VC-EVCC-P

Technical Reference

Version 2.2.0

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Document Information

History

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ssm	2021-02-03	2.1.0	Chapter 7.5 "Quality Documents" added
dim	2021-03-31	2.2.0	Chapter 4.8 Remark about HSOUT added

Reference Documents

No.	Source	Title
[1]	OppCharge	Network and application protocol specification for Siemens – Volvo OppCharge implementation, Version 1.3.0
[2]	Vector	TechnicalReference_CAN-WiFi-GW
[3]	DIN	DIN 70121:2014-12
[4]	DIN	DIN EN 61851-23 - Konduktive Ladesysteme für Elektrofahrzeuge - Teil 23 Gleichstromladestationen für Elektrofahrzeuge (IEC 61851-23:2014)
[5]	DIN	DIN EN 61851-23 Berichtigung 1 - Konduktive Ladesysteme für Elektrofahrzeuge - Teil 23 Gleichstromladestationen für Elektrofahrzeuge (IEC 61851-23:2014/COR1:2016)
[6]	Vector	User Manual
[7]	ISO	ISO 15118-2:2014(E)

Safety Instructions

Caution
To avoid personal injuries and damage to property you have to read and understand the following safety instructions and hazard warnings prior to installation and use of this ECU. Keep this documentation always near the ECU.

Proper Use and Intended Purpose

Caution
The ECU may only be operated according to the instructions and descriptions of this manual. The ECU is exclusively designed for use by skilled personnel as its operation may result in serious personal injuries and damage to property. Therefore, only those persons may operate the ECU who have understood the possible effects of the actions which may be caused by the ECU. Users have to be specifically trained in the handling (e.g. calibration) with the ECU, the applied embedded software and the system intended to be influenced. Users must have sufficient experience in using the ECU safely.

Hazard Warnings

Caution
The ECU may control and/or otherwise influence the behavior of control systems and electronic control units. Serious hazards for life, body and property may arise, in particular without limitation, by interventions in safety relevant systems (e.g. by deactivation or otherwise manipulating the engine management, steering, airbag and/or braking system) and/or if the ECU is operated in public areas (public traffic). Therefore, you must always ensure that the ECU is used in a safe manner. This includes inter alia the ability to put the system in which the ECU is used into a safe state at any time (e.g. by “emergency shutdown”), in particular without limitation in the event of errors or hazards. Furthermore, all technical safety and public law directives which are relevant for the system in which the ECU is used must apply. Provided that serious hazards for life, body and property may occur and before the use in public areas the system in which the ECU is used must be tested according to recognized rules of engineering in a non-public area.

Contents

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1 General

The Vector Controller - Electric Vehicle Communication Controller for Pantograph (VC-EVCC-P) is a generic ECU for 24V environments.

It realizes electrical charging according to OppCharge V1.3.0 (see [1]) in combination with an additional CAN-WiFi-Gateway for communication with the charging infrastructure.

In addition, charging with a roof-mounted pantograph is supported.

The hardware is the VC36PLC-24 with an integrated flash bootloader. VC-EVCC-P includes a modern MICROSAR stack with all relevant application modules to realize electrical charging communication.

Figure 1-1 VC-EVCC-P

The following parts are included in the delivery:

Part	Description
VC-EVCC-P	ECU with integrated software
Documentation	Customer receives a Technical Reference (this document) as well as a User Manual and Charging Sequence Diagrams
Remaining Bus Simulation	CANoe bus simulation for the VC-EVCC-P for bus test and evaluation purposes ▶ CAN database description (dbc) ▶ Diagnostic description file (cdd)

Table 1-1 Delivery Content

2 System Architecture

The VC-EVCC-P is designed to be integrated into the vehicle with one of the following system architectures.

