EVSE ComboCS4M - CCS simulation

Trialog

Accelerate and make CCS developments more reliable

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Trialog is working on EV charge since more than 10 years and had several opportunities to develop a strong expertise on EV charge protocols like IEC 61851, DIN 70121, ISO 15118 and OCPP1.6/2.0.
In this context, Trialog has developed several testing and validation tools.

ComboCS4M, the EVSE CCS simulator is one of these tools. It could be used in any setup in needs of a CCS EVSE implementation. For example to simplify CCS end of line validation and maintenance by providing quick test means for DIN 70121 and ISO 15118 protocols without any power transfer.

Technical Details

ComboCS is a box allowing to perform AC or DC, ISO 15118 or DIN 70121 communications, including the HPGP PLC and IEC 61851-1 communications.

Figure 1: ComboCS connectors - Face 1

Figure 2: ComboCS connectors - Face 2

- Size: 23x15x6 cm
- Connectors:
    - Control Pilot and Protective Earth: BNC
    - CAN: DB9 *(reserved for future usage or specific development)*
    - 6 GPIO: AWHW 10G-0202-T *(reserved for power transfer add-on or specific development)*
- Interface
    - WiFi hotspot
    - Ethernet RJ45
- Wires provided with the tool
    - AC/DC 230V/12V barrel jack
    - Type 2 plug with BNC connector
    - Ethernet wire

Supported Features

ComboCS4M could be used in any setup in needs of a CCS EVSE implementation.
For example, to validate the correct behaviour of a CCS vehicle or of an SECC for AC or DC, ISO 15118 or DIN 70121 communications, including the HPGP PLC and IEC 61851-1 communications.

The goal of ComboCS4M is not to entirely check the vehicle CCS implementation[1], but to provide a representative EVSE implementation for testing. It could be used to verify that the building process, installation operation or maintenance operation leads to a properly working device.

ISO 15118 and DIN 70121 standards define several use cases and functions. ComboCS4M supports all functions and more specifically:

- ISO 15118-3 / DIN 70121 for PLC communication
  - SLAC
  - SLAC Validation with BCB-Toggle
- ISO 15118-2 / DIN 70121
  - SDP
  - Supported state machines: AC and DC
  - Supported payment options: EIM and PnC
  - Supported optional use cases:
    - Service Details
    - PnC Certificate installation
    - Smart Charging
    - Renegociation
    - Metering Receipt
    - Welding Detection (DC charge only)
    - Pause / Resume

> **Implementation in progress**
> "Amplitude Map exchange" of ISO 15118-3 is still under validation and provided as developer preview into the ComboCS4M.

Auto Mode - Verify expected behaviour

In auto mode, once plugged to an EV or an EVCC, the ComboCS4M is starting a DIN 70121 and an ISO 15118 test suite.

The test suite can be quickly described as below:
- Do the SLAC mechanism
- Select the DIN 70121 version: the EVSE ComboCS4M is supporting only DIN 70121, and DIN 70121 is expected to start
- Once charging loop is reached, wait 15s before to request to stop
- At the end of the charge, simulate an unplugged wire and wait 7s
- Simulate a plugged wire and do the SLAC mechanism
- Select DIN 70121 or ISO 15118: the EVSE ComboCS4M is supporting ISO 15118 and DIN 70121, ISO 15118 is expected to start, but DIN 70121 is also accepted
- Once charging loop is reached, wait 15s before to request to stop
- At the end of the charge, simulate an unplugged wire

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1 Do you know ComboCS? It is done for that purpose! If you are interested, please contact us at contact@trialog.com.

Manual Mode – Simulate an EVSE

In manual mode, once plugged to an EV or an EVCC, the ComboCS4M is simply starting a DIN 70121 or ISO 15118 communication session.

