3.1.30
System Operator
SO
party that is responsible for a stable power system operation (including the organisation of physical balance) through a transmission grid in a geographical area

Note 1 to entry: The System Operator will also determine and be responsible for cross border capacity and exchanges. If necessary he may reduce allocated capacity to ensure operational stability.

Note 2 to entry: Transmission as mentioned above means "the transport of electricity on the extra high or high voltage network with a view to its delivery to final customers or to distributors. Operation of transmission includes as well the tasks of system operation concerning its management of energy flows, reliability of the system and availability of all necessary system services." (Definition taken from the ENTSO-E RGCE Operation handbook Glossary).

Note 3 to entry: Additional obligations may be imposed through local market rules.

[SOURCE: ENTSO-E RM:2014-01]

3.2 Acronyms

AC	Alternating Current
BEMS	Building Energy Management System
BRP	Balance Responsible Party
CIO	Charging Infrastructure Operator
CP	Control Pilot
DC	Direct Current
DCH	Demand Clearing House
DSM	Demand Side Management
DSO	Distribution System Operator
EEM	Electric Energy Meter
EIM	External Identification Means
EMSP	E-Mobility Service Provider
EV	Electric Vehicle
EVCC	Electric Vehicle Communication Controller
EVSE	Electric Vehicle Supply Equipment
EVU	Electric Vehicle User
HLC	High Level Communication
MO	Meter Operator
OEM	Original Equipment Manufacturer
PA	Primary Actor
PCC	Point of Common Coupling
PnC	Plug & Charge
PWM	Pulse Modulated Signal
RFID	Radio Frequency Identification
SA	Secondary Actor
SDR	Service Detail Record
SOC	State of Charge
SECC	Supply Equipment Communication Controller
TR	Technical Report
VAS	Value-Added Services

3.3 Abbreviated terms

Clause 4 of IEC 61850-7-4:2010 defines abbreviated terms for building concatenated data object names. Additional abbreviated terms are:

Term	**Description**	**Term**	**Description**
Cab	Cable	Cha	Charging
Comm	Communication		
Conn	Connection	DC	Direct Current
Dig	Digital	E	Earth
EV	Electrical Vehicle	EVSE	EV Supply Equipment
Id	ID / Identification	Plg	Plug
Soc	State of charge	Sys	System

4 Document integration and structure

The main idea of this technical report is to integrate plugged-in Electric Vehicles as a specific form of Distributed Energy Resource according to the paradigms defined in IEC 61850. The approach is based upon establishing a logical node model for EVs as part of IEC 61850-7-420. Figure 1 provides an overview on how IEC 61850-7-420 is integrated into the series of standards defined in IEC 61850.

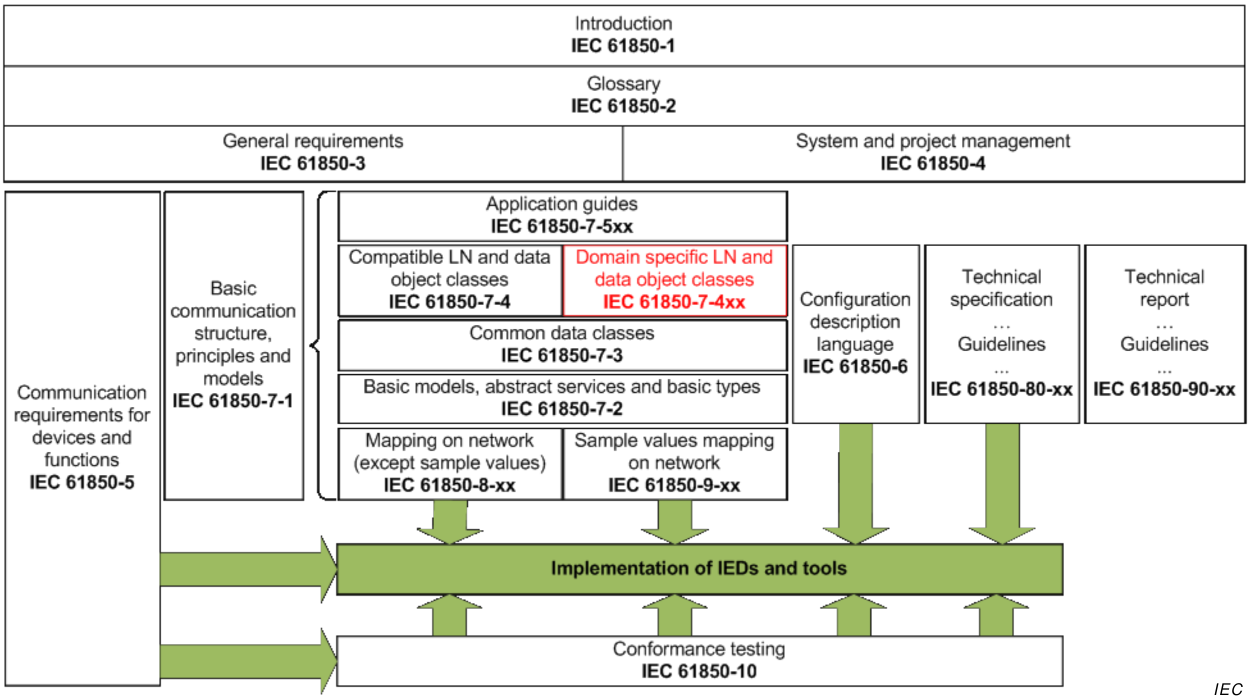


Figure 1 – Overall structure of IEC 61850 parts

IEC 61850-7-420 is called Communication networks and systems for power utility automation – Basic communication structure – Distributed energy resources logical nodes [IEC 61850-7-420] and defines the IEC 61850 information models for the information exchange between distributed energy resources (DER), e.g. including distributed generating units and storage devices, including reciprocating engines, fuel cells, micro turbines, PV, combined heat and power units and energy storage. IEC 61850-7-420 uses existing Logical Nodes of IEC 61850-7-4 as far as possible and defines new DER specific Logical Nodes when necessary.

This technical report is structured as shown in Figure 2. The main part of this document includes a common information model for AC and DC-based charging of EVs according to the IEC 61850-7-420 paradigms. The Annexes then provide specializations of this common information model and concrete mappings to various realizations of AC or DC-based charging approaches for EVs. This structure was chosen to cope with already existing charging approaches as well as to cope with future extensions (e.g. wireless power transfer (WPT)).

NOTE The DC charging system referred to as 'System B' is only partially modelled in this technical report.

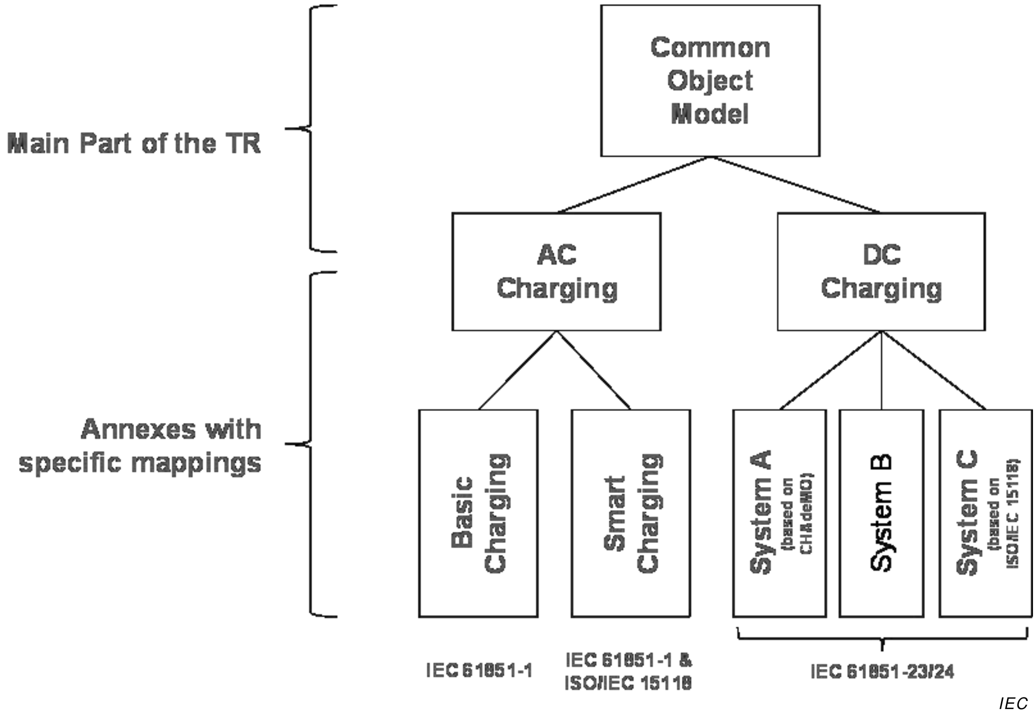


Figure 2 – Overview on document structure

5 The link between the power grid and electric vehicles

5.1 General

It is important to have a link between the power grid and the electric vehicles because:

- The most important success criteria for the EV will be the capability to charge when needed, which could conflict with the current power grid (low voltage distribution grid) at peak hours. A link between the EV and the power grid operator could make the difference.
- Using electricity instead of fossil fuel will lower the transportation cost for the users especially if the charge can be scheduled to 'low price periods', which requires a link between the EV user, the EV and the energy market.
- Many studies and reports have shown that the transport sector is one of the major players for CO_2 emissions and EV could be the solution to this problem given that renewable energy can be used for charging. A link between the power grid (Distributed Energy Resources like Wind and Solar) and the EV are needed if this should be the case.
- EVs could act as energy storage for volatile energy generators such as wind power plants or PV plants. This stored energy can then be fed in the grid in times when more energy is requested on the energy market than currently generated, given that the EV user is paid the amount of money he demands. A link between the EV user, the EV and the energy market is required.
- EVs could provide reactive power to support voltage stability. This requires a link between the EV user, the EV and the energy market.

A link or 'information exchange' between the power grid operators, the electric vehicle and the user, is an essential part of the future infrastructure for E-Mobility. International standardization is needed for harmonization between the different actors involved.

The criteria shown above require accessible and connected charging infrastructures in terms of information exchange. Furthermore the criteria show analogies to other forms of DERs like battery storage systems. Hence the approach of this technical report is to provide an information model for charging infrastructures which is consistent with the IEC 61850-7-420 paradigms. This simplifies integrating E-Mobility with other forms of DERs in the long term. Figure 3 shows a general hierarchical structure of the information model of IEC 61850.

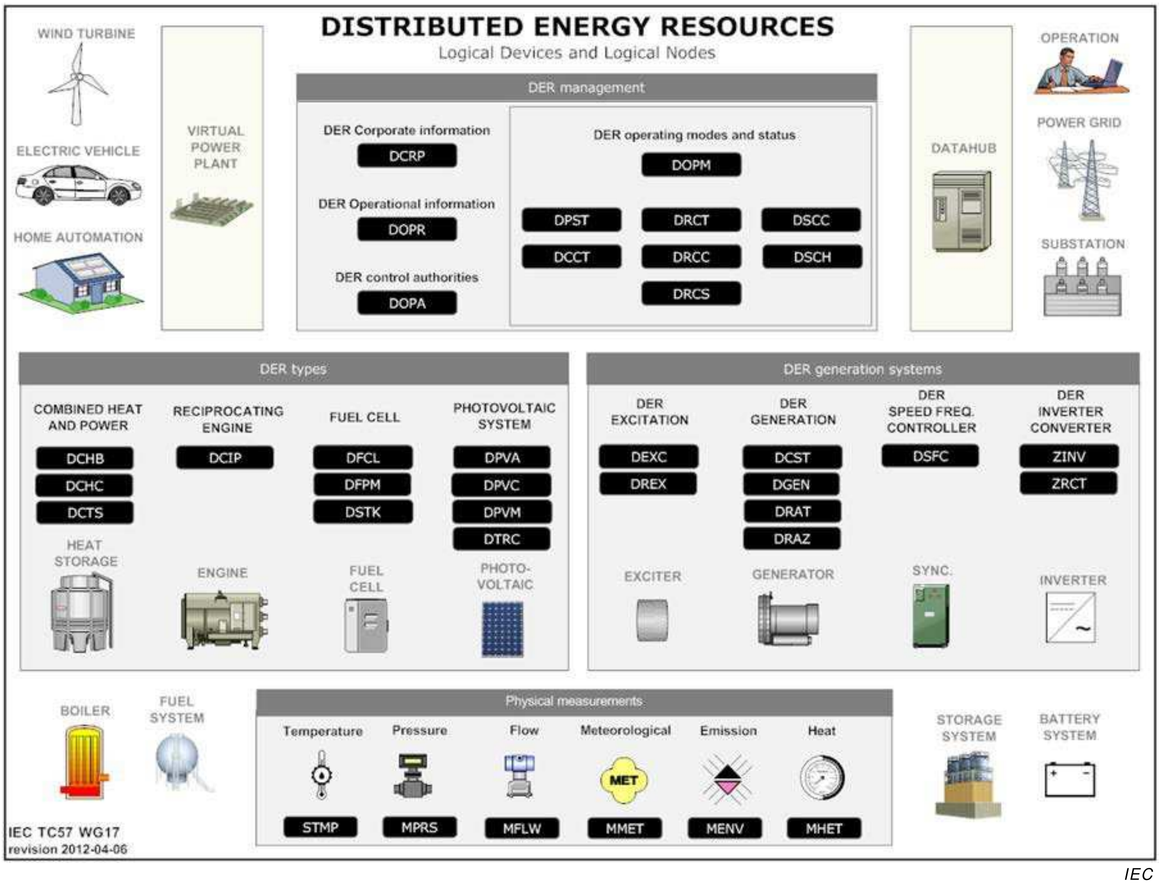
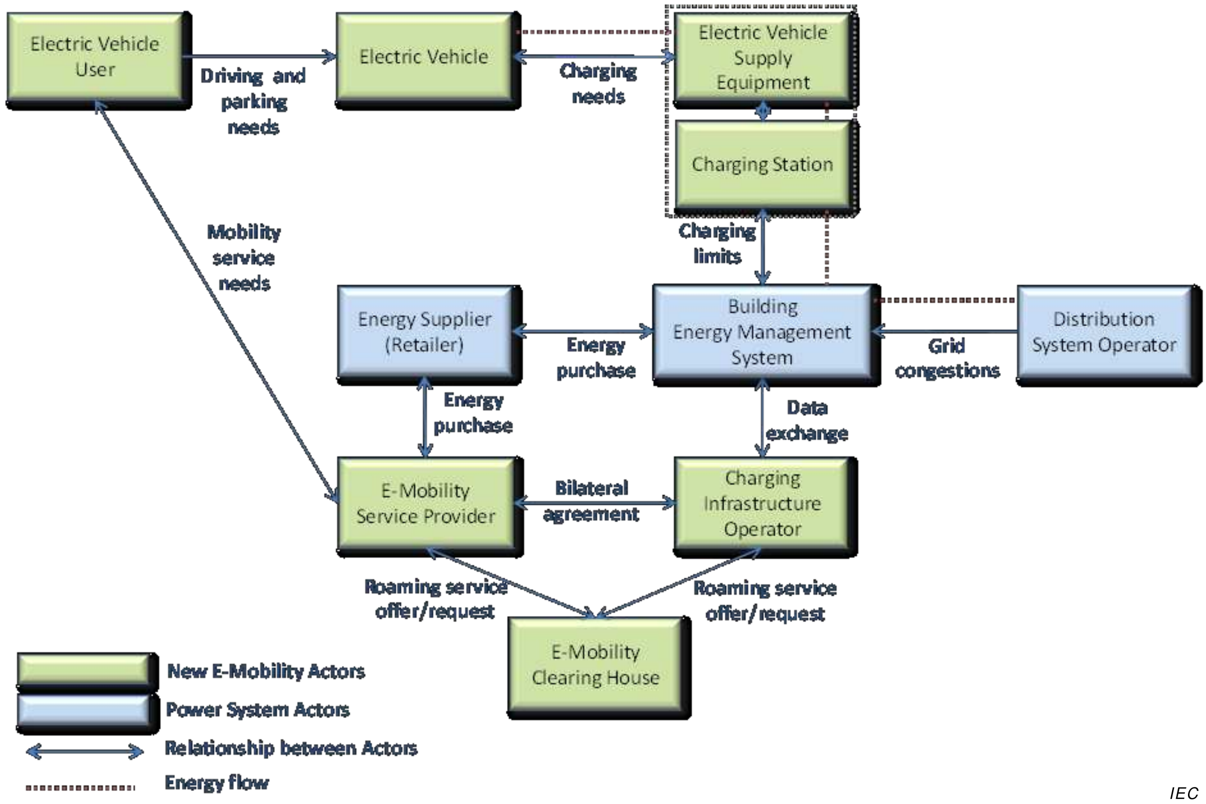


Figure 3 – Conceptual organization of Logical Devices and Logical Nodes of DER systems

NOTE While E-Mobility can be used for Demand Side Management (DSM), this is not in the scope of this technical report.

5.2 E-Mobility actors and their roles

The E-Mobility domain involves a multitude of new stakeholders for charging EVs. The diagram in Figure 4 provides an overview of the generic role model for actors involved on both the EV side (green elements) and the power system (blue elements).



NOTE The diagram may not be exhaustive with respect to real-world actors.

Figure 4 – Generic role model of relevant actors for smart charging EVs [CEN BT N987]

Each of the actors involved has a specific role in the context of this technical report. In a real-life scenario more actors could be combined into one legal entity. For example, the Charging Infrastructure Operator and the E-Mobility Service Provider could be the same legal entity.

The role model considers both public and private charging scenarios. In the public scenario more service providers could share a charging spot operated by a 3rd party.

All the actors are defined in 3.1.

5.3 E-Mobility use cases

5.3.1 General

The standards in the E-Mobility domain mainly consider the Electric Vehicle and the Supply Equipment for delivering energy to the vehicle. From the overview provided in Subclause 3.1 only ISO 15118 refers to interactions beyond the EV (Electric Vehicle) and EVSE (Electric Vehicle Supply Equipment) to Secondary Actors (e.g. DSO, BRP, MO, Service providers etc.).

The use cases listed in Table 1 are a subset of the use cases from [ISO 15118-1:2013], which also include information exchange with Secondary Actors that are relevant for the proposed information model.

NOTE 1 System A does not use ISO 15118 communication system. System A achieves the use case of 3.2.3.

NOTE 2 Use cases with a grey background are not included in this technical report but may be considered in a future version.

NOTE 3 This technical report is a step ahead of the upcoming IEC TS 62913-2-4[4], which is intended to publish informative use cases on this domain. The editors have tried to align the contents of both documents as much as possible. At the time of publication of this technical report, the question remains open whether the upcoming IEC TS 62913-2-4 will provide the level of detail required for modelling as needed by this technical report.

