E-Mobility – It’s all about the Charging
Agenda

- E-Mobility Information Exchange
  Discussion on Signal Level of CCS
  Live Demo with VT7870
  Generic Communication Modules
E-Mobility Information Exchange

E-Mobility – Common Terms

SA

(EV)SE
SECC

EV
EVCC
E-Mobility Information Exchange

Charging Methods
Overview Worldwide

**Combined Charging System (CCS)**
- Used in Europe and North America
- Supports AC Charging via PWM or PLC
- Supports DC Charging via PLC
- Involved Specifications for Communication
  - IEC 62196
  - IEC 61851
  - ISO/IEC 15118 ED1
  - DIN SPEC 70121
  - SAE J2847/2

**GB/T**
- Used in China
- Supports AC Charging via PWM
- Supports DC Charging via CAN
- Involved Specifications for Communication
  - GB/T 18487
  - GB/T 20234
  - GB/T 27930

**CHAdEOMO**
- Used in Japan
- Supports DC Charging via CAN
Differences in Standards

- Geometry of Inlet / Connector
- Electrical characteristics (P | V | I)
- System Architectures

- Communication Protocol between vehicle and EVSE
- ...

Source of Pictures: https://www.phoenixcontact.com
Agenda

E-Mobility Information Exchange

- **Discussion on Signal Level of CCS**
  
  Live Demo with VT7870
  
  Generic Communication Modules
Discussion on Signal Level of CCS
Discussion on Signal Level of CCS

IEC 61851 Control Pilot Status – Set by EV

- Vehicle not present
- Vehicle present
- Vehicle not ready to charge
- Vehicle ready to charge
- Vehicle needs cooling
- Error – Charging not possible

Graph showing signal levels corresponding to different statuses.
Discussion on Signal Level of CCS

IEC 61851 PWM Signal 1 kHz – Set by EVSE (AC Charging)

- Charging not allowed
  - 0…3 %
  - 7…8 %
  - 97…100 %

- Charging with
  - 85…96 %:
    - (DC – 64) * 2,5 A
    - 96…97 %: max 80 A
  - 10…85 %:
    - DC * 0,6 A
    - 8…10 %: max 6 A

- Optional: High-Level Communication on AC charging

Duty Cycle

- 100%
- 96%
- 85%
- 10%
- 5%
Discussion on Signal Level of CCS

IEC 61851 PWM Signal 1 kHz – Set by EVSE (DC Charging)

- Charging not allowed
  - 0...3 %
  - 7...8 %
  - 97...100 %

- Charging allowed
  - 3...7 %
  - Ethernet based High-Level Communication only

<table>
<thead>
<tr>
<th>Duty Cycle</th>
<th>Charging Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>Charging not allowed</td>
</tr>
<tr>
<td>96%</td>
<td>Charging allowed</td>
</tr>
<tr>
<td>85%</td>
<td>Charging not allowed</td>
</tr>
<tr>
<td>10%</td>
<td>Charging not allowed</td>
</tr>
<tr>
<td>5%</td>
<td>Charging not allowed</td>
</tr>
</tbody>
</table>

EVSE
SECC

EV
EVCC

(EV)SE
SECC

\( \text{Duty Cycle} \)

\( \text{t} \)
Discussion on Signal Level of CCS
Discussion on Signal Level of CCS

Charging Software

Application

vXMLSec  vSCC  vEXI

Crypto++

TCP/IP  OpenSSL

provided by Linux OS

Ethernet

Customer Functions

MicrosAR

vEXI  vSCC  vHTTP  vDNS

MICROSAR

vEXI  vXMLSec

vHTTP  vDNS

ETHSM  TCPIP

ETHSM  UDP, TCP, IPv4, IPv6

ARP, NDP, ICMPv4/v6, DHCPv4/v6

TLS

ETHIF

ETHIF

ETHSWT

ETHSWT

(PLC, WLAN)