2.1 OppCharge Architecture

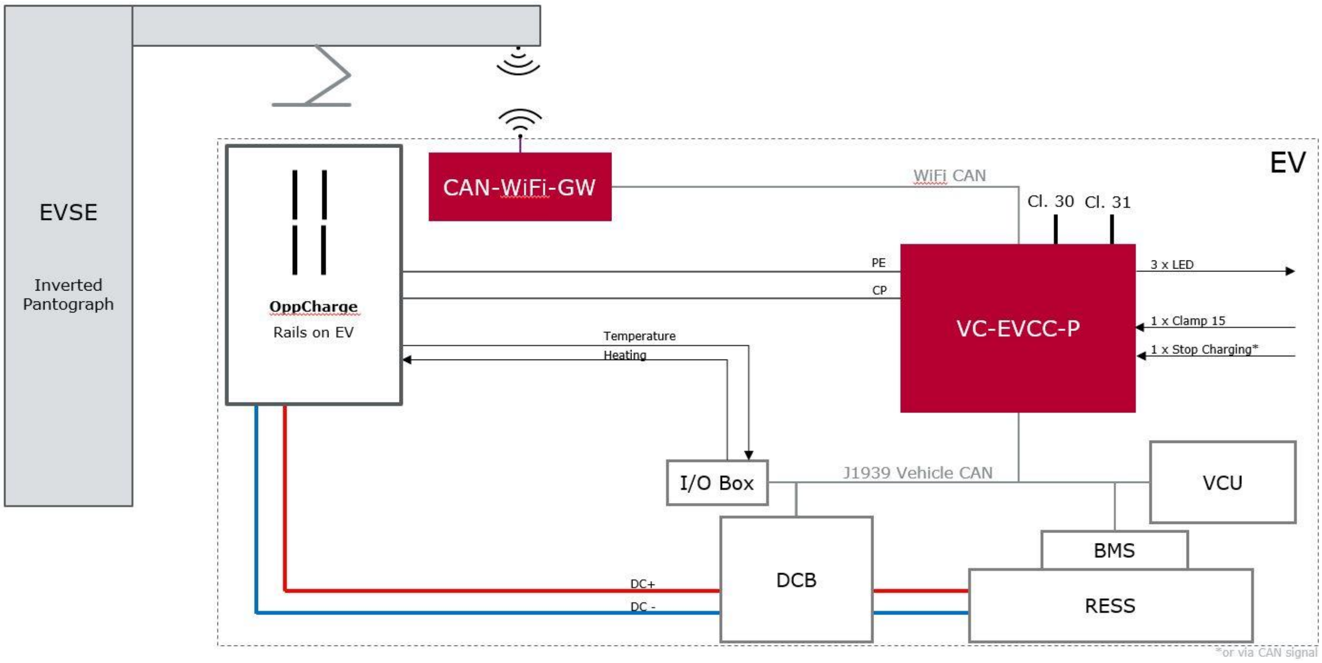

Figure 2-1 System Overview OppCharge (Inverted Pantograph)

Red components are in focus of VC-EVCC-P system context and are provided by Vector. Non-red components, e.g. CAN-I/O Interface, have to be supplied alternatively in case Temperature or Heater control shall be implemented.

