MENNEKES®

Plugs for the world

Infrastructure components for electric mobility

For future-proof electric mobility.

"First-class products are only as good as their components."

Infrastructure components for safe electric mobility.

MENNEKES®
Plugs for the world

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Components for electric mobility.

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Products

Glossary

Terminology. Abbreviations.

For the different components, we use the terminology currently applied in the standardisation committees. Company-specific component names may be used at times and may contain additional functions beyond the performance scope specified in the standard.

CP	Control Pilot, name for the connector contact/cable used to transmit the communication information
CP box or CP communication box	MENNEKES name for the PWM module
EVSE	Electric Vehicle Supply Equipment, international name of the charging stations for charging electric vehicles
ICCB	Incable Control Box, consisting of SPE-PRCD and PWM module
Mode 1 - 3	Different charging modes which vary with respect to the maximum charging capacity and the communication options with the vehicle
PRCD	Portable Residual Current Device
PRCD-S	Portable Residual Current Device Safety, includes additional earth detection and monitoring
Proximity/PP	Proximity contact or plug present contact for defining the ampacity of the charging cable and for activating the engine immobilizer
PWM	Pulse width modulation. Type of transmission for communication information
PWM module	Element of the ICCB (with mode 2 charging) and/or the charging station (with mode 3 charging) for communication with the vehicle
SPE-PRCD	Switched Protective Earth-Portable Residual Current Device = mobile fault current protection with switched earthed conductor, mobile device for increasing the level of protection
Resistance coding	The charging cables feature a resistance coding. This is used by the charger to limit the charging current to the maximum admissible current for the charging cable

Standardisation

Overview of the most important standards

IEC 62196-1:2003
Presently under revision.
Plugs, sockets, vehicle couplers and vehicle inlets – Conductive charging of electric vehicles – Part 1: Charging of electric vehicles up to 250 A A/C and 400 A D/C.
Corresponds to EN 62196-1:2003 and VDE 0623 Part 5:2004-06

IEC 62196-2
Currently under development.
Plugs, sockets, vehicle couplers and vehicle inlets – Conductive charging of electric vehicles – Part 2: Dimensional compatibility and interchangeability requirements for a.c. pin and sleeve accessories,
Status July 2009, also published as VDE AR-E 2623-2-2:2009-10

IEC 61851-1:2010
Electric equipment for electric road vehicles – Electric vehicle conductive charging system – Part 1: General requirements.

IEC 61851-21:2002
Presently under revision.
Electric equipment for electric road vehicles – Electric vehicle conductive charging system – Part 2-1: Electric vehicle requirements for conductive connection to an a.c./d.c. supply.
Corresponds to EN 61851-21:2001 and VDE 0122 Part 2-1:2002-10

IEC 61851-22:2001
Presently under revision.
Electric equipment for electric road vehicles – Electric vehicle conductive charging system – Part 2-2: AC electric vehicle charging station.
Corresponds to EN 61851-22:2001 and VDE 0122 Part 2-2:2002-10

IEC 60364-7-722
Currently under development.
Low voltage electrical installations – Part 7-722: Requirements for special installations or locations – Supply of electric vehicles.
Will presumably become VDE 0100 Part 722.

Please note:

Published standards can be obtained from Beuth-Verlag, Berlin.

Changes of the standard in the second generation

Until a norm is internationally binding, it passes through many stages where adjustments are still made for various reasons. This also applies to the international implementation of the standards for charging couplers.

Infrastructure socket and charging plug remain unchanged.

Vehicle plug and charging connector in accordance with the latest status of international standardisation.

Different charging modes

Charging mode. Mode 1, mode 2 or mode 3?

Different charging modes

Different charging modes were defined for the safe and demand-conform charging of electric vehicles. These charging modes differ in respect of the applied sockets (earthed, CEE, charging socket) on one hand, and on the other hand in respect of the maximum charging capacity and beyond this the communication options.

Charging modes - overview

Charging mode	Communication	Interlocking	Single-phase	Three-phase
Mode 1	none	in the vehicle	max. 16A 3.7 kW	max. 16A 11.0 kW
Mode 2	PWM module in the charging cable	in the vehicle	max. 32A 7.4 kW	max. 32A 22.0 kW
Mode 3	PWM module in the charging station	in the vehicle and in the charging socket	max. 63A 14.5 kW	max. 63A 43.5 kW

Mode 1

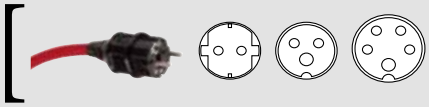
For mode 1 charging, the equipment is connected to the energy network using standard connectors. The maximum charging current is 16A but may not exceed the rated current of the used connector. A 16A three-phase CEE socket permits a charging capacity of max. 11 kW.
The charging time in this mode is relatively long due to the low charging capacity. On the vehicle side, the connection is established via a charging connector in accordance with IEC 62196-2.