Table 1 – Overview of use cases relevant to secondary actors [ISO 15118-1:2013]

ID	Use case name
C1	Certificate update
C2	Certificate installation
D2	Authentication from EV with Authorisation from secondary actors
D4	Identification at the EVSE with validation from the secondary actor
E2	Optimised charging with scheduling from the secondary actor
E3	Optimised charging with scheduling at EV
F4	Reactive power compensation
F5	Vehicle to grid support
G1	Value-added services
G2	Charging details

5.3.2 Identification (ID) (D2 & D4)

ISO 15118-2 differentiates between two different types of identification: “External Identification Means (EIM)” and ”Plug & Charge (PnC)” identification mode. However, the utilized identification mode does not have any relevance to the underlying information model for the IEC 61850 DER system. Identification is performed before the start of the charging process (energy flow). For the scope of this technical report these use cases are only relevant for the nameplate information of the LN defined in this technical report.

5.3.3 Charging status and control (E2 & E3)

ISO 15118-2 also defines means for control of the charging process. It defines in particular the negotiation of a charge schedule as well as renegotiation of such a schedule during the charging process if e.g. supply situation changes. In order to harmonize the ISO 15118-2 communication interface specification with the information model for E-Mobility, Subclauses 5.3.4 and 5.3.5 introduce the complete AC and DC charging sequences according to ISO 15118-2 and provide a detailed mapping of message elements according to ISO 15118-2 to the data objects being previously defined in this technical report.

Table 2 shows the selected use cases.

4 Under consideration.

Table 2 – Selected use cases E2 and E3 from [ISO 15118-1:2013]

ID	Use case name	Description
E2	Optimised charging with scheduling from the secondary actor	This use case covers the AC charging process with information about local installation, grid schedule and sales tariff table. With this, the EVSE can dynamically react to changes in the supply chain to reduce peak demand or oversupply situations. Additionally, the behaviour of the vehicle while charging becomes transparent to secondary actors in order to enhance electricity supply scheduling. The secondary actor needs to propose a charging schedule to the SECC, based on actual information about the local installation (e.g. power limits, local power generation), grid schedule and sales tariff table. It is necessary that EVCC, SECC and secondary actor have each the possibility to trigger a re-scheduling of the charging schedule. The Involved actors are: • Primary actors: EV, EVCC EVSE, SECC • Secondary actors: DCH, E-Mobility Operator Scenario descriptions: • USER inputs ―Target set‖ at EV • EV calculates the required amount of energy needed in order to fully charge (Wh) the battery for the user-provided departure time. • EVCC sends the required energy amount, departure time and charging capability of the EV to the SECC, which might forward it to a secondary actor. • A secondary actor collects ―Demand and prognosis. (e.g. Local physical limits from EVSE, local power generation, grid schedule from DCH, Sales tariff table from EP or E-Mobility Operator) NOTE This action might be performed prior to the charging event and could therefore be sent to the SECC. • A secondary actor or the SECC executes ―Level selector to provide input for charging schedule • A secondary actor or the SECC calculates ―Charging schedule • EVSE picks up the current limitation of ―Charging schedule for ―Charging Control‖. • SECC sends the current limitation to ―EVCC. • EV will start charging according to the current limitation

ID	Use case name	Description
E3	Optimised charging with scheduling at EV	This use case covers the AC charging process with information about local installation, grid schedule and sales tariff table. With this the EV can react on changes in the supply chain to reduce peak demand or oversupply situations. Additionally the behaviour of the vehicle while charging becomes transparent to secondary actors in order to enhance electricity supply scheduling. The secondary actor needs to propose a charging schedule to the SECC, based on actual information about the local installation (e.g. power limits, local power generation), grid schedule and sales tariff table. It is necessary that the EVCC, SECC and secondary actor each have the possibility to trigger a re-scheduling of the charging schedule. The actors involved are: • Primary actors: EV, EVCC EVSE, SECC. • Secondary actors: DCH, E-Mobility Operator. Scenario descriptions: • USER inputs ―Target set‖ at EV. • EV calculates the required amount of energy required for the charging (Wh) and the departure time to meet the target. • EVCC sends the calculated value and the charging capability of EV to the SECC, which might forward it to a secondary actor. • A secondary actor collects ―Demand and prognosis. (e.g. grid schedule from DCH, Sales tariff table from EP or E-Mobility Operator) and forwards this in-formation to the SECC. NOTE This action might be performed prior to the charging event and could therefore been sent to the SECC. • The SECC provides grid schedule, sales tariff table and local physical limits to the EVCC. • The EV executes ―Level selector to provide input for the charging schedule. • The EV calculates ―Charging schedule and shall send the schedule to the SECC for commitment. EV picks up the current limitation of ―Charging Schedule for ―Charging Control. • EV will start charging according to the current limitation

5.3.4 Use Case in System A for DC charging (E2 & E3)

For System A, an EVSE(Case1) or a unit coordinating with an EVSE(Case2) communicate with the upstream equipment in power grid system as shown in Figure 5. When the power grid system requires a peak shift or a demand response to DER, the EVSE stops, limits or schedules power output to achieve load leveling and demand restraint during power shortages.

In case a discharging function is added (see NOTE), System A conducts V2G (Vehicle to Grid) in order to keep the supply-demand balance.

NOTE IEC 61851-23 and -24 are currently being revised to add the requirements for the discharging function.

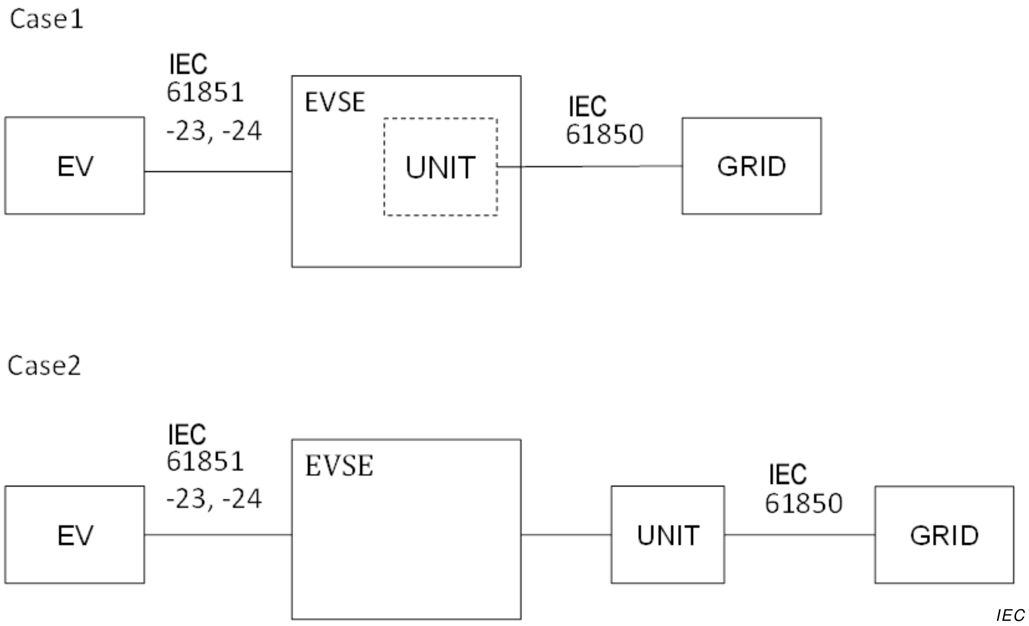


Figure 5 – Communication architecture of System A

5.3.5 Common information model for electric vehicles

The basic idea behind this technical report is to describe one information model in terms of IEC 61850 logical nodes, reflecting EVs plugged into supply equipments from the point of view of the power grid.

This technical report does not define how the exact implementation should be made. However, independent of the underlying hardware architecture as well as communication technologies / protocols behind the data exchange, the different information models should be harmonized.

From a power grid point of view, the operations of AC and DC charging an EV are very similar. Technically, the difference is in the placement of the charging equipment: *on-board* for AC charging, *off-board* for DC charging. This has an influence on the communication requirements between the EV and the charge spot which is already covered in [ISO 15118-2:2014]. The real difference is in the services provided to the connected EV in terms of charging power. Typically, dedicated off-board DC charging equipments provide higher charging power rates.

However, from the grid's point of view an EV connected to an AC or DC charging socket basically has the same need: Power is drawn from the grid connection point based upon requirements of the connected EV. In that respect it provides the same basic information relevant for power grid operations. Hence this technical report models AC and DC chargers using a very similar LN model to that shown in Figure 6.

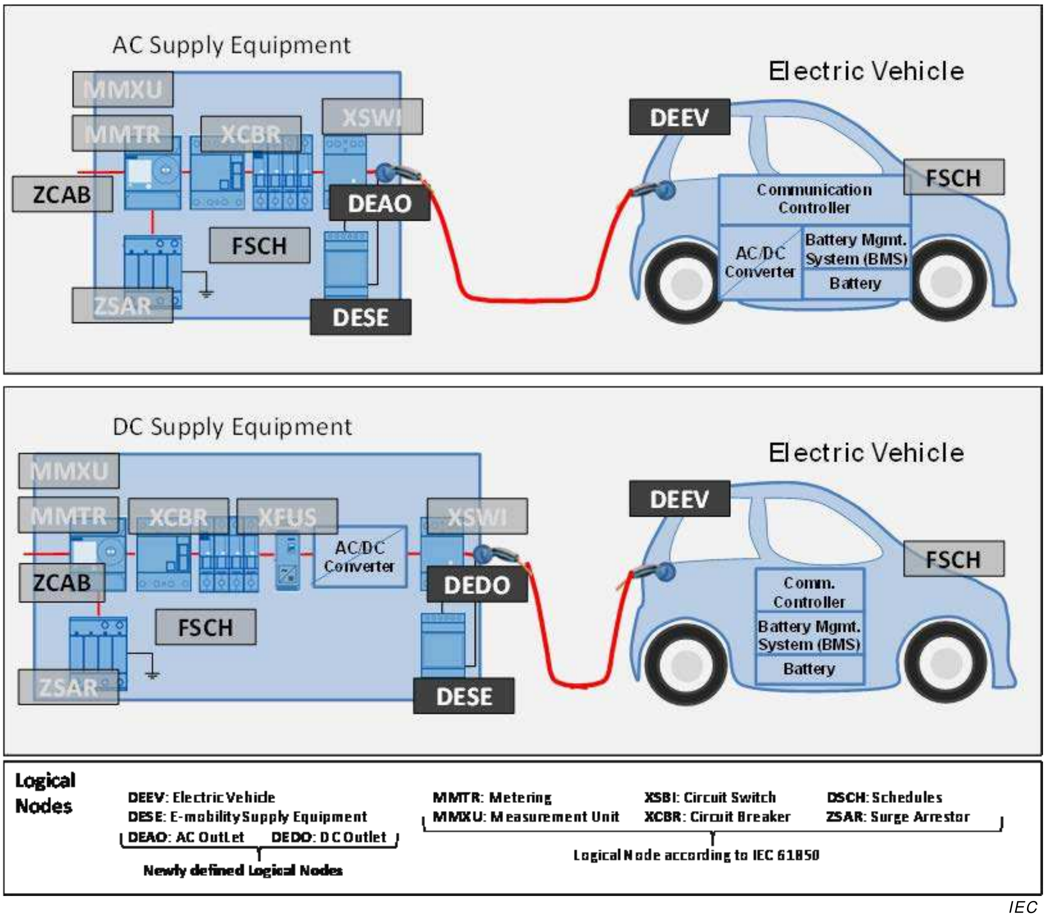


Figure 6 – IEC 61850 Logical Nodes overview, based on [IEEE VPPC2012]

5.4 Description of information model

5.4.1 General

Subclause 5.4 introduces all relevant and new Data Objects that are relevant for the IEC 61850 object model of electric mobility. Implementers of the model are advised to refer to Annex C for the exact details of the Logical Node model for electric mobility.

5.4.2 Plug present (PP) (AC and DC)

According to IEC 62196-2 and IEC 61851-1 a dedicated pin is used in the plug to signal if the plug and socket are connected. For AC systems, a resistor (see 5.4.5) will also signal the rated power for the charging cable.

To prevent 'hot unplug' and protection against theft of the charging cable, a mechanical locking mechanism can be used to lock and unlock the plug to the socket or maybe a mechanical shield.

The trigger that will lock or unlock is not defined in any of the current standards, but it could be the door lock/unlock of the EV, an RFID card on the EVSE or some other means.

Table 3 shows the data objects.

Table 3 – Data objects for plug present

<table>
<tr><th>Data object name</th><th>Common data class</th><th>Explanation</th></tr>
<tr><td>PlgStAC
PlgStDC</td><td>ENS</td><td>Plug present and coupler lock state (according to IEC 61851-1)
<table>
<tr><th>Value</th><th>Literal</th><th>Description</th></tr>
<tr><td>0</td><td>na</td><td>Not applicable / Unknown</td></tr>
<tr><td>1</td><td>disconnected</td><td>Disconnected</td></tr>
<tr><td>2</td><td>connected-unlocked</td><td>Connected and unlocked</td></tr>
<tr><td>3</td><td>connected-locked</td><td>Connected and locked</td></tr>
<tr><td>4</td><td>connected</td><td>Connected and not locked
(no locking mechanism available)</td></tr>
</table>
</td></tr>
</table>

5.4.3 Outlet charging current rating

This is a configuration (e.g. read-only) value that specifies the rated maximum charging current per pin in the EVSE outlet according to design. The value should never be exceeded when setting the allowed power to be drawn from the EVSE outlet.

Table 4 shows the data object.

Table 4 – Data object for charging current rating

Data object name	Common data class	Explanation
ChaARtg	ING	The rated maximum AC charging current of the outlet

5.4.4 EVSE charging power rating

This is the rated maximum charging power of the EVSE according to hardware design which cannot be exceeded. The information is typically relevant to operating a charging infrastructure with multiple charging outlets and accordingly attached charging cables.

Table 5 shows the data object.

Table 5 – Data object for charging power rating

Data object name	Common data class	Explanation
ChaPwrRtg	ASG	Rated maximum charging power of the EVSE

5.4.5 Charging cable rating

To prevent overheating or fire due to overload of the charging cable, a resistor on the ‘Plug Present’ pin will indicate the power rating of the charging cable.

Table 6 shows the current rating and equivalent value of the resistor, Table 7 shows the data object providing the current rating information for AC charging and Table 8 shows the data object providing the current rating information for DC charging.

Table 6 – Resistor coding for vehicle AC connectors and plugs [IEC 61851-1]

Current capability of the cable assembly	Equivalent resistance of Rc Tolerance ± 3% [c]
13 A	1,5 kΩ 0,5 W [a, b]
20 A	680 Ω 0,5 W [a, b]
32 A	220 Ω 0,5 W [a, b]
63 A (3 phase) / 70 A (1 phase)	100 Ω 0,5 W [a, b]

[a] The power dissipation of the resistor caused by the detection circuit shall not exceed the value given above. The value of the pull-up resistor shall be chosen accordingly.

[b] Resistors used should preferably fail open circuit failure mode. Metal film resistors commonly show acceptable properties for this application.

[c] Tolerances to be maintained over the full useful life and under environmental conditions as specified by the manufacturer.

Table 7 – Data object for AC charging cable rating

Data object name	Common data class	Explanation
CabRtgAC	ENS	Capability of the EV AC cable assembly (according to IEC 61851-1)

Value	Literal	Description
0	NA	Not applicable / Unknown
1	13A	13 A per phase
2	20A	20 A per phase
3	32A	32 A per phase
4	63/70A	63 A (3 phase) or 70 A (1 phase)

Table 8 – Data object for DC charging cable rating

Data object name	Common data class	Explanation
CabRtgDC	ENS	Capability of the EV DC cable assembly (according to IEC 62196-1)

Value	Literal	Description
0	NA	Not available / Unknown
1	13A	13 A
2	16-20A	16 – 20 A
3	30-32A	30 – 32 A
4	60-63A	60 – 63 A
5	70A	70 A
6	80A	80 A
7	125A	125 A
8	200A	200 A
9	250A	250 A
10	400A	400 A

5.4.6 Charging infrastructure supply cable characteristics

The charging infrastructure supply cable is the feeder cable that supplies electric power from the grid to the EVSE. It is therefore distinct to the charging cable connecting the EV with the EVSE outlet.

Table 9 shows some proposed new data objects that allow overloading of the cable.

Table 9 – Data objects allowing overload of a cable

Data object name	Common data class	Explanation
ARtg	ASG	Rated current of the cable in A
OvlMaxPct	ASG	Maximum overload of the cable in percent
OvlMaxTm	ING	Maximum time allowed for corresponding overload set as Tmm

5.4.7 Available connection types

When an EV is connecting to an EVSE, the EV can receive information about the connection types available on the outlet that the EV is plugged in to, using the 15118-2 Service Discovery mechanism.

NOTE IEC 61851-23 and -24 system A does not use the service discovery mechanism.

The outlet may support both AC and DC charging.

This is configuration (e.g. read-only) information that depends on the design of the EVSE, and can therefore not be modified by a 3rd party.

Table 10 shows the data objects for supported connection types.

Table 10 – Data objects for supported connection types of an outlet

Data object name	Common data class	Explanation
ConnTypPhs1	SPG	Single-Phase charging is supported if TRUE
ConnTypPhs2	SPG	Two-Phase charging is supported if TRUE
ConnTypPhs3	SPG	Three-Phase charging is supported if TRUE
ConnTypDC	SPG	DC charging is supported if TRUE

5.4.8 EV connection type

When an EV connects to an EVSE, the EVSE provides information about the connection types that the EVSE supports. The EV can to tell the EVSE which connection type it will use for charging.

The connection type selected by the EV can be transferred to the EVSE by the 15118-2 Service Discovery mechanism and can be read out by the ‘ConnTypSel’ attribute.

NOTE IEC 61851-23 and -24 system A does not use the service discovery mechanism.

Table 11 shows the data object holding information about the connection type selected by the EV.

Table 11 – Data object showing the selected connection type of an EV

<table>
<tr><th>Data object name</th><th>Common data class</th><th>Explanation</th></tr>
<tr><td>ConnTypSel</td><td>ENS</td><td>Selected AC / DC connection type according to IEC 61851 series
<table>
<tr><th>Value</th><th>Literal</th><th>Description</th></tr>
<tr><td>0</td><td>Not available / Unknown</td><td></td></tr>
<tr><td>1</td><td>Single Phase</td><td>Single phase AC charging</td></tr>
<tr><td>2</td><td>Three Phase</td><td>Three phase AC charging</td></tr>
<tr><td>3</td><td>System A</td><td>System A DC charging</td></tr>
<tr><td>4</td><td>System B</td><td>System B DC charging</td></tr>
<tr><td>5</td><td>System C</td><td>System C DC charging</td></tr>
</table>
</td></tr>
</table>

5.4.9 EV connection state (AC)

According to IEC 61851-1 and SAE J1772, the EV can signal to the EVSE what state it has (e.g. connected, ready to accept energy, ventilation required).

