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Electric vehicles conductive charging system

Part 3-4: DC EV supply equipment where protection relies on double or reinforced insulation — General definitions and requirements for CANopen communication

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Electric vehicles conductive charging system – Part 3-4: DC EV supply equipment where protection relies on double or reinforced insulation – General definitions and requirements for CANopen communication

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ELECTRIC VEHICLES CONDUCTIVE CHARGING SYSTEM –

Part 3-4: DC EV supply equipment where protection relies on double or reinforced insulation – General definitions and requirements for CANopen communication

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The text of this Technical Specification is based on the following documents:

Draft	Report on voting
69/650/DTS	69/671/RVDTS 69/671A/RVDTS

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

The language used for the development of this Technical Specification is English.

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INTRODUCTION

This document is published in separate parts according to the following structure:

IEC TS 61851-3-1, *Electric vehicles conductive charging system – Part 3-1: DC EV supply equipment where protection relies on double or reinforced insulation – General rules and requirements for stationary equipment*

IEC TS 61851-3-2, *Electric vehicles conductive charging system – Part 3-2: r DC EV supply equipment where protection relies on double or reinforced insulation – Portable and mobile DRI EV supply equipment*

IEC TS 61851-3-4, *Electric vehicles conductive charging system – Part 3-4:DC EV supply equipment where protection relies on double or reinforced insulation – General definitions and requirements for CANopen communication*

IEC TS 61851-3-5, *Electric vehicles conductive charging system – Part 3-5:DC EV supply equipment where protection relies on double or reinforced insulation – Pre-defined communication parameters and general application objects*

IEC TS 61851-3-6, *Electric vehicles conductive charging system – Part 3-6:DC EV supply equipment where protection relies on double or reinforced insulation – Voltage converter unit communication*

IEC TS 61851-3-7, *Electric vehicles conductive charging system – Part 3-7:DC EV supply equipment where protection relies on double or reinforced insulation – Battery system communication*

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ELECTRIC VEHICLES CONDUCTIVE CHARGING SYSTEM –

Part 3-4: DC EV supply equipment where protection relies on double or reinforced insulation – General definitions and requirements for CANopen communication

1 Scope

This part of IEC 61851, which is a Technical Specification, applies to CANopen communication for the conductive transfer of electric power between the supply network and an electric road vehicle or a removable rechargeable energy storage system (RESS) or on-board rechargeable energy storage systems (RESS) of an electric road vehicle.

The energy management system (EMS) for control of power transfer between battery systems and voltage converter units (VCU) provides the communication for all devices that can take part in energy management control.

The basic application profile for energy management systems (EMS) consists of IEC TS 61851-3-4, IEC TS 61851-3-5, IEC TS 61851-3-6, IEC TS 61851-3-7.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60309 (all parts), *Plugs, socket-outlets and couplers for industrial purposes*

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60884 (all parts), *Plugs and socket-outlets for household and similar purposes*

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC TS 61851-3-1:2023, *Electric vehicles conductive charging system – Part 3-1 DC EV supply equipment where protection relies on double or reinforced insulation – AC and DC conductive power supply systems*

IEC TS 61851-3-5:2023, *Electric vehicles conductive charging system – Part 3-5: DC EV supply equipment where protection relies on double or reinforced insulation – Pre-defined communication parameters and general application objects*

IEC TS 61851-3-6:2023, *Electric vehicles conductive charging system – Part 3-6: DC EV supply equipment where protection relies on double or reinforced insulation – Voltage converter unit communication*

IEC TS 61851-3-7:2023, *Electric vehicles conductive charging system – Part 3-7: DC EV supply equipment where protection relies on double or reinforced insulation – Battery system communication*

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IEC TS 62196-4: *Plugs, socket-outlets, vehicle connectors and vehicles inlet – Conductive charging of electric vehicles – Part 4: Dimensional compatibility and interchangeability requirements for DC pin and contact-tube accessories for class II or class III applications*[1]

ISO/IEC 646:1991, *Information technology – ISO 7-bit coded character set for information interchange*

ISO/IEC 14443 (all parts), *Identification cards — Contactless integrated circuit(s) cards — Proximity cards*

ISO/IEC 18092:2013, *Information technology – Telecommunications and information exchange between systems – Near Field Communication – Interface and Protocol (NFCIP-1)*

ISO 11898-2:2016, *Road vehicles – Controller area network (CAN) – Part 2: High speed medium access unit*

ISO 11898-5:2007, *Road vehicles – Controller area network (CAN) – Part 5: High speed medium access unit with low-power mode*

ISO 11898-6:2013, *Road vehicles – Controller area network (CAN) – Part 6: High speed medium access unit with selective wake-up functionality*

CiA 302-1:2009, *CANopen additional application layer functions – Part 1: General definitions (available at www.can-cia.org)*

CiA 302-2:2009, CANopen *additional application layer functions – Part 2: Network management* (available at www.can-cia.org)

CiA 302-3:2010, *CANopen additional application layer functions – Part 3: Configuration and program download (available at www.can-cia.org)*

CiA 305:2013, *CANopen layer setting services (LSS) and protocols* (available at www.can-cia.org)

EN 50325-4:2002, *Industrial communications subsystem based on ISO 11898 (CAN) for controller- device interfaces – Part 4: CANopen*

EN 50604-1:2016, *Secondary lithium batteries for light EV (electric vehicle) applications – Part 1: General safety requirements and test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61851-3-1, EN 50325-4:2002, ISO 11898-2:2016, ISO 11898-5:2007, ISO 11898-6:2013 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

[1] Under preparation. Stage at the time of publication: DTS.