A RCD required for this application on the connection side ensures electrical safety.

Charge connection in accordance with mode 1

Charging connector
in accordance with IEC 62196-2

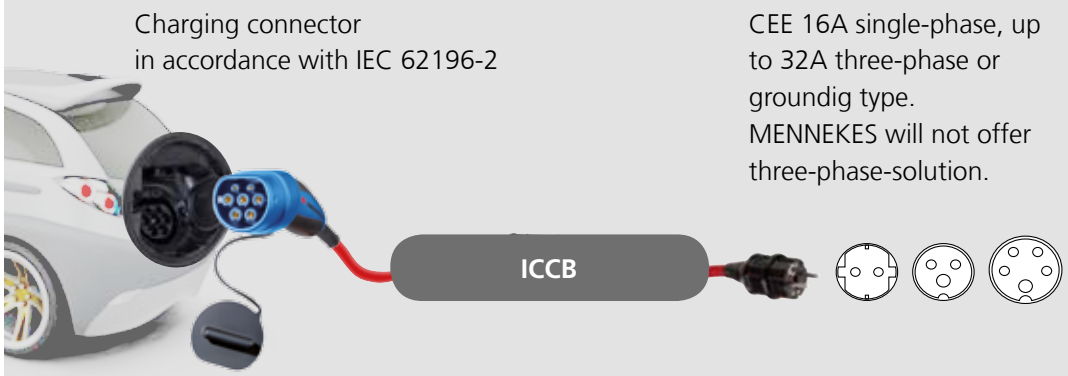
CEE 16A single-phase, three-phase or groundig type.
MENNEKES will not offer three-phase-solution.



Mode 2

For mode 2, the standard prescribes a mobile device for increasing the protective level (SPE-PRCD - Switched Protective Earth - Portable Residual Current Device). A communication device (PWM module) for communication with the vehicle is additionally required for setting the capacity and fulfilling the safety demands. These two components are united in the incable control box (ICCB).
Connection with the vehicle is established with a charging connector in accordance with IEC 62196-2 which is interlocked during charging. Standard charging connectors up to 32A three-phase are used on the mains side. These may be CEE or earthed connectors (SCHUKO® and/or country-specific connectors). The charging current is max. 32A and allows a charging capacity of up to 22 kW.

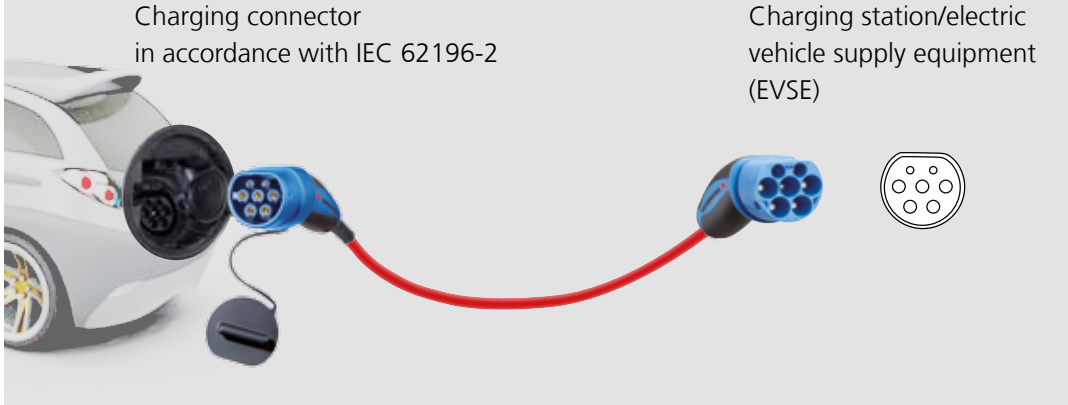
Charge connection in accordance with mode 2



Mode 3

For Mode 3 charging, defined charging equipment is used in accordance with IEC 61851, the so-called "Electrical Vehicle Supply Equipment" (EVSE), meaning the charging infrastructure. In this case PWM communication, RCD, overcurrent protector, switch-off as well as a specific charging socket are mandatory components of the charging station.
In mode 3, the vehicle can be charged with up to 63A three-phase current. This allows a charging capacity of up to 43.5 kW. Mode 3 also speeds up the charging process. Depending on the charger on board and the charge state, charging may take less than one hour.