The signaling is done using a dedicated pin referred to as the Control Pilot pin. The details about this signaling are described in Annex A of IEC 61851-1:2010 as shown in Table 12.

Table 13 shows the data object modelling of the connection state.

Table 12 – Functions of control pilot pin [IEC 61851-1]

<table>
<tr><th>Vehicle state</th><th></th><th>Vehicle connected</th><th>S2</th><th>Charging possible</th><th></th><th>Va [a]</th><th></th></tr>
<tr><td>A</td><td></td><td>no</td><td>open</td><td>no</td><td></td><td>12 V [d]</td><td>Vb = 0 V</td></tr>
<tr><td>B</td><td></td><td>yes</td><td>open</td><td>no</td><td></td><td>9 V [b]</td><td>R2 detected</td></tr>
<tr><td>C</td><td rowspan="2">}</td><td rowspan="2">yes</td><td rowspan="2">closed</td><td rowspan="2">Vehicle ready</td><td rowspan="2">{</td><td>6 V [c]</td><td>R3 = 1,3 kΩ ± 3 %
Charging area ventilation not required</td></tr>
<tr><td>D</td><td>3 V [c]</td><td>R3 = 270 Ω ± 3 %
Charging area ventilation required</td></tr>
<tr><td>E</td><td></td><td>yes</td><td>open</td><td>no</td><td></td><td>0 V</td><td>Vb = 0: EVSE, utility problem, pilot short to earth ...</td></tr>
<tr><td>F</td><td></td><td>yes</td><td>open</td><td>no</td><td></td><td>-12 V</td><td>EVSE not available</td></tr>
<tr><td colspan="8">[a] All voltages are measured after stabilization period, tolerance ±1 V.
[b] The EVSE generator may apply a steady state DC voltage or a ±12 V square wave during this period. The duty cycle indicates the available current as in Table A.5.
[c] The voltage measured is function of the value of R3 in Figure A.1 (indicated as Re in Figure A.2).
[d] 12 V static voltage.</td></tr>
</table>

Table 13 – Data object showing the connection status on an outlet

<table>
<tr><th>Data object name</th><th>Common data class</th><th>Explanation</th></tr>
<tr><td>ConnSt</td><td>ENS</td><td>Connection state (notation from IEC 61851-1)
<table>
<tr><th>Value</th><th>Literal</th><th>Description</th></tr>
<tr><td>0</td><td>Not applicable / Unknown</td><td></td></tr>
<tr><td>1</td><td>State A</td><td>No vehicle connected</td></tr>
<tr><td>2</td><td>State B</td><td>Vehicle connected, not ready for energy flow</td></tr>
<tr><td>3</td><td>State C</td><td>Vehicle connected, ready for energy flow, ventilation not required</td></tr>
<tr><td>4</td><td>State D</td><td>Vehicle connected, ready for energy flow, ventilation required</td></tr>
<tr><td>5</td><td>State E</td><td>Vehicle connected, charge spot fault</td></tr>
<tr><td>6</td><td>State F</td><td>Charge spot not available for action</td></tr>
</table>
</td></tr>
</table>

5.4.10 EV connection state (DC)

For System C the same EV connection state applies as defined for AC in 5.4.9.

Table 14 defines status according to IEC 61851-23/24 system A and Figure 7 depicts transition between states of an EV.

Table 14 – DC connection status in IEC 61851-23/24 system A

<table>
<tr><th>Data object name</th><th>Common data class</th><th>Explanation</th></tr>
<tr><td>ConnStA</td><td>ENS</td><td>Connection state for system A (notation from IEC61851-23/24 system A)
<table>
<tr><th>Value</th><th>Literal</th><th>Description</th></tr>
<tr><td>0</td><td>Not available / Unknown</td><td></td></tr>
<tr><td>1</td><td>DC-A</td><td>Vehicle unconnected</td></tr>
<tr><td>2</td><td>DC-B1</td><td>Vehicle connected and start request</td></tr>
<tr><td>3</td><td>DC-B2</td><td>Initialisation 1: Handshaking</td></tr>
<tr><td>4</td><td>DC-B3</td><td>Initialisation 2: Vehicle connector lock
Initialisation 3: Insulation test before charging</td></tr>
<tr><td>5</td><td>DC-C</td><td>Energy transfer</td></tr>
<tr><td>6</td><td>DC-D</td><td>Ventilation</td></tr>
<tr><td>7</td><td>DC-B'1</td><td>Shutdown 1: Termination of current output</td></tr>
<tr><td>8</td><td>DC-B'2</td><td>Shutdown 2: Verification of voltage</td></tr>
<tr><td>9</td><td>DC-B'3</td><td>Shutdown 3: Connector unlock
Connector unlocked</td></tr>
<tr><td>10</td><td>DC-B'4</td><td>Shutdown 4: Connector unlock
End of charge at communication level</td></tr>
<tr><td>11</td><td>DC-E</td><td>Not ready</td></tr>
<tr><td>12</td><td>DC-F</td><td>Not ready</td></tr>
</table>
</td></tr>
</table>

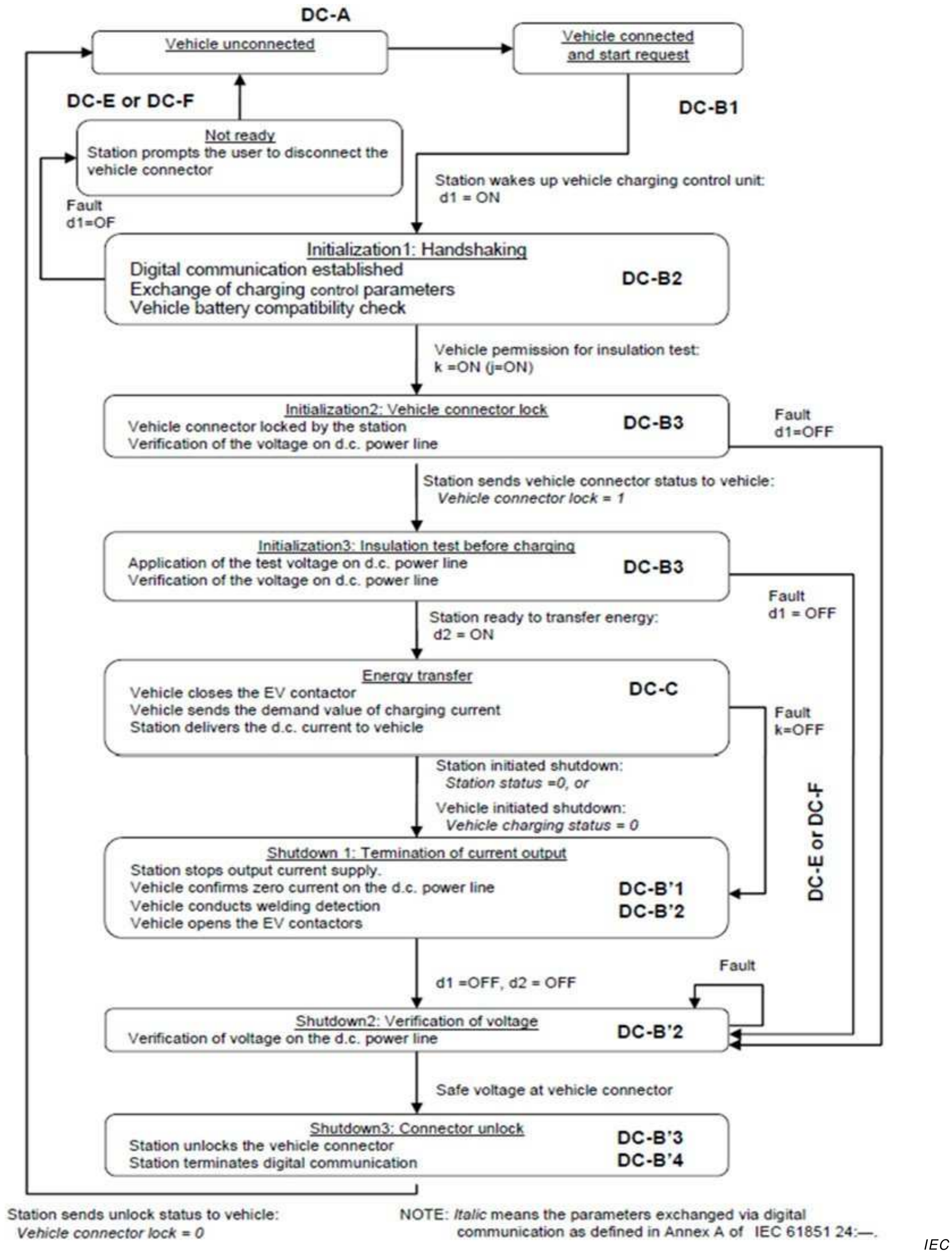


Figure 7 – State of DC charging state in IEC 61851-23/24 system A

5.4.11 EVSE PWM signaling

The EVSE can use the control pilot (CP) pin to signal the maximum allowed current to be drawn from the EVSE.

A pulse modulated signal (PWM) will signal to the on-board charger in the EV the maximum AC current to be drawn or if the PWM duty-cycle is 5 % (3 % to 7 %) the EVSE signals to the EV that ‘digital communication’ shall be used.

Table 15 shows how PWM values correspond to maximum allowed current drawn by the EV and Table 16 shows the data object used to model this information,

Table 15 – Maximum current to be drawn by vehicle [IEC 61851-1]

Nominal duty cycle interpretation by vehicle	Maximum current to be drawn by vehicle
Duty cycle < 3 %	Charging not allowed
3 % ≤ duty cycle ≤ 7 %	Indicates that digital communication will be used to control an off-board DC charger or communicate available line current for an on-board charger. Digital communication may also be used with other duty cycles. Charging is not allowed without digital communication. 5 % duty cycle shall be used if the pilot function wire is used for digital communication
7 % < duty cycle < 8 %	Charging not allowed
8 % ≤ duty cycle < 10 %	6 A
10 % ≤ duty cycle ≤ 85 %	Available current = (% duty cycle) × 0,6 A
85 % < duty cycle ≤ 96 %	Available current = (% duty cycle - 64) × 2,5 A
96 % < duty cycle ≤ 97 %	80 A
Duty cycle > 97 %	Charging not allowed
If the PWM signal is between 8 % and 97 %, the maximum current may not exceed the values indicated by the PWM even if the digital signal indicates a higher current.	

Table 16 – Data objects for handling PWM related features on an outlet

Data object name	Common data class	Explanation
DigComm	SPG	Enable digital communication with the EV (TRUE=enabled)
ChaAMax	ING	Available AC current (6-80A) to signal to the EV when not using digital communication

NOTE The data objects in Table 16 are only relevant for AC.

5.4.12 EV identification

An EVCC may provide EV nameplate information to the SECC.

Table 17 shows the related IEC 61850 data objects.

Table 17 – Data object for EV nameplate information

Data object name	Common data class	Explanation
EVId	VSG	In ISO 15118 compliant implementations, the EVId refers to the EVCCID Identifier as defined in [ISO 15118-2:2014].
EMAId	VSG	In ISO 15118-2:2014 compliant implementations, E-Mobility Account Identifier as defined in Annex H.1 in [ISO 15118-2:2014]

NOTE 1 In ISO 15118-2:2014 compliant implementations, the EVId is provided by the EV as part of the session establishment between the EV and EVSE as defined in [ISO 15118-2:2014].

NOTE 2 The EMAId may be provided by the EV through the plug and charge (PnC) mechanism or through alternative external identification means (EIM) as defined in [ISO 15118-2:2014]. External identification means cover e.g. RFID card based authentication or authentication through any other mobile equipment (e.g. mobile phone).

5.4.13 EVSE identification

When the EVSE is requested to identify itself, it must provide the EVSE nameplate information as shown in Table 18 – if the required validation has been approved by the operator.

Table 18 – Data object for EVSE nameplate information

Data object name	Common data class	Explanation
EVSEId	VSG	Electric Vehicle Supply Equipment ID (EVSEID) as defined in Annex H.2 of [ISO 15118-2:2014]

5.4.14 EV charge parameters

The EV charge parameters are provided through the digital communication interface. They include technical parameters of the EV, like maximum charging current and voltage as well as minimum charging current. Optionally they also include EVU target settings referring to the amount of energy to be charged until a given point in time, called departure time.

The EV charge parameters are part of the LN DEEV and are defined in Table 19.

Table 19 – Data objects for target setting and limit

Data object name	Common data class	Explanation
DptTm	TSG	Departure time is used to indicate when the vehicle intends to finish the charging process. A value of zero (0) indicates that the charging process shall be finished as fast as possible.
EnAmnt	ASG	Amount of energy required by the EV until the departure time has been reached or the EV battery's SOC is at 100%. This might include the amount of energy the EV consumes for other vehicle features than solely charging the EV Battery.
VMax	ASG	Maximum voltage supported by the EV. This is the voltage measured between one phase and neutral.
AMax	ASG	Maximum current supported by the EV.
AMin	ASG	Minimum current supported by the EV.

5.4.15 State of charge (SOC)

The battery's State of Charge (SOC) is determined by the EV and provides an estimated value of the current amount of energy available from the battery. The SOC is defined as the available capacity in a battery, expressed as a percentage of its rated capacity.

Table 20 shows the data object used to provide the SOC.

NOTE 1 The SOC can tell the EVSE operator how much energy the EV has used since the last connection. Legal metering could be done with a meter inside the EVSE or at the home installation, but for load balancing purposes, it could be useful to get this measurement directly from the EV.

NOTE 2 SOC is only available in case of DC charging,but may be provided for AC charging through a propriety value added service (VAS).

Table 20 – Data object for showing SOC from the EV

Data object name	Common data class	Explanation
Soc	MV	State of charge of the EV battery.

5.4.16 Isolation Test Fault

The isolation test is a key component in a personnel protection system for reducing the risk of electric shock.

Table 21 shows the data object that carries information about the result of an isolation test.

Table 21 – Data object for status of an isolation test

Data object name	Common data class	Explanation
IsoTestFlt	SPS	Isolation test fault. True = isolation test executed before charging has failed

5.4.17 Short-circuit Test Fault

The short circuit test is performed to check that the electrical connection between the EV and the EVSE is electrically functional.

Table 22 shows the data object that carries information about the result of a short-circuit test.

Table 22 – Data object for status of a short-circuit test

Data object name	Common data class	Explanation
ScTestFlt	SPS	Short circuit test fault. True = short circuit test before charging has failed.

5.4.18 Welding detection

For safety reasons the EVSE can detect and warn if voltage is present on the charging output with the charging power contactor commanded open.

Table 23 shows the data object that carries information such as welding condition detection.

Table 23 – Data object for status of welding test

Data object name	Common data class	Explanation
WldDet	SPS	Detection of a welding condition. True = welding condition detected.

5.4.19 Loss of digital communication

The EVSE can detect and notify about loss of digital communication between the EVSE and the connected EVs.

Table 24 shows the data object that carries information about loss of digital communication.

Table 24 – Data object for loss of digital communication

Data object name	Common data class	Explanation
DigCommLos	SPS	Detection of loss of digital communication. True = loss of communication detected.

5.4.20 Nameplate information

Table 25 shows the data objects that carries nameplate information.

Table 25 – Data objects for nameplate information

Data object name	Common data class	Explanation
EVNam	DPL	EV nameplate
EVSENam	DPL	EVSE nameplate

5.4.21 Data model references

Table 26 shows the data objects that can be used to identify the logical node instances that carries information about connections, connected EVs and charging profile schedules.

Table 26 – Data objects for logical node references

Data object name	Common data class	Explanation
ConnACRef	ORG	Reference to the logical node instance(s) representing AC charging connections
ConnDCRef	ORG	Reference to the logical node instance(s) representing DC charging connections
EVRef	ORG	Reference to the logical node instance representing a connected EV
SchdRef	ORG	Reference to the schedule logical node instance containing information on the charging profile of an connected EV

5.4.22 Charge schedules

5.4.22.1 General

One of the most important parts of ‘Smart Charging’ when it comes to charging of the EV according to the needs from the distribution grid and energy market is the exchange of charge schedules.

Two use cases have been identified within ISO 15118-1 for negotiation of a charge schedule between EVs and charging infrastructures (refer to 5.3, use cases E2 and E3). In order to enable both use cases a four-way handshake between the *EVCC* and *SECC* is specified in ISO 15118-2:2014.

NOTE 1 The part of ISO 15118-2:2014 describing the four-way handshake is only normative for the communication between the EVCC and the SECC. Any further communication between the SECC and other Secondary Actors (e.g. E-Mobility Infrastructure Operator) is out of the scope of ISO 15118-2:2014.

NOTE 2 Under consideration when IEC 61851-23/24 system A is used. (SchdSt = 1, ScheRef = NULL).

For the purpose of this technical report an exemplary scenario including the communication between the SECC and an E-Mobility Infrastructure Operator is shown in Figure 8 (see also [IEEE VPPC2011]).

1) Step: The E-Mobility Infrastructure Operator provides a *Local Limit Profile* which refers to the maximum power over time to be consumed from the feeder of one EVSE being associated to the SECC. This information may be provided asynchronously to the SECC (e.g. on a regular basis, event driven etc.).
2) Step (normative in ISO 15118-2:2014): When the EV is connected to the EVSE and the PnC profile is selected, the EV provides its technical charging characteristics (max. charging current & voltage and min. current) as well as the target settings (amount of energy to be delivered before departure time) of the EVU.
3) Step (normative in ISO 15118-2:2014): The SECC responds with a power schedule defining the maximum power to be consumed over time from the outlet of the EVSE that the EV is connected to.
4) Step (normative in ISO 15118-2:2014): Charging profile of the EV containing maximum power to be consumed by the EV over time. This schedule shall respect the limits of the schedule previously received in step 3.
5) Step (normative in ISO 15118-2:2014): SECC sends a confirmation of the schedule back to the EVCC.
6) Step: The SECC sends the Local Reservation Profile to the E-Mobility Infrastructure Operator which corresponds to the maximum power over time to be consumed from the PCC of the EVSE. This information may be provided asynchronously to the E-Mobility Infrastructure Operator (e.g. on a regular basis, event driven etc.)