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3.1
active device
device connected to DC power circuit, AUX supply circuit and CAN circuit

3.2
voltage converter
set of equipment, to convert one type of electric current to another type different in nature, voltage and/or frequency

[SOURCE: IEC 60050-811:2017, 811-19-01, modified – The word "voltage" has been added to the term, and the words "static or rotating" deleted from the definition.]

3.3
voltage converter unit
VCU
voltage converter with local EMS and communication interface

[SOURCE: IEC TS 61851-3-1:2023, 3.1.8]

3.4
rechargeable energy storage system
RESS
system that stores energy for delivery of electric energy and which is rechargeable

EXAMPLE Battery systems, capacitors.

Note 1 to entry: A battery system can be named in general within the context of IEC 61851-3 (all parts) as an RESS.

[SOURCE: ISO/IEC 17409:2015, 3.36, modified – In the example, the word "batteries" has been replaced by "battery systems", and the note to entry has been added.]

3.5
battery system
energy storage device that includes cells or cell assemblies or battery pack(s) as well as electrical circuits and electronics

Note 1 to entry: For further explanation, see ISO 12405-1:2011, 5.5.2, 5.5.3, A.3.1 and A.3.2. Battery system components can also be distributed in different devices (battery packs) within the vehicle.

Note 2 to entry: Examples of electronics are the BCU and contactors.

Note 3 to entry: For all applications according to IEC 61851-3 (all parts), the battery control unit (BCU) is replaced by a battery management system (BMS).

[SOURCE: ISO 12405-1:2011, 3.3, modified – The parentheses "(battery packs)" have been added to Note 1 to entry, and Note 3 to entry has been added.]

3.6
battery pack
energy storage device that includes cells or cell assemblies normally connected with cell electronics, voltage class A or B circuit and overcurrent shut-off device, including electrical interconnections, interfaces for external systems

Note 1 to entry: For further explanation, see 5.4 and Clause A.2 of ISO 12405-1:2011.

Note 2 to entry: Examples of external systems are cooling, voltage class B, auxiliary voltage class A and communication.

[SOURCE: ISO 12405-1:2011, 3.2, modified – The words "A or" have been added to the definition.]

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3.7
battery management system
BMS
local energy management system for the battery system, protecting the battery system from damage, monitoring and increasing the lifetime, and maintaining the functional state

Note 1 to entry: BMS and BCU (according to the ISO 12405 series) do not have the same functions.

3.8
energy management system
EMS
system consisting of active and passive devices for controlling the power transfer

Note 1 to entry: Active and passive devices are connected to the AUX supply circuit and the CAN circuit. Additionally, active devices are also connected to the DC power circuit.

3.9
energy management system controller
EMSC
device or virtual device that manages the communication as well as the energy exchange

3.10
local energy management system
local EMS
active device's internal system that protects the energy buffer, source or load from damage, monitors and increases the lifetime of the buffer, source or load, maintains the buffer, and source or load in a functional state

3.11
remote energy management system
remote EMS
further independent EMS coupled to EMS via a VCU

3.12
energy management system input
EMS input
current flow which occurs from source into the energy management system power lines

3.13
energy management system output
EMS output
current flow which occurs from energy management system power lines into load

3.14
human machine interface
HMI
passive device that allows user interaction, interface between operating staff or end-user and the instrumentation and computer systems connected to the EMS

EXAMPLE Display or user communication system.

3.15
node-ID check
monitoring unique node-ID usage in EV by EMSC

3.16
passive device
device connected to AUX supply circuit and CAN circuit

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3.17
safe state
device state in which the device is protected against influences of overcurrent or overvoltage

3.18
silent master
CANopen device that hosts NMT master capability, but acts as NMT slave in the network and issues neither NMT master services, LSS master services, SYNC messages nor any other NMT/LSS master-related service

Note 1 to entry: Examples of NMT/LSS master-related service are Configuration manager and EMSC.

3.19
state of charge
SOC
available capacity in a battery pack or system

Note 1 to entry: The state of charge is expressed as a percentage, Ah or Wh of rated capacity.

3.20
state of health
SOH
actual performance of the battery pack or system compared to the performance of a fresh battery pack or system

3.21
finite-state automaton
FSA
model of computation consisting of a set of states, a start state, an input alphabet, and a transition function that maps input symbols and current states to a next state

Note 1 to entry: Computation begins in the start state with an input string; it changes to new states depending on the transition function.

Note 2 to entry: Finite-state automaton (FSA) (plural: automata) or finite-state machine (FSM) or simply a state machine.

3.22
local layer settings
LLS
settings of a CANopen device's CANopen node-ID and CANopen bit timing

3.23
flying master
ability of an NMT master capable CANopen device to become dynamically the active NMT master in case the absence of a higher-prior NMT master is detected

3.24
logical device
logical entity of a CANopen device providing to the CANopen device status, control and diagnostic information in a pre-defined format

3.25
virtual device
entity of software capable of accomplishing a functional element of a field/physical device

4 Symbols and abbreviated terms

For the purposes of this document, the following symbols and abbreviated terms, and those given in ISO 11898-2:2016, ISO 11898-5:2007 and ISO 11898-6:2013 apply.