2.2 Roof-Mounted Pantograph Architecture

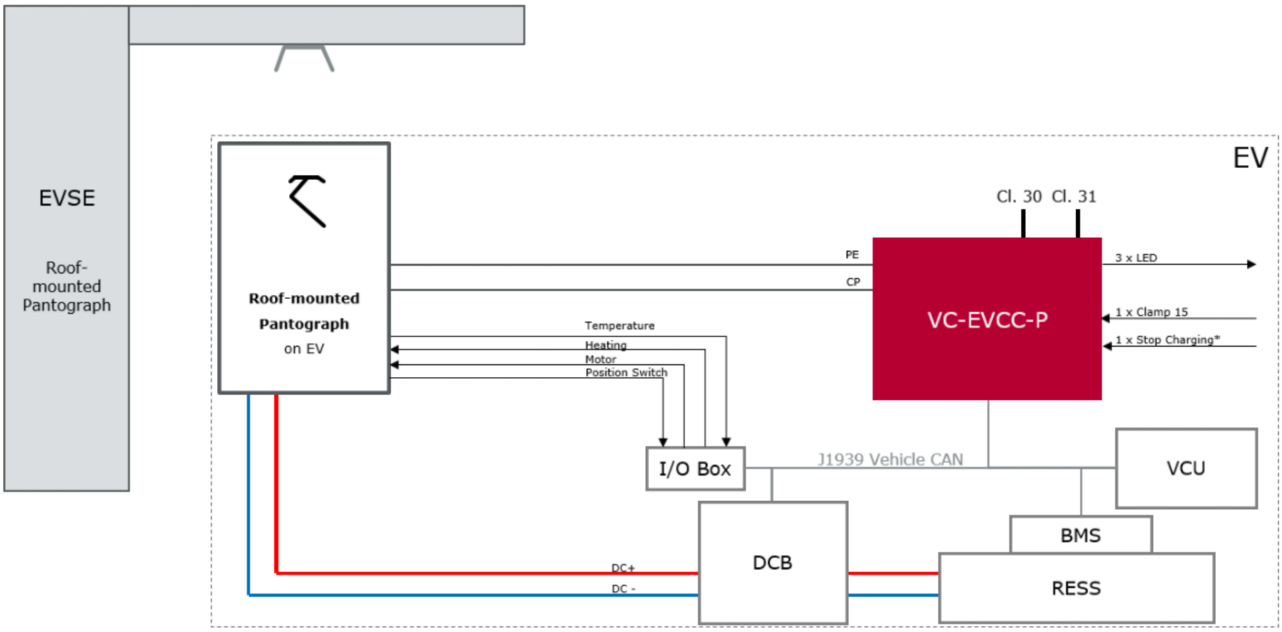

Figure 2-2 System Overview Roof-Mounted Pantograph (RMP)

Red components are in focus of VC-EVCC-P system context and are provided by Vector. Non-red components, e.g. CAN-I/O Interface, have to be supplied alternatively in case Temperature or Heater control shall be implemented.

2.3 Supported Peripherals

Supported peripherals of the VC-EVCC-P:

- CAN-WiFi-Gateway (Vector article no.: 180109):

Due to radio admission restrictions the CAN-WiFi-Gateway is only available for the European Market. For further information about restrictions of usage see [2].

3 ECU

This chapter contains an overview about the VC-EVCC-P. A detailed description of the electronics and housing can be found in the User Manual of the VC-EVCC-P.

3.1 ECU Overview

The following diagram and tables give an abstract overview of the interfaces of the hardware.

Note
There are many different configuration options for the hardware of the VC-EVCC-P. The following figure shows the configuration of the VC-EVCC-P.