NOTE 3 The ISO 15118-2:2014 four-way handshake for charge schedule negotiation applies to steps 2 till 5 in Figure 8.

NOTE 4 ISO 15118-2:2014 allows re-negotiation of charge schedules during the charge process.

Annex D provides detailed information on the message exchange between the EVCC, SECC and CIO.

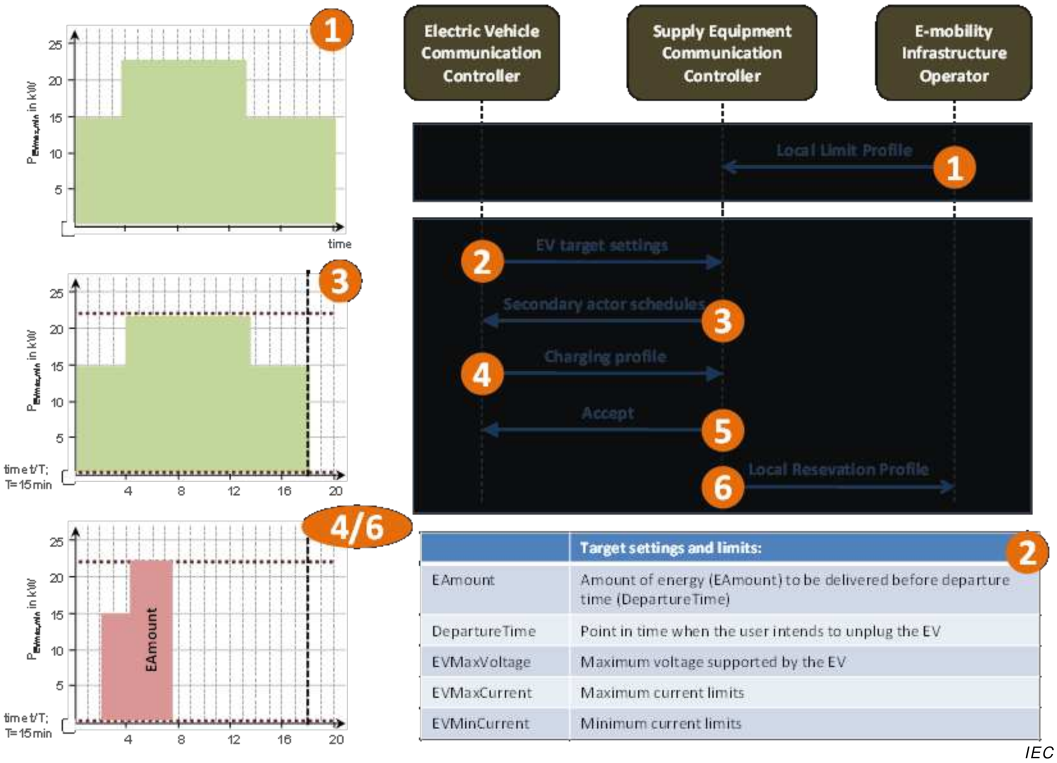


Figure 8 – Exemplary exchange of charge schedule information for an EVSE with one outlet, based on [IEEE VPPC2011]

Subclauses 5.4.16.2 and 5.4.16.3 define the object model relevant for the E-Mobility Infrastructure Operator which includes the *Local Limit Profile* (step 1 in Figure 8) and *Local Reservation Profile* (step 6 in Figure 8).

5.4.22.2 Local limit profile

The Local Limit Profile tells an EVSE the maximum power over time to be consumed from the feeder of the EVSE.

When an EV connects to the EVSE, it provides information on target settings and electrical limits and expects in return a schedule that informs of the maximum power allowed to be consumed from the EVSE outlet that the EV is connected to.

If the EVSE has multiple outlets, it shall make sure that the sum of the maximum power over time sent to each output does not exceed the maximum power schedule in the provided Local Limit Profile.

Based on the maximum power schedule received, the EV shall provide information on the maximum power over time it is expecting to consume from the EVSE outlet. This schedule is required to respect the limits of the maximum power schedule received from the EVSE.

The Local Limit Profile can be changed at any time before or during the EV charging process. It is modelled according to Table 27.

Table 27 – Data objects for a Local Limit Profile power schedule

Data object name	Common data class	Explanation
NumEntr	ING	The number of schedule entries that are valid out of the instantiated ValASG
SchdIntv	ING	The schedule interval duration in time entities as specified in the unit
ValASG[1..n]		The scheduled analogue values; one instance per interval
StrTm	TSG	Start time of the schedule in UTC time
IntvPer	ING	The periodicity interval duration in entities as specified in ClcIntvTyp
ClcIntvTyp	ENG	Interval type (units) to define the periodicity
SchdReuse	SPG	Whether to reuse the schedule

5.4.22.3 Local reservation profile

The Local Reservation Profile describes a forecast for the maximum power over time the EVSE is expecting to draw from the power feeder.

If the EVSE has multiple outlets, the power schedule in the Local Reservation Profile is the sum of expected power schedules provided by all the EVs connected to the EVSE.

The power schedule described in the Local Reservation Profile is required to be within the boundaries of the maximum power schedule provided by the Local Limit Profile.

Table 28 shows the data objects used to model the profile.

Table 28 – Data objects for a Local Reservation Profile power schedule

Data object name	Common data class	Explanation
NumEntr	ING	The number of schedule entries that are valid out of the instantiated ValASG
SchdIntv	ING	The schedule interval duration in time entities as specified in the unit
ValASG[1..n]	ASG	The scheduled analogue values; one instance per interval
StrTm	TSG	Start time of the schedule in UTC time
IntvPer	ING	The periodicity interval duration in entities as specified in ClcIntvTyp
ClcIntvTyp	ENG	Interval type (units) to define the periodicity
SchdReuse	SPG	Whether to reuse the schedule

Annex A
(informative)

Common information model mappings for AC charging

A.1 General

This annex defines specific models for AC charging options of electric vehicles.

A.2 Specific model definitions for basic charging with IEC 61851-1 support – Graphical representation of mapping IEC 61851-1 domain information

Figure A.1 demonstrates the mapping of IEC 61851-1 domain information to the IEC 61850-7-420 information model for AC charging.

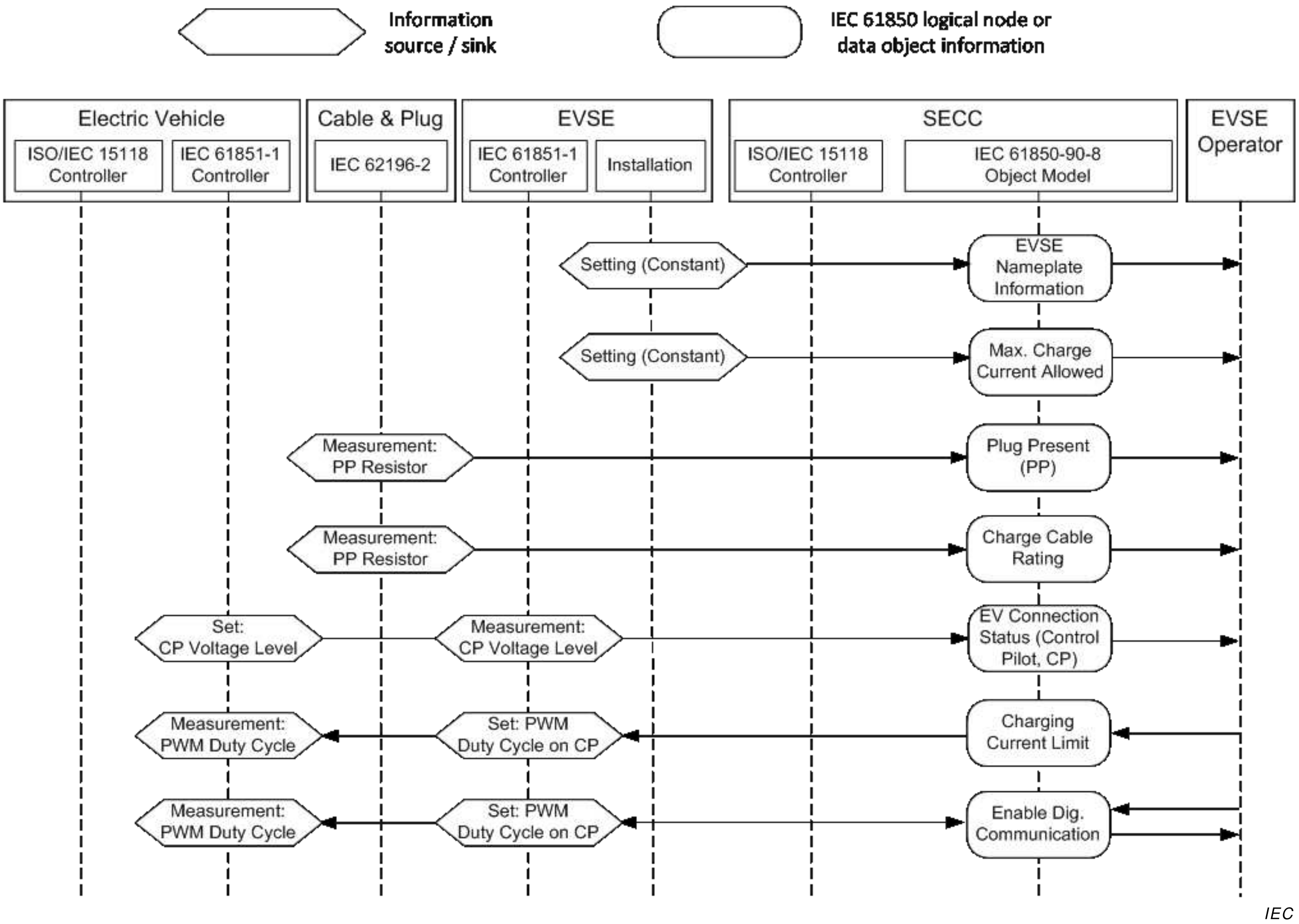


Figure A.1 – Mapping of IEC 61851-1 domain information to IEC 61850-7-420 information model for AC charging

A.3 Specific model definitions for smart charging with ISO 15118 support – Graphical representation of mapping IEC 61851-1 and ISO 15118-2 domain information

Figure A.2 demonstrates the mapping of ISO 15118-2 and IEC 61851-1 domain information to the IEC 61850-7-420 information model for AC charging.

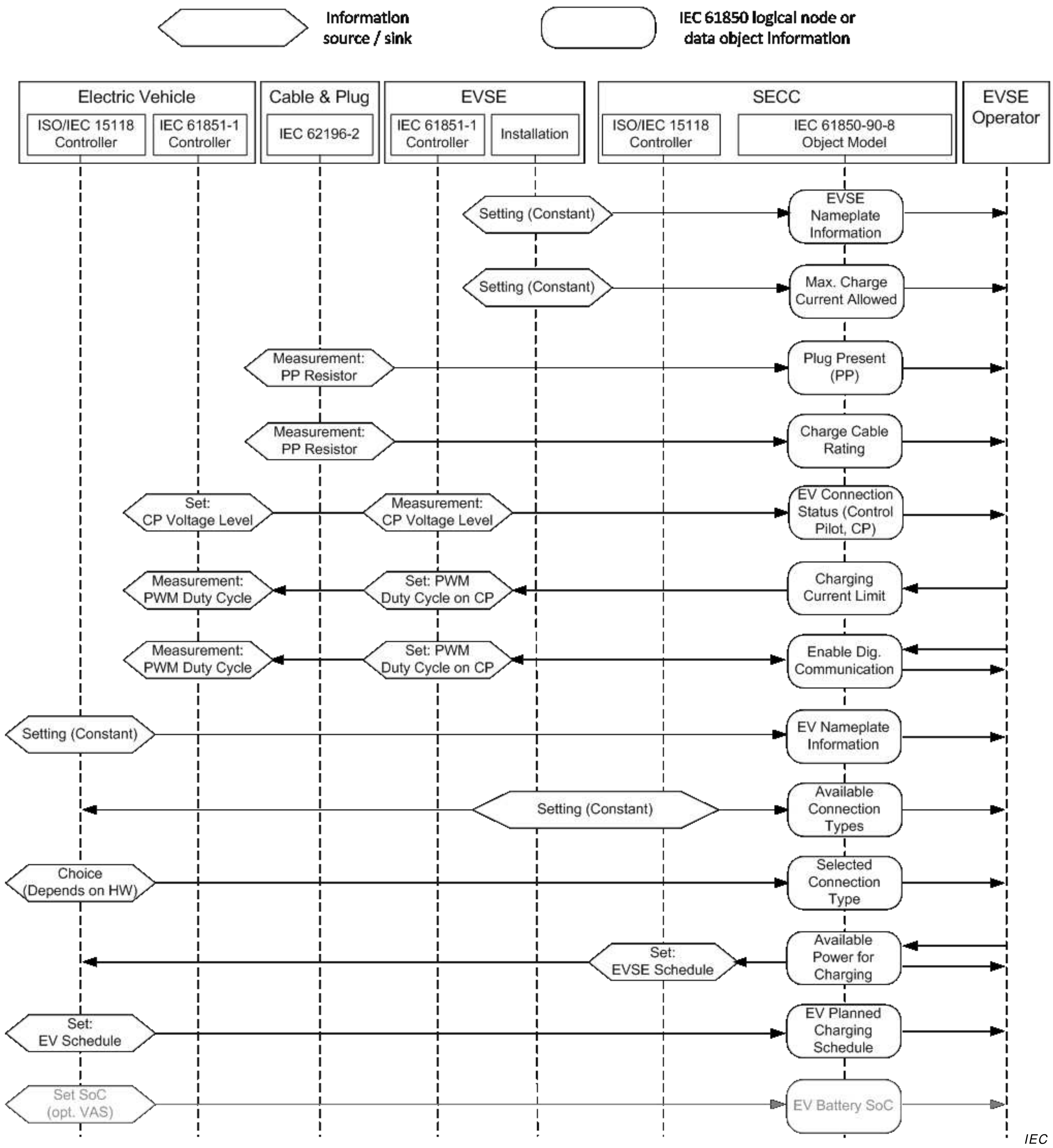


Figure A.2 – Mapping of ISO 15118-2 and IEC 61851-1 domain information to IEC 61850-7-420 information model for AC charging

Annex B
(informative)

Common information model mappings for DC charging

B.1 General

This annex defines specific models for DC charging options of electric vehicles.

B.2 Specific model definitions for IEC 61851-23/24 system A – DC charging – Graphical representation of mapping IEC 61851-23/24 system A domain information

Figure B.1 demonstrates a graphical representation of mapping IEC 61851-23/24 system A domain information.

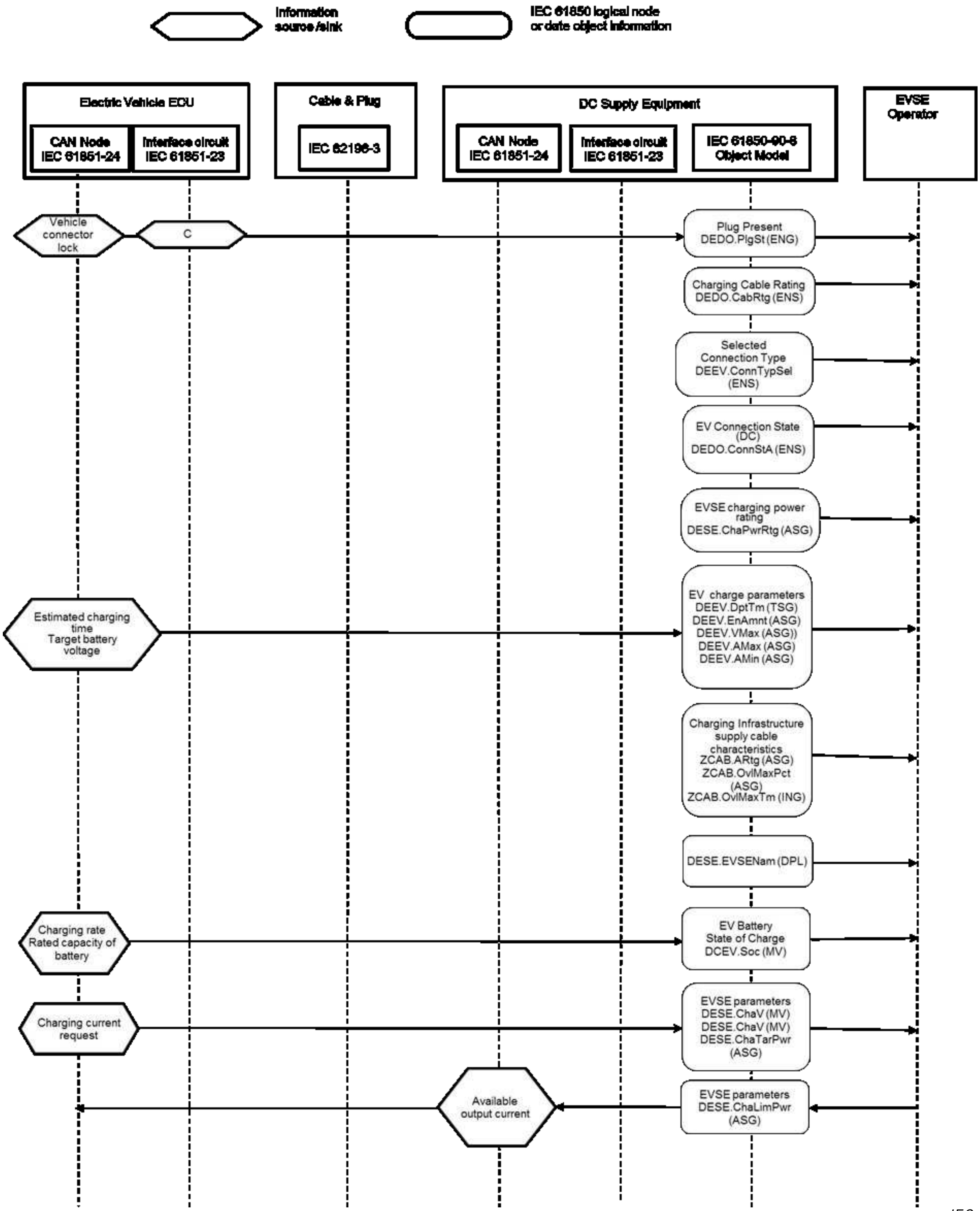


Figure B.1 – Mapping of IEC 61851-23/24 system A domain information to IEC 61850-7-420 information model for DC charging

B.3 Specific model definitions for IEC 61851-23/24 system C – DC charging – Graphical representation of mapping IEC 61851-23/24 system C domain information

Figure B.2 demonstrates the mapping of IEC 61851-23/24 system C (ISO 15118-2 and IEC 61851-1) domain information to the IEC 61850-7-420 information model for DC charging.