ETH

ETH

ETHTRCV

EVCC

EV

SECC

(EV)SE

SECC
Agenda

E-Mobility Information Exchange
Discussion on Signal Level of CCS

- Live Demo with VT7870
  Generic Communication Modules
Live Demo with VT7870

Setup to be show cased
<table>
<thead>
<tr>
<th>Step</th>
<th>Time</th>
<th>Eth</th>
<th>Protocol</th>
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</thead>
<tbody>
<tr>
<td>Communication Setup</td>
<td>38.604671</td>
<td>Eth 1</td>
<td>Rx CM_SLAC_Match.Reg</td>
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<tr>
<td>Parameter Discovery</td>
<td>39.685298</td>
<td>Eth 1</td>
<td>Tx CM_SLAC_Match.Cnf</td>
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<tr>
<td>Cable Check</td>
<td>42.439708</td>
<td>Eth 1</td>
<td>Rx Service Discovery Request</td>
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<td></td>
<td>42.740597</td>
<td>Eth 1</td>
<td>Rx Service Discovery Response (OK)</td>
</tr>
<tr>
<td>Pre Charge</td>
<td>45.944191</td>
<td>Eth 1</td>
<td>Rx Cable Check Request</td>
</tr>
<tr>
<td></td>
<td>44.250482</td>
<td>Eth 1</td>
<td>Tx Cable Check Response (OK)</td>
</tr>
<tr>
<td>Current Demand</td>
<td>64.289241</td>
<td>Eth 1</td>
<td>Rx PreCharge Request</td>
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<tr>
<td></td>
<td>64.590543</td>
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<td>Tx PreCharge Response (OK)</td>
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<tr>
<td>Power Delivery OFF</td>
<td>45.129339</td>
<td>Eth 1</td>
<td>Rx Current Demand Request</td>
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<tr>
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<td>45.100401</td>
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<td>Tx Current Demand Response (OK)</td>
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<tr>
<td>Welding Detection</td>
<td>45.529208</td>
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<td>Rx Power Delivery Request (Power OFF)</td>
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<td>45.520012</td>
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<td>Tx Power Delivery Response (OK)</td>
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<tr>
<td>Session Stop</td>
<td>45.599033</td>
<td>Eth 1</td>
<td>Rx Welding Detection Request</td>
</tr>
<tr>
<td></td>
<td>45.960462</td>
<td>Eth 1</td>
<td>Tx Welding Detection Response (OK)</td>
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<tr>
<td></td>
<td>45.939046</td>
<td>Eth 1</td>
<td>Rx Session Stop Request</td>
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<tr>
<td></td>
<td>46.240293</td>
<td>Eth 1</td>
<td>Tx Session Stop Response (OK)</td>
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</tbody>
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Possible Setups

Conformance Test Packages Available:
- CCS EV (2019/Q1) – CCS EVSE (2019/Q2)
- GB/T EV (2019/Q4) – GB/T EVSE (2020/Q1)
- CHAdeMO 2.0 EV (planned) – CHAdeMO 2.0 EVSE (planned)
Agenda

- E-Mobility Information Exchange
- Discussion on Signal Level of CCS
- Live Demo with VT7870

- **Generic Communication Modules**
Conductive Approach

Conductive Charging

- Interface for CCS
  - IEC 61851
  - DIN 70121
  - ISO 15118
- Generic approach: VC-VCCU
Generic Communication Modules

Architectural Overview

DCB := Distribution Contactor Box
Generic Communication Modules

Architectural Overview
Generic Communication Modules

VC-VCCU
### VC-VCCU Overview of Usage

**Generic Communication Modules**

<table>
<thead>
<tr>
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<th>Combo 1</th>
<th>Combo 2</th>
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<tbody>
<tr>
<td><strong>Prototyping</strong></td>
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<td>Available</td>
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<tr>
<td><strong>Series</strong></td>
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## Generic Communication Modules