Simple Configuration

The ComboCS4M is provided with a Wifi hotspot and an Ethernet plug allowing to access a configuration UI. Select the functioning mode of the ComboCS4M (AC, DC, EIM or PnC) and its SmartCharging behaviour: maximum current, voltage and power.
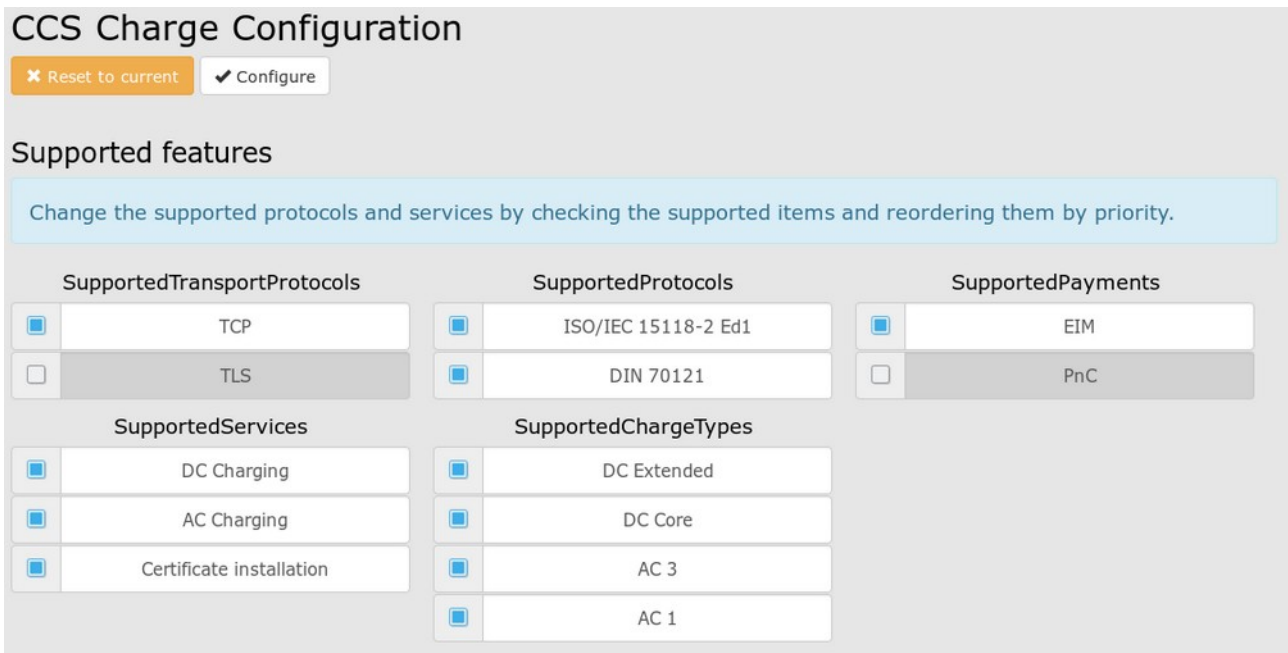

Figure 3: ComboCS4M configuration UI

Quick access to test result

On the ComboCS4M box, LEDs are indicating the progress of the charging session and the test suite result. It allows to visualize where it fails in case of failure.

Figure 4: ComboCS4M showing charging session progress

Quick access to test results history

The ComboCS4M is provided with a Web interface, compatible with Windows, Linux and Mac, accessible over Ethernet or Wifi.

An historic of all charging session is kept available on the ComboCS and can be downloaded in CSV format for Excel. It allows to quickly identify a session by a number, to know its status and the failure reason.

Figure 5: Session history view

Quick access to communication data

The supervision view provides access to real-time evolution of the ongoing CCS communication on the ComboCS4M.

Figure 6: ComboCS interface - Example of ISO 15118 communication

All data exchanged between the EVSE of the EV is available through the user interface. The history of the whole decoded communication can be downloaded as a log file.

ComboCS LEDs and GPIOs

Figure 7: Face 2 of the ComboCS

The ComboCS is provided with 6 LEDs indicating the progress of the charging session. At plugin LEDs are blinking and lighting one by one. If an error happen, LEDs are kept in their existing state to visualize quickly where it failed.

Meaning and behaviour of each LED is described below:

- **LED 1 : Control Pilot**
    - LED is off when unplugged (state A/E/F).
    - LED is blinking when plugged but not ready to charge (state B).
    - LED is on when plugged and ready to charge (state C/D). Therefore, for DC charge, it should become one at the beginning of the CableCheck process.