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AC	alternating current
BMS	battery management system
C. param.	communication parameter
Const	constant
DC	direct current
EEC	emergency error code
EMCY	emergency
EMS	energy management system
EMSC	energy management system controller
EV-EMSC	EV-Energy management system controller
EV	electric vehicle
FSA	finite-state automaton
GAO	general application objects
HMI	human machine interface
LSS	layer setting services
M_param.	mapping parameter
MCU	motor control unit
MSN	message number
MPPT	maximum power point tracker
NMT	network management
PDO	process data object
RPDO	receive PDOs
ro	read only
rw	read write
SDO	service data object
SOC	state of charge
SOH	state of health
TPDO	transmit PDOs
VCU	voltage converter unit
VD	virtual device
VDN	virtual device number
WLAN	wireless local area network

5 General conditions for the tests

It is recommended that implementers of devices obtain proof that a suitable conformance test has been performed.

The conformance test shall include:

– testing of all implemented CANopen communication services;
– testing of all implemented parameters specified in this document and IEC TS 61851-3-5, IEC TS 61851-3-6 and IEC TS 61851-3-7;
– testing of all implemented state automata specified in this document and IEC TS 61851-3-5, IEC TS 61851-3-6 and IEC TS 61851-3-7.

NOTE For testing:

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– CiA 310-1 covers the general conformance test plan for CANopen communication;

– CiA 312-7 covers the specific conformance test plan for CANopen communication according to IEC 61851-3 (all parts).

6 Physical layer specification

6.1 General

The general physical layer definitions for CANopen-related communication are provided in EN 50325-4:2002 and apply to CANopen devices compliant to this application profile.

6.2 Medium access unit

Any type of ISO 11898-2:2016 compliant transceiver may be used. With regard to energy saving, the medium access units with low power mode, compliant to ISO 11898-5:2007 or ISO 11898-6:2013 are recommended.

6.3 Transmission rates

Devices compliant to this profile shall support a bit rate of 250 kbit/s; other bit rates may be supported. The LSS shall be used, in case it is required to switch during runtime dynamically from the current bit rate to another bit rate. For initial adjustment of the bit rate during start-up, an automatic bit rate detection mechanism is recommended. Transmission rates of NFC are described in Annex F.

6.4 Node-ID assignment

The CANopen device hosting the virtual device EMSC in EV applications shall have the node-ID 1. The node-IDs for the other CANopen devices are assigned by LSS. The LSS master shall reside in the same device where EMSC resides. Scanning for non-configured devices shall be done via the LSS-fastscan services as defined in CiA 305. The LSS slaves shall be connected to the EMS application with the invalid node-ID FF_h and shall lose their node-ID settings as soon as they are disconnected from the bus.

The DRI EV supply equipment shall claim a fixed node-ID in the range 120 to 127 as specified in Table 1. Within an EV application, the node-IDs 120 to 127 shall be reserved (not used).

NOTE 1 Preferred location of the EV-EMSC can be in the same CANopen device as the MCU.

The diagnostic tool shall not support LSS slave functionality as well and shall claim the fixed node-ID 125.

A CANopen device in bootloader mode shall claim the fixed node-ID 126. Therefore, in an EV application, only one CANopen device is allowed to stay in bootloader mode. See also 10.4.

NOTE 2 The limitation of assigning a CANopen device in bootloader mode a fixed node-ID 126 was introduced to allow implementing bootloader applications for EVs, without the need of supporting LSS.

The DRI EV supply equipment shall not support LSS slave functionality and shall claim the node-ID 127. The fixed node-ID of the DRI EV supply equipment shall remain, if the device acts as master in case the EMSC of the EV is not available.

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Table 1 – DRI EV supply equipment and external device node-ID assignment

Node-ID	External device
120	Reserved
121	Reserved
122	Reserved
123	Reserved
124	Load monitoring device for charging/locking cable
125	Diagnostic tool
126	Bootloader
127	External power supply implementing VCU with integrated (EMSC)

6.5 Network topology

The network topology shall be as specified in EN 50325-4:2002. See also Figure 9 and Figure A.1.

NOTE Recommended bit-timing and estimated bus lengths can be specified according to EN 50325-4:2002.

6.6 Gateway

The use of a gateway is recommended to separate the CANopen EMS communication from external influences. For further information, see 8.4.3 and Annex A.

7 Error handling

7.1 General

Clause 7 specifies the handling of errors. Emergency messages shall be supported and triggered by internal errors in the device (see EN 50325-4:2002 for a description of emergency message handling).

7.2 Enhancement of the emergency message handling

In addition to the specifications provided in EN 50325-4:2002, the range for manufacturer-specific error information shall be shortened by 1 byte. This byte shall be used for indicating that a specific virtual device is the source of the device internal error.

In addition, a general addressing mask for the device profile specific emergency error code (EEC) is specified. The first digit of the 4 digit hexadecimal address indicates with "F" the application profile specific error. For a multiple logical device, the second digit indicates that logical device, in which the error occurred. The last two digits provide the profile specific error information.

