VC-EVCC

Technical Reference

Version 1.2.0

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Document Information

History

Author	Date	Version	Remarks
dim	2021-03-21	1.1.0	Chapter 4.7 Remark about HSOUT added
dim/ssm	2021-05-19	1.2.0	Document updates regarding formalities

Reference Documents

No.	Source	Title
[1]	DIN	DIN 70121:2014-12
[2]	DIN	DIN EN 61851-23 - Konduktive Ladesysteme für Elektrofahrzeuge - Teil 23 Gleichstromladestationen für Elektrofahrzeuge (IEC 61851-23:2014)
[3]	DIN	DIN EN 61851-23 Berichtigung 1 - Konduktive Ladesysteme für Elektrofahrzeuge - Teil 23 Gleichstromladestationen für Elektrofahrzeuge (IEC 61851-23:2014/COR1:2016)
[4]	Vector	User Manual VC-EVCC (*available within SOP*)
[5]	ISO	ISO 15118-2:2014(E)
[6]	VDV	VDV 261 specification
[7]	SAE	SAE J3068 Electric Vehicle Power Transfer System Using a Three-Phase Capable Coupler

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.

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1 General

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

It realizes electrical charging according to DIN SPEC 70121 see [1] and ISO 15118 see [5] for power line communication (PLC) with the infrastructure.

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

Figure 1-1 VC-EVCC

The following parts are included in the delivery:

Part	Description
VC-EVCC	ECU with integrated software
Documentation	Customer receives a Technical Reference (this document) as well as a User Manual and Charging Sequence Diagrams, see chapter 6.4
Remaining Bus Simulation	CANoe bus simulation for the VC-EVCC 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 is designed to be integrated into the vehicle with the following system architecture.

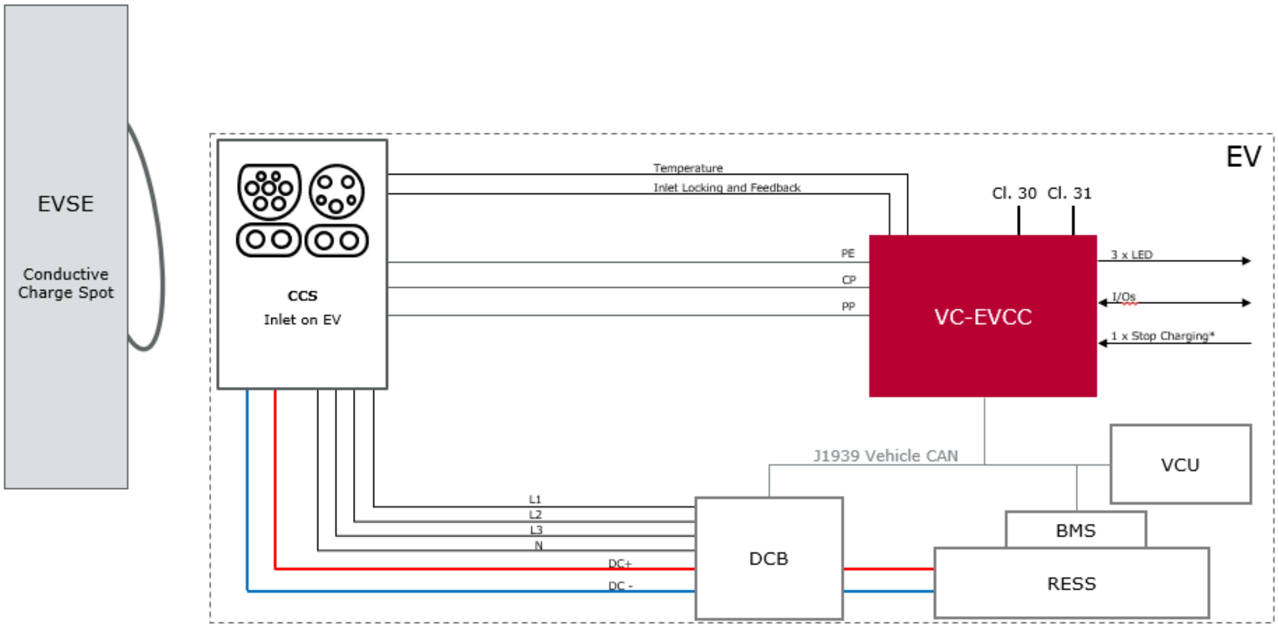

Figure 2-1 System Overview Inlet Charging

2.1 Supported Peripherals

The supported peripherals for inlet charging depend on the charging standard:

- **Charging standard CCS-1 (Combo 1 Inlet):**
  - Phoenix CCS Type 1 Inlet EV-T1GBIE12-1AC series (inlet w. lock)
  - Phoenix CHARX T1HBI12 series (inlet w. lock) **with restrictions (see caution note below)**
- **Charging standard CCS-2 (Combo 2 Inlet):**
  - Amphenol HVCO-CF6-ATR8-SF series (inlet) & C-NEVDC12V_ELOCK (lock)
  - Phoenix CCS Type 2 Inlet EV-T2GBIE12-1AC series (inlet w. lock)
  - Phoenix CCS Type 2 Inlet EV-T2GBIE12-3AC series (inlet w. lock)
  - Phoenix CHARX T2HBI12 series (inlet w. lock) **with restrictions (see caution note below)**
  - REMA REV-2C series (inlet) & REMA CCS Actuator (lock)

Caution
The Phoenix Inlets CHARX T1HBI12 and CHARX T2HBI12 (Generation 4) use a different PT1000 characteristic curve than implemented within the VC-EVCC. As a result, the VC-EVCC will not stop charging at the critical temperature of 90°C.

Instead, the vehicle must monitor the resistance values of PTC1 and PTC2 which are transmitted on the J1939 vehicle CAN. The vehicle is responsible to stop charging once a temperature of 90°C is reached.

- For details, please refer to the User Manual

- Inlet manufacturers are continuously developing inlets and adapting them to the new requirements. For this reason, the range of available inlets is also changing. Once other inlets are used than mentioned above, please contact the Vector support in order to check the compatibility with the VC-EVCC.

3 ECU

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

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. The following figure shows the configuration of the VC-EVCC.

