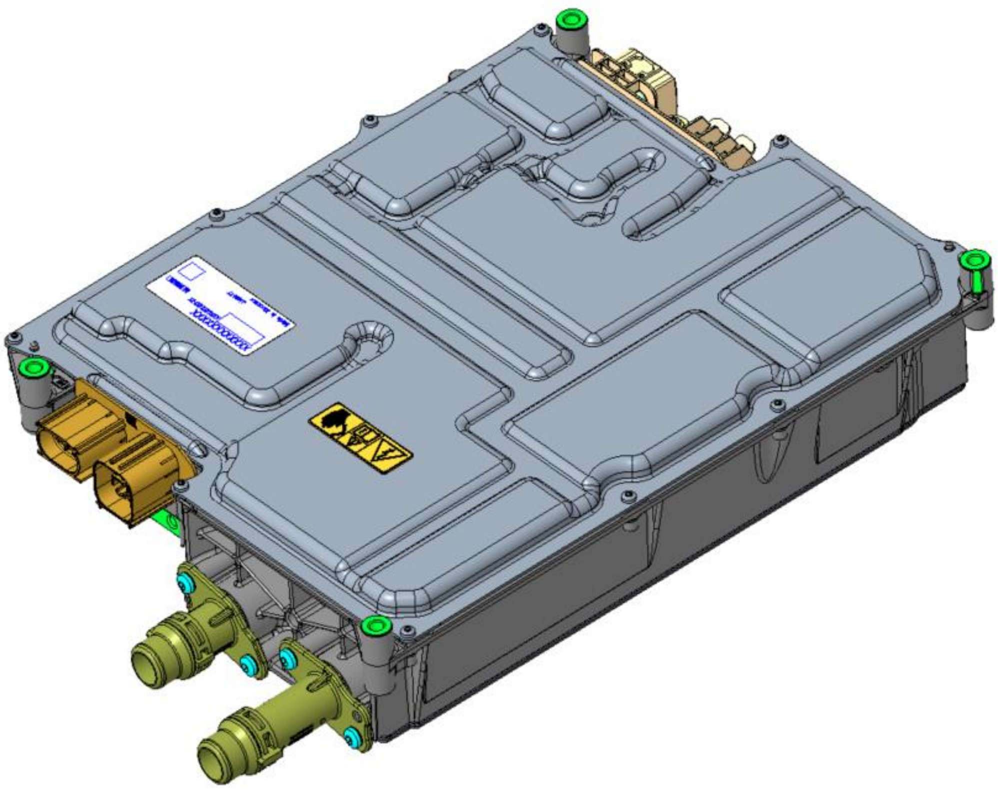
TCD Technical Customer Documentation

Preliminary

This preliminary TCD documents the present status of the agreed specifications. It will be confirmed when all validation has been completed with positive results.



Product designation:	CHARCON
Version:	2.3
Date:	2023-06-12

Table of contents

1 Product identification

Product designation:	CHARCON
Product part number:	TBD
Type designation:	CHARCON GEN4+ Base Variant 11kW EU
(Development) Part number:	TBD
Offer drawing number:	0437A00032
Name of customer:	PIAGGIO
Customer specification:	
Number:	NA
Edition/version	NA
Date:	NA
Title:	CHARCON GEN4+ Base
Application:	Light Commercial Vehicle (LCV), Battery Electric Vehicles (BEV)

Further applicable documents:
[NA]

The product has been developed, validated, and released exclusively for use in these applications Light Commercial Vehicle, Battery Electric Vehicles.

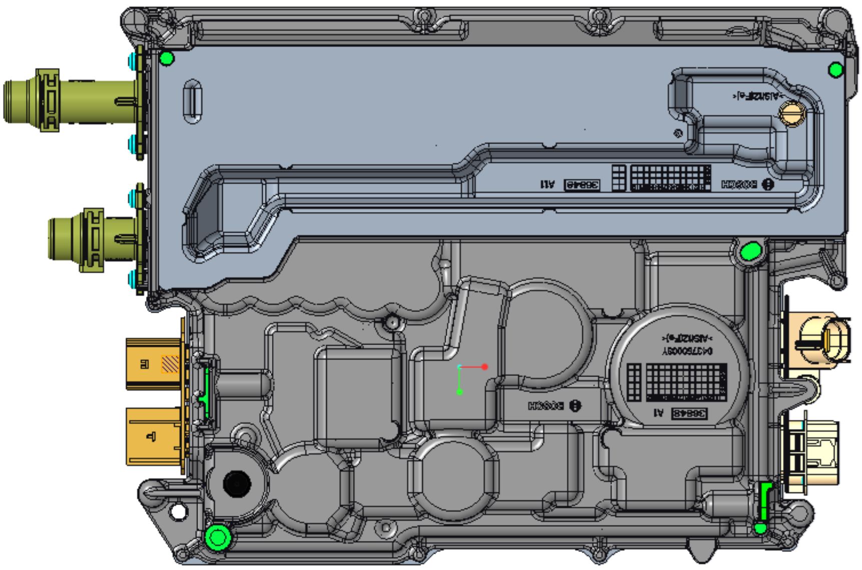


Figure 1: CHARCON Gen4+ base

2 General product description

2.1 Main functions and characteristics of the product

The CHARCON consists of an on-board CHARger with an integrated DC/DC CONverter.

On-board CHARger
Battery electric vehicles (BEVs) utilize electrical energy from a HV Battery to propel the vehicle. The HV Battery is charged when the vehicle is plugged into a charging station or a common household electrical socket. Depends on the source of the energy, i.e. the type of charging station, the vehicle is charged via AC or DC current. The On-Board Charger (OBC) provides the necessary interface to the charging station to enable charging, and in the case of AC charging, converts the energy from AC to DC. For AC charging, the Charger supports Mode 2 and Mode 3 charging according to IEC 61851. Mode 1 charging is not supported.

DC/DC CONverter.
In addition to the HV board net, BEVs also have a 12V board net (the same as traditional ICE vehicles). The 12V board net supports all the electrical auxiliary consumers, e.g. lights, radio, wipers, etc.. The DC/DC converter is primarily used to convert energy from the HV board net to the 12V board net to support the vehicle’s accessory load. Because this is a bi-directional DC/DC Converter, conversion from 12V to HV is also possible.

EVSE communication unit.
The EVSE communication unit in VCU will handle the communication with the charging station for both AC and DC charging stations. EVSE communication unit is not part of CharCon. CharCon is the slave and VCU is the master.

Misuse
prevent misuse or use of any application not approved by Bosch like:

- Mode 1 charging

2.2 Intended use

The product is released based on the regulatory requirements directly applicable to the product at the time of TCD creation in the following target market(s):

Countries
BE, BG, DK, DE, EE, FI, FR, GR, IE, IT, HR, LV, LT, LU, MT, NL, AT, PL, PT, RO, SE, SK, SI, ES, CZ, HU, CY, GB

The product can be used in a released target market in the applications set out in chapter 1, subject to the limits, conditions and other specifications described in this TCD ("Intended use").

In the case that the customer wants to use the product outside the Intended Use, the customer shall

(1) on its own responsibility evaluate and comply with any regulatory requirements resulting there from for the product and evaluate and ensure the usability of the product for the area of application intended by the customer or

(2) Obtain a new, extending Bosch release, which shall be ordered separately from Bosch (e.g. by means of a change request).

Deliveries and services (fulfilment of contract) shall be subject to the provision that there are no obstacles to performance due to national or international (re-)export control regulation, in particular embargoes or other sanctions.

2.3 Product safety

2.3.1 Functional safety

Class III component with ASIL rating

The customer has to ensure that the system/product is suitable to be used within the overall system regarding any functional safety requirements assigned to the system/product in the overall system. Bosch points out that the ASIL-classified requirements as per ISO 26262:2018, their implementation and the assumptions made for this purpose are documented in the following documents: / Table:

Category	Safety Goal	Safety Goal Description
No TI	**SG_NoTI_1:**	Avoid thermal incident of CHARCON, which lead to vehicle fire [ASIL C] Hint: requirement refers to complete CHARCON including housing.
High Voltage	**SG_HV_1:**	Ensure HV Safety in driving* mode [ASIL A] *Driving mode: customer operation (in/after crash situation, also during charging)
	SG_HV_2:	Ensure HV safety during service case [ASIL B]
Low Voltage	**SG_LV_OVR_1:**	Avoid LV overvoltage > 27V [ASIL D]
	SG_LV_OVR_2:	Avoid LV overvoltage • 17V and < 27V with failure tolerance time interval of 200ms [ASIL D]
	SG_LV_UDR_1:	Avoid LV under voltage caused by CHARCON failures (e.g. internal short) [ASIL B]

Table 1: Functional Safety

Warning: Active discharge of the HV net must be provided by another component in the vehicle, see also *BUR_AOD_57* in 2.3.3

The safety goals described in the above table are **preliminary**. More information will be discussed and agreed upon with the customer and documented accordingly.

It is the responsibility of the customer to validate the agreed upon documented requirements, their implementation and the assumptions made for this purpose.

The customer must ensure that the Bosch scope of delivery complies with the requirements on the functional safety within the overall system.

2.3.2 Data protection, cyber security and over-the-air aspects

Software Update reprogramming (Reflash) routines are implemented. These are protected with anti-tampering measures according to requirements agreed with the customer. The customer shall validate the implemented measures to prevent unauthorized reprogramming. If necessary additional mechanism(s) in the product or by an upper security layer, to comply with relevant legal requirements shall be implemented by the customer.

2.3.2.1 DATA PROTECTION

If the product contains functions that processes Personal Data, legal requirements of Data Protection and data privacy laws shall be complied with by the customer. As the data controller, the customer usually designs subsequent processing. Therefore, he must check, if the protective measures of the control unit are sufficient. Furthermore, requirements based on data protection and privacy should be documented in the security Development Interface Agreement.

Data protection (privacy) requirements for the Bosch product, based on the intended markets and use case.
The customer should define and communicate the derived requirements for data protection (privacy) for the Bosch product.
Note: RB ECUs and VCUs can store person related data in dependency to their calibration. Since such calibration is done sometimes by 3rd parties or by the customer itself, the customer needs to take care about the setting, in any case.

Agreement about the different aspects of the General Data Protection Regulation (GDPR) during Return Analysis:

RB products like the ECU and VCU can contain person related data (e.g.VIN). Depending on the contract and the kind of return analysis the responsibility of the GDPR compliance could change.
Therefore, it is recommended to define clear roles and responsibilities between customer and RB.

Specification of an erase functionality of person related data (e.g. VIN) or invalidation functionality for security assets (e.g. fleet keys) and the derived product requirements

For a secured decommissioning/ disposal of the vehicle and the RB-product it is recommended to have delete/erase functions embedded, which clear person related data (e.g. VIN, Fault Code Memory) from the respective memory.
The customer is responsible for such a concept and specification.
Bosch could give advice or support here.

Execution of an erase functionality of person related data or invalidation functionality for security assets (e.g. fleet keys)

If the erase function should be started via diagnostic interface, then the repair shop instruction shall consider this step.

2.3.2.2 GENERAL INFORMATION AND LIMITS ABOUT CYBERSECURITY

Bosch determines the conformity to the State-of-the-Art of Cybersecurity of his products on a regular basis. If the state of the art or the applicable laws change before end of delivery of the product, Bosch reserves the right to propose the necessary changes to the product via the change request process.

In case a security vulnerability, which affects a Bosch product, is discovered, or disclosed by the customer, Bosch shall be informed up-front its publication. Bosch will deliver updates only with the approval of the customer on the basis of contractual agreements. The installation of security relevant updates in the field needs to be performed by the customer's Software Logistic Infrastructure

The product or embedded control unit contains engineering access points in hardware and software to execute Bosch services for manufacturing and development purposes. This includes the capability to perform a software reflash. These Bosch interfaces are secured by:

- The constraint of physical access to the product, itself
- The design of the printed circuit board (PCB)
- Device individual passwords
- Removal of the respective routines in the memory of the product

The product is not protected against Denial-of-Service attacks (DoS) on the vehicle internal communication. If DoS attacks on vehicle internal networks have been evaluated as critical, this shall be considered by measures on vehicle level by the customer.

The product is not designed in a way to withstand fault injection or side channel attacks. Means the product does not employs dedicated protection mechanisms to prevent the extraction of sensitive data (e.g. Keys, IP, SW) via physical attacks. If necessary, additional mechanism(s) shall be implemented by the customer.

Software Update reprogramming (Reflash) routines are implemented. These are protected with anti-tampering measures according to requirements agreed with the customer. The customer shall validate the implemented measures to prevent unauthorized reprogramming. If necessary additional mechanism(s) in the product or by an upper security layer, to comply with relevant legal requirements shall be implemented by the customer.

The Software used in the product contains intellectual property ("IP") from Bosch, the customer and in some cases 3rd parties. For the purpose of IP protection and avoidance of re-engineering, the Software shall be handled as confidential during the distribution process into plants, workshops, customer flashing Updates. This shall be considered by appropriate measures within the Customer's Software Logistic Infrastructure and associated processes.

For a secure disposal (decommissioning), please refer to chapter 2.8.

2.3.2.3 CYBERSECURITY ASSUMPTIONS

Cybersecurity Information security measures can be implemented differently in the vehicle and its environment (security layers). Therefore, Bosch presumes that the customer satisfies the following assumptions by his security design of the overall system.