The protocol EMCY write is specified in Figure 1. Table 2 provides the value definition.

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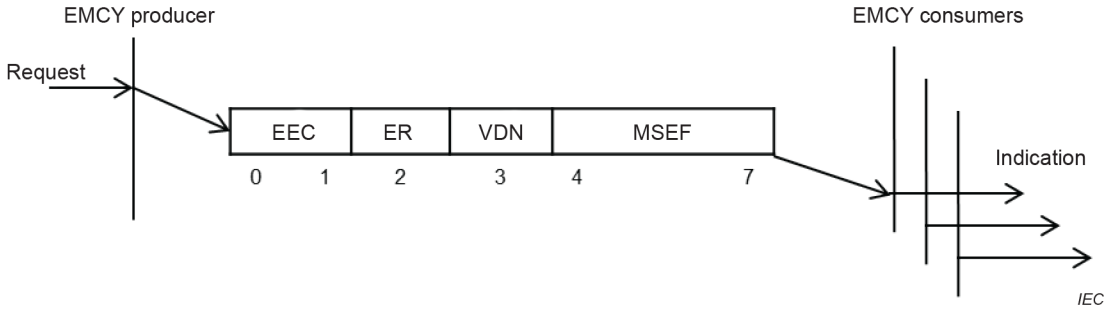

Figure 1 – Protocol emergency write for energy management applications

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Table 2 – Value definition for EMCY message

Bit field	Value [hex]	Description
EEC (emergency error code)	0000 to EFFF	See EN 50325-4:2002
	F000	Generic device error (see EN 50325-4:2002)
	F001 to F0FF	The error refers to the entire CANopen device.
	F100 to F1FF	The error refers to the logical device 1; a detailed error description is provided in the related part this application profile.
	F100	Logical device 1; generic error
	F200 to F2FF	The error refers to the logical device 2; a detailed error description is provided in the related part of this application profile.
	F200	Logical device 2; generic error
	F300 to F3FF	The error refers to the logical device 3; a detailed error description is provided in the related part of this application profile.
	F300	Logical device 3; generic error
	F400 to F4FF	The error refers to the logical device 4; a detailed error description is provided in the related part of this application profile.
	F400	Logical device 4; generic error
	F500 to F5FF	The error refers to the logical device 5; a detailed error description is provided in the related part of this application profile.
	F500	Logical device 5; generic error
	F600 to F6FF	The error refers to the logical device 6; a detailed error description is provided in the related part of this application profile.
	F600	Logical device 6; generic error
	F700 to F7FF	The error refers to the logical device 7; a detailed error description is provided in the related part of this application profile.
	F700	Logical device 7; generic error
	F800 to F8FF	The error refers to the logical device 8; a detailed error description is provided in the related part of this application profile.
	F800	Logical device 8; generic error
	F900 to FEFF	Reserved
	FF00 to FFFF	See EN 50325-4:2002
ER (error register)	See EN 50325-4:2002	
VDN (virtual device number)	00	Multiple virtual devices, which are listed in object 6000_h are responsible for the occurred error and/or distinguishing between the different error sources is not possible
	01 to FE	Value refers to that sub-index of object 6000_h which provides the description of that virtual device, which is source of the error
	FF	Reserved, shall not be used.
MSEF (manufacturer specific error field)	Manufacturer specific error information	

7.3 Pre-defined error field

The pre-defined error field (object 1003_h) is specified in EN 50325-4:2002 and shall be supported by all CANopen devices used in EMSs.

7.4 Error behaviour

If a severe device failure is detected in NMT operational state, the CANopen device shall enter by default the NMT pre-operational state (see EN 50325-4:2002 CANopen NMT state machine).

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If object 1029_h is implemented, the CANopen device may be alternatively configured in case of a device failure to enter the stopped state or remain in the current state.

Device failures shall include the following communication errors:

– bus-off conditions on the CAN interface;
– heartbeat event with state "occurred".

Severe device errors may also be caused by device internal failures.

7.5 Additional error codes

In addition to the error codes defined in EN 50325-4:2002, the additional error codes given in Table 3 shall be used if appropriate.

Table 3 – Additional error codes

EEC [hex]	Description
0n80	Warning; important device parameter was changed
0n81	Warning; at least one prefix of process data was changed
0n82	Warning; prefix of process data given in Ampere was changed
0n83	Warning; prefix of process data given in Volt was changed
0n84	Warning; prefix of process data given in Watt was changed
Fn01	Invalid control word (6001_h); generic error/unknown command
Fn02	Invalid control word (6001_h); target FSA state not supported
Fn03	Invalid FSA status
Fn04	Reserved
Fn10	Virtual device over-voltage at local EMS or "side B"
Fn11	Virtual device under-voltage at local EMS or "side B"
Fn12	Virtual device EMS input or " side B" over-current
Fn13	Virtual device EMS output or "side B" over-current
Fn14	Virtual device control components temperature limit (high) exceeded
Fn15	Virtual device temperature limit (low) exceeded control components
Fn16	Virtual device temperature limit (high) exceeded power components
Fn17	Virtual device temperature limit (low) exceeded power components
Fn18	Virtual device communication error
Fn19	Virtual device compatibility error
Fn1A	Virtual device non-authorized access
Fn1B	Virtual device over-voltage at remote EMS including "side A"
Fn1C	Virtual device under-voltage at remote EMS including "side A"
Fn1D	Virtual device over-current at remote EMS input including "side A"
Fn1E	Virtual device over-current at remote EMS output including "side A"
The character "n" shall indicate a number in the range of [0;8], depending on the logical device that was source of the error (see Table 2). NOTE The terms "side A", "side B" allow to distinguish between both sides of a voltage converter, for example in a setup where two power lines are controlled via one CANopen network.	