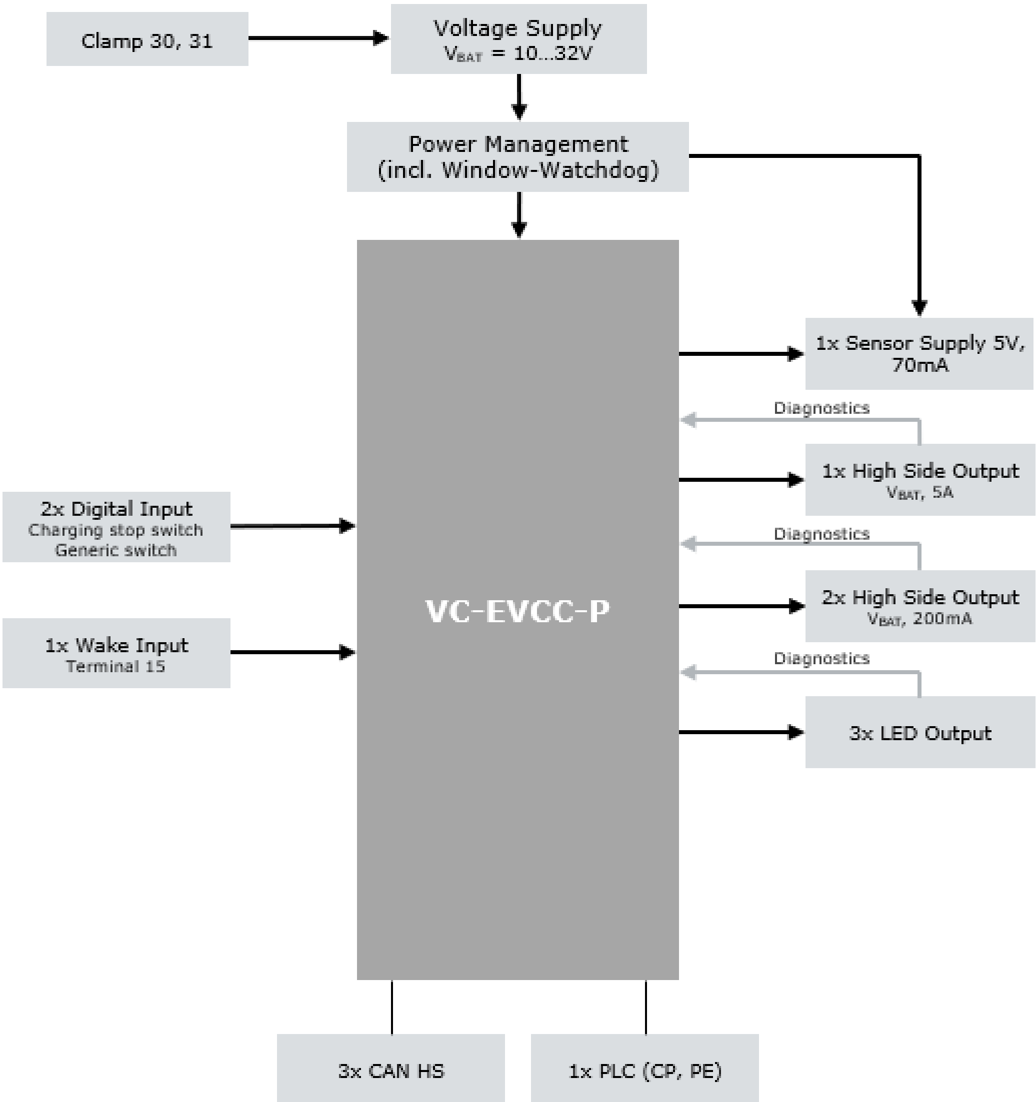

Figure 3-1 VC-EVCC-P Interfaces

3.2 Key ECU Characteristics

Parameter	Description
CPU	SPC564B74L7, 120MHz
Memory	3,0 MB Code-Flash, 4x16 kB Data-Flash, 192 kB RAM
Voltage range	10V … 32V (ISO 16750, Code E)
Connector	Molex CMC36 Hybrid Sealed (36 Pins)
Communication	3x CAN 2.0B (incl. shielding) 1x PLC – Power Line Communication based on IEC61851
I/O	Extensive Inputs and Outputs typically needed for in vehicle powerline charging systems
Temperature Range	-35°C … +85°C (ISO 16750, Code H)
Typical Current Consumption without loads	150mA
Quiescent Current	114µA
Weight	560 g
IP protection	IP6K6K / IP6K7 / IP6K9K (not valid for unsealed housing
Functional Safety	Not considered, development based on QM process

Table 3-1 VC-EVCC-P Key Characteristics

4 Functional Overview

4.1 CP Communication

The CP connection to rails is detected by measurement of CP voltage.

4.2 WiFi Communication (OppCharge only)

The VC-EVCC-P controls DC charging communication between EV and EVSE according to OppCharge V1.3.0 [1] communication via an additional CAN-WiFi-Gateway [2].