The interfaces, which are designed or implemented by the customer or 3rd parties, do not offer any service or routine to alter the memory content, besides the regular software update (reflash) services and intended changes by documented diagnostic services (e.g. UDS).

The interfaces, which are designed or implemented by the customer or 3rd parties to offer services for change of memory content, are well secured and limited to engineering purposes (e.g. XCP).

The interfaces, which are designed or implemented by the customer or 3rd parties, do not read out confidential data, cryptographic material or software with Intellectual Property as long as Bosch does not agree on this.

The software, which is designed or implemented by the customer or 3rd parties, does not compromise the intended function of the product.

A "defense in-depth" approach is applied to the vehicle E/E architecture.

Only, secured (signed) Software Updates (Reflash) are possible.

The diagnostic service Security Access ($27) implemented in the product is used in vehicle communication networks without internet connectivity only or an additional authorization mechanism is implemented in the product or by an upper security layer.

Bosch presumes that the customer takes care of a secure in-vehicle communication by implementing measures beyond the scope of the product or system to preserve the integrity, authenticity and freshness of the relevant signals, that are essential for the functionality of the product or system.

2.3.2.4 Security aspects during product decommissioning

During decommissioning the customer is responsible to prevent unauthorized access to any security assets (including but not limited to personal data) in the Bosch product.

2.3.3 Safety and warning notes

For a safe operation, the bottom-up requirements (BUR) described in the following table have to be met during operation and installation at the customer location.

Note: The word PEM stands for Power Electronic Module, which refers to the CharCon component.

ID	Bottom-Up Requirements (BUR) to the Vehicle
	Communication
BUR_AOD_5	The sender ensures integrity of safety relevant CAN bus signals. The receiver evaluates the safety mechanisms like alive counter, CRC, Sender-ID, timeout, qualifiers ... and triggers adequate safe system reactions [ASIL A..D]
BUR_AOD_6	In case of a crash the higher-level vehicle system sends a crash information signal. [ASIL A]
BUR_AOD_41	The PEM provides LV supply using operation mode, set points and limitations without plausibility check regarding appropriateness as requested by the vehicle.
BUR_AOD_26	If the PEM does not respond via CAN communication or the E2E verification fails, the higher-level vehicle system interprets this as a malfunction of the PEM to initiate an appropriate system reaction.
BUR_AOD_53	The higher-level vehicle system reacts appropriately on system fault messages, e.g. DTCs. Example: Some ASIL A latent fault diagnosis only sends a warning signal to the higher-level vehicle system without any other system reaction. Thus, it is required to inform the driver in case of a failure.
	HV safety
BUR_AOD_13	Isolation monitoring and coordination of safe system reaction is implemented in the higher-level vehicle system.
BUR_AOD_38	HV voltage is only applied (e.g., closing of HV-main contactors) if all HV-components are correctly connected.
BUR_AOD_63	During flashing the PEM cannot ensure the functional HV safety (e.g., active discharge). This has to be considered in the vehicle HV safety concept.

BUR_AOD_39	During service a back voltage* is considered in the vehicle HV safety concept. * The prevention of back voltage - (back EMF) by a rotating EM are the main points in consideration.
BUR_AOD_58	The HV voltage network is balanced.
BUR_AOD_73	The EVSE system detects a short circuit between phases, phases and housing and switch to a safe state (i.e., disconnect the AC supply source). EVSE: EV Supply Equipment
BUR_AOD_66	The Kl30c HW line is implemented/designed in such a way that neither “Short to LV-battery” nor “Short to ground” errors can occur.
BUR_AOD_71	The higher vehicle system prevents a HV-Battery overload.
	Control
BUR_AOD_57	In case of a discharge request (e.g. crash event) the PEM capacity (value tbd needs to be agreed with OEM) shall be discharged actively by an external device (e.g. inverter).
BUR_AOD_20	The higher-level vehicle system protects the HV voltage supply system against implausible high currents. Depending on the current level, the following two requirements have to be met: a.) In the case of high currents, the current square integral over time for interrupting the current shall be less than 4000A^2s (similar to a melting integral of a fuse). b.) The max. allowed current shall not exceed the upper limit of 10kA. Note: This BuR is intended to prevent a thermal event from spreading outside the housing of the PEU.
BUR_AOD_40	The higher-level vehicle system protects the LV voltage supply system (including the DCDC HV/LV converter) against implausible high currents.
BUR_AOD_75	The higher-level vehicle system provides a HV-Voltage and/or HV-current target value at all times and always takes the current HV-battery situation into consideration, so that no hazards occur during power transfer into HV-DC net.
BUR_AOD_54	The superior vehicle system shall provide the desired operation mode of the DCDC with the needed ASIL [ASIL B].
BUR_AOD_67	The superior system requests an active DCDC operation mode (e.g. Buck) during Charging.
	Mounting
BUR_AOD_10	Connecting the PEM with wrong polarity will lead to a defect of the PEM as the current load is to high for the PEM internal freewheeling diodes. As there is no PEM internal mechanism this scenario has to be considered by the higher-level vehicle system.
BUR_AOD_23	The potential equalization in the vehicle is implemented according to ISO 6469-3 over lifetime.

BUR_AOD_44	Faults regarding the wiring harness such as overload, mechanical stress, too high shield currents are not detected by the PEM.
BUR_AOD_24	During the definition of the mounting position a possible crash event is considered.
BUR_AOD_55	The PEM is operated within the allowed operating conditions as described in the technical customer documentation. This includes also a sufficient cooling depending on the requested power.
BUR_AOD_62	The OEM informs RB about all limitations or functions that this component has to comply with, in order to ensure the safety of other components in the vehicle. Note: This includes voltage- and current-limits for the connected components, temperature limitations (e.g. at the components interface) or additional functions (like a functions that request a continued ventilation to prevent accumulated heat in the electric machine).
BUR_AOD_70	The superior system provides a DC-Connector (T+/T- Connector) with an equivalent or better V-0 classified material Note: in accordance with UL94.
BUR_AOD_76	The higher-level vehicle system provides mating connectors (e.g., HV-DC, HV-AC, LV-battery, auxiliary supply etc.) which are designed to keep the maximum temperature within the specification over lifetime. The maximum specified temperature of the plating system (border temperature) shall not be exceeded. Faults leading to exceedance of specified temperature can be... corrosion at the active contact surface electrical (excessive) overload Example for max. temperature of plating system: Ag over Ni: 170°C Sn: 125°C Au: 150°C The higher-level vehicle system can implement measures such as a voltage monitoring internal / external to detect critical power-loss at the interconnections.

In case of non-compliance to any of the BURs described in the table above, it is in responsibility of the customer to discuss the deviations with Bosch in order to find a proper solution. The customer shall confirm to Bosch that these assumptions are understood and fulfilled.

2.4 Labeling of the product

The labels shown in this section are **preliminary** design and not yet finalized.

Product label:

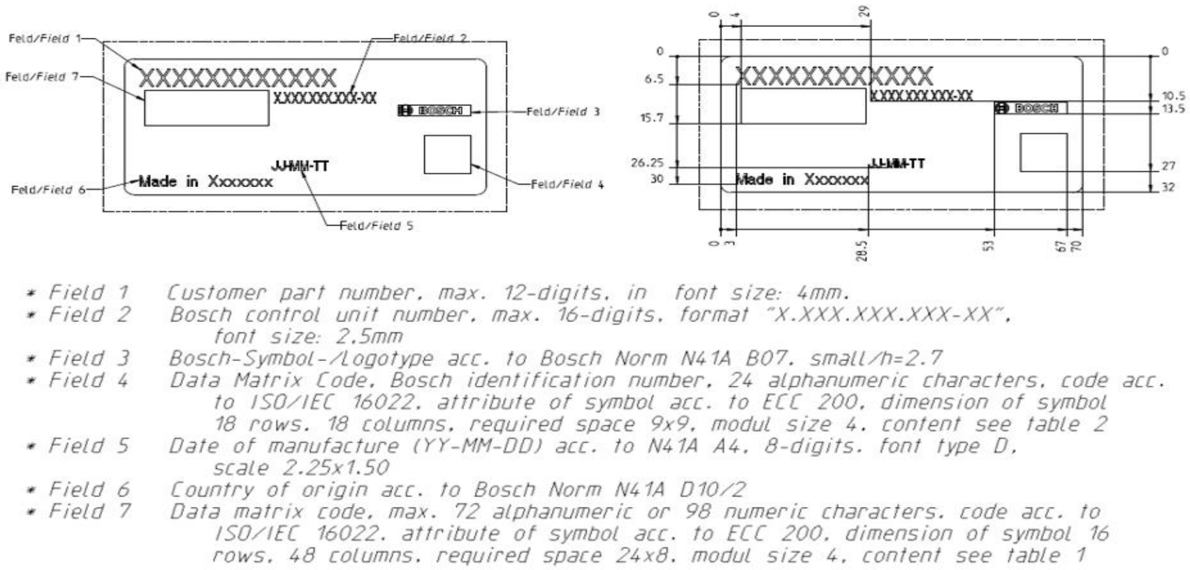


Figure 2: Product label with dimension

Warning label:

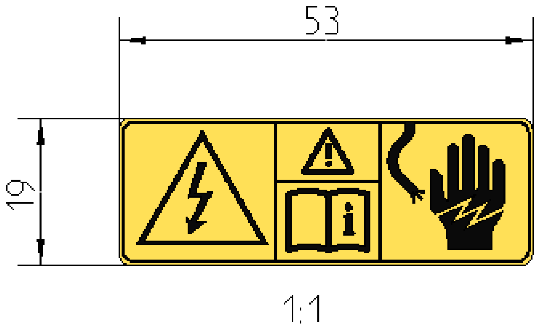


Figure 3: Warning label with dimensions

2.5 Dimensions and weights

The volume, weight, and dimensions are based on the **preliminary** design only and may not represent the final product.

Volume*	Box volume without connector: 9.16 l
Weight*	Approx. 11 kg +/-1kg
Dimensions*	Approx. 447 +/- 4 mm (length) x 292 +/-2 mm (width) x 86 +/-2 mm (height)

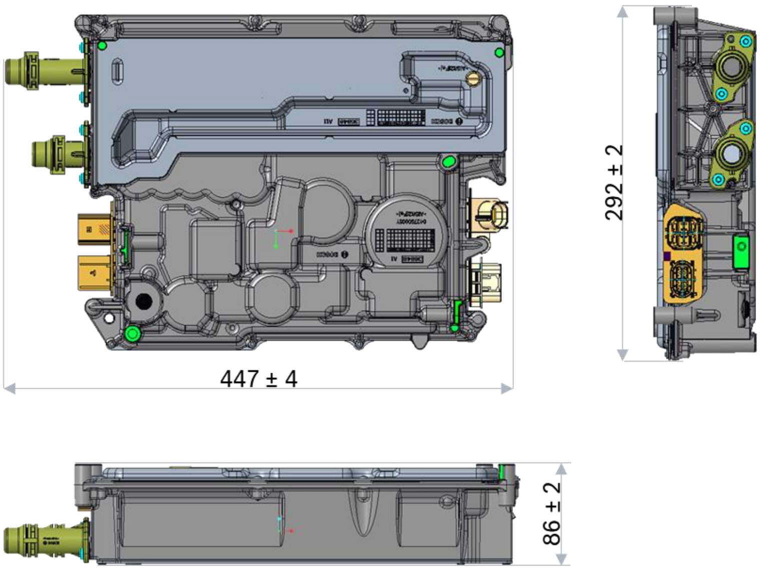


Figure 4: Dimensions

*Note: The dimensions and volume shown are based on the space claim defined by Bosch, which the preliminary design meets.

2.6 Power consumption / power output

General Power consumption (more details in chapter 4.3):

Charger: 11 kW (Input Power)

Converter: 2.4 kW (Output Power w/o internal supply)

2.7 General remarks on service, repair, and maintenance

Repair of the product is not possible.

An electrical service can be performed by the workshop using a tester device containing the available signal interfaces. Only measuring equipment that is subject to the inspection of measuring equipment at Bosch is suitable to reliably verify compliance with the specification. Service or the exchange of products are to be carried out exclusively by the authorized locations and by technically qualified personnel.