Charge connection in accordance with mode 3



Basic communication with the vehicle

Safety check and charge current limitation.

Before the charging process starts, PWM communication with the vehicle is established via the CP cables in charging modes 2 and 3. Several parameters are transmitted and adapted. Charging does not start until all safety prompts clearly meet the specifications and until the maximum admissible charging current is transmitted.

The following test steps are performed by default:

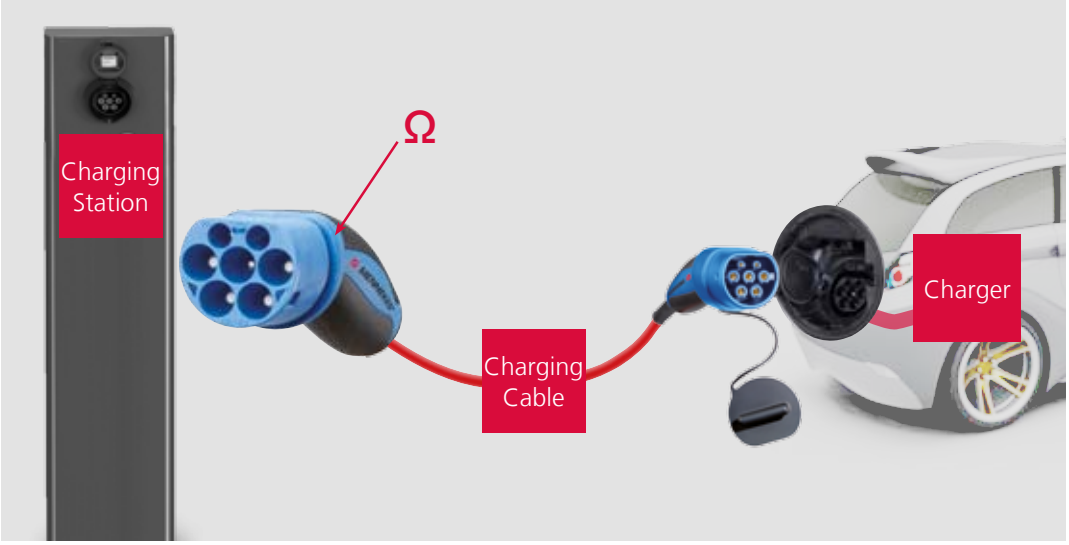
- The charging station (in mode 2 the control device in the charging cable) checks the connection of the earthed conductor to the vehicle and transmits the available charging current.
- The vehicle adjusts the charger accordingly.
- The vehicle interlocks the charging connector and requests the start of charging.
- The charging station interlocks the infrastructure charging connector.

If all other requirements are fulfilled, the charging station activates the charging socket.

The earthed conductor is monitored for the duration of charging via the PWM communication and the vehicle can communicate with the charging station to cut power supply.
A stop device (in the vehicle) terminates the charging process and unlocks the connectors. These signals are transmitted to the charging station via the CP conductor.

Limiting the charging current

The vehicle charger defines the charging process. To prevent the vehicle charger from exceeding the capacity of the charging station or the charging cable, the capacity data of the systems is identified and adapted to each other. The CP box reads the capacity data of the charging cable from the cable. The capacity data of the charging station is recorded in the CP box. Prior to starting the charging process, the CP box transmits the capacity data via PWM signal to the vehicle. The charger of the vehicle is adapted accordingly and the charging process can start without risking an overload.

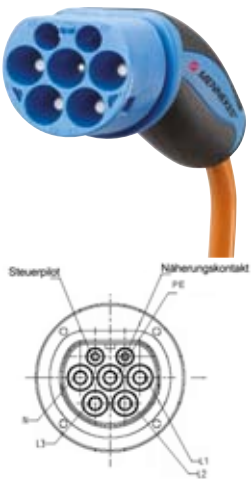
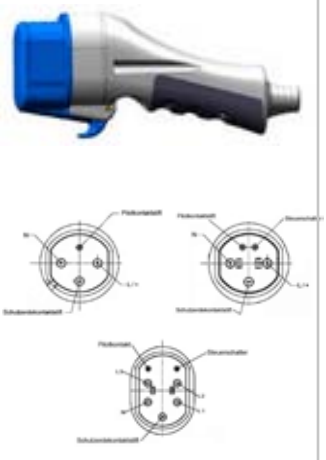


The weakest link in the charging chain decides the maximum admissible charging current: Depending on the capacity of the charging station and the resistance coding in the plug of the charging cable, the charging current is limited in the charger.