The DC charging via ACD (inverted pantograph) is done according to the following sequence:

- WiFi Communication Setup
- Setup of High Layer Communication
- Charge Parameter Discovery
- Cable Check incl. ACD connection, isolation measurement and immobilization of the vehicle
- Pre-Charge
- Power Delivery True
- Current Demand incl. monitoring of charging progress
- Power Delivery False
- Session Stop incl. retraction of ACD to home position and mobilization of the vehicle
- Stop Communication Session

Caution
Plug and Charge is not supported by the VC-EVCC-P.

4.3 Power Line Communication

4.3.1 Low Level communication with EVSE

According to [4] and [5] a low-level communication via PWM on the CP pin is supported. The following PWM duty cycles are valid:

Duty Cycle of CP PWM	Description
0% <= DC < 3%	No charging allowed
3% <= DC <= 7%	Usage of high-level protocol according to ISO 15118 and DIN 70121. Charging without this high-level protocol is not possible.
7% < DC < 8%	No charging allowed
8% < DC < 10%	Max current consumption is 6A
10% <= DC <= 85%	Available current = Duty Cycle * 0,6A
85% < DC <= 96%	Available current = (Duty Cycle – 64) * 2,5A
96% < DC <= 97%	Max current consumption is 80A
97% < DC <= 100%	No charging allowed

Table 4-1 Low Level Communication – Duty Cycle of CP PWM

4.3.2 DC Charging with High Level Communication

According to [3] and [7], high level communication for DC charging is supported. The supported charging profile is EIM (External Identification Means).

Caution
Plug and Charge is not supported by the VC-EVCC-P.

The DC charging is done in the following sequence:

- Get charging clearance from vehicle
- Session setup with EVSE
- Parameter exchange with EVSE (charging mechanism, schedule tables…)
- Isolation measurement with EVSE
- Start pre-charge
- Start charging
- Continuously monitoring of charging progress
- Vehicle state monitoring; Stop button monitoring; Temperature monitoring; EVSE communication; Self-diagnostic of actuators/sensors
- Stop charging

Note
For detailed information, please refer to the DC Charging diagram.

The first schedule table from EVSE will always be accepted on the protocol layer but ignored in the application (charging will start immediately, independent from the received schedule table).

4.4 Stop Button

The button is monitored continuously when the VC-EVCC-P is active. If the button is pressed, the charging is stopped.
Alternatively, the VC-EVCC-P checks a CAN signal for charge abortion information.

In case of an error during ACD retraction the VC-EVCC-P disables immobilization of the vehicle after driver confirmation of full clearance of the vehicle via pushing the Stop Button.

4.5 StopCharge CAN Signal

The StopCharge CAN Signal is monitored continuously when the VC-EVCC-P is active and the feature is activated. If the StopCharge CAN Signal is set to pressed, the charging is stopped.

4.6 Clamp 15 Signal Input

For a discrete wakeup of the ECU instead of a CAN network wakeup the Clamp 15 signal input may be used to wake the ECU and keep it awake. Clamp 15 has to be available during the whole OppCharge sequence.

4.7 Status LEDs

The charging status can be displayed via three LEDs which can be controlled via CAN messages by an external ECU. For more details please refer to the User Manual of the VC-EVCC-P.

4.8 High Side Outputs

Caution
If the VC-EVCC-P suffers from an unintentional GND contact loss, the freewheeling diode inside HSOUT4 may lead to an unexpected flow of current from HSOUT4 via its external load to GND.

As this may lead to undefined behavior of the external load (e.g. a BMS relay), the usage of HSOUT4 must be considered with care.

If in doubt, please contact the Vector support.

Three High Side Outputs are available for general purposes which can be controlled via CAN signals by an external ECU. For more details please refer to the User Manual of the VC-EVCC-P.

> **Caution**
> If the High Side Outputs of the VC-EVCC-P are used, measures must be taken to ensure a load current greater than 15mA (HSOUT0, HSOUT1) respectively 330mA (HSOUT4).
>
> An appropriate load resistor must be calculated depending on the supply voltage. Otherwise, the VC-EVCC-P will detect an OpenLoad error which leads to a switch-off of the respective High Side Output.