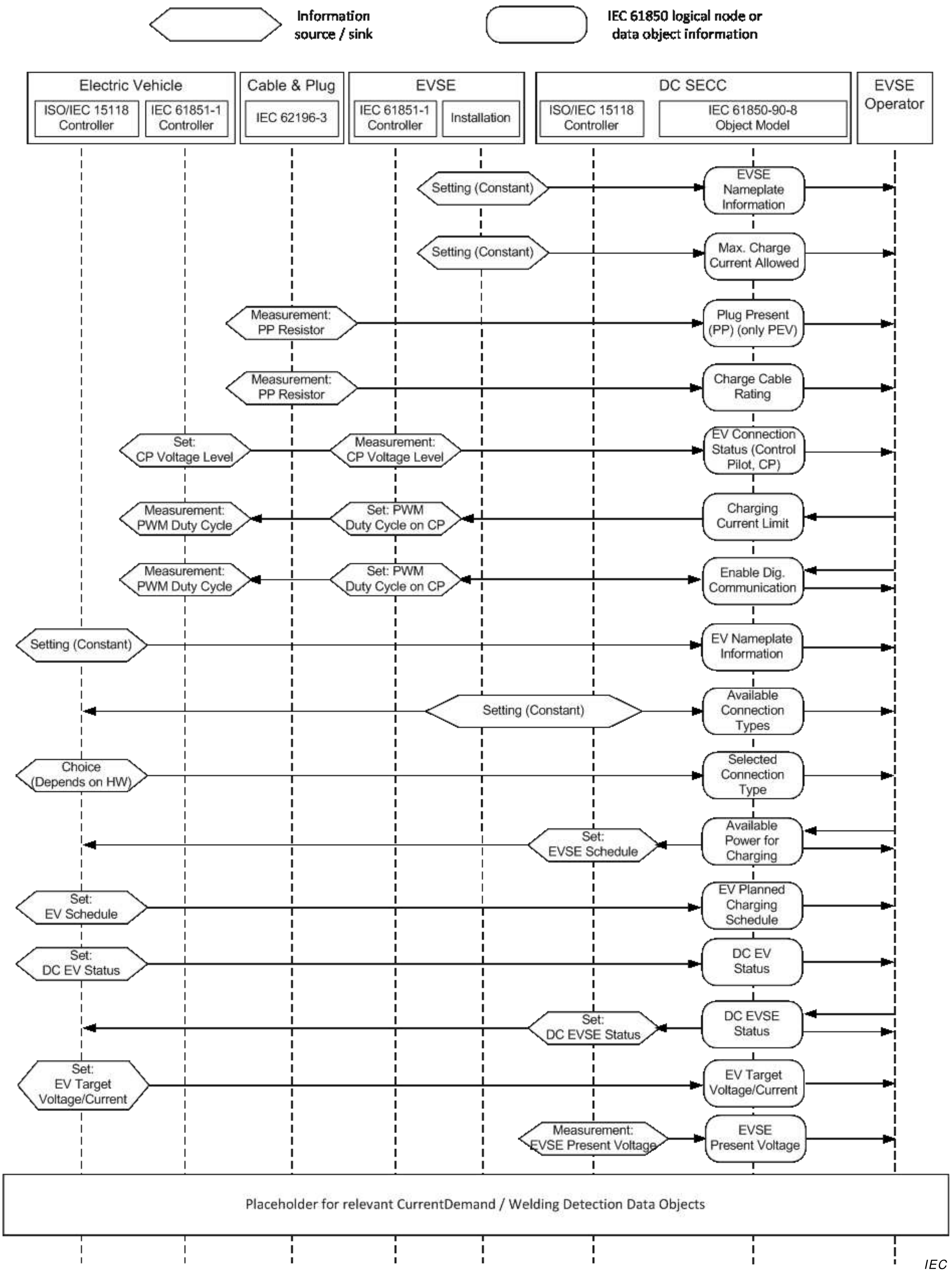


Figure B.2 – Mapping of IEC 61851-23/24 system C (ISO 15118-2 and IEC 61851-1) domain information to IEC 61850-7-420 information model for DC charging

Annex C
(normative)

61850 Logical Nodes for Electric Mobility

C.1 Overview

This annex provides an overview of the logical nodes referred to in this document. Subclause C.2 shows the logical nodes with the layout decided upon in the IEC 61850 series based on the UML modeling, while Subclause C.3 shows an exploded view of the logical nodes and their attribute names as an example on how to represent data.

C.2 New and existing logical nodes

C.2.1 LN: E-Mobility supply equipment Name: DESE

This logical node contains information related to monitoring and controlling the features of an EVSE.

Table C.1 shows all data objects of DESE.

Table C.1 – E-Mobility supply equipment logical node

DESE				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EVSENam	DPL		EVSE nameplate	M / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
IsoTestFlt	SPS		Isolation test fault (i.e. the isolation test executed before charging has failed)	O / F
ScTestFlt	SPS		Short circuit test fault (i.e. short circuit test before charging has failed)	O / F
DigCommLos	SPS		Detection of loss of digital communication	O / F
WldDet	SPS		Detection of a welding condition	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MO(1) / MO(1)
Measured and metered values				
ChaV	MV		Charging voltage	AllOrNonePerGroup(1) / O
ChaA	MV		Charging current	AllOrNonePerGroup(1) / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
EVSEId	VSG		Electric Vehicle Supply Equipment ID (EVSEID) as defined in Annex H.2 in [ISO 15118-2:2014]	O / F
ChaPwrRtg	ASG		Rated maximum charging power of the EVSE	O / F
ChaPwrTgt	ASG		The power value that the EVSE requires to grid	AllOrNonePerGroup(1) / F
ChaPwrLim	ASG		The power value that the grid limits to the charger	AllOrNonePerGroup(1) / F
ConnTypDC	SPG		True = DC charging is supported	O / F
ConnTypPhs	SPG		True = AC n (n = 1, 2, 3) phase charging is supported. Use ConnTypPhs1 for one phase charging, ConnTypPhs2 for two phase charging and ConnTypPhs3 for three phase charging.	Omulti / F
ConnACRef	ORG		Reference to the logical node(s) representing AC charging connections	Omulti / F
ConnDCRef	ORG		Reference to the logical node(s) representing DC charging connections	Omulti / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M

DESE				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

C.2.2 LN: E-Mobility AC charging outlet Name: DEAO

C.2.2.1 General

This logical node contains information related to monitoring and controlling the features of an EVSE outlet for AC charging.

Table C.2 shows all data objects of DEAO.

Table C.2 – E-Mobility AC charging outlet logical node

DEAO				
Data object name	Common data class	T	Explanation	PresCond nds/ds
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
ConnSt	ENS (EVACConnectionStateKind)		Connection state (notation from IEC 61851-1)	M / F
PlgStAC	ENS (EVACPlugStateKind)		Plug present and coupler lock state (according to 61851-1)	O / F
CabRtgAC	ENS (EVACCableCapabilityKind)		Capability of the EV cable assembly (according to 61851-1)	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MO(1)/MO(1)
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
ChaARtg	ING		The rated maximum AC charging current of the outlet	O / F
DigComm	SPG		Enable digital communication with the EV	O / F
ChaAMax	ING		Available AC current (6-80A) to signal to the EV when not using digital communication	O / F
EVRef	ORG		Reference to the logical node instance containing information on a connected EV	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

C.2.2.2 AC Connection State (EVACConnectionStateKind enumeration)

This enumeration lists the connection states of electrical vehicles (notation from IEC 61851-1). Used in logical node DEAO or DEDO for IEC 61851-23 and -24 system C.

Table C.3 shows all literals of EVACConnectionStateKind.

Table C.3 – Literals of EVACConnectionStateKind

EVACConnectionStateKind		
enumeration item	**value**	**description**
State A	1	No vehicle connected
State B	2	Vehicle connected, not ready for energy flow
State C	3	Vehicle connected, ready for energy flow, ventilation not required
State D	4	Vehicle connected, ready for energy flow, ventilation required
State E	5	Vehicle connected, charge spot fault
State F	6	Charge spot not available for action
Not applicable / Unknown	98	

C.2.2.3 EV Plug Present and Coupler Lock State (EVACPlugStateKind enumeration)

This enumeration lists the plug present and coupler lock states (according to IEC 61851-1). Used in logical node DEAO.

Table C.4 shows all literals of EVACPlugStateKind.

Table C.4 – Literals of EVACPlugStateKind

EVACPlugStateKind		
enumeration item	**value**	**description**
Disconnected	1	
Connected and unlocked	2	
Connected and locked	3	
Connected	4	Connected but not locked (no locking mechanism available)
Not applicable / Unknown	98	

C.2.2.4 EV AC Charging Cable Capability (EVACCableCapabilityKind enumeration)

This enumeration lists the capability of the EV AC charging cable assembly (according to IEC 61851-1). Used in logical node DEAO.

Table C.5 shows all literals of EVACCableCapabilityKind.

Table C.5 – Literals of EVACCableCapabilityKind

EVACCableCapabilityKind		
enumeration item	**value**	**description**
13A	1	13 amps per phase
20A	2	20 amps per phase
32A	3	32 amps per phase
63/70A	4	63 amps (3 phase) or 70 amps (1 phase)
Not applicable / Unknown	98	

C.2.3 LN: E-Mobility DC charging outlet Name: DEDO

C.2.3.1 General

This logical node contains information related to monitoring and controlling the features of an EVSE outlet for DC charging.

Table C.6 shows all data objects of DEDO.

Table C.6 – E-Mobility DC charging outlet logical node

DEDO				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
ConnStA	ENS (EVDCConnectionStateAKind)		Connection state for system A connection type (notation from IEC 61851-23/24 system A)	O / F
ConnStC	ENS (EVDCConnectionStateCKind)		Connection state for system C connection type (notation from IEC 61851-23/24 system c)	O / F
CabRtgDC	ENS (EVDCCableCapabilityKind)		Capability of the EV cable assembly (according to 61851-1)	O / F
PlgStDC	ENS (EVDCPlugStateKind)		Plug present and coupler lock state (according to 61851-1)	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MO(1) / MO(1)
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
EVRef	ORG		Reference to the logical node instance containing information on a connected EV	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

C.2.3.2 EV DC Connection State for IEC 61851-23/24 system A (EVDCConnectionStateAKind enumeration)

This enumeration lists the connection states of electrical vehicles for DC charging IEC 61851-23/24 system A. Used in logical node DEDO.

Table C.7 shows all literals of EVDCConnectionStateAKind.

Table C.7 – Literals of EVDCConnectionStateAKind

EVDCConnectionStateAKind		
enumeration item	**value**	**description**
DC-A	1	Vehicle unconnected
DC-B1	2	Vehicle connected and start request
DC-B2	3	Initialisation 1: Handshaking
DC-B3	4	Initialisation 2: Vehicle connector lock Initialisation 3: Insulation test before charging
DC-C	5	Energy transfer
DC-D	6	Ventilation
DC-B'1	7	Shutdown 1: Termination of current output
DC-B'2	8	Shutdown 2: Verification of voltage
DC-B'3	9	Shutdown 3: Connector unlock – Connector unlocked
DC-B'4	10	Shutdown 4: Connector unlock – End of charge at communication level
DC-E	11	Not ready
DC-F	12	Not ready
Not applicable / Unknown	98	

C.2.3.3 EV DC Connection State for IEC 61851-23/24 system C (EVDCConnectionStateCKind enumeration)

This enumeration lists the connection states of electrical vehicles for DC charging IEC 61851-23/24 system C. Used in logical node DEDO.

Table C.8 shows all literals of EVDCConnectionStateCKind.

Table C.8 – Literals of EVDCConnectionStateCKind

EVDCConnectionStateCKind		
enumeration item	**value**	**description**
State A	1	No vehicle connected
State B	2	Vehicle connected, not ready for energy flow
State C	3	Vehicle connected, ready for energy flow, ventilation not required
State D	4	Vehicle connected, ready for energy flow, ventilation required
State E	5	Vehicle connected, charge spot fault
State F	6	Charge spot not available for action
Not applicable / Unknown	98	

C.2.3.4 EV DC Charging Cable Capability (EVDCCableCapabilityKind enumeration)

This enumeration lists the capability of the EV DC charging cable assembly (according to IEC 61851-1). Used in logical node DEDO.

Table C.9 shows all literals of EVDCCableCapabilityKind.

Table C.9 – Literals of EVDCCableCapabilityKind

EVDCCableCapabilityKind		
enumeration item	**value**	**description**
13A	1	13 A
16-20A	2	16 to 20 A
30-32A	3	30 to 32 A
60-63A	4	60 to 63 A
70A	5	70 A
80A	6	80 A
125A	7	125 A
200A	8	200 A
250A	9	250 A
400A	10	400 A
Not available / Unknown	98	

C.2.3.5 EV DC Plug Present and Coupler Lock State (EVDCPlugStateKind enumeration)

This enumeration lists the plug present and coupler lock states (according to IEC 61851-1). Used in logical node DEDO.

Table C.10 shows all literals of EVDCPlugStateKind.

Table C.10 – Literals of EVDCPlugStateKind

EVDCPlugStateKind		
enumeration item	**value**	**description**
Disconnected	1	
Connected and unlocked	2	
Connected and locked	3	
Connected	4	Connected but not locked (no locking mechanism available)
Not applicable / Unknown	98	

C.2.4 LN: E-Mobility Electric Vehicle Name: DEEV

C.2.4.1 General

The E-Mobility electric vehicle logical node as shown in Table C.11 contains information on an EV connected to an EVSE. If DEAO.ConnSt, DEAO.PlgStAC (for AC charging) or DEDO.ConnStA, DEDO.ConnStC, DEDO.PlgStDC (for DC charging) indicates that no vehicle is connected, the data in DEEV is to be considered invalid.

NOTE The VMax, AMax and AMin DOs are only relevant for an EVSE supporting AC charging.

Table C.11 – E-Mobility electric vehicle logical node

DEEV				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EVNam	DPL		EV nameplate	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
ConnTypSel	ENS (EVConnectionChargingKind)		Selected connection type according to 61851-1	M / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MO(1) / MO(1)
Measured and metered values				
Soc	MV		State of charge	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
EVId	VSG		In ISO 15118 compliant implementations, the EVId refers to the EVCCID Identifier as defined in [ISO 15118-2:2014]	O / F
EMAId	VSG		In ISO 15118-2:2014 compliant implementations, E-Mobility Account Identifier as defined in Annex H.1 of [ISO 15118-2:2014]	O / F
DptTm	TSG		Departure time is used to indicate when the vehicle intends to finish the charging process. A value of zero (0) indicates that the charging process shall be finished as fast as possible.	O / F
EnAmnt	ASG		Amount of energy required by the EV until the departure time has been reached or the EV battery's SOC is at 100%. This might include the amount of energy the EV consumes for other vehicle features than solely charging the EV battery.	O / F
VMax	ASG		Maximum voltage supported by the EV. This is the voltage measured between one phase and neutral.	AllOrNonePerGroup(1) / F
AMax	ASG		Maximum current per phase supported by the EV.	AllOrNonePerGroup(1) / F
AMin	ASG		Minimum current per phase supported by the EV.	AllOrNonePerGroup(1) / F
SchdRef	ORG		Reference to the schedule logical node instance containing information on the charging profile of the EV.	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O

DEEV				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

C.2.4.2 EV Connection Charging Type (EVConnectionChargingKind enumeration)

This enumeration lists the connection charging types (according to IEC 61851-1). Used in logical node DEEV.

Table C.12 shows all literals of EVConnectionChargingKind.

Table C.12 – Literals of EVConnectionChargingKind

EVConnectionChargingKind		
enumeration item	**value**	**description**
Single Phase	1	Single phase AC charging
Three Phase	2	Three phase AC charging
System A	3	System A DC Charging
System B	4	System B DC Charging
System C	5	System C DC Charging
Not applicable / Unknown	98	

C.2.5 LN: Power cable Name: ZCAB

This logical node represents a power cable.

Table C.13 shows only the proposed new DOs in order to allow for overloading the cable.

Table C.13 – Additions to power cable logical node

ZCAB				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Settings				
ARtg	ASG		Rated current of the cable in A	M / F
OvlMaxPct	ASG		Maximum overload of the cable in percent	AllOrNonePerGroup(1) / F
OvlMaxTm	ING		Maximum time allowed for corresponding overload set as Tmm	AllOrNonePerGroup(1) / F

NOTE The suggested approach from this TR is not supported by the ZCAB definition in 61850-7-4:2010. It remains to be clarified whether these changes can be applied to the ZCAB node.

C.2.6 LN: Schedule Name: FSCH

This logical node defines a DER energy and/or ancillary services schedule. Multiple schedules can be defined, using FSCC LN to control which ones are active.

Table C.14 shows the Schedule logical node.

NOTE The logical node version shown in Table C.14 reflects that of the draft IEC DTR 61850-90-10:2015.

Table C.14 – Schedule logical node

FSCH				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / na
Status information				
SchdSt	ENS (ScheduleStateKind)		State of this schedule	M / na
SchdEntr	INS		The current schedule entry of a running schedule. This is the Data-Instance-ID of the data object ValXXX (e.g. ValASG). As long as the schedule is not running the value shall be 0.	O / na
ValINS	INS		Current value determined by the schedule. As long as the schedule is not running the quality of the value is invalid. The unit of this data shall be the same as the unit of the data object(s) ValING.	AtMostOne / na
ValSPS	SPS		Current value determined by the schedule. As long as the schedule is not running the quality of the value is invalid.	AtMostOne / na
ValENS	SubstitutionCDC (ENS)		Current value determined by the schedule. As long as the schedule is not running the quality of the value is invalid.	AtMostOne / na
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / na
Health	ENS (HealthKind)		inherited from: DomainLN	O / na
Mir	SPS		inherited from: DomainLN	MO(1) / na
Measured and metered values				
ValMV	MV		Current value determined by the schedule. As long as the schedule is not running the quality of the value is invalid. The unit of this data shall be the same as the unit of the data object(s) ValASG.	AtMostOne / na
Controls				
VldReq	SPC	T	Validate transition request according to the state diagram.	M / na
EnaReq	SPC	T	Enable transition request according to the state diagram.	M / na
EdtReq	SPC	T	Edit transition request according to the state diagram.	M / na
DsaReq	SPC	T	Disable transition request according the state diagram.	M / na
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / na
Settings				
SchdPrio	ING		The priority relation of this schedule (0..n) with higher numbers superseding lower numbers. Shall be a positive value. If missing the default is zero.	O / na
NumEntr	ING		The number of schedule entries that are valid out of the instantiated ValASG, ValING, ValSPG or ValENG.	M / na
SchdIntv	ING		The schedule interval duration in time entities as specified in the unit.	M / na
ValASG	ASG		The ASG scheduled values (current value output as MV).	MmultiF(ValMV) / na

FSCH				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ValING	ING		The ING scheduled values (current value output as INS).	MmultiF(ValINS) / na
ValSPG	SPG		The SPG scheduled values (current value as SPS).	MmultiF(ValSPS) / na
ValENG	BasePrimitiveCDC (ENG)		The ENG scheduled values (current value as ENS).	MmultiF(ValENS) / na
StrTm	TSG		The periodicity interval duration in entities as specified in ClcIntvTyp; if the value is 0, the schedule shall not be repeated periodically.	M / na
IntvPer	ING		The periodicity interval duration in entities as specified in IntvTyp; if the value is 0, the schedule shall not be repeated periodically.	M / na
IntvTyp	ENG (ScheduleIntervalKind)		Interval type (units) to define the periodicity.	M / na
EvTrg	SPG		If set to TRUE, the change of the schedule to the running and activated state is triggered by an external event and not by the start time. The external event is referenced through the data object InSyn.	O / na
InSyn	ORG		Reference to the external trigger if the schedule is triggered by an event.	MF(EvTrg) / na
SchdReuse	SPG		If set to TRUE, once terminated or disabled, the schedule will change to the validated state. If set to FALSE, the schedule will change to the not ready state.	M / na
InRef	ORG		inherited from: DomainLN	Omulti / na

C.2.7 Schedule states (ScheduleStateKind enumeration)

This enumeration lists possible states of a schedule.