2.8 Information on disposal and recycling

All parts of the product must be disposed of or recycled in an environmentally friendly manner. All relevant legal regulations, general state of the art and operational standards must be complied according to country specific laws in which the product is used. Data Protection aspect needs to be considered as well (chapter 2.3.2.1)

3 System description

3.1 System of Interest (SOI)

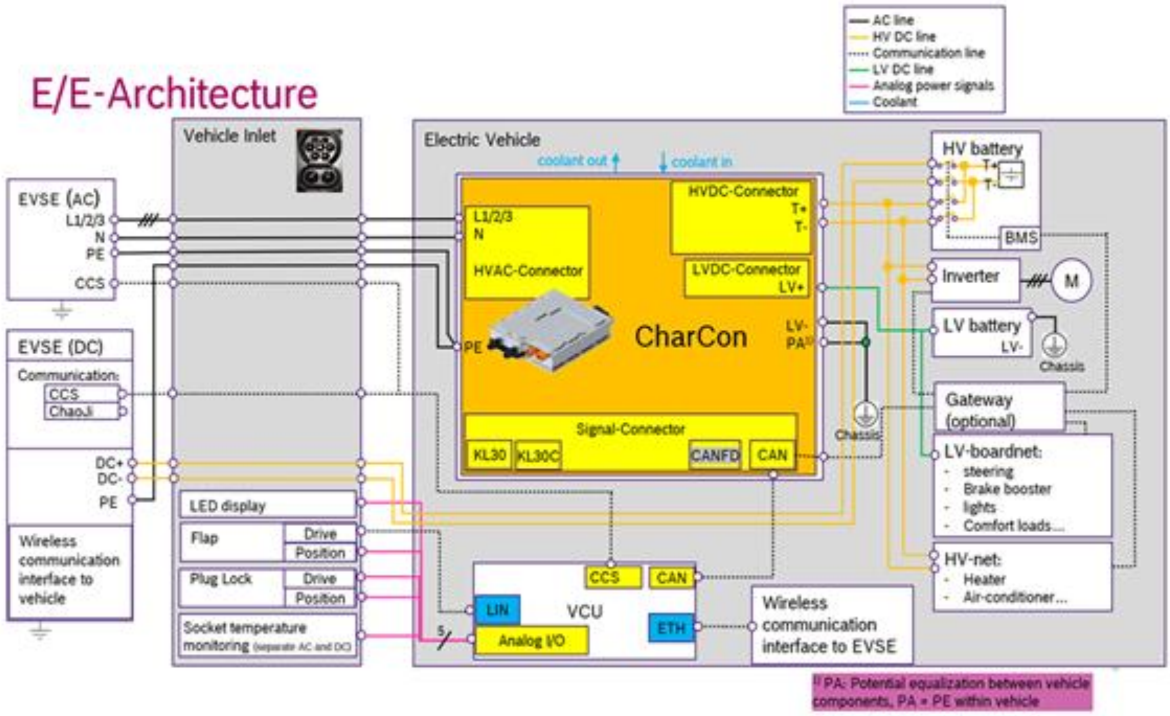


Figure 5: Preliminary High-level system diagram with the CharCon

The CharCon product consists of the component itself and the interfaces to its environment, e.g., vehicle and EVSE. The Hardware Interfaces (i.e., electrical & coolant connectors) were selected by Robert Bosch. Additional information about these interfaces is described 3.2.

The system context diagram is shown in Figure 4, where the CharCon is highlighted in the foreground. This is a preliminary diagram to show how the CharCon interfaces with the vehicle.

3.1.1 PRODUCT VARIANT

The CharCon product offers several variants based on power and region. The variants are summarized in the table below:

Charger Power	DCDC Power	Region	Grid-Connection-Specifications
11 KW	2.4KW	EU	1-phase 3.6kW; 1-phase 7.2kW; 3-phase 11kW

Table 2: Product Variants

Note:
***2.4Kw possible @<50^{o}C ambient temperature**

3.1.2 OVERALL FUNCTION DESCRIPTION

The charging function of the CharCon provides electrical energy to the vehicle's HV battery from the AC grid via the Electrical Vehicle Supplier Equipment (EVSE). The EVSE is connected to the grid and provides either AC or DC power.
If the EVSE provides AC power, the CharCon converts AC to DC to charge the HV battery. In this case, the EVSE is expected to include overcurrent detection and disconnection mechanisms (e.g., fuse or relay).
If the EVSE provides DC power, then its output is connected directly to the HV board net of the vehicle to charge the HV battery.

The DC/DC Conversion function of the CharCon provides electrical power to the vehicle's 12V board net, to support vehicle accessories such as headlights, seat-heaters, power steering, etc. To do so, the CharCon converts electrical power from the HV board net to the LV board net. This is referred to as *forward operation* or *buck* mode, where DC power is converted from a higher voltage level to a lower voltage level (e.g., 400V to 12V).

It's important to note that the CharCon is a slave to a supervisory control unit on the vehicle (e.g., VCU, etc.) for both charging and DC/DC conversion functions.

For the charging function, the VCU measure the charge port flap status, lock status, and plug temperature, and decide when and how to charge and request the commands to the CharCon via CAN.

For the DC/DC conversion function, the CharCon determines voltage and current of the HV and LV buses and send the information to the supervisory control unit via CAN. The supervisory controller determines the operation mode and voltage setpoint forward direction(buck operation) and send the commands to the CharCon via CAN. For detailed CAN messages transmitted and received by the CharCon, please refer to 4.1.2.

As a slave, the CharCon will always follow the commands from the supervisory controller, except when:

- The operational limits (e.g. temperature, current, voltage, etc.) as described in this document are exceeded
- Internal or external faults are detected requiring self-remedial actions

In the above cases, the CharCon will inform the supervisory controll unit of its actions and reasons for not following the commands via CAN. See 4.1.2.

To ensure proper functionality and reliability of the component, the vehicle must operate the CharCon within the boundary conditions specified in this documents, e.g. observe the voltage & current limits, provide sufficient coolant flow, etc.. Of course, these boundary condition may require updates as new finding emerge over the product and vehicle development cycle. Hence this document will be maintained and updated accordingly to reflect the agreed upon operational parameters between Robert Bosch and customer.

3.2 Hardware Interfaces

3.2.1 Hardware Interfaces General

Thermal interface to the vehicle includes coolant inlet and outlet ports.
Electrical interface to the vehicle includes HV AC, HV DC, signals connector, 12V (B+), Ground (B-), and Protective Earth (PE) connections. The **preliminary Sample** design is shown below:

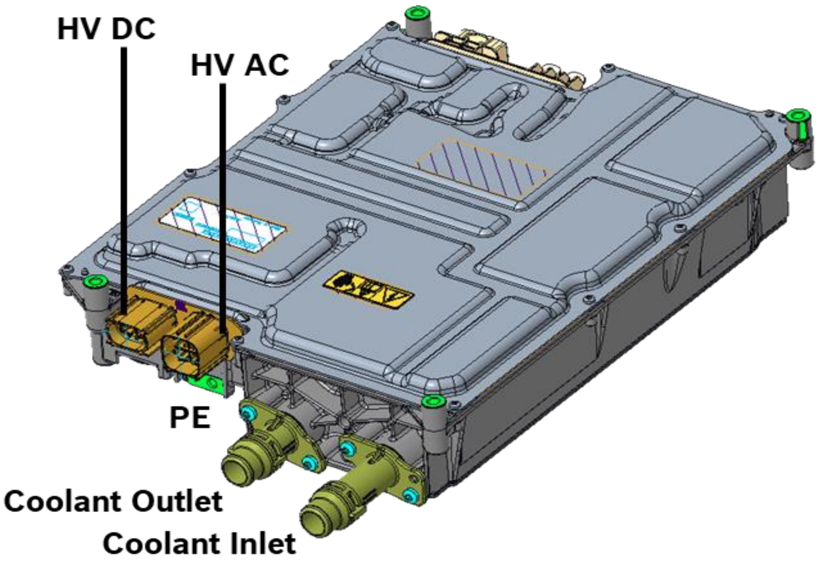


Figure 6: Side view (+x) of the CharCon (Preliminary)

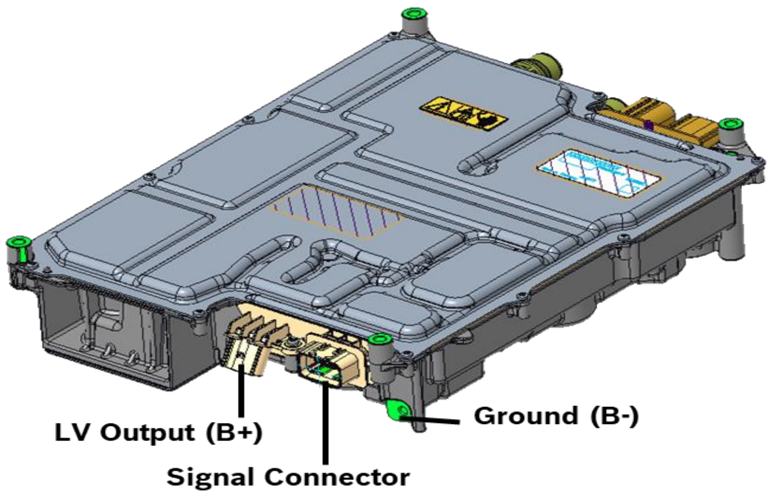


Figure 7: Side view (-x) of the CharCon (Preliminary)

The CHARCON does not have a reverse-polarity protection neither for HV nor for LV. A reversed polarity on LV will lead to high currents through the CON and can potentially damage it.

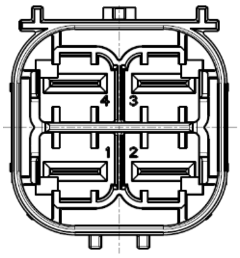
3.2.2 Connector Pins and Rating

There is no RB-liability for defects in the function of any plug connection although some recommended connectors are specified by BOSCH. Customer is responsible to assure specification conformity and reliability. In addition, RB is not liable for defects on the wiring harness plug and any possible consequential defects resulting thereof and is exempt from third party claims. Bosch assures component-related interface conformity in accordance with the specified interface drawing. Unless otherwise specified, the following responsibility matrix (RASIC) is valid:

RASIC valid for components with connected plug interfaces:

Scope / subject	Responsible: Bosch	Responsible: customer
Wiring harness plug	No	Yes
Observance of specification plug connection	No	Yes
Type plug interface, component related	Yes	No

HV AC connector:

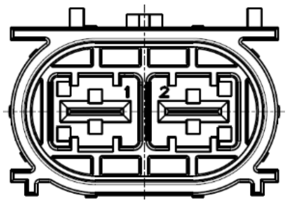


Pin	Terminal Description
1	L1 (32 A)
2	N (32 A)
3	L2 (16 A)
4	L3 (16 A)

Figure 6: HV AC connector

Interface drawing: TE drawing 208-18167, Code A Ag plating
Recommended plug: TE part number. 6-2396290-1, see TE drawing ENG_CD_2396290 (Code A)
Recommended terminal: TE part number. 2-1241418-3, see TE drawing C-1241438 (Ag Plating)

HV DC connector:



Pin	Terminal Description
1	HV+ (36 A)
2	HV- (36 A)

Figure 7: HV DC connector

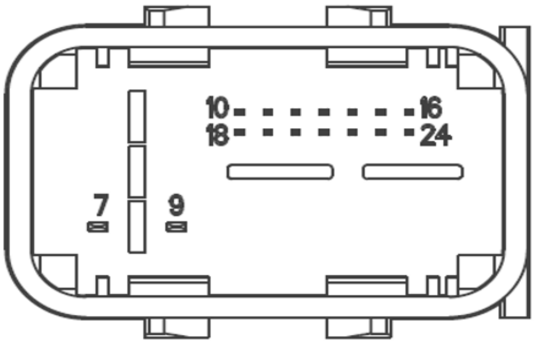
Note: Current device is intended for unshieled system and hence no shieled connection at HV connector.

Interface drawing: TE drawing 208-18043, Code A Ag plating
Recommended plug parts:

- TE part number. part 1 2p wire harness plug ZSB Code A TE Part no: 2319389-1
- TE part number. part 2 cable fixation 6mm² TE Part no: 2319395-1 (Black)

Recommended terminal: TE part number. 2-1241418-3, see TE drawing C-1241438 (Ag Plating)

Signal connector:



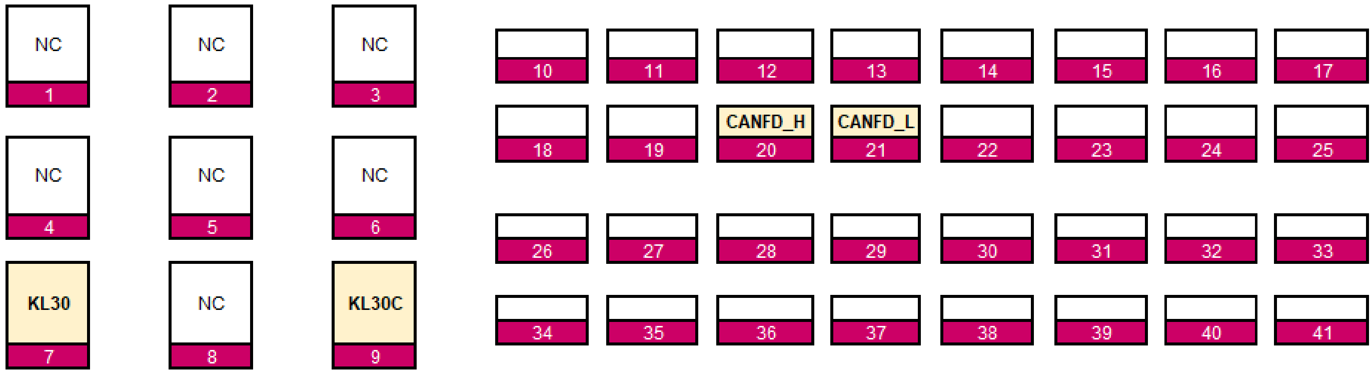


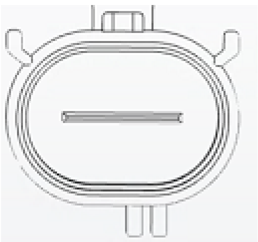
Figure 8: Signal Connector & Pinout

*Note: Pins 17 and 25 are not available on Connector mounted on CharCon.