4.9 Reprogramming of the ECU Software

Reprogramming will be done via diagnostic CAN (CAN0). Therefore, the ISO 14229 UDS protocol will be used. The following reprogramming features are supported:

- Download of one logic block of application and basic software
- Download of one logic block of Ethernet transceiver firmware
- Download of CWG software
- Security via CRC (no signature)
- Updater for the flash bootloader itself is not supported

4.10 Self-Diagnostics

The VC-EVCC-P continuously monitors all relevant inputs and outputs. The information is available in the self-diagnostic messages of the outputs.

In addition to that the self-diagnostic also includes faults during charging or in case of internal faults.

4.11 ECU State Handling

An ECU wakeup is performed due to following reasons:

- Clamp 15 signal
- CAN wakeup
- Stop button pressed
- Control Pilot Pin active
- Wake up from real time clock

If the ECU is active there are the following awake reasons possible to stay active:

- Clamp 15 signal
- Control Pilot activity
- CAN active
- Active Diagnostic session
- Active OppCharge charging session

In all other cases, the VC-EVCC-P will go to sleep.

4.12 Vehicle Immobilization (OppCharge only)

The VC-EVCC-P starts immobilization of the vehicle as soon as the EVSE is requested to start movement of the ACD. The immobilization of the vehicle is kept active until the EVSE is requested to retract the ACD and the EVSE successfully responds about the ACD back at its home position.

In case of errors during ACD movement the VC-EVCC-P keeps the vehicle immobile and indicates an error value via CAN (see dbc. for details). In this case the driver has to confirm safe position of the ACD via pushing the Stop Button.

4.13 Configuration of Software

The VC-EVCC-P allows configurations of the firmware on the diagnostic channel:

- Baudrate adjustment between 250 kBaud, 500 kBaud and 1 MBaud on the J1939 CAN
- Automatic switch of high side output to wakeup other ECUs
- Charging stop user interaction via charging stop button or dedicated CAN message
- Configurable message cycle times of several messages
- Security Key Constant

4.14 Charging Arbitration

The charging arbitration enables the operation of a VC-EVCC-P together with a VC-VCCU on the same CAN channel. It targets use cases which require two charging options (pantograph and charging inlet) per vehicle but only one option is used at a time.

For charging arbitration, the VC-EVCC-P provides the following configurations on the diagnostic channel:

- Configuration of Primary Source Address
- Configuration of Secondary Source Address
- Activation/Deactivation of Charging Arbitration

For more details, please refer to the User Manual of the VC-EVCC-P [6].

5 Qualification

This section describes the qualification of the VC-EVCC-P. The qualification of Vector ECUs is executed by accredited test labs according to international standards. Documents with detailed test specification and test results are not provided. Further details on the performed tests could be available on individual request.

5.1 Configuration

The qualification of the VC-EVCC-P design has been performed in the following configuration of the hardware.

<table>
<tr><th>Feature</th><th>Configuration</th></tr>
<tr><td>High-speed CAN</td><td><table><tr><th>Channel</th><th>Termination</th><th>Ground coupling</th></tr><tr><td>CAN0</td><td>not populated</td><td>capacitive (100nF)</td></tr><tr><td>CAN1</td><td>120Ω</td><td>directly connected</td></tr><tr><td>CAN2</td><td>120Ω</td><td>capacitive (100nF)</td></tr></table></td></tr>
<tr><td>20mA LED Output</td><td>> PWM dimming</td></tr>
<tr><td>200mA High-Side Output</td><td>> Static digital</td></tr>
<tr><td>5A High-Side Output</td><td>> Freewheeling diode
> Static digital</td></tr>
<tr><td>5A H-Bridge</td><td>> Static digital</td></tr>
<tr><td>IP Protection Class</td><td>> Housing sealed</td></tr>
</table>

Table 5-1 Qualification Configuration

5.2 Electrical Tests

The following electrical tests have been performed:

- E-01 Overvoltage
- E-05 Load dump
- E-06 Superimposed alternating voltage
- E-07 Slow decrease and increase of supply voltage
- E-08 Slow decrease, quick increase of the supply voltage
- E-08 Reset behavior at voltage drop
- E-10 Short interruptions
- E-11 Starting profile

- E-12 Voltage curve with interactive generator regulation
- E-13 Single line interruption
- E-14 Multiple line interruption
- E-15 Reversed voltage
- E-16 Ground reference and supply offset
- E-17 Short circuit protection
- E-19 Quiescent current
- E-22 Overcurrent
- E-23 Direct current supply voltage
- E-24 Voltage transient to engine rpm steps
- E-25 Momentary drop in supply voltage

5.3 EMC Test

The following tests have been performed:

- EMC1 - RF-emissions - Measurements at the artificial network (AN-Test, CISPR 25:2008-03)
- EMC2 - RF-emissions – Measurements with antennas (RE-Test, CISPR 25: 2008-03)
- EMC7 - Transient emissions on supply cables (CTE-Test, ISO 7637-2: 2011-03)
- EMC9 - RF-immunity to interference – Bulk current injection (BCI-Test, ISO/DIS 11452-4: 2010-01)
- EMC10 - RF-immunity to interference – Using antennas (ALSE-Test, ISO 11452-2: 2004-11)
- EMC14 - Transients on supply lines (TSUP-Test, ISO 11452-2: 2004-11)
- EMC15 - Transients on lines except supply lines (TOL-Test, ISO 7637-3: 2007-07)
- EMC16 - Electrostatic discharge – Handling Test (ESDH, ISO 10605: 2008-07)
- EMC17 - Electrostatic discharge – Direct discharge (ESDD, ISO 10605: 2008-07)
- EMC18 - Electrostatic discharge – Indirect discharge (ESDI, ISO 10605: 2008-07)

5.4 Climatic Tests

The following climatic tests have been performed:

- K-01 High / Low temperature storage test
- K-02 Temperature step test
- K-03 High / Low temperature operation test
- K-05 Rapid change of temperature with specified transition duration

- K-06 Salt spray tests - Leakage and function test
- K-07 Salt spray tests - Corrosion test
- K-09 Humid heat, cyclic test - Composite temperature/humidity cyclic test
- K-10 Protection against water
- K-11 Steam jet test
- K-12 Ice water shock test - Splash water test
- K-13 Ice water shock test - Submersion test
- K-14 Damp heat, steady-state test
- K-15 Humid heat, cyclic test - Dewing test
- K-19 Temperature cycle with specified change rate

5.5 Mechanical Tests

The following mechanical tests have been performed:

- M-01 Free fall
- M-03 Dust test
- M-04 Vibration test (Profile D)
- M-06 Mechanical shock (Severity II, Drivers door)

5.6 Life Tests

The following life tests have been performed:

- L-02 High temperature endurance test
- L-03 Alternating temperature endurance test

Assumed Life time: 50,000h / 15 Years

5.7 Chemical Tests

The following chemical tests have been performed:

- AA - Diesel fuel
- BA - Engine oil
- BE - Greases
- BF - Silicone oil
- CC - Antifreeze fluid
- CD - Urea
- CG - Protective lacquer remover

- CA - Battery fluid
- CE - Cavity protection
- CF - Protective lacquer
- DF - Cold cleaning agent
- DJ - Ammonium containing cleaner
- EB - Transpiration
- ED - Refreshment containing caffeine and sugar
- EF - Cream, coffee whitener
- DB - Vehicle washing chemicals
- DC - Interior cleaner
- DD - Glass cleaner
- DE - Wheel cleaner
- EE - Runway de-icer
- AE - Methanol
- DG - Acetone
- DH - Cleaning solvent
- DK - Denatured alcohol

6 Industrialization

This section describes the elements of the VC-EVCC-P industrialization, which are installed and released by Vector:

- Production engineering
  - Production requirements
  - Quality requirements
  - Control plan
  - P-FMEA
  - D-FMEA
- Production installation
  - Series Production line for electronic parts
  - Automated Optical Inspection (AOI)
  - In Circuit Test (ICT)
  - Production line for mechanical assembly
  - Leakage test
  - Generic End of Line Test (EOL)
- Production Specification
  - The common part of production is described in the Production Specification and is released by Vector.

