VECTOR

# Power Electronics Protocol over CAN PEP-CAN

## Networking and Application Protocol Requirements

Version 1.4 of 2022-10-15

| | |
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VECTOR

# Contents

# Change History

| Date | Name | Changes |
|---|---|---|
| 2021-02-15 | mkiefer | Release Version 1.0 |
| 2021-05-19 | mkiefer | Clarified use of status signal in PECCStatus2 message |
| 2021-08-15 | mkiefer | Added stopCharging message |
| 2021-09-15 | mkiefer | CAN message IDs are now relative to a base address |
| 2021-11-03 | mkiefer | Clarified importance of isolationStation on reset |
| 2022-01-25 | mkiefer | Added chargingSessionInfo message |
| 2022-05-25 | mkiefer | Added chargingSessionInfo2 message |
| 2022-05-25 | mkiefer | Updated charging sequence diagram |
| 2022-08-26 | vistio | Added new input/output related messages |
| 2022-08-26 | vistio | Added explanation on EVSE agnostic messages |
| 2022-08-26 | vistio | Marked SECCSensors message as deprecated for future versions |
| 2022-10-10 | mkiefer | Added/Updated PeccLimits and ChargingSessionInfo for BPT |

# 1 General

## 1.1 Scope

This document specifies the communication protocol between the Power Electronics Communication Controller (PECC) and the Supply Equipment Communication Controller (SECC). This Power Electronics Protocol (PEP-CAN) is designed to control and monitor the energy transfer of a power electronics used in the context of Electric Vehicle (EV) charging. Its design is based on the requirements of the EV communication protocols supported by the vSECC Controllers.

## 1.2 Communication

The communication is based on the CAN protocol. The messages and control flow are inspired by the websocket-based PEP-WS protocol. The signals in the CAN messages have the same meaning as their respective counterparts in the websocket-based PEP-WS protocol. Refer to the PEP-WS document for further details and explanations of the signals.

## 1.3 CAN-ID Base Address Handling

All CAN-IDs are relative to a base address. Within the provided .dbc file, a base address of 0x300 is assumed for the single EVSE in use. The EVSE agnostic messages start from 0x500.

## 1.4 Differences to the websocket-based PEP-WS protocol

- There is no cableCheck message. It is part of the chargingState signal in the VehicleStatus message.
- There is no contactorsStatus message. Requests to change the contactors status is done via the targetContactorsStatus signal in the VehicleStatus message.
- Error handling is simplified compared to websocket-based PEP-WS. The PECC can send proprietary status/error information via the status signal in the PECCStatus message. This information is not interpreted by the SECC, but can be used for monitoring/reporting scenarios and can be forwarded to a Charging Station Management System (CSMS).

## 1.5 CAN message format

The CAN message format is modeled inside the provided .dbc file and can be viewed with the Vector CANdb++ Editor. It can be downloaded here: CANdb++. The .dbc file opened with the CANdb++ editor gives a complete overview and a more detailed insight of the CAN messages and signals. We recommend using the editor instead of the following extract (in tables) in this document.

# 2 CAN Messages

Please note that EVSE specific messages such as `VehicleStatus` use a different base address (`base address`) than the EVSE agnostic messages such as `DigitalIns` (*base address i/o*).

## 2.1 VehicleStatus (*base address* + 0x1)

This message is sent periodically (250ms) by the SECC.

BatteryStateOfCharge, TargetVoltage and TargetCurrent values are not valid in the STANDBY and CABLE_CHECK states. EvConnectionState is only informational, the charging cycle is controlled by ChargingState.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| targetContactorsStatus | 0 | 1 | Unsigned | 1 | 0 | 1 | None | contactorsStatusType |
| evConnectionState | 1 | 2 | Unsigned | 1 | 0 | 3 | None | evConnectionStateType |
| chargingState | 3 | 3 | Unsigned | 1 | 0 | 7 | None | chargingStateType |
| targetVoltage | 8 | 16 | Unsigned | 0.1 | 0 | 6553.5 | V | None |
| targetCurrent | 24 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | A | None |
| batteryStateOfCharge | 40 | 7 | Unsigned | 1 | 0 | 100 | % | None |
| cableCheckVoltage | 48 | 16 | Unsigned | 1 | 0 | 65535 | V | None |