Table C.15 shows all enumeration items of ScheduleStateKind.

Table C.15 – Literals of ScheduleStateKind

ScheduleStateKind		
enumeration item	**value**	**description**
Not ready	1	
Validated	2	
Ready	3	
Running	4	

C.2.8 Scheduling interval types (ScheduleIntervalKind enumeration)

This enumeration lists interval types for scheduling

Table C.16 shows all enumeration items of ScheduleIntervalKind.

Table C.16 – Literals of ScheduleIntervalKind

ScheduleIntervalKind		
enumeration item	**value**	**description**
Millisecond	1	
Minute	2	
Hour	3	
Day	4	
Week	5	
Month	6	
Year	7	

C.3 Example of an AC charging station model

C.3.1 General

This clause provides an example of how an AC charging station could be modelled. The model is not complete with respect to the modelling rules in IEC 61850, in that it for the sake of simplicity only includes the logical nodes described in C.2.

In the example shown in Figure C.1, the charging station contains two EVSE, each having one outlet for AC charging.

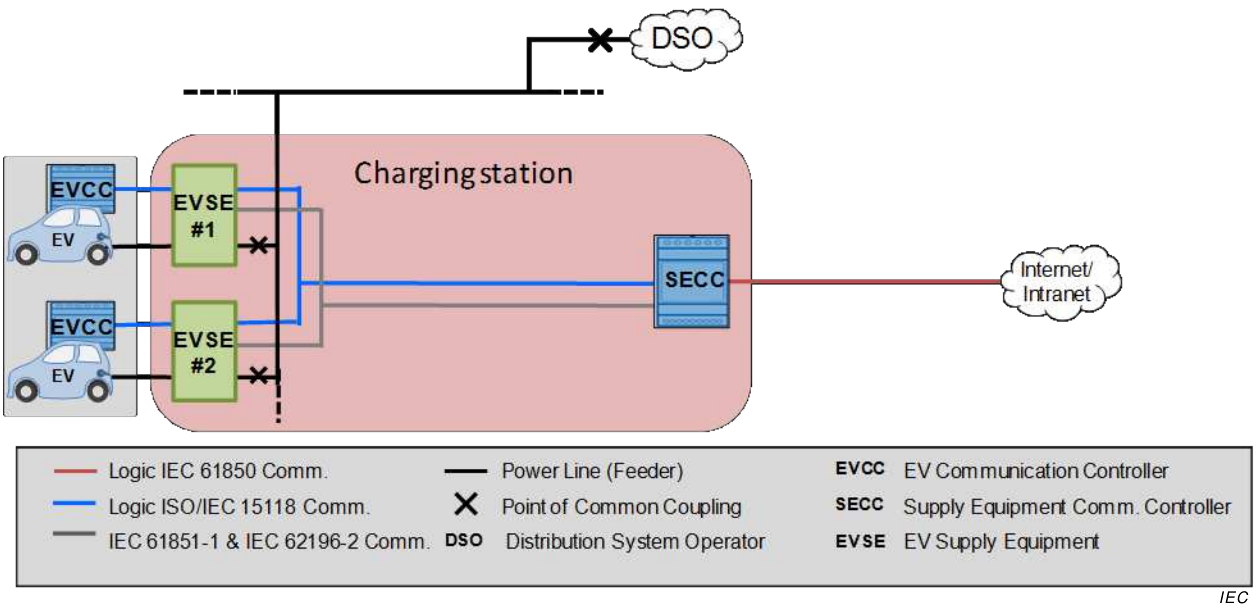


Figure C.1 – Example of an AC charging station

The SECC contains the IEC 61850 model, which includes the logical nodes as shown in Table C.17.

Table C.17 – Example logical node instances

Logical node instance	Description
DESE1	Models EVSE #1
DEAO1	Models the outlet of EVSE #1
DEEV1	Models the EV connected to the outlet of EVSE #1
DESE2	Models EVSE #2
DEAO2	Models the outlet of EVSE #2
DEEV2	Models the EV connected to the outlet of EVSE #2
FSCH1	Models the schedule information for the Local Limit Profile. The SECC has to divide the content of the power schedule between outlets, so that the sum of power over time for the outlets does not exceed the maximum power over time as indicated by the power schedule.
FSCH2	Models the schedule information for the Local Reservation Profile. The power schedule reflects the sum of maximum power over time to be drawn from each outlet.

Following are exploded views of the logical nodes mentioned in Table C.17 in order to provide information on selected data objects and their data attributes used in the example model.

C.3.2 Exploded view of DESE1 and DESE2

Table C.18 shows an exploded view of DESE1 and DESE2.

Table C.18 – Exploded view of DESE1 and DESE2

Logical node instanses: DESE1, DESE2		
Data object / Attribute name	**Common data class / Attribute type**	**Description**
EVSENam	DPL	EVSE nameplate information
vendor	VisString255	Name of the EVSE manufacturer
serNum	VisString255	EVSE ID
model	VisString255	Type of EVSE
primeOper	VisString255	E-Mobility Infrastructure Operator ID
ChaPwrRtg	ASG	Rated maximum charging power of the EVSE
setMag	AnalogueValue	Set to value reflecting the maximum power this EVSE can deliver by design. The value is read-only.
ConnTypPhs1	SPG	Whether AC one phase charging is supported.
setVal	BOOLEAN	Set to TRUE because one phase charging is supported by design. The value is read-only.

C.3.3 Exploded view of DEAO1 and DEAO2

Table C.19 shows an exploded view of DEAO1 and DEAO2.

Table C.19 – Exploded view of DEAO1 and DEAO2

Logical node instances: DEAO1, DEAO2		
Data object / Attribute name	**Common data class / Attribute type**	**Description**
PlgStAC	ENS	Plug present and coupler lock state according to IEC 61851-1.
stVal	ENUMERATED	Reflects if a plug is inserted in the outlet socket and whether it is locked.
q	Quality	Always set to good.
t	TimeStamp	Set to the point in time when the state was read.
ConnSt	ENS	Connection state according to IEC 61851-1.
stVal	ENUMERATED	Reflects if an EV is connected to the outlet and if so, if it is ready to accept energy.
q	Quality	Should always be set to good
t	Timestamp	Set to the point in time when the state was detected.
CabRtgAC	ENS	Capability of the EV cable assembly according to IEC 61851-1.
stVal	ENUMERATED	Reflects the maximum current of the EV charge cable plugged into the outlet socket.
q	Quality	If plug is present, quality should be set to good, and otherwise to invalid.
t	TimeStamp	Set to the point in time of the capability being read from the plug.
ChaARtg	ING	The rated maximum AC charging current of the outlet
setVal	ING32	Set to the maximum current supported by design. The value is read-only.
DigComm	SPG	Enable digital communication with the EV
setVal	BOOLEAN	Set to TRUE to enable high level communication.
ChaAMax	ING	Available AC current (6-80A) to signal to the EV when not using digital communication.
setVal	ING32	Value shall respect the maximum value as specified by ChaARtg.

C.3.4 Exploded view of DEEV1 and DEEV2

Table C.20 shows an exploded view of DEEV1 and DEEV2.

Table C.20 – Exploded view of DEEV1 and DEEV2

Logical node instance: DEEV1, DEEV2		
Data object / Attribute name	**Common data class / Attribute type**	**Description**
EVNam	DPL	EV device nameplate information
vendor	VisString255	Name of the vehicle manufacturer. If unknown, it should be set to the string “unknown”.
serNum	VisString255	VIN or other EV serial number. If unknown, it should be set to the string “unknown”.
model	VisString255	Type and model of EV. If unknown, it should be set to the string “unknown”.
primeOper	VisString255	E-Mobility Service Provider ID. If unknown, it should be set to the string “unknown”.
ConnTypSel	ENS	Selected connection type according to IEC 61851-1
stVal	ENUMERATED	Reflects the type of connection the EV has selected to use for charging.
q	Quality	If selected type is not known, quality should be set to invalid and otherwise good.
t	TimeStamp	Set to the point in time when the selected type was provided by the EV.
DptTm	TSG	Departure time is used to indicate when the vehicle intends to finish the charging process. A value of zero (0) indicates that the charging process shall be finished as fast as possible.
setTm	TimeStamp	Set to value as received from the EV. The value is read-only.
EnAmnt	ASG	Amount of energy required by the EV until the departure time has been reached or the EV battery's SOC is at 100%. This might include the amount of energy the EV consumes for other vehicle features than solely charging the EV Battery.
setMag	AnalogueValue	Set to value as received from the EV. The value is read-only.
VMax	ASG	Maximum voltage supported by the EV. This is the voltage measured between one phase and neutral.
setMag	AnalogueValue	Set to value as received from the EV. The value is read-only.
AMax	ASG	Maximum current supported by the EV per phase.
setMag	AnalogueValue	Set to value as received from the EV. The value is read-only.
AMin	ASG	Minimum current supported by the EV per phase.
setMag	AnalogueValue	Set to value as received from the EV. The value is read-only.

C.3.5 Exploded view of FSCH1 and FSCH2

Table C.21 shows an exploded view of FSCH1 and FSCH2.

Table C.21 – Exploded view of FSCH1 and FSCH2

Logical node instance: FSCH1		
Data object / Attribute name	**Common data class / Attribute type**	**Description**
NumEntr	ING	The number of schedule entries that are valid out of the instantiated ValASG
setVal	INT32	Set to number of values in the schedule
units	Unit	Set to reflect 'none' (SIUnit 1:dimensionless, multiplier 0:1)
SchdIntv	ING	The schedule interval duration in time entities as specified in the unit
setVal	INT32	Set to 5 (i.e. schedule contains 12 values per hour)
units	Unit	Set to reflect 'minute' (SIUnit 85:minute, multiplier 0:1)
ValASG[1..n]	ASG	The scheduled analogue values; one instance per interval
setMag	AnalogueValueCtl	Set to value for the interval
units	Unit	Set to reflect 'kW' (SIUnit 38:W, multiplier 3:k)
StrTm	TSG	Start time of the schedule in UTC time
setTm	Timestamp	
IntvPer	ING	The periodicity interval duration in entities as specified in ClcIntvTyp
setVal	INT32	Set to 0 (i.e. the schedule shall not be repeated periodically)
units	Unit	Set to reflect 'none' (SIUnit 1:dimensionless, multiplier 0:1)
ClcIntvTyp	ENG	Interval type (units) to define the periodicity
setVal	ENUMERATED	Set to EXTERNAL (i.e. the schedule shall not be repeated periodically)
SchdReuse	SPG	Whether to reuse the schedule.
setVal	BOOLEAN	Set to FALSE (i.e. do not reuse)

C.4 Example of a DC charging station model (system A)

C.4.1 General

This subclause provides an example of how a DC charging station could be modelled. The model is not complete with respect to the modelling rules in IEC 61850, in that it for the sake of simplicity only includes the logical nodes described in Subclause 3.2.

In the example shown in Figure C.2, the charging station contains two EVSE, each having one outlet for DC charging.

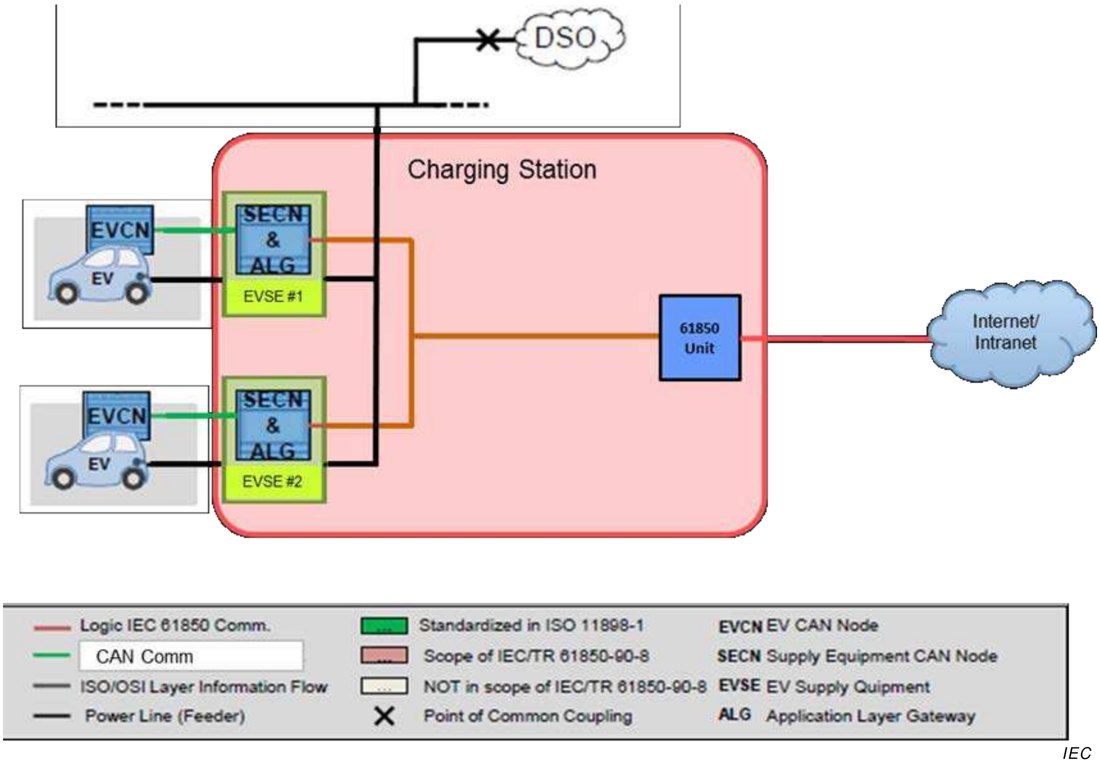


Figure C.2 – Example of a DC charging station

The 61850 Unit contains the 61850 model, which includes the logical nodes as shown in Table C.22.

Table C.22 – Example logical node instances

Logical node instance	Description
DESE1	Models EVSE #1
DEDO1	Models the outlet of EVSE #1
DEEV1	Models the EV connected to the outlet of EVSE #1
DESE2	Models EVSE #2
DEDO2	Models the outlet of EVSE #2
DEEV2	Models the EV connected to the outlet of EVSE #2

The following sub clauses shows exploded views of the logical nodes mentioned in Table C.22 in order to provide information on selected data objects and their data attributes used in the example model.

C.4.2 Exploded view of DESE1 and DESE2

Table C.23 shows an exploded view of DESE1 and DESE2.

Table C.23 – Exploded view of DESE1 and DESE2

Logical node instanses: DESE1, DESE2		
Data object / Attribute name	**Common data class / Attribute type**	**Description**
EVSENam	DPL	EVSE nameplate information
vendor	VisString255	Name of the EVSE manufacturer
hwRev	VisString255	Hardware version of EVSE
swRev	VisString255	Software version of EVSE
serNum	VisString255	EVSE ID
model	VisString255	Type of EVSE
primeOper	VisString255	E-Mobility Infrastructure Operator ID
secondOper	VisString255	E-Mobility Infrastructure Operator ID
IsoTestFlt	SPS	Isolation test fault (i.e. the isolation test executed before charging has failed)
stVal	BOOLEAN	TRUE | FALSE
q	Quality	Always set to good.
t	TimeStamp	Timestamp of the last change
ScTestFlt	SPS	Short circuit test fault (i.e. short circuit test before charging has failed)
stVal	BOOLEAN	TRUE | FALSE
q	Quality	Always set to good.
t	TimeStamp	Timestamp of the last change
DigCommLos	SPS	Detection of loss of digital communication
stVal	BOOLEAN	TRUE | FALSE
q	Quality	Always set to good.
t	TimeStamp	Timestamp of the last change
WldDet	SPS	Detection of a welding condition
stVal	BOOLEAN	TRUE | FALSE
q	Quality	Always set to good.
t	TimeStamp	Timestamp of the last change
ChaV	MV	Charging voltage
mag	AnalogueValue	Set to value reflecting the charging voltage that EVSE can measure. The value is read-only.
q	Quality	Always set to good.
t	TimeStamp	Timestamp of the last change
units	Unit	Set to reflect ‘V’
ChaA	MV	Charging current
mag	AnalogueValue	Set to value reflecting the charging current that EVSE can measure. The value is read-only.
q	Quality	Always set to good.
t	TimeStamp	Timestamp of the last change.
units	Unit	Set to reflect ‘A’
ChaPwrRtg	ASG	Rated maximum charging power of the EVSE
setMag	AnalogueValue	Reflect the maximum power this EVSE can deliver by design. The value is read-only from Grid.

units	Unit	Set to reflect 'W'
ChaPwrTgt	ASG	Reflect the power value that the EVSE requires to grid. Set to "Target battery voltage"(∗) x "Charging current request"(∗) ∗Defined in IEC 61851-24
setMag	AnalogueValue	Set to value reflecting the power that the EVSE requires to grid. The value is read-only from Grid.
units	Unit	Set to reflect 'W'
ChaPwrLim	ASG	The power value that the grid limits to the charger
setMag	AnalogueValue	Reflect the power that the grid limits to the charger. The value is read-only from EVSE.
units	Unit	Set to reflect 'W'
ConnTypDC	SPG	Whether DC charging is supported.
setVal	BOOLEAN	Set to TRUE because this is a DC charging station. The value is read-only from EVSE.
ConnDCRef	ORG	Reference to the logical node(s) representing DC charging connections
setSrcRef	ObjectReference	Refer to 'DEDO1' or 'DEDO2'.