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8 Operating principles

8.1 General

Clause 8 provides a description of the operating principles, device modelling and an application FSA.

8.2 Functional description

8.2.1 General

The energy management system (EMS) consists of devices, for example:

– energy management system controller (EMSC);
– voltage converter unit (VCU);
– battery system.

It also consists of optional devices, for example:

– security unit;
– manufacturer device.

Battery systems are charged or discharged by a VCU, while located inside or outside of the EMS. The switching from one battery system to another is handled by the EMSC. See also 8.3.3.5 and Annex E.

Each device connected to the EMS shall be able to limit its voltage, current and power consumption to avoid overload of the system and to adjust the power consumption to the power available in the system. The voltage, current and power limits of every device connected to the EMS shall be known and controlled by the EMSC.

NOTE Active devices, for example solar panels, hydrogen fuel cells, or battery systems, deliver power to the public infrastructure via DC to AC VCU.

8.2.2 Voltages, currents, loads

8.2.2.1 General

The voltage ranges are specified in 7.2 of IEC TS 61851-3-1:2023 and the voltage ranges definitions for EMS are provided in 6.2.2 of IEC TS 61851-3-5:2023.

8.2.2.2 Current counting direction

This subclause specifies the current counting direction for applying the Kirchhoff's circuit laws. In this profile, the source counting current direction shall apply. Any current flow from a device to the EMS is counted positive. Any current flow from the EMS to a device is counted negative.

NOTE According to the counting direction specification, the current flow to a consumer for example motor is counted in a negative way. The current flow from a producer for example solar cells to the EMS is counted in a positive way.

8.2.2.3 General specifications for energy management systems (EMS) in EVs

The recommended system voltage for active devices shall be in the range as defined in 7.2.1 of IEC TS 61851-3-1:2023. The nominal voltage at AUX supply circuit shall be according to 7.2.3 of IEC TS 61851-3-1:2023.

Protection for maximum system current shall be checked and managed by the EMSC. Each device shall be self-protected against over- and under voltage as well as against over-current in both directions. See also Clause 13 of IEC TS 61851-3-1:2023.

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The maximum sum of all directly connected capacities shall not exceed 1 000 µF. The active devices shall be protected against high currents (peak-currents) resulting from switch-on the big capacitive loads. See also 12.1.6 of IEC TS 61851-3-1:2023.

8.2.3 Activating of the energy management system (EMS)

8.2.3.1 General

The EMS is activated and switched off by the EMSC only. For activating the EMS, the EMSC shall handle the following tasks:

– initiate power up the AUX supply circuit;
– remote wake-up of the network participants;
– compatibility check according to 8.2.3.4;
– limiting and operating.

NOTE In addition the EMSC checks cyclically, whether further un-configured LSS slaves have accessed the EMS.

8.2.3.2 Initiate power up of the AUX circuit

When coupling the EV or the battery system to the DRI EV supply equipment, the DRI EV supply equipment can power on the AUX supply circuit according to 7.2.3 of IEC TS 61851-3-1:2023. Also by using the battery system voltage, the EMS shall be able to communicate with all devices.

In case no battery system is available but other power sources are available (e.g. VCU, solar cells), these power sources may be used to power the AUX supply circuit. These other power sources supply the AUX supply circuit so that all connected devices are enabled to start communication.

8.2.3.3 Remote wakeup of the network participants

The EMSC shall initiate the wake-up service as specified in D.3.4.

8.2.3.4 Compatibility check with regard to identity and electrical parameters

Prior to the activation of power sources in the system a compatibility check between all connected devices shall be done by the EMSC. The EMSC shall check the following CANopen device attributes:

– device type;
– supported functionality;
– device vendor;
– serial number;
– software and hardware version;
– physical limits (e.g. minimum/maximum voltage, maximum current);
– node-ID.

Within the CANopen object dictionary of the device, which hosts the EMSC, the object dictionary index range from $1F80_h$ to $1F88_h$ shall be supported. Beside the CANopen slave assignment list these objects provide a database indicating the data required for device compatibility check. After the compatibility check the EMSC allows activation of power sources, see also Annex B.

Prior to switch on an active device, the EMSC shall compare the maximum voltage of all active devices to the voltages of the active devices with fixed (pre-defined/rated) voltage (e.g. battery systems).

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8.2.3.5 Limiting and operating

Prior to switch on an active device with controllable voltage (e.g. voltage converter unit) the voltage limits of that active device shall be set to the voltage of the already connected active device with the lowest voltage maximum.

Prior to switch on an active device with controllable current (e.g. voltage converter unit) the current limit in both directions shall be set to the maximum current of the device with fixed (pre-defined/rated) voltage (e.g. battery system).