## 2.2 PECCStatus1 (*base address* + 0x2)

This message is sent periodically (250ms) by the PECC.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| contactorsStatus | 0 | 1 | Unsigned | 1 | 0 | 1 | None | contactorsStatusType |
| operationalStatus | 1 | 1 | Unsigned | 1 | 0 | 1 | None | operationalStatusType |
| isolationStatus | 2 | 3 | Unsigned | 1 | 0 | 7 | None | isolationStatusType |
| drivenVoltage | 8 | 16 | Unsigned | 0.1 | 0 | 6553.5 | V | None |
| drivenCurrent | 24 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | A | None |
| temperature | 40 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |

## 2.3 PECCStatus2 (*base address* + 0x3)

This message is sent periodically (250ms) by the PECC.

The PECC can send proprietary status/error information via the status signal. This information is not interpreted by the SECC, but can be used for monitoring/reporting scenarios and can be forwarded to a Charging Station Management System (CSMS).

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| measuredVoltage | 0 | 16 | Unsigned | 0.1 | 0 | 6553.5 | V | None |
| measuredCurrent | 16 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | A | None |
| status | 32 | 16 | Unsigned | 1 | 0 | 65535 | None | None |

## 2.4 PECCLimits1 (*base address* + 0x4)

This message is sent periodically (250ms) by the PECC.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| limitVoltageMin | 0 | 16 | Unsigned | 0.1 | 0 | 6553.5 | V | None |
| limitVoltageMax | 16 | 16 | Unsigned | 0.1 | 0 | 6553.5 | V | None |
| limitPowerMax | 32 | 16 | Unsigned | 10 | 0 | 655350 | W | None |
| limitPowerMin | 48 | 16 | Unsigned | 10 | 0 | 655350 | W | None |

## 2.5 PECCLimits2 (*base address* + 0x5)

This message is sent periodically (250ms) by the PECC.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| limitCurrentMin | 0 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | A | None |
| limitCurrentMax | 16 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | A | None |

## 2.6 PECCLimits3 (*base address* + 0xC)

This message is sent periodically (250ms) by the PECC. Only required for ISO 15118-20 and bi-directional power transfer (BPT).

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| limitDischargeCurrent-Min | 0 | 16 | Unsigned | -0.1 | -6553.5 | 0 | A | None |
| limitDischargeCurrent-Max | 16 | 16 | Unsigned | -0.1 | -6553.5 | 0 | A | None |
| limitDischargePower-Min | 32 | 16 | Unsigned | -10 | -655350 | 0 | W | None |
| limitDischargePower-Max | 48 | 16 | Unsigned | -10 | -655350 | 0 | W | None |

## 2.7 Reset (*base address* + 0x6)

This message is sent event-based (not periodically) by the SECC, requesting a reset of the PECC. When this message is sent, the PECC shall return to a valid, well-defined standby state. In this state, the contactors are open, the driven voltage and current are set to 0 and the operationalStatus is “operative”. To prevent the isolation check from being skipped for the next charging session, make sure to also set the `isolationStatus` to invalid. The message has a DLC of 0, and contains no data.

## 2.8 SECCSensors (*base address* + 0x7)

Please note: This message will be *removed* in a future PEP-CAN version and is not recommend for new implementations. Please use the "AnalogIns1", "AnalogIns2" and "AnalogIns3" messages instead.

This message is only sent if the SECC provides sensor inputs, then it is sent periodically (1000ms). It contains readings of two temperature sensors (PT 1000 type) connected to the SECC.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| temperatureSensor1 | 0 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |
| temperatureSensor2 | 16 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |

## 2.9 VehicleId (*base address* + 0x8)

This message is sent whenever a vehicle is connected and contains the vehicle identification, e.g. the MAC address. If no vehicle ID is available or the vehicle communication protocol does not support it, a default value of *FF:FF:FF:FF:FF:FF* is sent.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| vehicleId | 0 | 48 | Signed | 1 | None | None | None | None |

## 2.10 StopCharging (*base address* + 0x9)

This message is sent event-based (not periodically) by the PECC, requesting a graceful termination of the current charging session. If no charging session is running, or it cannot be terminated in the current state, this message SHALL be ignored. The message has a DLC of 0, and contains no data.