Note
The documents listed in this chapter are for internal documentation of processes only. They are not released for external use or delivery to Customer.

7 Delivery Content

The VC-EVCC-P hardware is packed in a single packaging and shipped as off-the-shelf product from Vector warehouse. The standard delivery for software and documents takes place via download link as ZIP file from the Vector homepage.

7.1 ECU

Based on the offer and order the customer will receive an off-the-shelf product:

> VC-EVCC-P Series (No.: 89518)

> VC-EVCC-P Evaluation (No.: 89519)

The ECUs are stored inside the cardboard package. The goods will be extracted from the stock as per ordered quantity and packed individually within our logistics department in Stuttgart.

7.2 Packaging

The VC-EVCC-P is packed in a single box (non ESD) with the following description:

> Approximate sizing of a single package: 250 mm x 191 mm x 64 mm (L x W x H, approximately)

> Approximate weight: 0,74 kg (approximately, Cardboard 0,18 kg + ECU 0,56 kg)

Figure 7-1 VC-EVCC-P packed in Cardboard Package

Several ECUs in one shipment are packed in overpacks, e.g.:

> 5 ECUs: Approximately 450 x 320 x 320 mm, 5 kg

> 10 ECUs: Approximately 560 x 360 x 310 mm, 10 kg

> 25 ECUs: Approximately 800 x 600 x 400 mm, 25 kg

7.3 Software

> VC-EVCC-P for vFlash package (.vflashpack)
> CANoe project (.cfg)
> CAN J1939 communication matrix (.dbc)
> WiFi CAN communication matrix (.dbc)
> Diagnosis CAN communication matrix (.dbc)
> Diagnosis description file for CANdela Studio (.cdd)

7.4 Technical Documents

> Release Notes VC-EVCC-P (.pdf)
> Technical Reference VC-EVCC-P (.pdf)
> Technical Reference CAN-WiFi-Gateway (.pdf)
> User Manual VC-EVCC-P (.pdf)
> User Manual CAN-WiFi-Gateway (.pdf)
> Charging Sequence Description OppCharge (.pdf)
> Charging Sequence Description Roof-mounted Pantograph (.pdf)
> Envelope model 3D (STEP)
> VC-EVCC-P technical drawing (2D)
> VV-Report VC36PLC-24 (.pdf)*

7.5 Quality Documents

The following quality documents can be made accessible to a customer representative remotely:

> PFMEA (Top 10)
> Control Plan

*will be provided if required

8 Glossary and Abbreviations

Term	Description
AC	Alternating Current
ACD	Automatic Connection Device
AUTOSAR	AUTomotive Open System ARchitecture
CAN	Controller Area Network
.cdd	CANdela Diagnostic Description File
CP	Control Pilot
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CWG	CAN-WiFi-Gateway
DC	Direct Current
DCB	Disconnecting Circuit Breaker
ECU	Electronic Control Unit
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
LED	Light Emitting Diode
PLC	Power Line Communication
PE	Physical Earth
PP	Proximity Pin / Plug Present
PWM	Pulse-Width Modulation
QM	Quality Management
RAM	Random Access Memory
RESS	Rechargeable Energy Storage System
RMP	Roof-mounted Pantograph
UDS	Unified Diagnostic Services
V2G	Vehicle-to-Grid
VAS	Value Added Services
VC-EVCC-P	Vector Controller – Electric Vehicle Communication Controller for Pantograph
VDV	Verband Deutscher Verkehrsunternehmen
WiFi	Wireless communication according to IEEE-802.11