NOTE Example of implementation of compatibility check is given in Annex C.

8.2.4 Connection and disconnection of devices

It shall be possible to add or remove devices (e.g. battery systems, voltage converter) to or from the EMS. The connecting and disconnecting of devices to or from the EMS shall be detected by the EMSC. The EMSC shall switch off the power in the EMS, see also 8.4.4.

After connecting an either active or passive device, the EMSC shall execute a compatibility check as specified in 8.2.3.4. Handling of multiple sources is described in Annex E.

8.2.5 "Sleep"

All devices in the system shall support the "sleep".

NOTE 1 For implementation according to Annex D, "sleep" maintains at least for a certain time (0,1 ms).

The maximum current consumption of all EMS-connected devices shall be chosen in a way that the battery systems are not deeply discharged (see also 7.2.3 of IEC TS 61851-3-1:2023).

NOTE 2 Transition from "sleep" is possible to "controller switched on" according to Annex D.

The "sleep" is considered as an energy saving mode; the vehicle is still capable to power up with the remaining energy buffered in the battery system. All devices consume only the power that is required for holding the microcontrollers (EV-EMSC, EMSC, local EMS) in "sleep" and to wait for further communication on CAN.

8.3 Use case specific definitions for EMSs in EVs

8.3.1 General

This subclause provides examples of several use case specific definitions for EMS.

The DRI EV supply equipment is classified according to the EV supply system configuration of IEC TS 61851-3-1:2023 as follows:

– EV supply system configuration type A;
– EV supply system configuration type B;
– EV supply system configuration type C;
– EV supply system configuration type D;
– EV supply system configuration type E;
– EV supply system configuration type F.

8.3.2 EMS in operation

In case the EMS is in operation, the EMS is controlled via the EMSC. In case there is no active EMSC, the EMS shall transit into the safe state, see also 8.4.4.

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8.3.3 Design and implementation for EV supply system configurations Types "A-F"

8.3.3.1 General

This subclause covers the concept for power transfer between a battery system (in the EV) and a DRI EV supply equipment. But this does not exclude other applications using the DRI EV supply equipment for further energy consumers/generators.

See also Annex A for use cases.

8.3.3.2 EV supply system configuration Type "A"

EV supply system configuration Type "A", a removable or non-removable RESS and the EV is supplied with energy using a portable or mobile DRI EV supply equipment connected to the supply network over a fixed cable on vehicle side (case "A"). See Figure 2.

In EV supply system configuration Type A the VCU, the battery system and the EMSC are placed inside the EV. The use of EMS is optional as long the battery system is not removable. If the battery system is removable, at least the battery system has to comply with the relevant standards for example EN 50604-1:2016 for removable battery systems.

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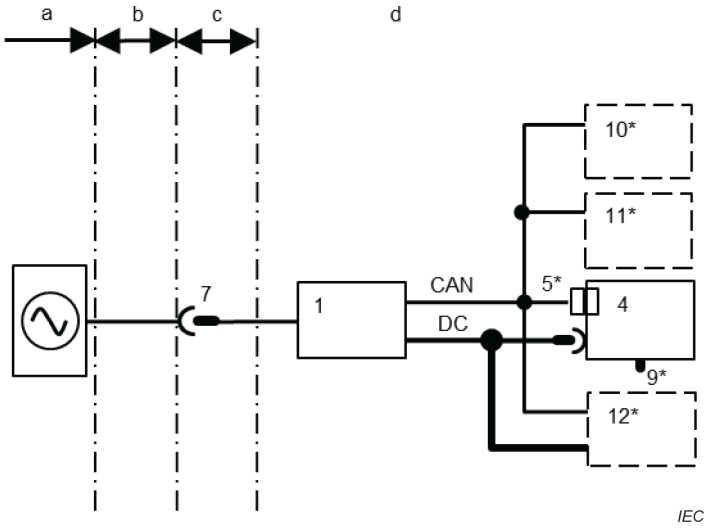

Key	Description	Abbreviation
a	supply network (AC or DC), and fixed installation (according to IEC 60364)	
b	stationary equipment (see 6.7 of IEC TS 61851-3-1:2023)	
c	portable or mobile equipment (see 6.7 of IEC TS 61851-3-1:2023)	
d	EV (located inside of the electric vehicle)	EV
1	portable or mobile DRI EV supply equipment (not permanently fixed to the EV)	
2	pPortable or mobile DRI EV supply equipment	
3	stationary DRI EV supply equipment	
4	removable or non-removable RESS (battery system)	
5	vehicle coupler (DC) (according to IEC TS 62196-4)	
7	standard plug and socket-outlet (AC) (according to IEC 60884 or IEC 60309)	
8	dedicated plug and socket-outlet (DC) (according to IEC TS 62196-4)	
9	A/B coupler (manufacturer specific)	
10	EMS controller in the EV (according IEC TS 61851-3-4)	EV-EMSC
11	human machine interface, passive device, optional (according to CiA 454)	HMI
12	motor control unit, optional (according to CiA 454)	MCU
13	EMS controller in the VCU (according IEC 61851-3 series)	EMSC
14	security unit in the VC optional (according to CiA 454)	
15	security unit in the EV (according to CiA 454)	
16	manufacturer specific battery system	
17	ateway according CiA 454	
18	conversion device	
19	voltage converter	VC
20	load unit	
*	optional	

Key list is valid for Figure 3 to Figure 8.