## 2.11 ChargingSessionInfo1 (*base address* + 0xA)

This message is sent periodically (250ms) by the SECC. The `chargingProfileMaxPowerLimit` value is updated, whenever the SECC applies a new charging profile (e.g. sent by the CSMS). `timeToFullSoc` is only valid during a charging session.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| chargingProfileMax-PowerLimit | 0 | 16 | Unsigned | 10 | 0 | 655350 | W | None |
| timeToFullSoc | 16 | 16 | Unsigned | 1 | 0 | 65535 | s | None |

## 2.12 ChargingSessionInfo2 (*base address* + 0xB)

This message is sent periodically (250ms) by the SECC. The values inside this message are only valid during a charging session. Some EV limits are not available if the charging standard in use does not support it or the EV does not provide it.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| evMaxVoltage | 0 | 16 | Unsigned | 1 | 0 | 65535 | V | None |
| evMaxCurrent | 16 | 16 | Unsigned | 1 | 0 | 65535 | A | None |
| evMaxPower | 32 | 16 | Unsigned | 1000 | 0 | 65535000 | W | None |

## 2.13 ChargingSessionInfo3 (*base address* + 0xD)

This message is sent periodically (250ms) by the SECC. The values inside this message are only valid during a charging session. Some EV limits are not available if the charging standard in use does not support it or the EV does not provide it.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| evMinVoltage | 0 | 16 | Unsigned | 1 | 0 | 65535 | V | None |
| evMinCurrent | 16 | 16 | Unsigned | 0.1 | 0 | 6553.5 | A | None |
| evMinPower | 32 | 16 | Unsigned | 10 | 0 | 655350 | W | None |
| chargeMode | 48 | 8 | Signed | 1 | None | None | None | chargeModeType |

## 2.14 ChargingSessionInfo4 (*base address* + 0xE)

This message is sent periodically (250ms) by the SECC. The values inside this message are only valid during a charging session. Some EV limits are not available if the charging standard in use does not support it or the EV does not provide it.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| evMinDischarge-Current | 0 | 16 | Unsigned | -0.1 | -6553.5 | 0 | A | None |
| evMaxDischarge-Current | 16 | 16 | Unsigned | -0.1 | -6553.5 | 0 | A | None |
| evMinDischargePower | 32 | 16 | Unsigned | -10 | -655350 | 0 | W | None |
| evMaxDischargePower | 48 | 16 | Unsigned | -10 | -655350 | 0 | W | None |

## 2.15 DigitalOuts1 (*base address i/o* + 0x500)

This message is sent periodically (250ms) by the PECC. Please note that this message is EVSE agnostic and therefore has a fixed CAN-ID without a base address being applied. The PECC can define the desired states of the vSECC's digital outputs d1 to d15. Only output states for which the respective mask bit (e.g. "doutMask2" for "dout2") has been set are evaluated and applied. Both DigitalOutputs1 and DigitalOutputs2 can be sent simultaneously on the same bus. However, it is not recommended to access the same outputs on both messages.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| dout1 | 0 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout2 | 1 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout3 | 2 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout4 | 3 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout5 | 4 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout6 | 5 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout7 | 6 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout8 | 7 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout9 | 8 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout10 | 9 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout11 | 10 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout12 | 11 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout13 | 12 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout14 | 13 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout15 | 14 | 1 | Unsigned | 1 | 0 | 1 | None | None |

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| doutMask1 | 16 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask2 | 17 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask3 | 18 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask4 | 19 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask5 | 20 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask6 | 21 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask7 | 22 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask8 | 23 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask9 | 24 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask10 | 25 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask11 | 26 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask12 | 27 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask13 | 28 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask14 | 29 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask15 | 30 | 1 | Unsigned | 1 | 0 | 1 | None | None |