### We Are Compliant and Interoperable

<table>
<thead>
<tr>
<th>Company</th>
<th>DIN 70121</th>
<th>ISO 15118</th>
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<tr>
<td>AKKA GmbH</td>
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<tr>
<td>Auronik</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Charge Point*</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Delta</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Eko Energetyka*</td>
<td>X</td>
<td>X</td>
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<tr>
<td>GridVis</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Heliox*</td>
<td>X</td>
<td>X</td>
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<tr>
<td>I2SE GmbH</td>
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<td>X</td>
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<td>Kostal Industrie Elektrik</td>
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<tr>
<td>Neusoft</td>
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<td>X</td>
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<tr>
<td>PNI Systems</td>
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<td>X</td>
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<tr>
<td>Siemens AG*</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Tritium</td>
<td>X</td>
<td>X</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Company</th>
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<th>ISO 15118</th>
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<tbody>
<tr>
<td>V2G Clarity</td>
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<tr>
<td>Vedecom</td>
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<td>X</td>
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<tr>
<td>Verisco (TU Dortmund)</td>
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<td>X</td>
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<tr>
<td>Vestel Electronics</td>
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<td>X</td>
</tr>
</tbody>
</table>

*: Test have been performed additionally in vehicle.
Illustration of charging sequence with a simplified architecture on system level

- **Sequence Phase**
  - Mated
  - Initialize
  - Cable Check
  - Precharge
  - Charge
  - Power Down
  - Unmated

- **Time Period**
  - 10

**Supply Station**
- **Communication**
  - High Level (PLC)
  - Low Level (Pilot)
- **DC Power Unit (including Charge Controller)**
- **Isolation Check**
- **Disconnecting Device**
- **HV System (including Battery)**

**Vehicle**
- **Communication**
  - High Level (PLC)
  - Low Level (Pilot)
- **Lock Monitor**
- **Lock**
- **PP**
- **PE**
- **CP**

**CP** enters state B1 instantly with mating. Vehicle is immobilized (PP).

* According to IEC 61851-23

Date: 2015-06-02

Source: [https://www.charinev.org/ccs-at-a-glance/design-guide-for-ccs/](https://www.charinev.org/ccs-at-a-glance/design-guide-for-ccs/)
Generic Communication Modules

VC-EVCC

**Inverted Pantograph**
- VC-EVCC based on OppCharge
  - Planned availability in Q1/2020
  - Prototyping only
- Series approach based on ISO 15118-20

**Roof-Mounted Pantograph**
- VC-VCCU can be used
  - External modifications needed
  - PLC communication only
Further Features within ISO 15118-20

Inductive Charging
- WiFi required
- Standardized in ISO 15118-20

Bidirectional Power-Transfer
- Return Energy to Grid
### ISO 15118 vs. ISO 15118-20

<table>
<thead>
<tr>
<th></th>
<th>ISO/IEC 15118</th>
<th>ISO/IEC 15118-20</th>
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<tbody>
<tr>
<td><strong>Energy Transfer Modes</strong></td>
<td>▶ AC Charging</td>
<td>▶ AC Charging</td>
</tr>
<tr>
<td></td>
<td>▶ DC Charging</td>
<td>▶ DC Charging</td>
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<tr>
<td></td>
<td>▶ Wireless Power Transfer (WPT)</td>
<td>▶ Wireless Power Transfer (WPT)</td>
</tr>
<tr>
<td></td>
<td>▶ Automatic Connection Device (ACD)</td>
<td>▶ Automatic Connection Device (ACD)</td>
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<td></td>
<td>▶ Bidirectional Power Transfer (BPT)</td>
<td>▶ Bidirectional Power Transfer (BPT)</td>
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<tr>
<td><strong>Authorization Modes</strong></td>
<td>▶ External Identification Means (EIM)</td>
<td>▶ External Identification Means (EIM)</td>
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<td></td>
<td>▶ Plug and Charge (PnC)</td>
<td>▶ Plug and Charge (PnC)</td>
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<tr>
<td><strong>Security</strong></td>
<td>▶ TLS mandatory for PnC</td>
<td>▶ TLS mandatory</td>
</tr>
<tr>
<td></td>
<td>▶ TLS optional for EIM</td>
<td></td>
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<tr>
<td><strong>Physical Layer</strong></td>
<td>▶ Powerline Communication (HomePlugAV)</td>
<td>▶ Powerline Communication (HomePlugAV)</td>
</tr>
<tr>
<td></td>
<td>▶ Wi-Fi (802.11n)</td>
<td></td>
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</tbody>
</table>
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