Figure 2 – EV supply system c~~C~~onfiguration type A

8.3.3.3 EV supply system configuration type B and C

In configuration type B and C, the EV is in operation (not in motion) while connected to DRI EV supply equipment. Plug present (proximity function) according to 7.3.1 of IEC TS 61851-3-1:2023 shall be activated in the EV.

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NOTE For EVs using accessories according to IEC TS 62196-4 over 60 V or over 5 A, under configuration type B and C while connected to the supply network, plug present (proximity function) is provided according to 10.3 of IEC TS 62196-4. For communication purpose, object 6311_h can be used according to IEC TS 61851-3-5:2023.

This use case is considered as a lengthening of the EV energy management system (EMS). The EV-EMSC functionality as well as the NMT master functionality remains in the EV. The EMSC functionality as well as the NMT master functionality in the DRI EV supply equipment shall be disabled.

In order to assure that only a single active EMSC is in the system, the EMSC hosted by the VCU scans for the heartbeat of the EV-EMSC (node-ID 01h). In case VCU detects an active NMT master/EMSC, the EMSC master functionality in the DRI EV supply equipment shall act as a silent master. Neither NMT/LSS master, nor EMSC-related tasks shall be executed. In this case, the EV-EMSC transfers all relevant data between battery systems and the VCU, so that the DRI EV supply equipment is enabled to execute the power transfer process.

In case the DRI EV supply equipment is supplying an EV battery system while the EV is switched off, the DRI EV supply equipment acts as EMSC and NMT master. In case someone is activating the EV respectively the EV-EMSC during the power transfer process, that EV-EMSC will become the active NMT master and will take over the energy management. The DRI EV supply equipment will act as silent master. In this case, the EV-EMSC transfers all relevant data between battery systems and the VCU, so that the DRI EV supply equipment is enabled to execute the power transfer process.

See, for portable device, Figure 3 and for fixed installation, Figure 4.

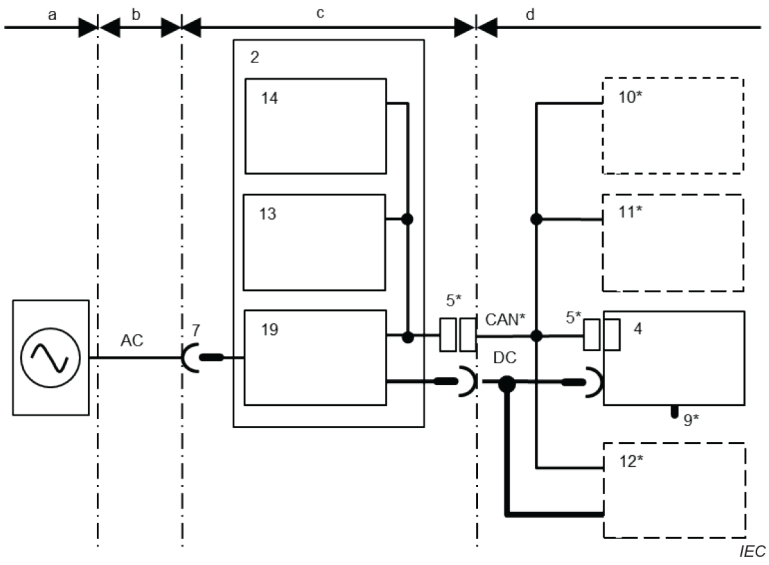

Figure 3 – EV supply system configuration type B

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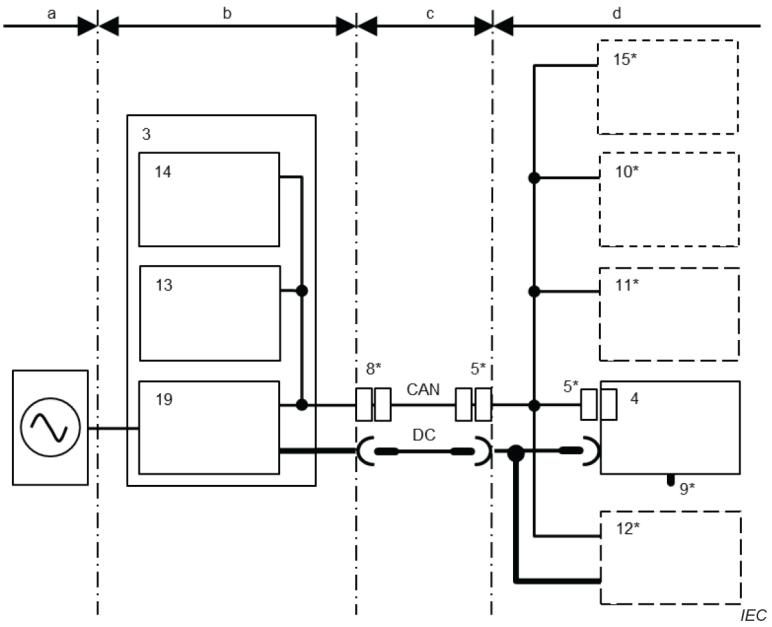

Figure 4 – EV supply system c~~C~~onfiguration type C

8.3.3.4 EV supply system configuration type D and E

In case a battery system is removed from the EV and connected to a DRI EV supply equipment, the active EMSC resides within the DRI EV supply equipment. In such a use case, the typical EMS consists of a connection between one battery system, a voltage converter with AC-to-DC converter functionality and the EMSC. The EMSC resides in the same CANopen device as the AC-to-DC converter functionality. See, for portable device, Figure 5 and for fixed installation, Figure 6.