## 2.16 DigitalOuts2 (*base address i/o* + 0x501)

This message is sent periodically (250ms) by the PECC. The PECC can define the desired states of the SECC's digital outputs d1 to d15. Only output states for which the respective mask bit (e.g. "doutMask2" for "dout2") has been set are evaluated and applied. Both DigitalOutputs1 and DigitalOutputs2 can be sent simultaneously on the same bus. However, it is not recommended to access the same outputs on both messages.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| dout1 | 0 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout2 | 1 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout3 | 2 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout4 | 3 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout5 | 4 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout6 | 5 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout7 | 6 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout8 | 7 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout9 | 8 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout10 | 9 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout11 | 10 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout12 | 11 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout13 | 12 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout14 | 13 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| dout15 | 14 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask1 | 16 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask2 | 17 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask3 | 18 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask4 | 19 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask5 | 20 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask6 | 21 | 1 | Unsigned | 1 | 0 | 1 | None | None |

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| doutMask7 | 22 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask8 | 23 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask9 | 24 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask10 | 25 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask11 | 26 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask12 | 27 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask13 | 28 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask14 | 29 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| doutMask15 | 30 | 1 | Unsigned | 1 | 0 | 1 | None | None |

## 2.17 DigitalIns (*base address i/o* + 0x502)

This message is sent periodically (250ms) by the SECC. The SECC reports the state of its digital inputs d1 to d8.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| din1 | 0 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| din2 | 1 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| din3 | 2 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| din4 | 3 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| din5 | 4 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| din6 | 5 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| din7 | 6 | 1 | Unsigned | 1 | 0 | 1 | None | None |
| din8 | 7 | 1 | Unsigned | 1 | 0 | 1 | None | None |

## 2.18 AnalogIns1 (*base address i/o* + 0x503)

This message is sent periodically (250ms) by the SECC. The SECC reports the state of its temperature inputs t1 to t4.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| temperature1 | 0 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |
| temperature2 | 16 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |
| temperature3 | 32 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |
| temperature4 | 48 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |

## 2.19 AnalogIns2 (*base address i/o* + 0x504)

This message is sent periodically (250ms) by the SECC. The SECC reports the state of its temperature inputs t5 to t8.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| temperature5 | 0 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |
| temperature6 | 16 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |
| temperature7 | 32 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |
| temperature8 | 48 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |

## 2.20 AnalogIns3 (*base address i/o* + 0x505)

This message is sent periodically (250ms) by the SECC. The SECC reports the state of its temperature input t9 and its general purpose analog inputs a1 and a2.

| Name | Startbit | Length | Valuetype | Factor | Min | Max | Unit | Valuetable |
|---|---|---|---|---|---|---|---|---|
| temperature9 | 0 | 16 | Signed | 0.1 | -3276.8 | 3276.7 | ℃ | None |
| ain1 | 16 | 16 | Unsigned | 1/4096 | 0 | 16 - 1/4096 | V | None |
| ain2 | 32 | 16 | Unsigned | 1/4096 | 0 | 16 - 1/4096 | V | None |

# 3 Value Tables

## 3.1 evConnectionStateType

| Value | Description |
|---|---|
| 0x0 | disconnected |
| 0x1 | connected |
| 0x2 | energyTransferAllowed |
| 0x3 | error |

## 3.2 operationalStatusType

| Value | Description |
|---|---|
| 0x0 | operative |
| 0x1 | inoperative |

## 3.3 isolationStatusType

| Value | Description |
|---|---|
| 0x0 | invalid |
| 0x1 | valid |
| 0x2 | warning |
| 0x3 | fault |

## 3.4 contactorsStatusType

| Value | Description |
|---|---|
| 0x0 | open |
| 0x1 | closed |

## 3.5 chargingStateType

| Value | Description |
|---|---|
| 0x0 | standby |
| 0x1 | cableCheck |
| 0x2 | preCharge |

| Value | Description |
|---|---|
| 0x3 | charge |
| 0x4 | postCharge |

## 3.6 chargeModeType

| Value | Description |
|---|---|
| 0x0 | unknown |
| 0x1 | scheduled |
| 0x2 | dynamic |
| 0x3 | dynamicBpt |