- **LED 2 : PLC Matched**
    - LED is blinking when the first SLAC message is received, until the end of the Matching process described in ISO 1511863 and DIN 70121.
    - LED is on when the SLAC process ifs finished with the succesful Matched state.

- **LED 3 : Cable Checked**
    - LED is blinking when the first SDP request is sent, just after the SLAC Matching process, until the end of the CableCheck process described in ISO 15118-2 and DIN 70121. A lot of steps are done in this stage (SDP, TCP/TLS connexion, Hadnshake, SessionSetup, Authorization, ChargeParameterDiscovery and also CableCheck for DC charge).
    - When CableCheck process is started, the LED 1 "Control Pilot" shall be on, since the EV is required to go to state C before CableCheck.
    - LED is on when the end of the CableCheck mechanism is reached.

- **LED 4 : Charging**
    - LED is on when the Charging Loop is reached (CurrentDemandReq in DC or ChargingStatusReq in AC)

- This LED is always either on or off, it does not blink, in order to let the user use this GPIO as a a logical state to switch a charge relay.
- **LED 5 : End of charge**
  - LED is blinking when the end of the charge is requested by the EV or the EVSE
  - LED is on when the charging session is ended
- **LED 6 (red) : Test result**
  - LED is blinking when the session result is "Failure"
  - LED is on when the session result is "Success"

As a sumary:

- A LED is off when the related state is not yet reached.
- A LED is blinking when the related state is in progress. With an exception for PreCharge: LED 4 is kept off until Charging Loop is reached in order to let the user use this GPIO as a a logical state to switch a relay.
- A LED is on when the related state is finished.

Therefore, all LEDs are going off when unplugged.

The GPIO connector of the ComboCS is a mirror of the LEDs. It alows the GPIO to be used to read the digital status of the LEDs, and therefore to know the status of the charging session.
The LED 4 "Charging" is always either on or off, it does not blink, in order to let the user use this GPIO as a a logical state to switch a charge relay.

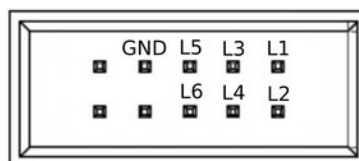The illustration below describes the pinouts of the GPIO connector:

Figure 8: GPIO pinout

Female connector is not provided with the tool. Search for HCSD-05-D-11.40-01-N-G-R reference (10 pins, 2 entries, 2.54mm space between pins).

ComboCS4M Options

SW UPGRADE TO ISO 15118-20 EXTENSION

> This feature is an option, not provided by default in ComboCS. It is available as a software update.

> ***Development in progress***
> Implementation in progress. First release available since June 2022.

By default, the ComboCS only supports the original versions of the standard: DIN 70121 and ISO 15118-2. This SW upgrade enables the brand new ISO 15118-20 support on ComboCS.

This option provides the same feature basis as the default one but for ISO 15118-20. However, it does not provide any test case mode for ISO 15118-20 since conformance tests are not defined yet byt the normative comitee.

In order to simplify validation of ISO 15118-20, the tool allows to disable TLS or to use the TLS 1.2 mechanism defined in Iso 15118-2.

The following table is listing the current status of the implementation:

Use Case	Status
SDP	Available
V2GTP	Available
Protocol selection with SupportedAppProtocol	Available
AC unidirectional and bidirectional state machines Dynamic mode	Available
DC unidirectional and bidirectional state machines Dynamic mode	Available
AC unidirectional and bidirectional state machines Schedule mode	To be scheduled
DC unidirectional and bidirectional state machines Schedule mode	To be scheduled
TLS 1.3 with Mutual Authentication	Implementation in progress
Service Renegotiation	Implementation in

	progress
User Mobility Needs exchange	First version already available Implementation in progress
Plug&Charge Authorization	To be scheduled
Plug&Charge Contract Installation	To be scheduled
Pause & Resume	To be scheduled

SW UPGRADE TO OCPP EXTENSION

This feature is an option, not provided by default in ComboCS. It is available as a software update.

Development in progress
Implementation in progress. First release is already available with an almost complete OCPP implementation but a limited User Interface. A more complete release is excepted for December 2022. For more information, please contact us.