C.4.3 Exploded view of DEDO1 and DEDO2

Table C.24 shows an exploded view of DEDO1 and DEDO2.

Table C.24 – Exploded view of DEDO1 and DEDO2

Logical node instances: DEDO1, DEDO2		
Data object / Attribute name	**Common data class / Attribute type**	**Description**
ConnStA	ENS	Connection state for system A connection type (notation from IEC 61851-23/24 system A)
stVal	ENUMERATED	Set to value reflecting the charging status from connected to disconnected. In detail, see the clause 5.4.10.
q	Quality	Always set to good.
t	TimeStamp	Timestamp of the last change
CabRtgDC	ENS	Capability of the EV cable assembly (according to 61851-1)
stVal	ENUMERATED	Set to value reflecting the capability of the EV cable assembly that EVSE can deliver by design. In detail, see the clause 5.4.5.
q	Quality	Always set to good.
t	Timestamp	Timestamp of the last change
PlgStDC	ENS	Plug present and coupler lock state (according to 61851-1)
stVal	ENUMERATED	Reflects if a plug is inserted in the outlet socket and whether it is locked. In detail, see the clause 5.4.2.
q	Quality	Always set to good.
t	TimeStamp	Timestamp of the last change
EVRef	ORG	Reference to the logical node instance containing information on a connected EV
setSrcRef	ObjectReference	Refer to Logical node instance 'DEEV1' or 'DEEV2'.

C.4.4 Exploded view of DEEV1 and DEEV2

Table C.25 shows an exploded view of DEEV1 and DEEV2.

Table C.25 – Exploded view of DEEV1 and DEEV2

Logical node instance: DEEV1, DEEV2		
Data object / Attribute name	Common data class / Attribute type	Description
ConnTypSel	ENS	Selected AC/DC connection type according to IEC 61851 series
stVal	ENUMERATED	Reflects the connection type of EV Inlet. In detail, see the clause 3.3.7.
q	Quality	Always set to good.
t	TimeStamp	Timestamp of the last change
Soc	MV	State of charge
mag	AnalogueValue	Reflects the available capacity of EV battery. Set to "Charging rate(*)" x "Rated capacity of battery capacity"(*). *Defined in IEC 61851-24.
q	Quality	Always set to good.
t	TimeStamp	Timestamp of the last change
units	Unit	Set to reflect 'Wh'
DptTm	TSG	Departure time is used to indicate when the vehicle intends to finish the charging process. A value of zero (0) indicates that the charging process shall be finished as fast as possible.
setTm	TimeStamp	Set to "Estimated charging time"(*) *Defined in IEC 61851-24
EnAmnt	ASG	Amount of energy required by the EV until the departure time has been reached or the EV battery's SOC is at 100%. This might include the amount of energy the EV consumes for other vehicle features than solely charging the EV battery.
setMag	AnalogueValue	Reflect the remaining energy. Set to (100 – "Charging rate") x "Rated capacity of battery capacity"
units	Unit	Set to reflect 'Wh'
VMax	ASG	Maximum voltage supported by the EV. This is the voltage measured between one phase and neutral.
setMag	AnalogueValue	Reflect the maximum voltage that EVSE can output to EV. Set to "Available output voltage" (*). *Defined in IEC 61851-24
units	Unit	Set to reflect 'V'
AMax	ASG	Maximum current supported by the EV.
setMag	AnalogueValue	Reflect the maximum current that EVSE can output to EV. Set to "Available output current" (*). *Defined in IEC 61851-24
units	Unit	Set to reflect 'A'
AMin	ASG	Minimum current supported by the EV.
setMag	AnalogueValue	Reflect the minimum current that EV requires to EVSE. If not available, set to "5A".
units	Unit	Set to reflect 'A'
SchdRef	ORG	Reference to the schedule logical node instance containing information on the charging profile of the EV.
setSrcRef	ObjectReference	Set to NULL. System A does not use the scheduling function.
d	VisString255	Text

Annex D
(informative)

Information exchange between EV, EVSE and CIO for charge scheduling

Figure D.1 details information exchange related to an EV charge schedule.

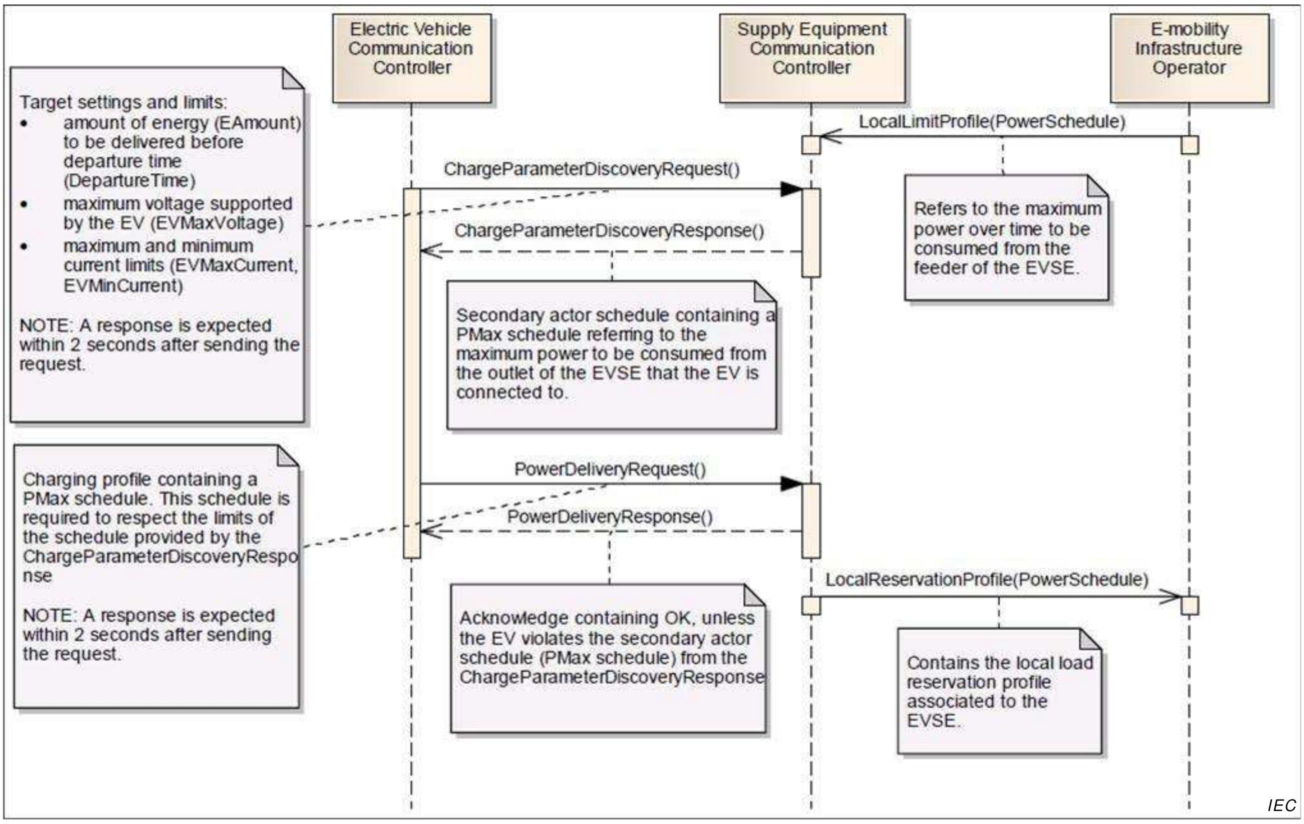


Figure D.1 – EV, EVSE and CIO information exchange

Annex E
(informative)

Architectural concepts (implementation guide)

E.1 Overview

This annex provides a detailed graphical overview on the information exchanged between all involved entities. Furthermore, it provides a non-exhaustive overview on the architectural concept behind mapping EV charging digital communication interface to IEC 61850-7-420.

E.2 Architectural concept for mapping ISO 15118 to IEC 61850

This clause provides an overview on how charging infrastructure architectures according to ISO 15118-1 may be mapped to an IEC 61850 compliant meta model. This overview is non-exhaustive and only provides a guideline for potential scenarios.

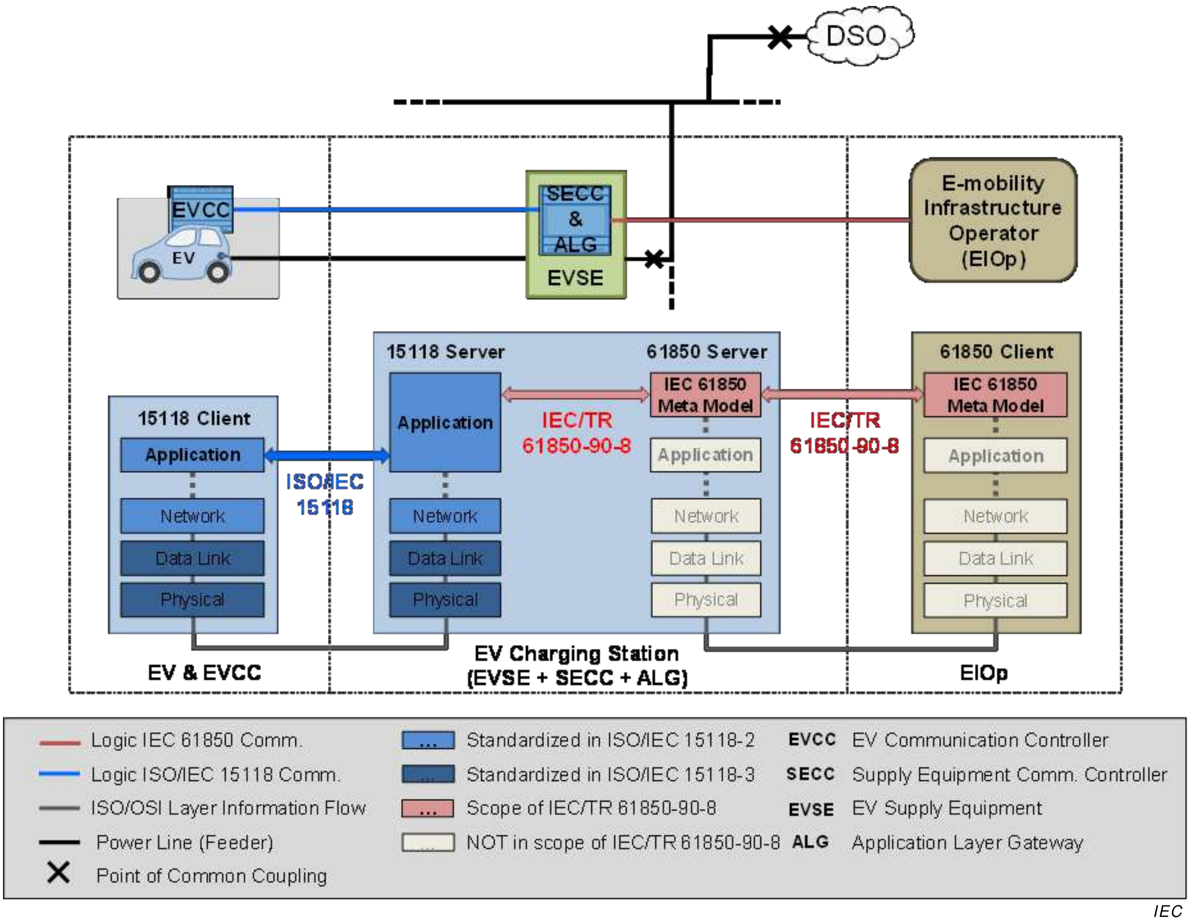


Figure E.1 – Basic concept of mapping ISO 15118 V2G Communication Interface to IEC 61850 DERs with dedicated SECC in the EVSE managing one EV

In Figure E.1 the basic architecture concept of the mapping between ISO 15118 and an IEC 61850 meta model is illustrated. According to the ISO 15118-2 V2G communication interface paradigm, the EV Communication Controller (EVCC) is always the client whereas the Supply Equipment Communication Controller (SECC) is always the server. Information provided from the EV is made available through the V2G communication interface at the ISO 15118 server side. All relevant information (see Annex B) is mapped to an IEC 61850 meta model according to Subclause 5.4 and provided to the client-side (E-Mobility Infrastructure Operator).

NOTE 1 The communication binding is out of scope of this TR. Also refer to [IEEE SGC2010-1], [IEEE SGC2010-2], [IEEE SGC2011].

NOTE 2 Figure E.2 only illustrates the mapping between ISO 15118 and IEC 61850 meta model. All other aspects (e. g. IEC 61851-1) are not illustrated. Refer to Annex A for a complete overview of the underlying mappings.

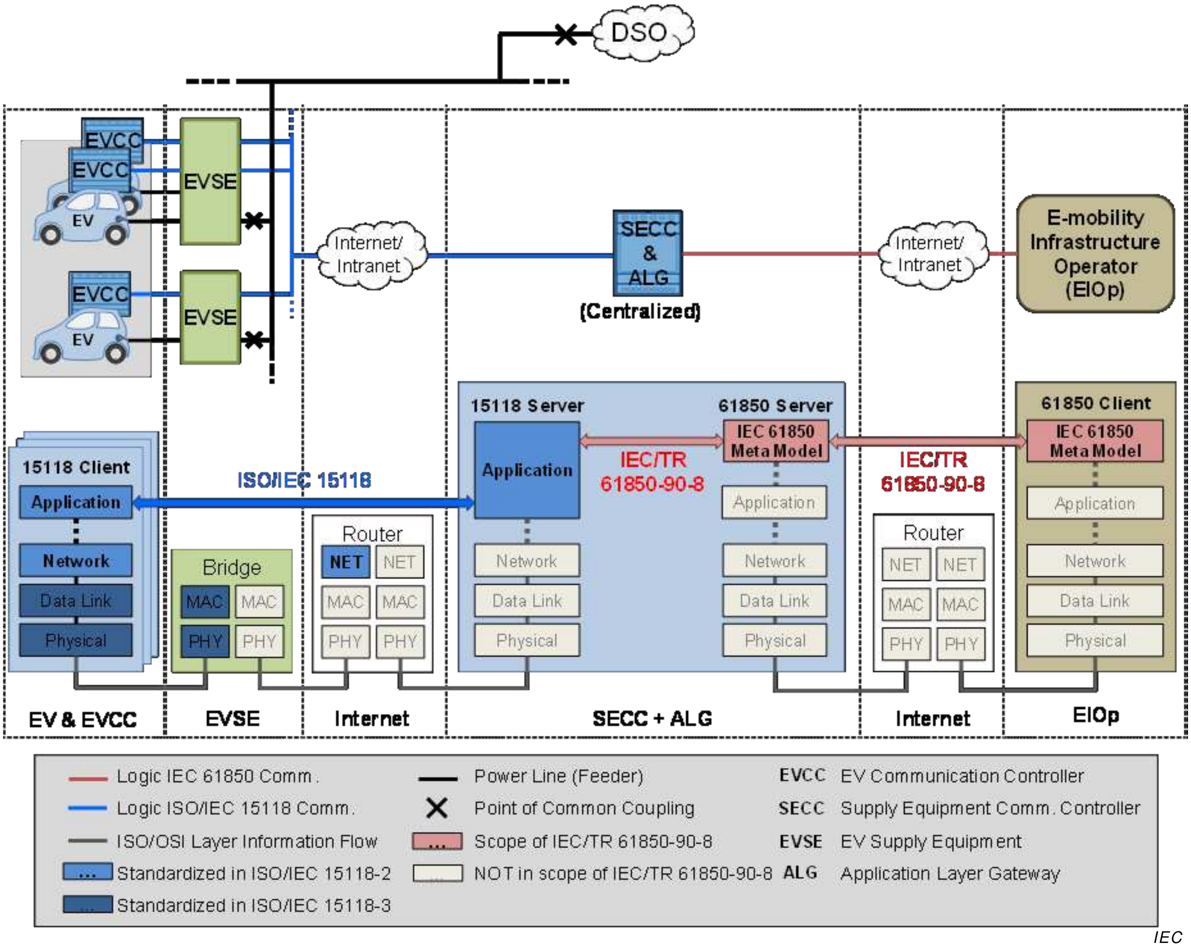


Figure E.2 – Basic concept of mapping ISO 15118 V2G Communication Interface to IEC 61850 DERs with centralized SECC outside of EVSE managing a set of EVs

According to ISO 15118-1 various types of architectures for EVSE and SECC deployment scenarios are possible. Figure E.2 illustrates how a centralized SECC with optional bridges and routers in the communication path between the EVCC and SECC may be deployed in order to manage a set of EVSEs. In this case each EVSE handles safety related functions (e.g. IEC 61851-1) but the SECC handles all high level communication for a whole set of EVs being connected to respective EVSEs. The EVCC does not observe any difference compared to the deployment shown in Figure E.1. The basic concept of the mapping between ISO 15118 and IEC 61850 client/server architectures remains the same. According to the V2G communication interface paradigm, the EVCC still is the client and the SECC the server. Information provided from each EV is made available through the V2G communication interface at the ISO 15118 server side in the centralized SECC. All relevant information is mapped to an IEC 61850 meta model according to Subclause 5.4 and provided to the client-side (E-Mobility Infrastructure Operator).

NOTE 3 Any combination of the previous architectures (Figure E.1 and Figure E.2) may be implemented.

NOTE 4 The use of a Multi-Use DER (MUDER) interface offered by the E-Mobility Infrastructure Operator for the purpose of aggregation/pooling a set of DER units in the context of E-Mobility is still under discussion.

E.3 Architectural concept for mapping IEC 61851-23/24 system A to IEC 61850

This clause provides an overview on how charging infrastructure architectures according to the IEC 61851-23/24 system A may be mapped to an IEC 61850 compliant meta model. This overview is non-exhaustive and only provides a guideline for potential scenarios.