Interface drawing number: 3284490800

Recommended plug parts: see drawing: **1928A00087-000**

LV DC (B+) connector:



Pin	Terminal Description
1	B+ 166A(<50°C ambient temperature)

Figure 9: LV DC (B+) connector

Interface Drawing Number: **TBD**

Recommended plug:

- Lear part number. T&C: 19623 000 001, Version 2, Code A, see Lear drawing: 80511-______cg-zD00105.tif

Recommended terminal: LEAR part number: 29110.000.001, MAk12Evo4, 180°-Variant, Ag plated

Cable lug (B-) connector:
Recommended wire size: 35 mm²

Cable lug (PE) connector:
Recommended wire size: 6 mm²

Mounting of CHARCON:
4 x M8 according to Bosch specification.

3.3 SOFTWARE/COMMUNICATION INTERFACES

As communication interface, the CharCon has CAN-HS channel in compliance with ISO 11898-2. For CAN pins see 3.2.2)

CAN interface details are described in chapter 4.1.2.1

For detailed information on CAN messages supported by the CharCon, please refer to 4.1.2
In addition to normal CAN communication, diagnostic services are implemented per UDS protocol according to ISO 14229-1. The network and transport layer (or ISO-TP) are compliant to ISO 15765-2.

Actuator tests (using the Routine Control UDS service) will not be implemented.

During development, the software may be flashed via several interfaces, as shown described in chapter 4.1.10

4 Technical data with measured variables and measuring conditions

4.1 Functions, function states (modes of operation), functional characteristics and boundary conditions

4.1.1 ManageDiagnosticEvents

The CHARCON will be developed as “OBD ready”. “OBD ready” means, that all the hardware sensors and actuators for implementation of OBD concepts in accordance with the coordinated Customer /RB interpretation of the legal requirements for defined market and model year are present in the device. But only the diagnosis functions relevant for functional safety and component protection will be implemented. The OBD certification itself will not be done, and the corresponding documents will not be provided.

The CHARCON will be developed as primary ECU for “OBD ready” with a diagnostic system manager.

Changes in the legal requirements for defined markets and model year must be brought to notice to RB by the OEM and must be clarified with RB for impact on cost and time schedule.

Detection of malfunctions of the on-board charger

Any failure that disables charging or affects charging performance (e.g., preventing the ESS from fully charging or limits charging rate) will be diagnosed.

Diagnosis functions to detect indistinct charging failures that cannot be distinguished from failures originating outside the vehicle or charging failures originating outside the vehicle will not be implemented.

For full OBD Implementation, the charger phases will be diagnosed independently from each other and will have individual specific denominators for IUMPR calculation. The control of the denominators must be done by the OBD master, the ECU controlling the charging process (e.g. VCU, ...).

SensorDiagnosis

Internal and external sensors identified as relevant for OBD will be diagnosed according to requirements for Comprehensive-Components (CoCo). This includes diagnosis functions for electrical failures (Short-Circuit-Ground, Short-Circuit-Battery, Open-Load), Out-of-Range failures (Out-of-Range-High, Out-of-Range-Low) and offset-, amplification- and stuck-in-range failures diagnosed by plausibility checks with other sensors or derived values (models) – to the extend feasible. Sensors used for those derived values (models) will also be diagnosed according to requirements for Comprehensive-Components.

External sensors provided by OEM must be capable to fulfill the requirements for Comprehensive-Component diagnosis, this applies also to measurement values provided by OEM via communication interface used for OBD diagnosis.

Diagnosis functions, that are restricted for technical reasons (“to the extend feasible”), will be disclosed to the OEM and documented.

The following internal sensors will be diagnosed (by on-board CHARger with an integrated DC/DC CONverter, except last items in list – as stated below)

- AC HV input voltage and AC input current sensors of CHAR
- DC HV output voltage, as well as DC output current sensors of CHAR
- Rectifier capacitor voltage
- DC HV input current sensor of CON
- DC LV output voltage sensors (two sensors), as well as output current sensor of CON
- PCB temperature sensors
- Terminal 30 and Terminal 30C voltage sensors

ActuatorDiagnosis

Internal and external actuators („output components") identified as relevant for OBD will be diagnosed according to requirements for Comprehensive-Components (CoCo). This includes diagnosis functions for intentional, as well as unintentional activation and deactivation. The diagnosis functions will qualify the activation and deactivation of the actuator by monitoring selected measurement values for appropriate change. Those measurement values, if not used as sensor values elsewhere in the system, are handled as part of the actuator and not as independent sensors. Additionally for the EU version, external actuators will be diagnosed for electrical failures (circuit continuity or circuit fault e.g., short to ground or high voltage, or communication errors or the lack of communication if the signal to the output component is digital).

External actuators provided by OEM must also be capable to fulfill the requirements for Comprehensive-Component diagnosis, this includes actuators interfaced via digital interfaces (e.g CAN, LIN, ...).

The following internal actuators will be diagnosed (by on-board CHARger with an integrated DC/DC CONverter, except last in list)

- internal supplies
- shut-off-path actuators (via SOPT)
- relais and switches

Overall system performance

Internal failures preventing the charger from fully charging or limiting charging rate by a certain extend ("to the extend feasible"), will be diagnosed by

- sensor and actuator diagnosis functions to detect malfunction of the component
- system diagnosis functions to detect over- and under-voltage, over-current and over-temperature due to internal failures (if distinguishable from external influences)
- system diagnosis functions to detect internal Level-3 failures (e.g. watch-dog, memory failures, ...)
- Performance Check of the charger, using charger efficiency rating (not implemented for OBDReady)

The charger efficiency will be calculated by comparing the measured input power on the HV AC side with the measured output power on the HV DC side (battery side). If in a certain operating point, the efficiency is significantly lower than the nominal efficiency, a failure will be detected. The accuracy obtained is derived from the over-all accuracy of the sensors involved, as required for the purpose of controlling the charger ("to the extend feasible").

Internal failures limiting the converter (CON) output power below the defined output power in a certain operating point by a certain extend ("to the extend feasible") will be diagnosed by

- sensor and actuator diagnosis to detect malfunction of the component
- system diagnosis to detect over-voltage and under-voltage, over-current and over-temperature due to internal failures (if distinguishable from external influences)
- Performance Check of the CON will not be implemented

CANCommunication

CAN communication will be implemented according to the description in chapter 4.1.2 (see also BUR_AOD_5 in chapter 2.3.1).

ObdCommunication

Generic scan tool communication will not be implemented for OBDready*.

*Realization of OBD in SW will not be provided within this project.

UdsCommunication

Diagnostic services for service tester communication will be implemented according to the description in chapter 4.1.2.2

4.1.2 COMMUNICATION WITH EXTERNAL CONTROL UNITS

4.1.2.1 CAN

The communicate With External Control Units function exchanges information on CAN-HS with the vehicle ECUs. The detailed signal description can be found in the CAN Matrix.
The CharCon will include the following sub-functions:

- End2End Protection
- Receive and transmit information as per the CAN DBC

1.	Nominal Voltage	CAN_H: 3.5V CAN_L: 1.5V
2	Baud rate	500 kbps Refer to ISO 11898
3	Communication error detection.	Refer to DFC list shared along SW release

Table 3: EV CAN electrical parameter

Note: CAN FD is optional and its Max Baud rate is 2Mbps.

Refer to DBC file described within the SW release

- • End2End Protection ——> AUTOSAR profile 2
- • Network management——>: AUTOSAR based
- • CAN communication diagnosis refer to chapter 3.3

4.1.2.2 UDS SERVICE

Diagnostic services (UDS) are implemented according to ISO 14229-1.
CAN Transport Protocol (ISO 15765-2) is used for the communication with the client.

SID	Service	Sub Service	ASW		CB		
			Default Session	Ext. Session	Default Session	Prog. Session	Ext. Session
0x10	DiagnosticSession Control	Default Session	x	x	x	x	x
		Programming Session		x	x	x	x
		Extended Session	x	x	x	x	x
0x11	ECU Reset	Hard			x	x	x
		KeyOnOff	x	x			
0x19	ReadDTCInformation	ReportNumberOf DTCByStatusMask	x	x			
		ReportDTCBy StatusMask	x	x			
		ReportDTC SnapshotRecord ByDTCNumber	x	x			
0x22	ReadDataByIdentifier		x	x	x	x	x
0x2E	WriteDataByIdentifier			x*		x*	x*
0x27	SecurityAccess					x	
0x28	CommunicationControl	EnableRxAndTx		x		x	x
		EnableRxAnd DisableTx		x		x	x
0x3E	Tester Present		x	x	x	x	x
0x31	RoutineControl			x	x	x	x
0x34	RequestDownload					x	
0x36	TransferData					x	
0x37	RequestTransferExit					x	
0x85	ControlDTCSetting			x		x	x

Table 4: UDS matrix

Note:

- x* DIDs are secured and require a Security Access Service.
- ext = extended diagnosis session, Prog = programming.
- If Programming session is called from ASW, the software will switch to CB after verifying the preconditions

4.1.3 FILTERENERGY

The filterEnergy function will filter in- and output signals in order to maintain the limits specified in the relevant norms and standards, as well as customer specification. The filters of the CHARCON can be seen in Figure 14: HW block diagram with sensors: EU11kW HW block diagram with sensors. The filters consist of AC and DC filters for the CHArger and of HV and LV filters for the Converters and a HV EMC filter for the complete CHARCON.

4.1.4 ConvertPowerActoDc

The convertAcToDc function unidirectionally transfers electrical energy from the EVSE to the HV side with the intention of charging a HV traction battery. This function is available while the operating conditions are within the limits specified in 4.3
The CharCon will include the following sub-functions:
Charge mode control (HV DC current and voltage control)
Conversion efficiency is defined in 4.3.
The efficiency curve will follow a characteristic similar to the figure below, values are preliminary and can be lower or higher.

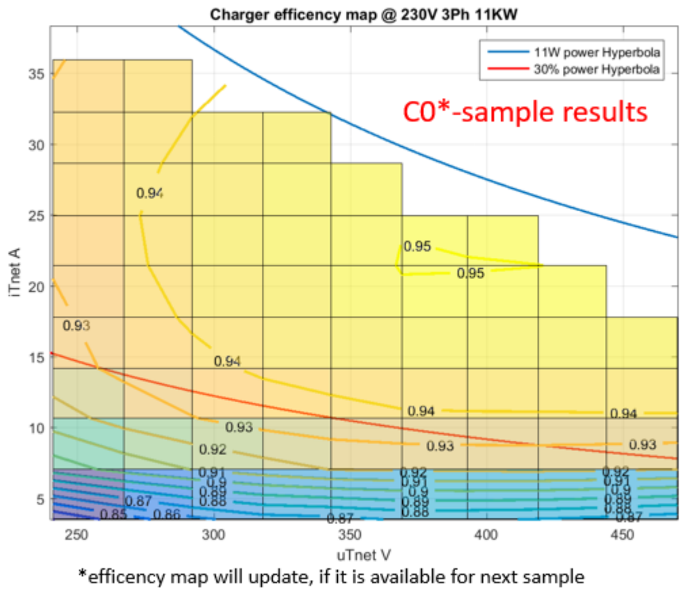


Figure 10: Efficiency characteristics

4.1.5 ConvertPowerDcToDc

The convertPowerDcToDc function transfers electrical energy from the HV to LV side. This function is available while the operating conditions are within the limits specified in 4.3
The CharCon will include the following sub-functions:

- Buck mode control (LV voltage Control)

Conversion efficiency is defined in 4.3.1

SupplyCharConwithElectricalPower

The supplyCharConwithElectricalPower function provides energy to the logic hardware modules which include the microcontrollers. The operating voltage ranges are defined in 4.3.

The CharCon will cover the operating voltage range for the power path in the figure below:

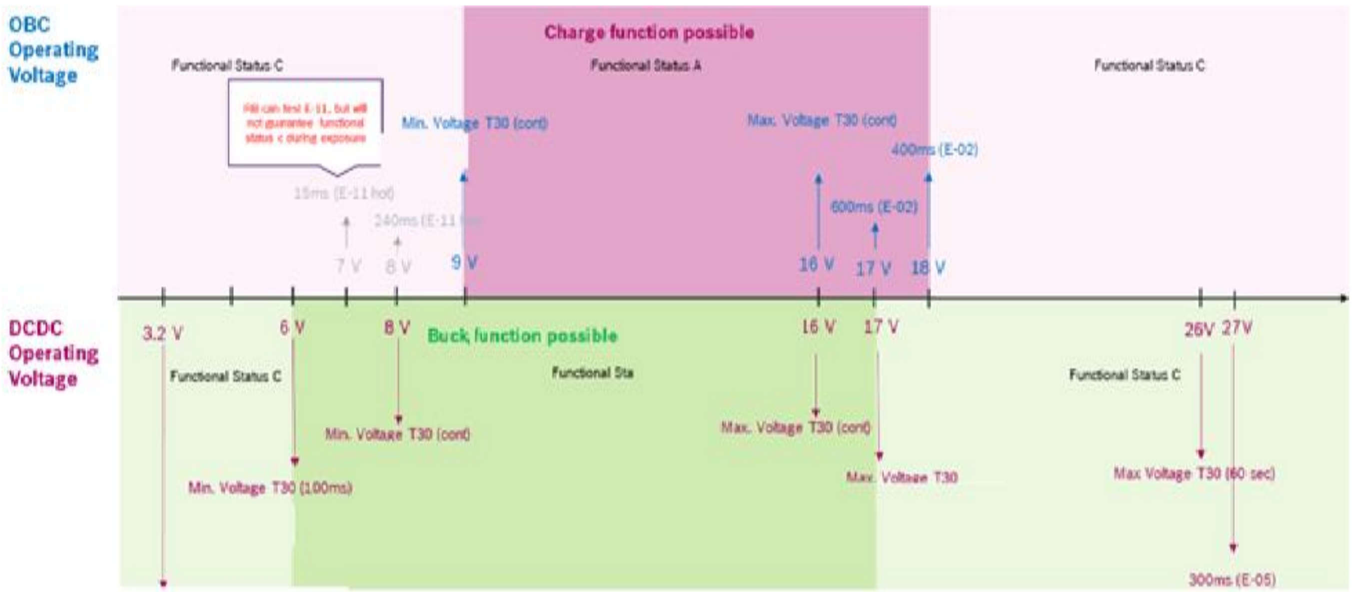


Figure 11: Operation Voltages on T30

The operating voltage range for the communication is shown in the figure below.