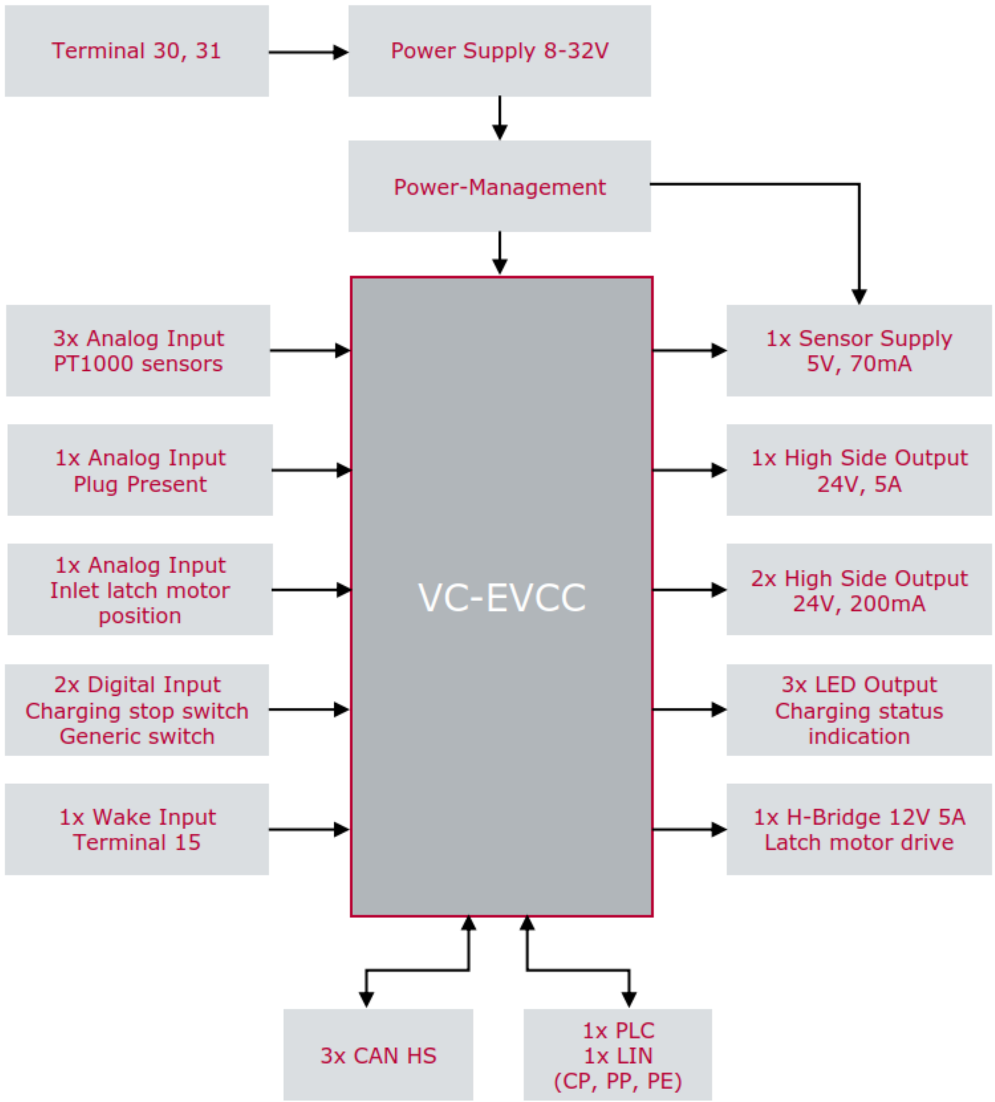

Figure 3-1 VC-EVCC Interfaces

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	8V … 32V (ISO 16750, Code E)
Overvoltage 2 min	48V
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	203µA
Weight	560 g
IP protection	IP6K6K / IP6K7 / IP6K9K (not valid for unsealed housing
Functional Safety	Safety targets according to ASIL B

Table 3-1 VC-EVCC Key Characteristics

4 Functional Overview

4.1 Power Line Communication

4.1.1 Low Level Communication with EVSE

According to [2] and [3] 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

4.1.2 AC Charging with Low Level Communication

With the low-level communication, AC charging can be performed in the following sequence:

> Lock coupler after plugged into inlet
> Establish communication to EVSE via CP
> Get charging clearance from vehicle
> Start charging
> Continuous monitoring of charging progress
> Vehicle state monitoring; Stop button monitoring; Temperature monitoring; EVSE communication; Self-diagnostic of actuators/sensors
> Stop charging
> Release coupler after a pressed stop button or a CAN signal

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

4.1.3 DC Charging with High Level Communication

According to [1] and [5], high level communication for DC charging is supported. The supported charging profile is EIM (External Identification Means).

The DC charging is done in the following sequence:

> Lock coupler after plugged into inlet
> 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
> Release coupler after a pressed button or StopCharge CAN signal

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

4.2 Stop Button

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

> **Caution**
> The voltage levels at the inlet power supply pins are not checked by the VC-EVCC prior to unlocking the coupler. This must be done by the other system components and controlled by the CAN signal which sets the signal VCVCCU_Vehicle_PlugUnlockPermission.
>
> Please refer to the UserManual_VC-EVCC for details (chapter TBD) [4].

4.3 StopCharge CAN Signal

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

4.4 Generic Switch Input

An additional digital input to connect an additional button. Besides, the generic input is used for the charging arbitration.

4.5 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.

4.6 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.

4.7 High Side Outputs

> **Caution**
> If the VC-EVCC 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.

Caution
If the High Side Outputs of the VC-EVCC 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 will detect an OpenLoad error which leads to a switch-off of the respective High Side Output.

4.8 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
- Security via CRC (no signature)
- Updater for the flash bootloader itself is not supported

4.9 Self-Diagnostics and Fault Memory

The VC-EVCC 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.

Furthermore, the VC-EVCC includes a fault memory that can store several DTCs.