With the OCPP extension, the EVSE ComboCS4M could be used in any setup in needs of a Mode 3 or CCS EVSE implementation for OCPP validation. For example, to validate the correct behaviour of an OCPP 1.6 or 2.0.1 CSMS implementation.

The ComboCS4M OCPP configuration and CSMS endpoint can be configured from the Web interface.
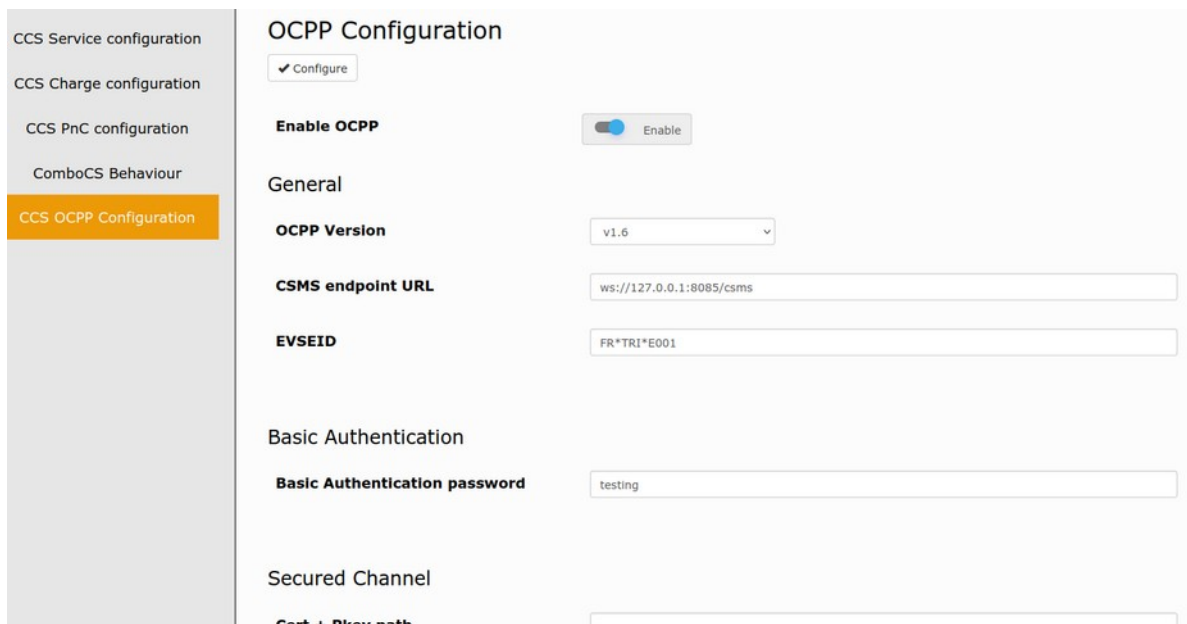
Figure 9: OCPP configuration interface

The OCPP ComboCS4M is supporting both OCPP 1.6 and 2.0.1 versions. All OCPP messages are supported, but the OCPP ComboCS4M does not react necessarily to all of them. The following use cases are currently supported:

Use Case	Status
A01 - Update Charging Station Password for HTTP Basic Authentication	Available
A02 - Update Charging Station Certificate by request of CSMS	Validation in progress
A03 - Update Charging Station Certificate initiated by the Charging Station	Validation in progress
B01 - Cold Boot Charging Station	Available
B02 - Cold Boot Charging Station - Pending	Available
B03 - Cold Boot Charging Station - Rejected	Available
B04 - Offline Behavior Idle Charging Station	Validation in progress
B05 - Set Variables	Validation in progress
B06 - Get Variables	Available
B11 - Reset - Without Ongoing Transaction	Available
B12 - Reset - With Ongoing Transaction	Available