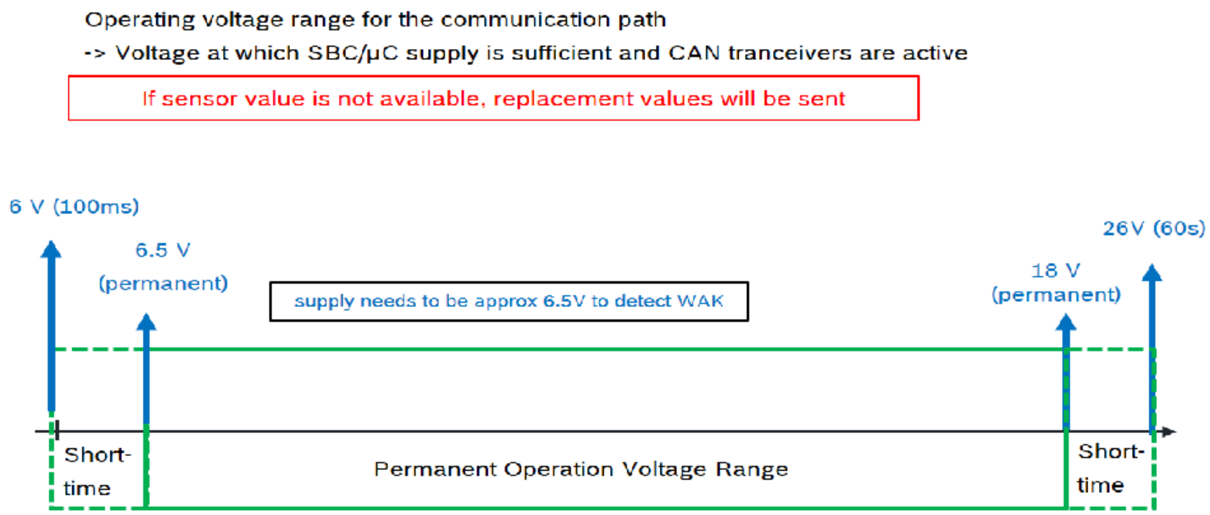


Figure 12: Operation Voltage Range Requirements

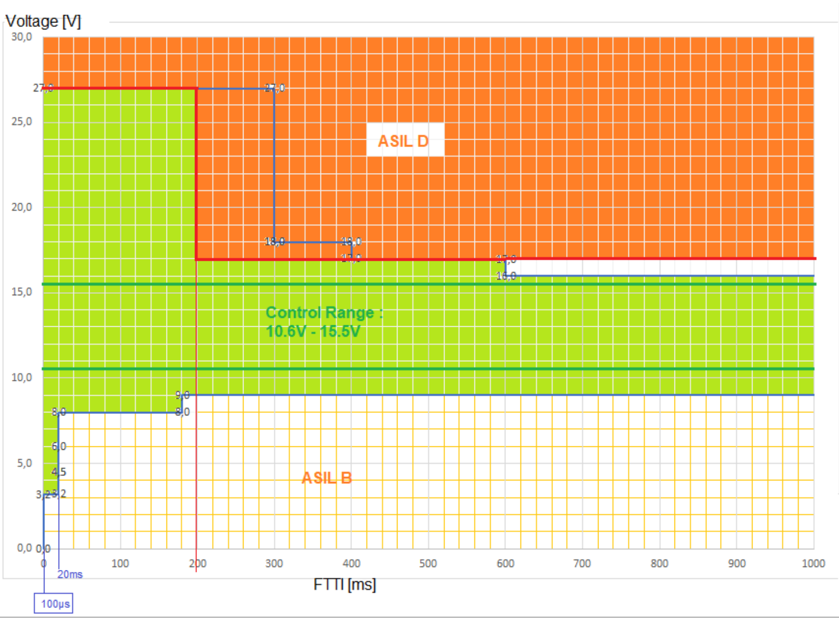
4.1.6 SystemfunctionalSafety

4.1.6.1 Avoid LV Hazard

Hazard Description			ASIL Integrity
Prevent for LV-Overvoltage at B+ caused by DCDC			**[ASIL D]**
	>17V (≤27V) (FTTI 200ms)		
	> 27V (FTTI 0ms)		
Prevent for LV-Undervoltage			**[ASIL B]**
	Prevent for LV internal short, (HW-Shut Off)		
	Inform superior system about DCDC activity state		**[ASIL A]**
		DCDC set operation mode	
		Error status	
		Derating	
	Ensure DCDC availability		[QM]

Figure 13: Fault Tolerance Time Interval

4.1.6.2 ProvideSafetyInfrastructure



Description	ASIL Integrity
µC safety	[ASIL D]
Shut Off Path Test (for latent fault detection of shut off paths)	[ASIL A]
Communication safety (E2E safety mechanism)	[ASIL B]

4.1.6.3 AvoidHighVoltageHazard

	Description	ASIL Integrity
	Prevent for DCDC reverse operation	

		during Service Case (or in case of HV error)		[ASIL B]
			Kl30c interruption (HW-Shut Off Path)	
			HV_Deactivation_request (SW-Shut Off Path)	
		after Crash		[ASIL A]
	Information to superior system			
		Kl30c State		[ASIL A]
		Meas. HV-Voltage (uTnet)		[QM]
Charger	Prevent Charging Operation			
		during Service Case (or in case of HV error)		[ASIL B]
			HV_Deactivation_request (SW-Shut Off Path)	
		after Crash		[ASIL A]
	Prevent for Backflow Current into AC-grid			[QM]
	Non-Functional Safety			
		Basis isolation		n.a.
		IT-net		n.a.

4.1.6.4 ProvideSafetyThermal

	Description	**ASIL Integrity**
CharCon	Basis isolation	
	Coolant cooling system	[XM]
	Housing prevents for extension of TI event outside the housing	[XM]
	coolant temperature derating	[ASIL A]
	Prevent for HV-DC Overvoltage	[ASIL A]
DCDC Converter	Detect LV-reverse overcurrent	[ASIL C]
	Detect HV-Overcurrent	[ASIL C]
	Prevent for permanent short on HV-DC Link (Fuse)	[XM]
Charger	Prevent for permanent HV-AC short circuit (AC Fuses)	[XM]
	Detect HV-Overcurrent	[ASIL C]
	Prevent for Elko Overload/Overvoltage	[ASIL A]

4.1.7 ProvideSystemSensing

The provideSystemSensing function captures the internal thermal and electrical data. This multipurpose function will provide the basis for control, derating or signals to external ECUs (i.e. on CAN, see 4.1.2).
The CharCon will include the following sub-functions:

- Measurement of electric in- and output signals
- Thermal modelling of the coolant water temperature

The complete overview of implemented sensors in the CharCon is available in the figure below.
For sensor accuracies see 4.3.2

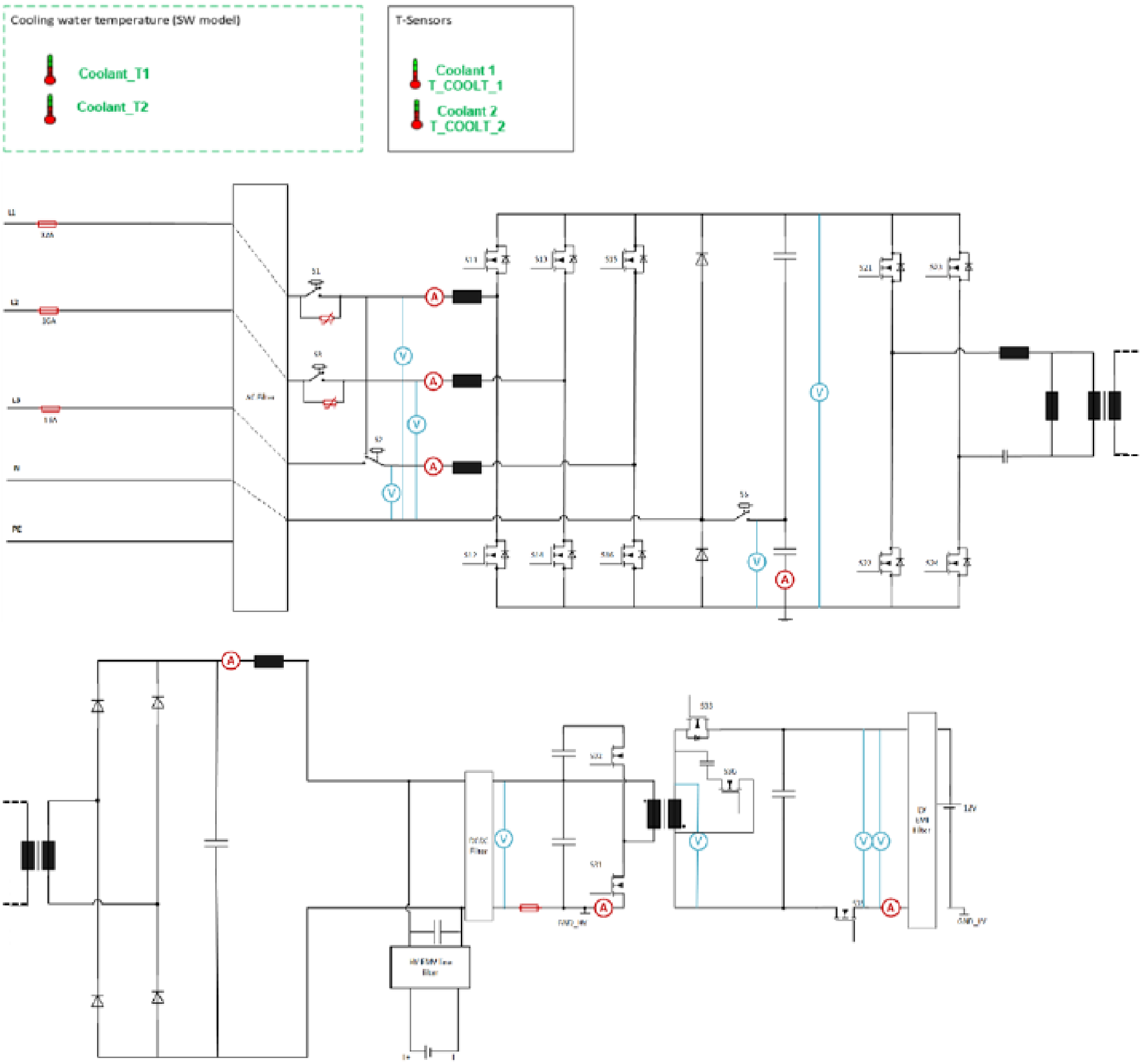


Figure 14: HW block diagram with sensors

4.1.8 ManageCharConOperation

The manageCharConOperation function defines the operating setpoint of the CharCon based on external input (i.e. CAN) and internal data (i.e. sensors).
The design will include the following sub-functions:

- Grid Detection
  - 1-ph (L1) → single phase charging via L1 up to 32 A.
  - 3-ph (L1,L2,L3) → 3-phase charging via L1, L2 and L3 up to 16 A per phase
- Inrush Current Limitation
- Derating
- Power distribution on internal modules (lifetime/efficiency optimal)
- The charger's and DCDC preliminary operational modes and state transitions are shown in the following diagram:

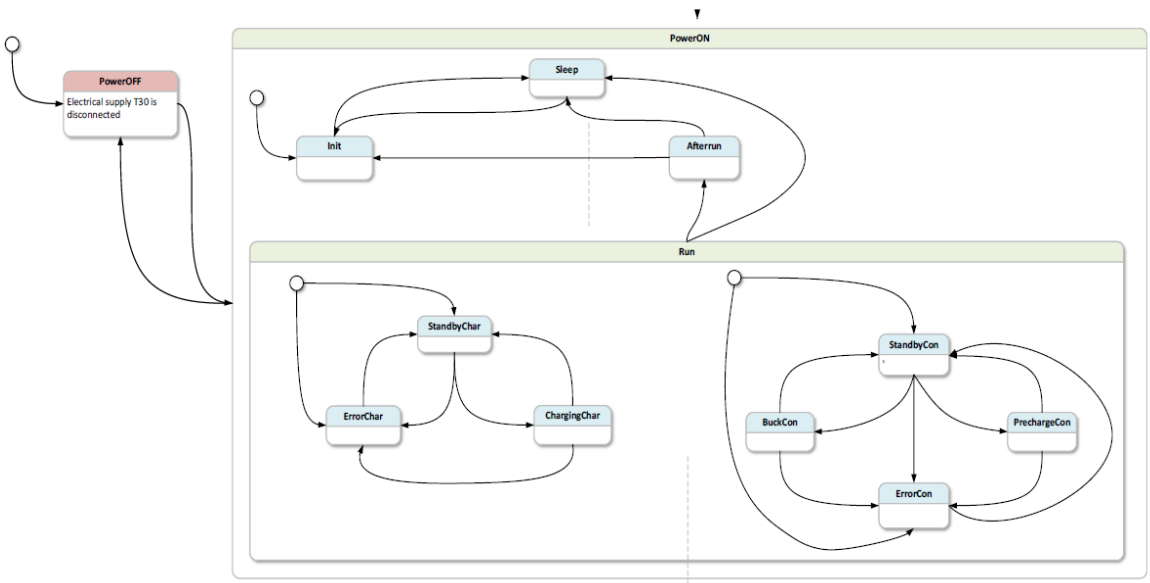


Figure 15: Preliminary State machine of the CharCon

4.1.9 ProtectAgainstManipulation

See Chapter 2.3.2

4.1.10 Program Control Unit

The design will include the following sub-functions:

- Flashing via UDS
- Flashing via ETK

Programming	RB			Only Customer+ RB
Implemented in	Boot Control(RB programming)	Debugger	CUST specific	Customer Block(CB)
Tool	CUST specific	UDE	CUST specific	CUST specific
For initial Programming	-	-	✓	-
Source File	Complete Hex-file	Complete Hex-file	Complete Hex-file	Complete Hex-file
HSM active	✓	✓	✓	✓

Table 5: Programming table

4.2 Mechanical characteristics

CHARCON housing is comprised of a die-cast aluminum cooler and a stamped aluminum cover. Coolant flow is guided in a cooling channel inside the cooler. The connector panels are made of flame-retardant material according to UL94-V0 specification.