4.10 ECU State Handling

An ECU wakeup is performed due to following reasons:

- Clamp 15 signal
- CAN wakeup
- Stop button pressed
- Vehicle coupler connected
- 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

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

4.11 Coupler Present Detection

For the coupler present detection, the proximity pin (PP) or the PWM signal of the control pilot line (CP) is used.

4.12 Locking / Unlocking the Combo2 and Combo1 Coupler

The locking / unlocking of the Combo2 and Combo1 coupler is done with a motor, controlled by an H-Bridge.

The coupler will be locked when:

> A vehicle coupler is detected and

> A CAN lock signal is received

> If the coupler was unlocked but not removed after a certain time

The locking is performed after a specified time the coupler was detected.

The coupler will be unlocked when:

> An unlock message is received on CAN and

> The charging stop button is pressed or

> [in case of Combo1] the S3Switch is pressed or

> The StopCharge CAN Signal is pressed

4.13 Temperature Monitoring

The supported Combo2 and Combo1 vehicle inlets have up to 3 temperature sensors:

> One sensor is used for AC charging

> Two sensors are used for DC charging

4.14 Configuration of Software

The VC-EVCC 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

4.15 Value Added Services (VAS)

Value added service are additional service which are not part of the V2G communication and not mandatory for charging. The VC-EVCC supports VAS according to ISO 15118-2 [5] and VDV 261 [6].

4.16 Charging Arbitration

The charging arbitration enables the operation of two VC-EVCCs on the same CAN channel. It targets use cases which require two charging inlets (two VC-EVCCs) per vehicle but only one charging inlet is used for charging at a time.

For charging arbitration, the VC-EVCC 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 [4].

4.17 3-Phase Charging

The VC-EVCC supports 3-Phase Charging ‘LIN over CP’ according to SAE J3068 [7].

4.18 Charging Schedules

The VC-EVCC supports Charging Schedules according to ISO15118 [5].

4.19 Plug and Charge

The VC-EVCC supports Plug and Charge (‘PnC’) according to ISO15118-2 [5].

4.20 Functional Safety

The VC-EVCC is developed to fulfill functional safety goals rated with ASIL_B.

Note
Due to the safety concept of the VC-EVCC, E2E protection according to AUTOSAR Release 4 has to be implemented.

5 Industrialization

This section describes the elements of the VC-EVCC 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.

6 Delivery Content

The VC-EVCC 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.

6.1 ECU

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

> VC-EVCC Series (No.:89524)

> VC-EVCC Evaluation (No.:89523)

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.

6.2 Packaging

The VC-EVCC 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 6-1 VC-EVCC 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

6.3 Software

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

6.4 Technical Documents

> Release Notes VC-EVCC (.pdf)
> Technical Reference VC-EVCC (.pdf)
> User Manual VC-EVCC (.pdf)
> Safety Manual VC-EVCC (.pdf)
> Charging Sequence Description AC/DC (.pdf)
> Envelope model 3D (STEP)
> VC-EVCC technical drawing (2D)
> VV-Report VP-EVCC (.pdf) *

6.5 Quality Documents

> No additional quality documents will be provided

*will be provided if required

7 Glossary and Abbreviations

Term	Description
AC	Alternating Current
AOI	Automated Optical Inspection
BMS	Battery Management System
CAN	Controller Area Network
CCS	Combined Charging Standard
.cdd	CANdela Diagnostic Description File
CP	Control Pilot
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
DC	Direct Current
DCB	Disconnecting Circuit Breaker
E2E	End-To-End
ECU	Electronic Control Unit
EMC	Electromagnetic Compatibility
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
(D- / P-) FMEA	(Design / Process) Failure Mode and Effects Analysis
ICT	In Circuit Test
LED	Light Emitting Diode
PLC	Power Line Communication
PE	Physical Earth
PP	Proximity Pin / Plug Present
PWM	Pulse-Width Modulation
RAM	Random Access Memory
RESS	Rechargeable Energy Storage System
UDS	Unified Diagnostic Services
V2G	Vehicle-to-Grid
VAS	Value Added Services
VC-EVCC	Vector Controller – Electric Vehicle Communication Controller
VDV	Verband Deutscher Verkehrsunternehmen

8 Contact

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