C01 - EV Driver Authorization using RFID	Available
C08 - Authorization at EVSE using ISO 15118 External Identification Means (EIM)	Available
C15 - Offline Authorization of unknown Id	Validation in progress
Additional UC: Authentification via l'EVCCID	Not implemented yet
E01 - Start Transaction Options	Available
E02 - Start Transaction - Cable Plugin First	Available
E03 - Start Transaction - IdToken First	Available
E04 - Transaction started while Charging Station is offline	Available
E06 - Stop Transaction options	Available
E07 - Transaction locally stopped by IdToken	Validation in progress
E11 - Connection Loss During Transaction	Validation in progress
E12 - Inform CSMS of an Offline Occurred Transaction	Validation in progress
E13 - Transaction related message not accepted by CSMS	Validation in progress
E15 - End of charging process	Validation in progress
F03 - Remote Stop Transaction	Available
F04 - Remote Stop ISO / IEC 15118 charging from CSMS	Available
F05 - Remotely Unlock Connector	Validation in progress
F06 - Trigger Message	Available
G01 - Status Notification	Available
G02 - Heartbeat	Available
G03 - Change Availability EVSE	Implementation in progress
G04 - Change Availability Charging Station	Implementation in progress
J02 - Sending transaction related Meter Values	Available
K01 - SetChargingProfile	Implementation in progress
K02 - Central Smart Charging	Implementation in progress
K05 - Remote Start Transaction with Charging Profile	Implementation in

	progress
K06 - Offline Behavior Smart Charging During Transaction	Implementation in progress
K07 - Offline Behavior Smart Charging at Start of Transaction	Implementation in progress
K16 - Optimized charging with scheduling to the CSMS	Implementation in progress
K17 - Renegotiating a Charging Schedule	Implementation in progress
N01 - Retrieve Log Information	Validation in progress

OCPP communication logs can be downloaded to analyse the OCPP connexion status and the last exchanged OCPP messages and OCPP errors.

SW UPGRADE TO COMBOCS VERSION EXTENSION

> This feature is an option, not provided by default in ComboCS4M. It is available as a software update.

Not sure the full-featured ComboCS version is the right one for your needs? Start with the ComboCS4M version and switch later on to the ComboCS one thanks to this extension.

NON-INTRUSIVE SNIFFER OPTION

> This feature is an option, not provided by default in ComboCS4M. It requires to add some measurement hardware.

In Sniffer mode, the ComboCS4M does not simulate anymore an EV or a Charging Station, but is plugged directly between an EV and a Charging Station communicating using CCS. ComboCS4M can then snif passively the communication without interacting in any way with the PLC trafic. In such a mode, all PLC trafic is available on a dedicated RJ45 port, providing access to the raw Ethernet trafic from SLAC to ISO 15118-2 or DIN 70121. This trafic can be displayed on a Wireshark opened on the operator machine, for further analysis.
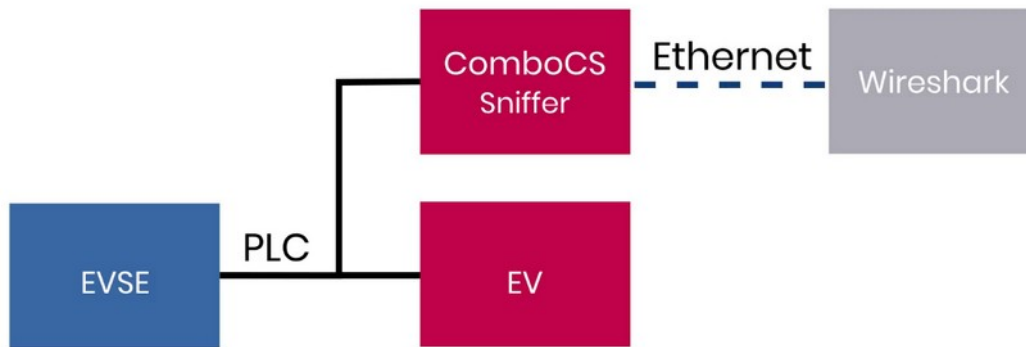
Figure 10: ComboCS + sniffer option