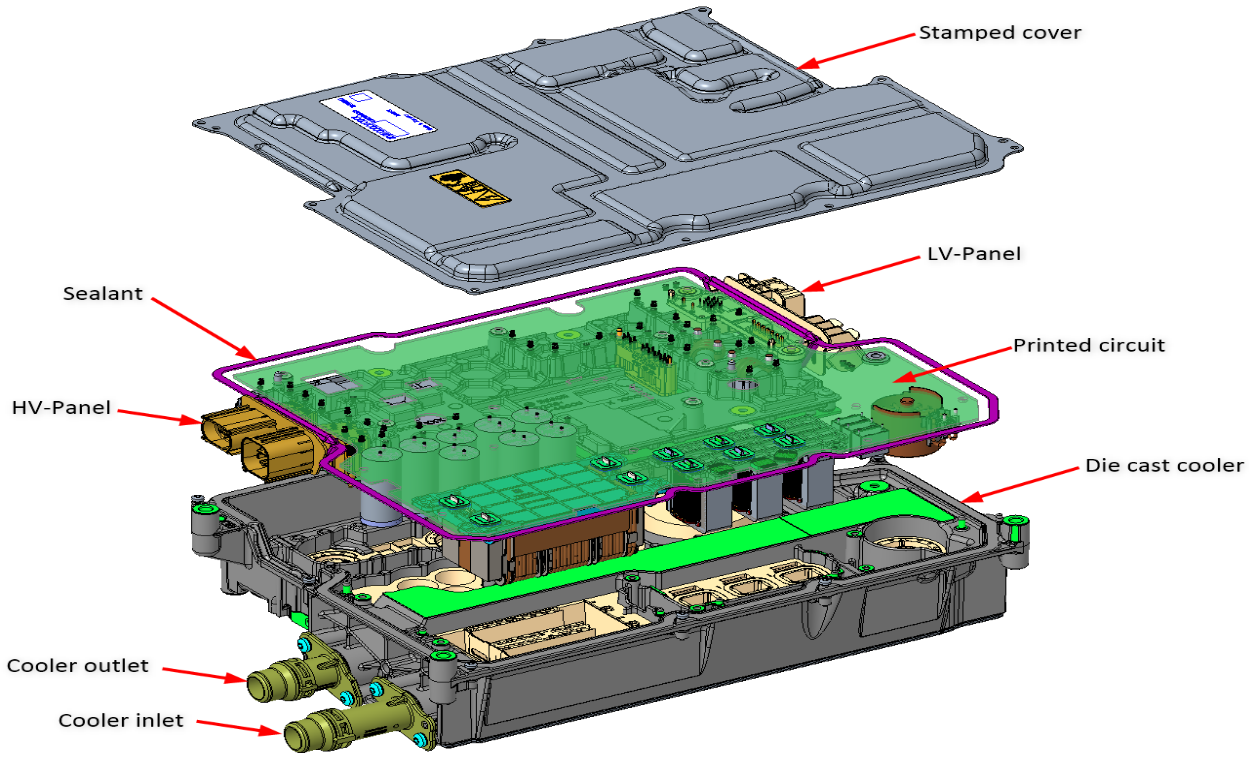


Figure 16: CHARCON Exploded view

4.2.1 Cooling of the Product

To reach the specified performance and prevent mechanical or thermal damages to the product, the cooling system must be operated within the following specifications:

Parameter	Value(s)
Coolant temperature	Full performance: -30°C to 65°C Derating: -30°C to -40°C and 65°C to 75°C
Coolant flow rate	1.5L/min at -30°C 2.7L/min at 0°C 8 L/min at 65°C (Values needs to be confirmed by simulation)
Coolant medium	50% water / 50% glycol
Coolant inlet pressure	3.5 bar maximum
Volume of coolant in device	Approximately 120cm3
Pressure drop	< 100mbar in accordance to coolant temperature and flow rate

Table 6: Cooling spec.

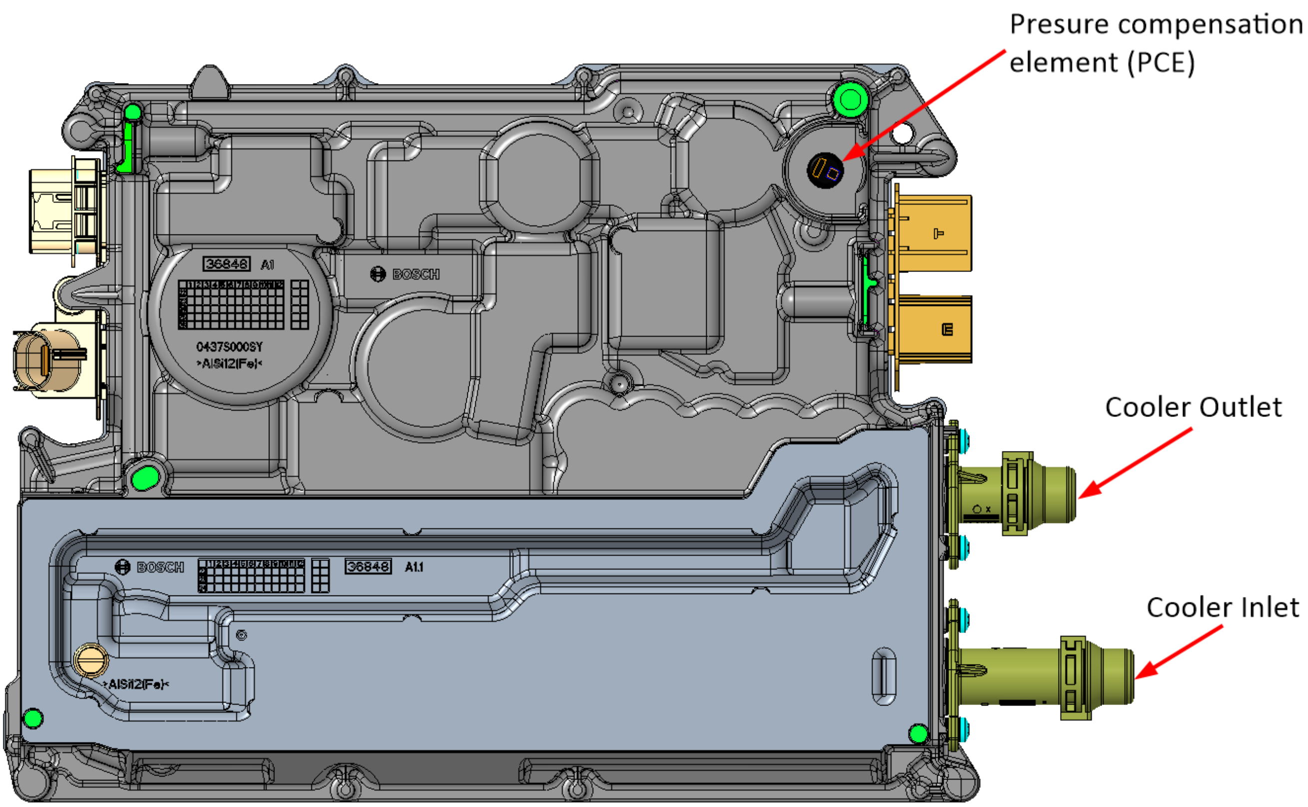


Figure 17: Direction of Coolant Flow and Location of PCE

4.2.2 Pressure Compensation

An impermissible high-pressure difference between the interior of the product components and the environment can lead to malfunctioning of the housing sealing and therefore fluids can enter in (Consequence: loss of function, accelerated aging, higher safety risks, loss of warranted protection class).
For prevention, a pressure compensation element (PCE) is installed in the housing wall, which prevents an impermissible pressure difference. The following disturbances must be avoided:

- Covering of the pressure equalization element (PEE)
- Wetting the membrane with media
- Contamination of the air entry or the membrane
- Mechanical damage, e.g. due to water jets or other mechanical influences
- The pressure compensation element (PCE) is not allowed to be subjected to water build-up and is not allowed to be positioned under the wading line or water transit line of the vehicle.
- Direct high speed air flow on to the PCE is not permissible

4.2.3 Protection Class of the Housing

During the operation and maintenance/cleaning, water and dust affect the product with different energy. As long as the exposure does not exceed a permissible extent, with appropriate sealing of the housing, it is ensured that malfunctions due to penetrating water/dust or limitation of service life do not occur. If the product is in use, it is not possible to prevent people from coming in contact with the product. For this reason, suitable measures are taken to prevent contact with high voltage parts within the product.

The following protection classes are applicable under the following pre-requisites:

- All electrical plug connections and the coolant pipes are inserted and locked/ screwed
- Appropriate measures are taken on the vehicle-side to prevent the entry of fluids in the product through the interior of the electrical connection lines
- Complete immersion of the product is not permissible.

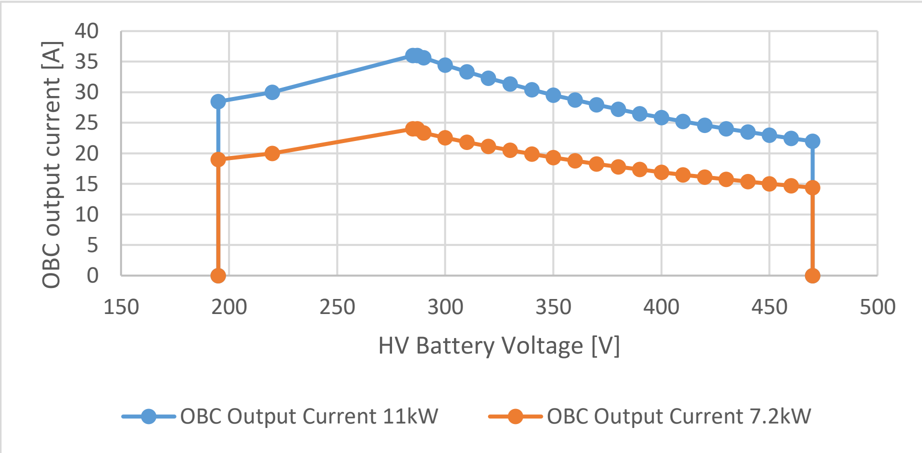
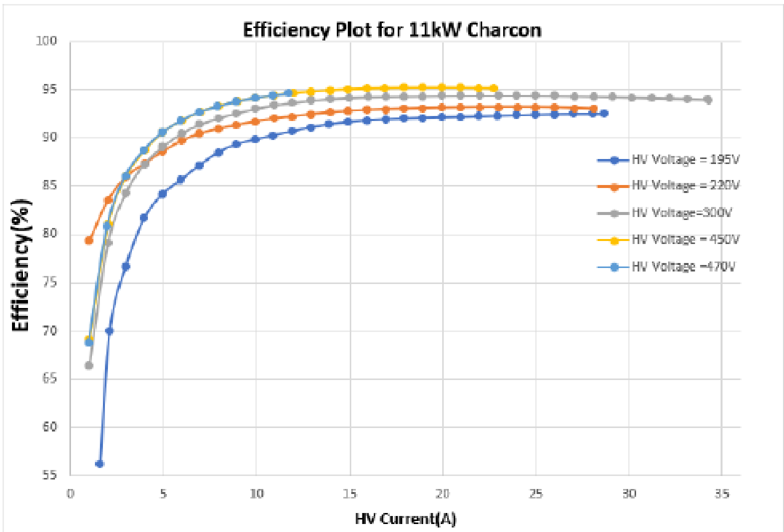
Product State	Protection against	Protection Class	Comments
Product fully assembled	Dust	IP6KX	All electrical and coolant connections are connected. Tightness of coverage according to assembly. BOSCH is not responsible regarding cables and connections.
	Water	IPX6K	
	High pressure water	IPX9K	
	Immersion	IPX7 (passive)	