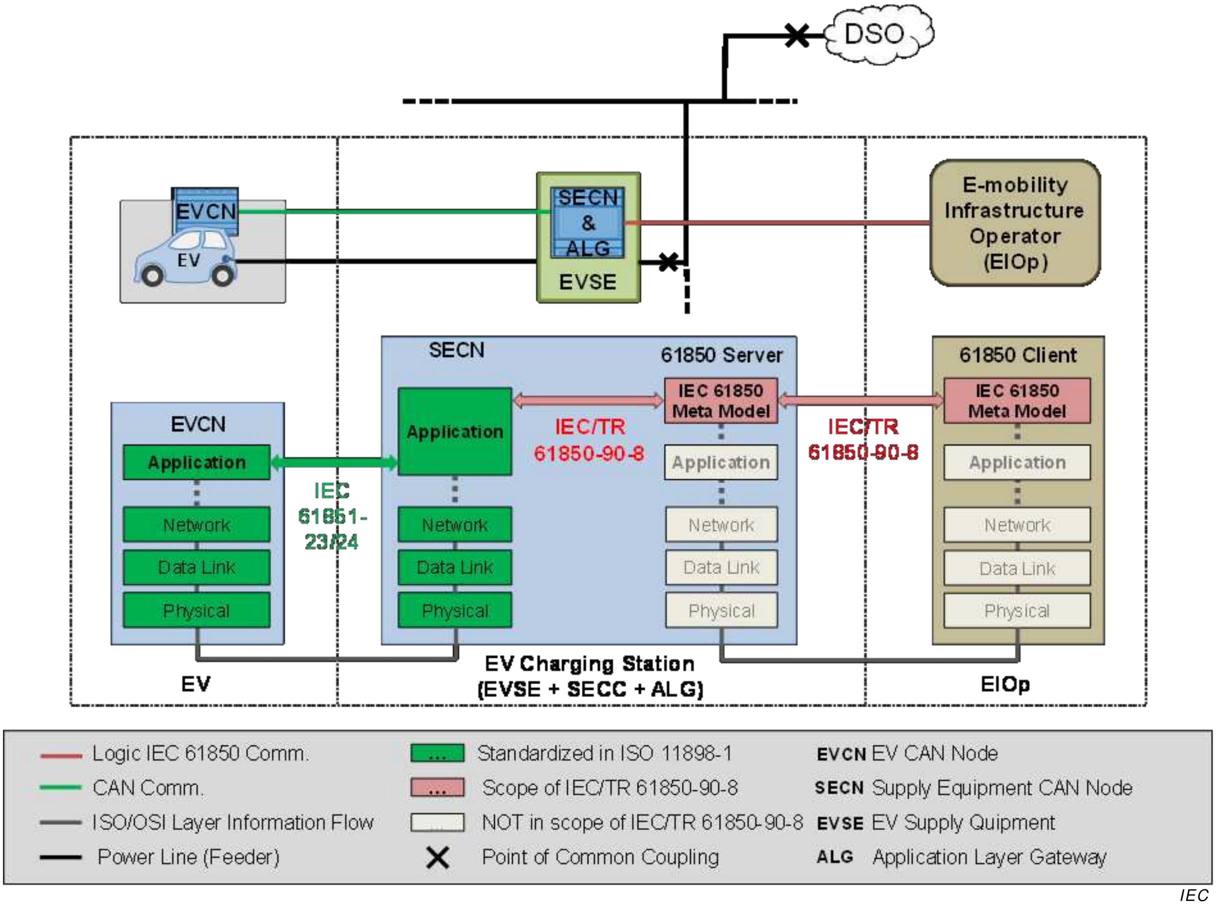


Figure E.3 – Basic concept of mapping IEC 61851-23/24 system A communication interface to IEC 61850 DERs

In Figure E.3 the basic architecture concept of the mapping between IEC 61851-23/24 system A and an IEC 61850 meta model is illustrated. Information provided from the EV is made available through the CAN interface in the EV Charging Station. All relevant information is mapped to an IEC 61850 meta model according to Subclause 5.4 and provided to the client-side (E-Mobility Infrastructure Operator).

Annex F
(informative)

Relevant standards for E-Mobility object model

F.1 Overview

An overview of relevant standards in the E-Mobility landscape is depicted in Figure F.1.

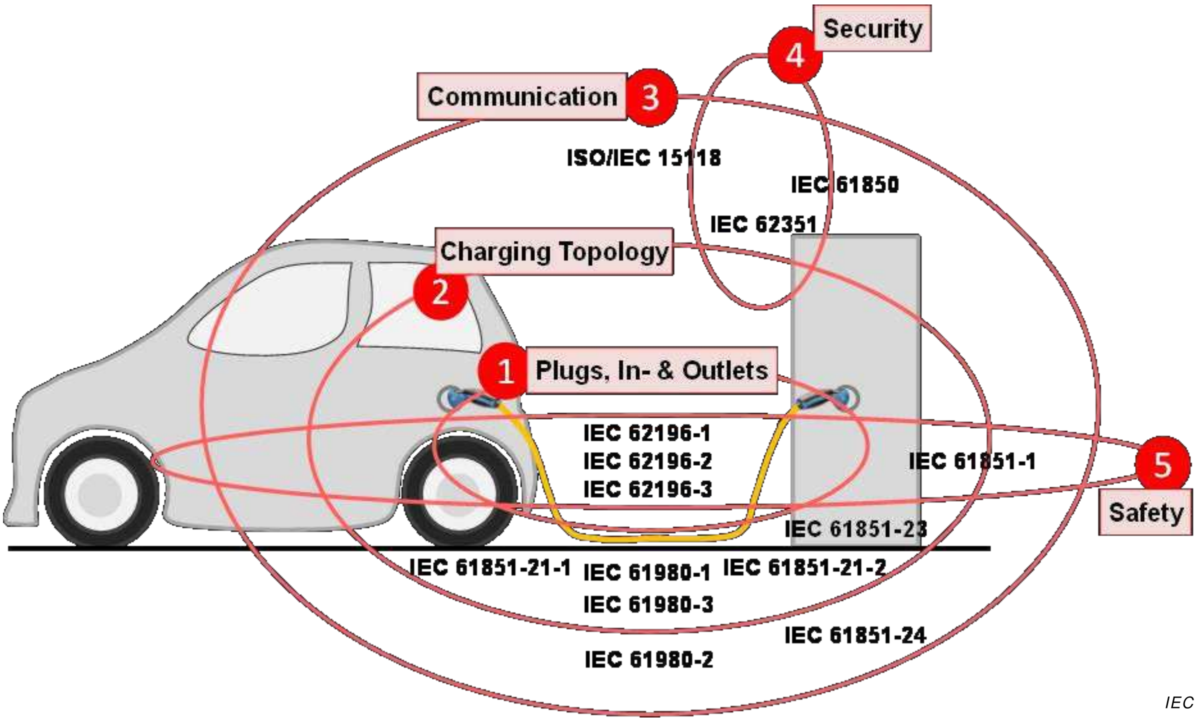


Figure F.1 – Overview of relevant E-Mobility ISO standards for the V2G interface, based on [EVS27 2013]

F.2 Basic structure of IEC 62196 – Plugs, socket-outlets, vehicle couplers and vehicle inlets – Conductive charging of electric vehicles

- IEC 62196-1, *Plugs, socket-outlets, vehicle couplers and vehicle inlets – Conductive charging of electric vehicles – Part 1: Charging of electric vehicles up to 250 A a.c. and 400 A d.c.*:

  This part of the standard defines general requirements for dedicated plugs, socket outlets, vehicle connectors and vehicle inlets for interfacing dedicated charging equipment with an EV. The last version was released end of 2011 and represents the second edition of this standard but work on the third edition has already started.

- IEC 62196-2, *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 62196-2]:

  This part of the standard defines the dimensional compatibility and interchangeability requirements for AC plugs (in- & outlets). The standards defines three different types of connectors, type 1 for one phase charging supporting charging rates of up to 7,4 kW. Whereas type 2 connectors support single and three phase charging, the latter with rates of up to 44 kW. In January 2013 the European Commission declared the type 2 connector as a common basis for charging infrastructures and EVs in the European Union.

- IEC 62196-3, *Plugs, socket-outlets, and vehicle couplers – Conductive charging of electric vehicles – Part 3: Dimensional compatibility and interchangeability requirements for dedicated d.c. and combined a.c./d.c. pin and contact-tube vehicle couplers*:

  This part of the standard defines dimensional compatibility and interchangeability requirements for DC plugs (in- & outlets) as well as Combo Plugs (combined AC & DC plugs and in- & outlets). This part is still work in progress and not yet published as an international standard.

F.3 Basic structure of IEC 61851 – Electric vehicle conductive charging system

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

  This part of the standard applies to on-board and off-board equipment for charging electric road vehicles at standard AC supply voltages (as per IEC 60038) up to 1 000 V and at DC voltages up to 1 500 V, and for providing electrical power for any additional services on the vehicle if required when connected to the supply network. It includes characteristics and operating conditions of the supply device and the connection to the vehicle; operators and third party electrical safety, and the characteristics to be complied with by the vehicle with respect to the AC/DC EVSE, only when the EV is earthed. This second edition cancels and replaces the first edition published in 2001. A third edition is currently work in progress and approved for 3. Committee Draft (A3CD) and is forecasted to be published in March 2014.

  Violation of any of the safety requirements in IEC 61851-1 immediately results in the termination of the charge process. Hence the safety means provided by IEC61851-1 must be considered as a continuously and concurrently running process during charging next to the higher level means for authentication/authorization, charging status & control provided by ISO 15118-2, IEC 61851-23, and IEC 61851-24.

- IEC 61851-21-1:–, *Electric vehicle conductive charging system – Part 21-1 Ed. 1.0: Electric vehicle onboard charger EMC requirements for conductive connection to a.c./d.c. supply* [IEC 61851-21-1 Edition 1.0, CCDV]
- IEC 61851-21-2:–, *Electric vehicle conductive charging system – Part 21-2: EMC requirements for OFF board electric vehicle charging systems* [IEC 61850-21-2 Edition 1.0, 3CD]
- IEC 61851-23:2014, *Electric vehicle conductive charging system – Part 23: D.C. Electric vehicle charging station* [IEC 61851-23:2014]
- IEC 61851-24:2014, *Electric vehicle conductive charging system – Part 24: Digital communication between a d.c. EV charging station and an electric vehicle for control of d.c. charging* [IEC 61851-24:2014]:

  This part of IEC 61851, together with Part 23, applies to digital communication between a DC EV charging station and an electric road vehicle (EV) for control of DC charging, with AC supply input voltages up to 1 000 V and DC output voltages up to 1 500 V for the conductive charging procedure. The EV charging mode is mode 4, according to IEC 61851-1. Charging station supplied by high voltage AC supply is not covered by this standard. Annexes A, B, and C give descriptions of digital communications for control of DC charging specific to DC charging systems A, B and C as defined in Part 23.

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

  The proposed DIN SPEC (PAS) defines Numbering Schemes of Identifiers for E-Roaming to enable a customer specific charging of electric vehicles at charging stations by contract identification.

F.4 Basic structure of ISO 15118 – Vehicle to grid communication interface

The ISO 15118 standards series specifies the communication between EVs and EV power supply equipment. It specifies the entire protocol stack from the Application Layer to the

Physical Layer according to the OSI-model of ISO/IEC 7498-1 and is also referred to as High Level Communication as opposed to Low Level Communication based on IEC 61851-1. The standard covers information exchange between all actors involved in the electrical energy supply process to the EV. Besides setup and negotiation of the charging process itself, ISO 15118 will also enable value added services comprising comfort functions for the EV user, e.g. information of the current battery status, changes in the time of departure and/or cruising range [ETG2010_Gaul].

ISO 15118, *Road vehicles – Vehicle to grid communication interface* comprises the following parts being assigned to OSI-layers according to figure F.2:

- *Part 1: General information and use-case definition* [ISO 15118-1:2013]

  This part specifies basic definitions and use cases. Beside of the communication participants the general course of events of a charging session is described. Different use cases are described varying from immediate charging to delayed charging (via schedules) as well as diverse billing scenarios.

- *Part 2: Technical protocol description and Open Systems Interconnections (OSI) layer requirements* [ISO 15118-2:2014]

  This part specifies the messages to be exchanged between the communication partners (Application Layer), the associated data and data types (Presentation Layer) via TCP/IP-based transport and Network Layer to the Ethernet based Data Link.

- *Part 3: Wired physical and data link layer requirements* [ISO 15118-3:FDIS]

  This part specifies the Physical Layer for which a PLC technology is used that does not require additional lines. Besides, time response diagrams are described showing the details concerned with installation and de-installation of connections in co-action with IEC 61851-1.

- *Part 4: Network and application protocol conformance test.*

  This part of the standard was approved as new project in 2012-06.

- *Part 5: Physical and data link conformance test.*

  This part of the standard was approved as new project in 2012-06.

- *Part 6: General information and use-case definition for wireless communication.*

  This part of the standard was approved as new project in 2013-01.

- *Part 7: Network and application protocol requirements for wireless communication.*

  This part of the standard was approved as new project in 2013-01

- *Part 8: Physical and data link layer requirements for wireless communication.*

  This part of the standard was approved as new item in 2013-01.

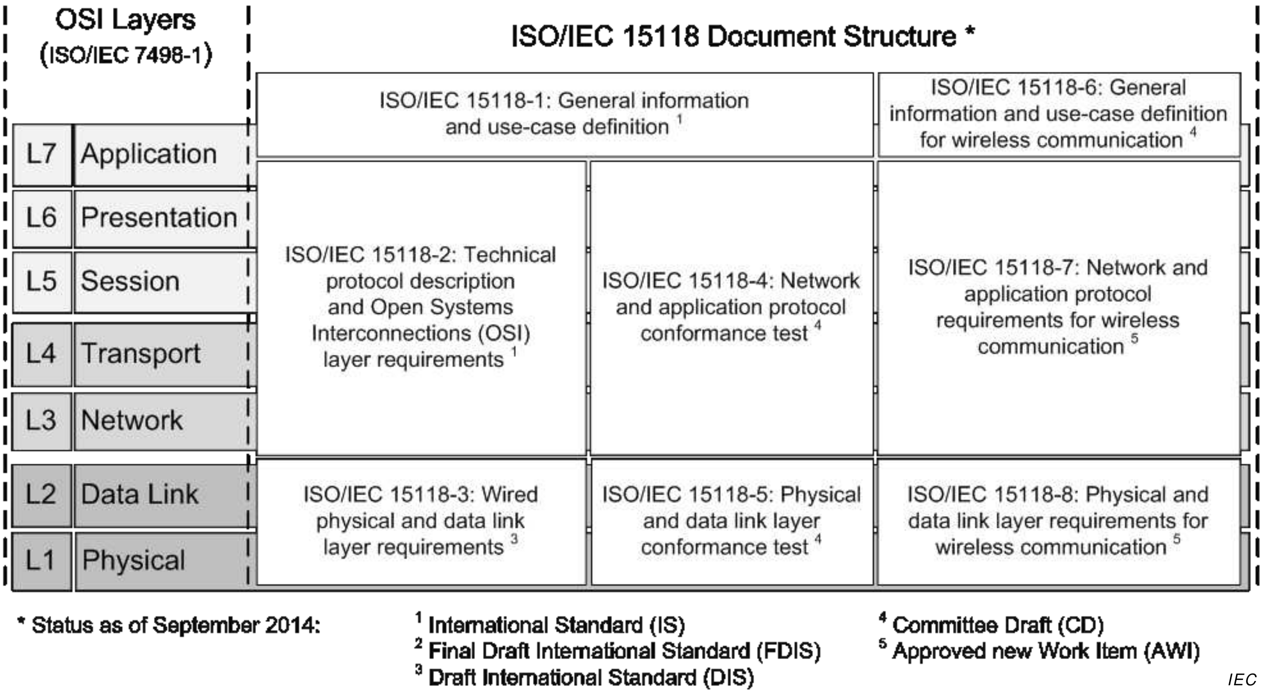


Figure F.2 – ISO 15118 document structure according to ISO/IEC 7498-1 OSI-layers, based on [IEEE VPPC2012]

F.5 Basic structure of IEC 61980 – Electric vehicle wireless power transfer systems

- IEC 61980-1:2015-07, *Electric vehicle wireless power transfer systems (WPT) – Part 1: General requirements*.
- PD IEC TS 61980-2:–, *Electric vehicle wireless power transfer (WPT) systems – Part 2: Specific requirements for communication between electric road vehicle (EV) and infrastructure with respect to wireless power transfer (WPT) systems*.[5]
- IEC TS 61980-3:–, *Electric vehicle wireless power transfer (WPT) systems – Part 3: Specific requirements for the magnetic field power transfer systems*.[5]

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5 To be published.

Annex G
(informative)

Typical use of data objects in the charger domains

This annex provides information about typical use of IEC TR 61850-90-8 specific data objects with the different types of AC and DC charging systems.

Table G.1 maps use of data objects to charging systems.

Table G.1 – Use of data objects in charging systems

Logical Node / Data Object	AC Charging		DC Charging	
	Basic Charging	Smart Charging	System A	System C
DESE				
EVSENam	+	+	+	+
IsoTestFlt	+	+	+	+
ScTestFlt	+	+	+	+
DigCommLos	+	+	+	+
WldDet	+	+	+	+
ChaV	+	+	+	+
ChaA	+	+	+	+
EVSEId	-	+	-	+
ChaPwrRtg	+	+	+	+
ChaPwrTgt	+	+	+	+
ChaPwrLim	+	+	+	+
ConnTypDC	-	-	+	+
ConnTypPhs	+	+	-	-
ConnACRef	+	+	-	-
ConnDCRef	-	-	+	+
DEAO				
ConnSt	+	+	-	-
PlgStAC	+	+	-	-
CabRtgAC	+	+	-	-
ChaARtg	+	+	-	-
DigComm	+	+	-	-
ChaAMax	+	+	-	-
EVRef	+	+	-	-
DEDO				
ConnStA	-	-	+	-
ConnStC	-	-	-	+
CabRtgDC	-	-	+	+
PlgStDC	-	-	+	+
EVRef	-	-	+	+
DEEV				
EVNam		+		
ConnTypSel	+	+	+	+
Soc	+	+	+	+
EVId	-	+	-	+
EMAId	-	+	-	+
DptTm	+	+	+	+
EnAmnt	+	+	+	+
VMax	+	+	+	+
VMin	+	+	+	+

Logical Node / Data Object	AC Charging		DC Charging	
	Basic Charging	Smart Charging	System A	System C
AMax	+	+	+	+
AMin	+	+	+	+
SchdRef	+	+	+	+
ZCAB				
ARtg	+	+	+	+
OvlMaxPct	+	+	+	+
OvlMaxTm	+	+	+	+

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IEEE VPPC2011, Schmutzler et al: "A Mutual Charge Schedule Information Model for the Vehicle-to-Grid Communication Interface", 7th IEEE Vehicle Power and Propulsion Conference 2011, Chicago, Illinois, USA

IEEE VPPC2012, Schmutzler et al: "Distributed Energy Resource Management of EV Fleets using IEC 61850 and ISO/IEC 15118", 8th IEEE Vehicle Power and Propulsion Conference 2012, Seoul, South Korea

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