Thanks to a Wireshark plugin developped by Trialog, the Ethernet traffic is directly decoded in Wireshark and ready for analysis.
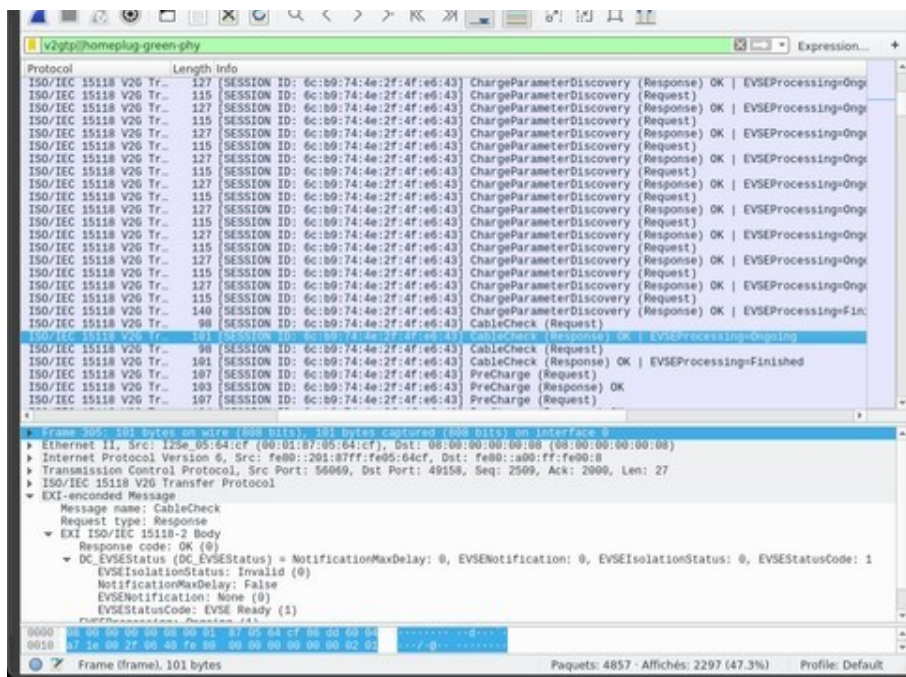

Figure 11: PLC traffic is available through Wireshark

Such a mode could have an impact on PLC power emission and shall not be used during PSD measurement.

PSD MEASUREMENT OPTION

This feature is an option, not provided by default in ComboCS. It is available as a software update and delivery of new hardware parts.

Specific development required

To fully automate the process, the CCS implementation shall be adapted to use the ComboCS interface, or a custom development is required on the ComboCS to put the CCS implementation in a dedicated measurement mode and change the PLC calibration.

In order to comply with ISO 15118 and DIN 70121, a CSS implementation shall emit a PLC level of -35dBm (i.e. -75dBm/Hz) for each PLC carrier beween 1.8MHz and 30MHz. The measurement shall be done at the Vehicle inlet , a calibration shall be done according the internal wiring of the Vehicle from the point of measurement to the PLC Modem.

The generic PSD Measurement option of the ComboCS facilitates the calibration of a CSS implementation. In this mode, the ComboCS shall be connected to a Vehicle that communicates permanently over PLC[2]. A specific development shall be done on the Vehicle to trigger such a communication. The ComboCS will then measure the PLC power emission on each carrier thanks to the setup defined in ISO 15118-3 and DIN 70121 summarized below.
The result is analysed and computed by the ComboCS in order to provide the delta to be applied on the Vehicle PLC Modem calibration.
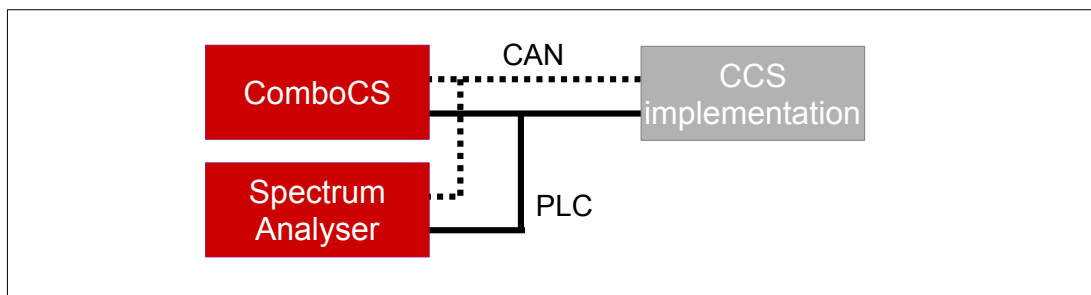
PSD measurement add-on basic setup

The ComboCS also provides a generic communication interface over HTTP to:
  • trigger the permanent PLC communication on the Vehicle
  • retrieve the current PLC Modem calibration of the Vehicle
  • apply the new PLC Modem calibration of the Vehicle

If the Vehicle is adapted to integrate this communication interface, the PSD measurement setup could be completely automated. Otherwize, it requires several manuel steps.