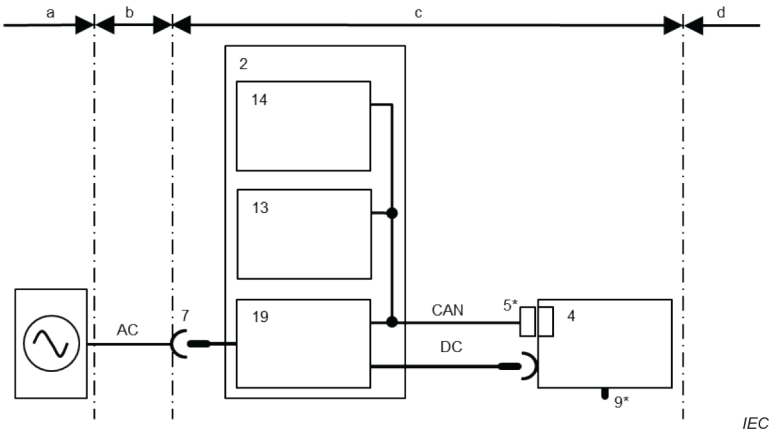

Figure 5 – EV supply system configuration type D

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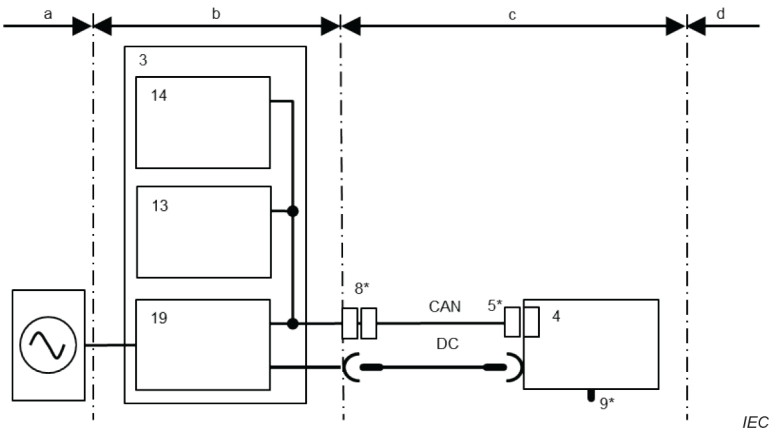

Figure 6 – EV supply sytem configuration type E

8.3.3.5 EV supply system configuration type F

This use case is typical for battery swapping station. One VCU can handle up to 16 instances of battery systems. See also Figure 7.

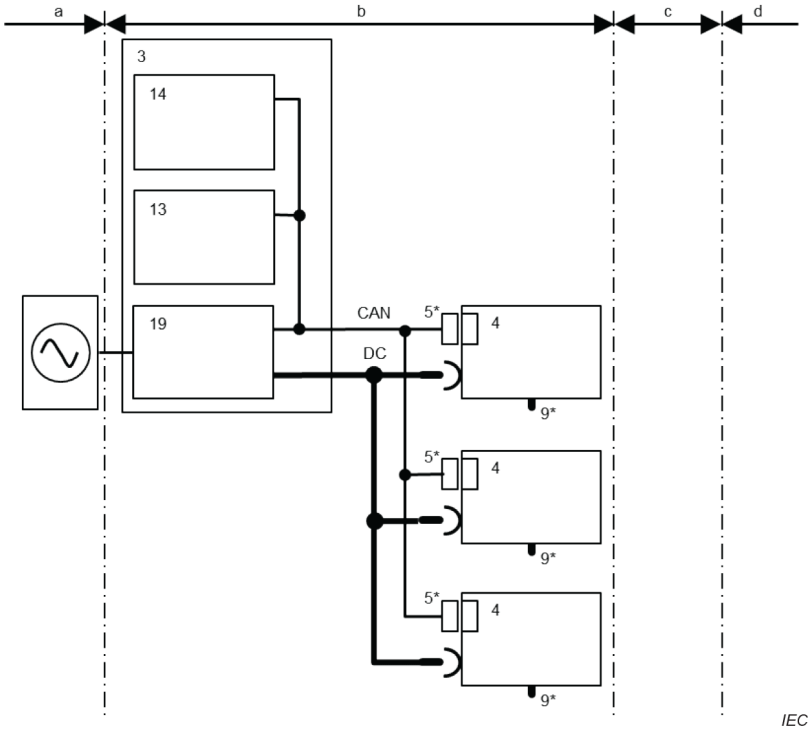

Figure 7 – EV supply system configuration type F

8.3.3.6 Conversion device

With the conversion device it is possible to connect a proprietary EV to supply network according to 7.1.8 of IEC TS 61851-3-1:2023. See Figure 8.

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