Table 7: Housing protection class

4.3 Electrical characteristics

4.3.1 Operation Values

The **preliminary** values for operation are defined in the following table:

		EU Variant
OBC Charge	AC Input Voltage Range	Without Derating: [230Vrms, 272 Vrms] With Derating: [180Vrms, 230Vrms]
	AC Frequency	45Hz - 65Hz (45 Hz - 49.5 Hz and 60.5 Hz - 65 Hz with input current limitation)
	max. AC input current	Three phase grid: 16A per phase One phase grid: Phase1=32A
	DC (BAT) Output Voltage Range	Diagram per phase: (current and power limitation) 
	DC (BAT) Output Current Range	[0.5A, 36A]
	Rated Input Current	1-Phase up to 32A 3-Phase Up to 16A per phase
	Efficiency (25°C)	

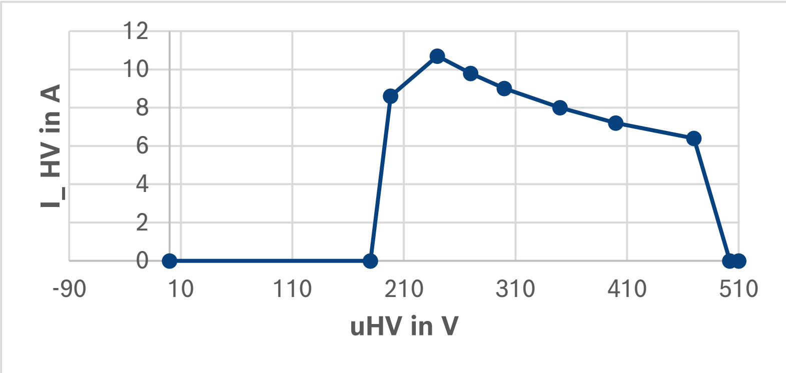
	Maximum HV DC voltage Ripple	+/- 5V
	Standby current	750mA @13.5V, room temperature, current drawn at the KL30
	Quiescent Current	200uA @ 13.5V, room temperature, current drawn at the KL30
	Charging mode	1550mA @ 13.5V, room temperature, current drawn at the KL30
	Isolation resistance	2.5 MOhm (measured between T+/T- and ground)
	Dielectric strength	Verification the Dielectric strength with tests with following withstand voltages: DC: 500V AC: 1550Vrms / 3100Vrms
	HV discharge	< 2 min, passive discharge to below 60 V (measured < TBD s passive)
	Isolation coordination	Pollution degree 2, overvoltage category II based on ICE 60664 Nominal Altitude for AC charging up to 4400 m, for driving (DCDC conversion) up to 5500 m allowed
	Surge&Burst Voltage	Development target for EU variant 4KV – In testing
	Isolation Monitoring concept	The insulation resistance monitoring is not implemented. The OEM has to ensure the insulation coordination between T+ and T-, as well as T+ and GND, and T- and GND.
	Cx/DC link capacitor(max)	Cx cap. Lx / N: 11.6µF (typical) DC-Link cap. per phase: 960µF
	Cy capacitor(max)	Cy cap. Lx / PE: 9.1nF (typical)

Table 8: Charger Operating Range

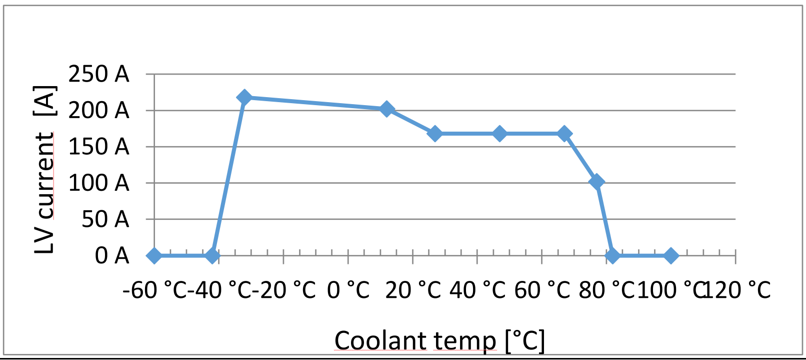
		EU Variant
DCDC Buck Mode	DC Output Voltage (LV)	[10.6V, 15.5V]
	DC current	166A @14,5V

<table>
<tr><td></td><td>DC Output Current (LV)</td><td>166A (additional deratings like derating LV current by coolant temperature apply in addition. For UHV derating only see curve below).

Derating LV current by UHV:



Derating LV current by coolant temp in normal operation mode:


</td></tr>
<tr><td></td><td>DC (BAT) Input Voltage Range</td><td>Without Derating [240V, 475V]

With Derating [180V, 240V] & [475V, 500V]</td></tr>
<tr><td></td><td>Power</td><td>Pmax = 2,4kW 240V-475V

Pmax = 500W 190V-210V (Continuous operation)</td></tr>
<tr><td></td><td>Efficiency</td><td>Average 93% for 5…50% iLvmax</td></tr>
</table>

Table 9: DCDC Electrical Parameters

		EU Variant
Supply Voltage (Details in Fig 13)	[6V, 16V]	Wake-up and CAN Communication Possible (If sensors are not available, replacement values will be sent)
	[8V, 16V]	DCDC Operation range
	[9V, 16V]	Charger Operation range
	Max Voltage on B+	26V for 60s at room temperature 27V for 300ms
Supply currents	Current in sleep mode	<195µA @13,5V ; Tamb<=40°C
	Current in standby mode	<1050mA @13,5V

	Current in typ. operation	<1500mA @13,5V
	Withstand HV DC voltage (passive mode)	550V (10s / 10 times over lifetime) in clarification
	LV reverse current withstanding time	600A for 1sec(Fuse to be used externally to protect charcon)

Table 10: General CharCon specification

4.3.2 Sensor Tolerances

The **preliminary** values for sensor tolerances are defined in the following table:

	Sensor	Error	3sigma (EOL)	Worst case (EOL)
Charger	**IAC** AC current sensor (L1, L2, L3)	Gain-error	+/- 1.7%	+/-4,4%
		Offset	+/- 0.52A	+/- 0,73A
	UAC AC voltage sensor (L1, L2, L3)	Gain-error	+/- 1.4%	+/-1,5%
		Offset	+/- 0.36V	+/- 0,5V
	iHV CHAR Charger output current sensor	Gain-error	+/- 3%	+/-4%
		Offset	-0.65A / +0.88 A	+1,15A / -0,65A
CHAR CON	**UHV** Tnet voltage sensor	Gain-error	+/- 1.4%	+/-1,5%
		Offset	+/- 0.5V	+/- 0,6V
DC/DC	**iHV DCDC** DCDC HV input current sensor	Gain-error	+2,5% / -4,5%	+2,5% / -4,5%
		Offset	+0,5A / -1,5A	+0,5A / -1,5A
	iLV DCDC LV current sensor	Gain-error	+/-2%	+/-3%
		Offset	+ 2,6A / -2,4A	+ 2,6A / -2,4A
	uLV 1 DCDC LV voltage sensor (for control)	Gain-error	+/-1,04%	+1,7% / -1,4%
		Offset	+0,025V / -0,028V	+0,025V / -0,028V
	uLV 2 DCDC LV voltage sensor (for monitoring)	Gain-error	+/-1,04%	+1,7% / -1,25%
		Offset	+0,082V / -0,085V	+0,082V / -0,085V
	ULV3 (UDS)	Gain-error	+/-4,5%	+/-4,5%
		Offset	+/-7V	+/-7V

Table 11: Sensor Tolerances for charger and DCDC

4.4 Climatic characteristics

Intended Use:
During storage, transport and operation, different temperatures, temperature gradients and humidity levels affect the product. This leads to thermo-mechanical aging of the individual components of the product. The product is designed for the following ambient condition in combination with an active cooling as defined in chapter 4.2.1 Cooling of the Product.

Environmental Parameter	Value(s)
Ambient temperature	-40°C to 85°C
Operation humidity	0% to 93% till 65°C (max)

Table 12: Environmental Parameter

Verification:
The resistance of the product against climatic loads is verified according to the Bosch VALT (Validation Accelerated Life Test) Test plan as described in chapter 6.1.

4.5 Chemical characteristics

Intended use:
During the operation and maintenance of the vehicle, reagents such as salt spray, fluids or gases can have an effect on the product and lead to corrosion. As long as the exposure does not exceed a permissible extent, with appropriate material selection or sealing of the housing, it is ensured that the load does not lead to any malfunctions or service life limitations.

Validation:
Chemical characteristics of the CHARCON are validated according to Bosch specification. This is considered in Bosch VALT (Validation Accelerated Life Test) Test plan as described in chapter 6.1.

Impermissible use:
Loads which exceed any of the above-mentioned specifications and tests (e.g., due to exposure with media, higher intensity, aggressive media and longer duration of the load) are not permissible.

Possible consequences:
Visible and invisible damages to the product due to corrosion or material decomposition, with immediate or subsequent function failure, reduction of the warranted service life, safety risks due to impairment of the protection classes.

4.6 Acoustic characteristics

Not yet specified / Not applicable

4.7 Lifetime

With respect to the use and usage conditions described in this TCD, the life of the product is validated for <8000h in terms of miles traveled, and 22,500h of charging, or 300,000km distance driving, or 15 years (whichever occurs first).

The reliability target as basis for lifetime testing is R= 97 % with PA= 80 %.
The commercial warranty and liability is not affected by this and is governed separately by the delivery conditions.

This lifetime statement must be differentiated from the applicable warranty period which expires independently from the duration of this lifetime statement.

Bosch trusts that the OEM will assess if the Bosch-product's lifetime specified in this TCD is in line with the relevant legal lifetime requirements applicable to the OEM's system in the specific target country and whether any particular measures need to be taken in order to comply with relevant legal lifetime requirements (e.g., if the Bosch-product needs to be replaced after the Bosch-product's lifetime period).

The behavior of Bosch-product after its lifetime as stated above is not validated. A safety risk when used beyond the stipulated component's lifetime cannot be ruled out (for potential hazards refer to chapter [2.3]). Therefore, customer has to evaluate what measures to implement when reaching the end of Bosch-product's lifetime in order to avoid such risk (e.g., after customer's evaluation, information to end-customer or other more far-reaching measures).

4.8 Transport, assembly, start and end of operation, storage

Please pay special attention to the safety and warning notes!

4.8.1 Transport

Device will be delivered with caps on HV/AC/signal and coolant inlet and outlet connectors.

4.8.2 Assembly

Please pay special attention to the safety and warning notes and labels.
To avoid issues in testing and contamination of the cooling circuit, it is recommended to unpack, store and handle the product in a clean environment until the product is connected to the electrical and thermal system.
To avoid contact corrosion and contamination of the connections, it is recommended to wear gloves while mounting the component.
If the product was dropped or suffered a severe impact, further use is forbidden. The product shall be labeled as defective and not used further.
Customer must perform an optical check of CHARCON appearance. No defects or visual abnormalities are allowed.

4.8.3 Start and end of operation

Start:	End:
- Tighten all 4 screws - Connect cooling connectors (ensure no leakage) - Connect Signal connector - Connect LV-connectors and screw LV(-) - Connect HV-connectors - Start cooling flow - Start CAN-communication (cl.15) - Check DTC's →Operation Mode OK if there are no DTC's	- Stop running mode/CAN communication - Stop cooling flow - Disconnect Signal connector - Disconnect LV connector - WAIT 3min - Disconnect HV-connectors - Reduce cooling fluid pressure and drain - Disconnect cooling connectors - Release all 4 screws

4.8.4 Storage

The maximum allowed storage/transport (no active operation) time and temperature in a clean and dry environment is:
8 Years (no active operation) (70.080h) with the following allowed conditions
Maximum of 100h: at 70°C and 80% RH and
Maximum of 300h: at 45°C and 80% RH with the
Rest of the time (69.680h): at 23°C und 30% RH

5 Series-accompanying tests

The product is end-of-line tested according to internal guidelines.

6 Testing

6.1 Testing by Bosch

Overview:

Tests	Test Description	Test Environment
System Release		
ECU-MST: ECU Monitoring & Safety Test)	verification of functional and technical safety requirements and architecture concepts (safety aspects taken into account)	HV-Lab, HIL, vehicle
EMC: electromagnetic compatibility	checks whether the device complies the required EMC features (emission, immunity, etc.)	EMC-Lab
RST: robustness system tests	checks the fulfilment of the product/system requirements regarding system robustness. Also covers customer specific tests.	HV-Lab
DIAG: diagnosis Test	checks fulfillment of fault class (one DFC per class) and diagnostic system requirements (legal aspects taken into account)	HV-Lab (vehicle to be ordered by customer)
VERTH:	checks whether the device can be operated in the permissible temperature range	HV-Lab
Electronics Release		
VERDI: verification design integration	checks the HW module integration and whether the integration is done correctly	HV-Lab
Mechanical Release		
VALT: Validation Accelerated Life Test	Checks against the requirements specifications, whether the components and the complete system withstand all the relevant wear and tear mechanisms that are caused by using it in the vehicle.	Environmental test lab
SW Release		
UEKO-check:	covers the monitoring concept “check safety”	HIL and reviews
SEC: security testing	checks the software security integration	HV-Lab
FT: functional tests	checks the fulfilment of the functional software requirements	HIL
Testing prototype manufacturing		
PAV	checks the basic functionalities after production	HV-LAB
Testing in plant		
EOL	checks the basic functionalities after production	HV-LAB

Table 13:Bosch Test list

6.2 Testing by the customer

The customer shall ensure the functionality of the product within the complete system by carrying out appropriate vehicle testing under realistic operating conditions.