A custom development can also be discussed with the *Trialog* team and added into the ComboCS4M in order to adapt the setup to your specific needs.

2Some other solution are available on the market, that do not required the implementation of this permanent communication over PLC on the Vehicle, but they are not compliant with ISO 15118-3 and DIN 70121.

POWER TRANSFER SUPPORT

In order to perform power transfer using DIN 70121 or ISO 15118 communication, you can plug your power modules for AC and DC to the ComboCS4M and use the LED4 GPIO and HTTP API to synchronize the tool with your power bench.

Trialog can provide hours of support to help your team during this integration process.

VDC261 and OPPCharge OPTION

This feature is an option, not provided by default in ComboCS4M. It is available as a software update.

Development in progress
Implementation of these specific modules for buses and trucks are still under investigation. For more information, please contact us.

ADDITIONAL ACCESORIES

Additional accessories are available.

	Additional Type 2 / BNC plug One is already provided with the tool.
	External 12V battery An external battery allows to use the ComboCS tool even when no AC high power source is available.

Annual Subscription

The ComboCS tool described in this document is ready to use. It has been tested and validated by the Trialog team, tested with several Vehicles in the field and during 3 Testing Symposiums and 2 CharIN Testivals and is currently used by more than 50 companies around the world.

The ComboCS is also still actively maintained by Trialog to fix eventual remaining bugs, test with new Vehicles, facilitate the usage of the tool, and ensure the correct behaviour of the Simulation mode regarding the current consensus of the normative groups and ISO 15118 user group.

In order to provide such corrective and evolutive updates of the ComboCS, Trialog is proposing an annual subscription including:

- Access to corrective releases of the ComboCS
- Access to evolutive releases of the ComboCS

Trialog will deliver at least one release per year to fix bugs that might have been detected and to deploy enhancement of existing features (same feature basis).

Trialog can share its internal previsional roadmap but does not garanty any delivery planning in the scope of this annual subscription. A dedicated contract can be defined to adapt this roadmap to your company requirements.

In addition to the access of these releases, the subscription also offers access to Trialog's hotline through an online ticketing system. It can be used to ask questions about ComboCS usage and report issues encounter with the ComboCS.

The subscription is done on a yearly basis. The first year of the ComboCS subscription is already included when buying the tool. Subscription for upcoming years is done on the conditions defined when buying the tool if done continuously. In case of interruption, paying for the not covered period is necessary to get the update.

Contact us

*For more information about **ComboCS**, please contact us:* emobilitysales@trialog.com.

Do you know ComboCS?

Trialog has also developed a full-feature version of ComboCS4M dedicated to Vehicle development and validation: the ComboCS version is embedding conformance and interoperability test cases, expert mode to reproduce exact EVSE behaviours and more advance features like the inspection mode.

Check below the differences between the 2 versions:

	ComboCS4M	ComboCS
Session History view	✓	✓
Supervision view	✓	✓
Simulation mode	✓	✓
Analogic output at charge startup	✓	✓
HTTP API	✓	✓
PCAP per session	✓	✓
Expert mode	Limited	✓
Test case mode		✓
Inspection mode		✓
SW upgrade to ComboCS option	Compatible	N/A
SW upgrade to ISO 15118-20 option *soon available*	Compatible	Compatible
SW upgrade to OCPP option *soon available*	Compatible	Compatible
Sniffer option	Compatible	Compatible
PSD measurement option	Compatible	Compatible
Custom development	Compatible	Compatible

ComboCS is the perfect tool for your technical team developing and validating a vehicle.

Interested? Please contact us!