Safe use: The customer is responsible for the safe use of the product within the scope of the permissible operating conditions.

7 Assessment of products returned from 0-mileage and from the field

Products are considered good if they fulfill the specifications/test data for 0-mileage and field listed in the TCD.
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8 Appendices and references

8.1.1 REFERENCE TO STANDARDS, EACH CASE WITH THE ISSUE DATE

Law Requirement/ HV Safety Standards:

ISO 17409	Electrically propelled road vehicles - Connection to an external electric power supply - Safety requirements
ISO 6469-1	Electric road vehicles - Safety specification - Part 1: On-board electrical energy storage.
ISO 6469-2	Electric road vehicles - Safety specification - Part 2: Functional safety means and protection against failures.
ISO 6469-3	Electric road vehicles - Safety specifications - Part 3: Protection of persons against electric hazards.
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 – Part 3: Physical and data link layer requirements
LV123	Electrical characteristics and electrical safety of high voltage components in road vehicles- Requirements and tests According to Norm matrix 12.06.2014 covered by "ISO 6469-3: Electrically propelled road vehicles - Safety specifications - Part 2: Vehicle operational safety means and protection against failures”
ISO 19295	Electrically propelled road vehicles - Specification of voltage sub-classes for voltage class B
2000/53/EG	EU- End-of-life vehicle regulation
Regulation (EC) No 1907/2006	concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)
2000/53/EC	Directive 2000/53/EC on End-of-Life Vehicles (ELV)
2011/65/EU	Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS 2)
UN-R 116/00 Suppl.2	Protection of motor vehicles against unauthorized use
UN-R 116/00 Suppl.3	Uniform technical prescriptions concerning the protection of motor vehicles against unauthorized use
UN-R 97/01 Suppl.6	Uniform provisions concerning the approval of vehicle alarm systems (VAS) and of motor vehicles with regard to their alarm systems (AS)
UN-R 97/01 Suppl.8	Approval of vehicle alarm systems (VAS) and of motor vehicles with regard to their alarm systems (AS)
(EU) No 528/2012	Biocidal Products Regulation (BPR), Regulation (EU) No 528/2012
2006/66/EC	Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators
UN-R 116/00 Suppl.5	Protection of motor vehicles against unauthorized use
G.S.R. 207 (E) 05-March-2018	The Regulation of Persistent Organic Pollutants Rules, 2018, G.S.R. 207 (E) 05-March-2018, India
REGULATION (EU) 2019/1021	Regulation (EU) 2019/1021 on persistent organic pollutants

ANSI Z535	Product Safety Signs & Labels

Diagnostics Standards:

ISO 15031 - 5	Road vehicles - Communication between vehicle and external equipment for emissions-related diagnostics Part 5: Emissions-related diagnostic services
ISO 15765 - 4	Road vehicles - diagnosis communication about CAN (DoCAN) - part 4: Requirements for systems relevant for exhaust gas
SAE J 1979	Diagnostic Test Modes
SAE J 2012	Diagnostic Trouble Code Definitions
ISO 11898-1: 2015	Road vehicles — Controller area network (CAN) — Part 1: Data link layer and physical signaling
ISO 15031 - 6	Road vehicles - Communication between vehicle and external test equipment for emissions-related diagnostics, Part 6: Trouble code definitions
ISO 14229 - 1	Road vehicles - Unified diagnostic services (UDS) - Part 1: Specification and requirements
ISO 15765 - 2	Road vehicles - Diagnostic communication over Controller Area Network (DoCAN) - Part 2: Transport protocol and network layer services
ISO 15765-2	ISO transport protocol (Network layer)

Functional Safety:

ISO 26262	2018 Road vehicles - Functional safety

Materials and Design for Environment:

ISO 20653	Road vehicles -Degrees of protection (IP code) - Protection of electrical equipment again foreign objects, water and access
2000/53/EG	EOL End of Life vehicle directive
REACH	Registration Evaluation and Authorization Chemical
IEC 60529	Degrees of protection provided by enclosures (IP Code)

Table 14: Standards/References

Disclaimer: Analysis of Piaggio Standards is in progress to check mapping with the existing standards. Any deviation from the Bosch platfrom design would be considered as the change request.

8.1.2 Definitions, abbreviations, and symbols

3-D	Three-dimensional
A/C	Air conditioning
ABG components	Components subject to type approval
AC	Alternating Current
ADA	Modul-Dia-Allg
AECD	Auxilary Emission Control Device
AGC	Aging-Counter
AOD	Assumption on Design
ASAM	Association for Standardizations of Automation and Measuring Systems
ASC	Active Short Circuit
ASCII	American Standard Code for Information Interchange
ASIC	Application-specific integrated circuit
ASIL	Automotive Safety Integrity Level
ASSY	Assembly
Autosar	Automotive Open Systems Architecture
BEM	battery energy management system
BGA	Ball grid array
BNW	DCDC
BOM	Bill of materials
BS	Blocksize
BSCM	Brake System Control Module
BTV	Part owner
BUR	Bottom-Up Requirement
BZD	Build status documentation
C	Conditional
CAD	Computer-aided design
CAF	Conductive anodic filament (copper ion migration along the glass fiber)
CAN	Controller Area Network
CARB	California Air Resources Board
CCB	Change Control Board
CCP	CAN Calibration Protocol
CDTC	ConfirmedDTC
CF	Consecutive Frame
COP	Carry over Part
CP	Calibration Protocol
CP	Control Pilot
CP-pin	Control Pilot Pin
CRC	Cyclic Redundancy Check
CRL	Certificates Revocation List
CSA	Core Service Authentication
CVN	Calibration Verification Number
CVN	Calibration Verification Numbers
Cvt	Conventional

DCDC	DC-to-DC converter
DDKM	Digital data control model
DECECU	Diagnostic or emission critical ECU
DFC	Diagnostic Failure Code
DIA	Development Interface Agreement
DID	DataIdentifier
DK	diagnostic class
DL	DataLength
DMC	Data matrix code
DMU	Digital Mock-Up
DOP	DATA-OBJECT-PROPERTY
(D)DOS	(Distributed) Denial of Service
DPF	Diesel particulate filter
DSD	data set download
DSDL	data set download
DTC	Diagnostic Trouble Code
DTC-DFCC	ECU's or diagnostic server's symptoms
DUT	Device Under Test
E2E	End-to-End network
EBD	Electronic Brake Force Distribution
EC	European Community
ECE	Economic Commission for Europe
ECU	Electronic Control Unit
EEPROM	Electrically Erasable Programmable Read-Only Memory
EFS	Functional Safety Development Guideline
EMC	Electromagnetic Compatibility
ENTI eNTI	Electronic New Parts Information Sheet
EOL	End of line
ERC	Emission-related component
ESD	Electrostatic Discharge
ESS	EnergyStorageSystem
ESoP	European Statement of Principles
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
EVSEID	Electric Vehicle Supply Equipment ID
FFS	fault-finding strategies
FMEA	Failure modes and effects analysis
FMEDA	Failure mode, effect, and diagnostics analysis
FTA	Fault Tree Analysis
FTTI	Fault Tolerant Time Interval
GND	Ground
GV	Overall ECU network
H h	Hours
HLC	High-level communication
HSD	High-speed data transmission
HSM	Hardware Security Module

HV	High Voltage (>60V)
HVIL	High Voltage Interlock (Pilot line)
HW	Hardware
HiL	Hardware-in-the-loop
I/O	Input and Output
IC	Integrated circuit
ICCPD	In Cable Control and Protective Device
ICT	In-circuit test
IPC	Association Connecting Electronics Industries
IS	Integrationsstufe (Sample phase for prototype vehicle)
IUMPR	In-use Monitor Performance Ratios
IVIS	In-vehicle information system
JIS	Just in sequence
JTAG	Joint Test Action Group
KL30C	T30C
KM km	Kilometers
KSDA	Modul-Dia-Komp
KVS	Engineering data management system
KWP	Keyword Protocol
LCD	Liquid crystal display
LED	Light emitting diode
LG	Plug and charge ECU known as Ladegerät
LIN	Local Interconnect Network
LM	charging management
LSB	Least significant bit
LV	Low Voltage (typically 12V net)
M	Mandatory
MBT	Model Descriptions for Engineering
MCD	Measurement Calibrate Diagnosis
MELF	Metal electrode leadless face
MID	Monitor Identifier
MIL	Malfunction Indication Lamp
MLCC	Multilayer ceramic chip capacitor
MMI	Multimedia-Interface
MOST	Media Oriented Systems Transport
MS	Microsoft
MSB	Most significant bit
N/A n/a	not applicable
NAD	Node Address
NAR	North American Region
NRC	Negative Return Code
NVM	Non-Volatile Memory
N_AE	Network Address Extension
N_AI	Network Address Information
N_SA	Network Source Address
N_TA	Network Target Address

N_TAtype	Network Target Address type
OBC	Onboard Charger
OBD	On-board Diagnosis
OBDC	On Board Data Collector
OBDECUnoECM	(legislated) OBD-ECUs except ECM (Master)
OC	Open Circuit
OCC	Occurrence Counter
OCC	On-board Charge Client
CHARCON	Combined On-board Charger with DCDC Converter
OCY	Operation-Cycle
ODX	Open Diagnostic Data Exchange
OEM	Original Equipment Manufacturer
ORH	Out of Range High
ORL	Out of Range Low
OSI	Open System Interconnection
OSP	Organic surface passivation
OTL	OBD threshold limit
PCB	Printed Circuit Board
PCI	Protocol Control Information
PDM	Product data management
PDTC	PendingDTC
PDU	Protocol Data Unit
PDX pdx	packed odx
PEM	Power Electronics Module
PEU	Power Electronics Unit
PHEV	Plug-in hybrid electric vehicle
PID	Parameter Identifier
PLC	Power line communication
PP	Proximity Pilot, Plug Present
PPM ppm	Parts per million
PR Layer	Protocol Layer
PVE	Production Vehicle Evaluation
PVS	Pilot Production
PnC	Plug & Charge
QA	Quality Assurance
QFN	Quad flat no-leads
QM	Quality management
R	Read
RAH	Rationality High
RAM	Random Access Memory
RB	Robert Bosch
RFID	Radio-frequency identification
RID	RecordDataIdentifier
RIF	Requirements Interchange Format
ROM	Read Only Memory
ROM	Read-only memory

RS	Shunt-test resistance
SAE	Society of Automotive Engineers
SCB	Socket Control Board
SDG	Special Data Group
SE	Simultaneous engineering
SF	Single Frame
SID	Service-ID, Service-Identifier
SID	Subfunction Identifier
SLAC	signal level attenuation characterization
SMD	Surface-mounted device
SN	Sequence Number
SOA	Service Oriented Communications
SOP	Start of Production
SPI	Serial Peripheral Interface
SPN	Suspect Parameter Number
SPRMIB	suppressPosRspMsgIndicationBit
SW	Software
T15	Terminal 15 Terminal for ignition
T30	Terminal 30 Terminal for battery voltage
TBAD	Basic test requirements document
TCD	Technical customer Document
TE	Tyco Electronics
TF	TestFailed
TFSLC	TestFailedSinceLastClear
TFSLC	TestNotCompleteSinceLastClear
TFTOC	TestFailedThisOperationCycle
TG_nominal	Nominal glass transition temperature
TI	Thermal Incident
TI	text identifiers
TID	TestIdentifier
TM	Transceiver Module
TNCTOC	TestNotCompleteThisOperationCycle
TP	Transport protocol
TVP	Parts installation check
U	User-Optional
UDS	Unified Diagnostic Service
UL	Underwriters Laboratories
VAL	Vehicle Abstraction Layer
VDA	German Association of the Automotive Industry
VDC	Vehicle Diagnosis Client
VIN	Vehicle Identification Number
VIS	Vehicle-Information- Specification
VOBD	Vehicle OnBoardDiagnostics
VR	ECU network release
W	Write
W (RAM)	Write (RAM)

WIR	WarningIndicatorRequested
WSC	Workshop-Code
WUC	WarmUp-Cycle
WWH-OBD	Worldwide Harmonized
Wk	Week
XHTML	Extensible HyperText Markup Language
XML	Extensible Markup Language
XV	Exchange-Variant

8.1.3 Figures

8.1.4 Table

9 History

Release	Date	Edited by	Release description
1.0	14.06.2022	Roberto Criscito (PS-PE/PJ-CCON)	First Draft
2.0	02.12.2022	Kathirvelu Kumarasamy (MS/EHB4-PS)	Initial version for EU variant
2.1	19.12.2022	Kathirvelu Kumarasamy (MS/EHB4-PS)	Updated for Review comments
2.2	04.05.2023	Kathirvelu Kumarasamy (MS/EHB4-PS)	Updated latest test info
2.3	12.06.2023	Shalini K N (MS/EHB-PJ-CCON)	TCD updated after Piaggio project kick-off

10 Contact person

- Contact person: Kathirvelu Kumarasamy (MS/EHB4-PS)