One standard – three systems

Different approaches.

Prerequisite for the comfortable charging of the vehicle battery at any location is a unique charging connector system together with the corresponding infrastructure provided by the electric utility companies. This is the only way electric vehicles will become the means of transport of the future.
At present, the international standardisation of the charging couplers is still under development with altogether three different solution approaches. However, these vary greatly. Besides the German standards draft by MENNEKES (type 2), which is favoured by the European car manufacturers and electric utility and considers both the infrastructure as well as the vehicle aspects in a comprehensive manner, there is also a Japanese and an Italian draft. All three types will be standardised in the international standard IEC 62196-2. As a result, different systems can be applied in different regions. The consequence: As these plug and socket connectors are not compatible with each other, it may be a problem to find a matching charging column due to the different connection technologies. To prevent this, regions like e.g. Europe will opt for one type only.
MENNEKES pursues this approach with the standards draft type 2. European OEMs have already clearly opted for type 2.

Standard drafts	**Draft type 1 developed in Japan**	**MENNEKES draft (type 2) developed in Germany**	**Draft type 3 developed in Italy**
			
Geometry	one geometry	one geometry	three different geometries
Capacity	up to 7.4 kW up to 32A single-phase	up to 44 kW up to 63A single to three-phase	up to 22 kW up to 32A single to three-phase

The MENNEKES draft (type 2)

As innovation leader for industrial plugs and sockets, MENNEKES has submitted a standards draft to the IEC. In spring 2009, this formed the basis for the agreement of the European energy suppliers and car manufacturers on the key points for the charging connection on electric vehicles.

Bidirectional energy transmission

The plug-type charging couplers developed by MENNEKES are ready for future demands. This also includes bidirectional energy transmission: The energy can be transmitted from the charging station to the vehicle battery. Vice versa, it can be fed to the electricity network from the vehicle battery.

MENNEKES provides open standards draft

The standards draft by MENNEKES fulfils the following demands:

- It is suitable for charging currents ranging from 13A to 63A.
- Suited for single-phase and three-phase connections
- Allows bidirectional energy transmission.
- The "control pilot" and "earth" contact enable data communication.

This standards draft by MENNEKES was the basis for the VDE application regulation VDE-AR-E 2623-2-2 which serves as temporary solution.
International standardisation is also based on the MENNEKES standards draft but has not been finalized yet.

VDE-tested

The first charging cables with charging plugs and sockets were successfully tested by the VDE.

Examples for charging capacities

	230V	400V
13A	3.0 kW	9.0 kW
16A	3.7 kW	11.0 kW
20A	4.6 kW	13.8 kW
32A	7.4 kW	22.0 kW
63A	14.5 kW	43.5 kW

The solution for you

Which system will assert itself?

Among other criteria, a uniform charging coupler system is decisive for the acceptance of electric mobility. The following factors are crucial here:

- Compatibility with different energy supply networks
- Safety demands
- System costs
- Handling
- Maintenance effort

Capacity

On an international level, there are different opinions concerning the required capacity data of the charging couplers.
Important: Higher capacity means shorter charging times.
The MENNEKES draft (type 2) enables the highest charging capacity of all three systems without drawbacks concerning costs, weight or size.

Safety

Charging electric vehicles must be safe. This is why various safety demands were defined:

- All installations for charging electric vehicles must be equipped with a RCD.
- Mode 3 charging sockets are generally deactivated as long as no plug is connected and interlocked.
- Mode 3 charging sockets are generally deactivated until communication is established with the vehicle and until the earthed conductor connection was checked.

Increased protection against contact, which is required for household sockets in some European countries, is not necessary as the mode 3 charging sockets are voltage-free when not connected.

System costs

The system costs are influenced by the constructional design, number of required sockets per charging spot, maintainability and production volume.

The MENNEKES draft (type 2) offers advantages in all these sectors:

- Simplest construction with as few components as necessary.
- Only one socket for all capacities up to 43.5 kW/63A.
- The robust construction minimises maintenance and repair costs.

Handling

A plug without additional mechanical operating elements is user-friendly and robust. The possibility cannot be ruled out that vehicles drive over the charging cable and the plug. Robust, cast plugs without moveable parts offer the highest level of safety possible here.

The MENNEKES draft (type 2), which was developed in cooperation with European electric utility and car manufacturers, meets all requirements.

Triple safety

The charging coupler is energized via the contactor not before all the following conditions are fulfilled:

1. The charging couplers are completely connected.
2. The charging couplers connection is interlocked in the vehicle as well as on the infrastructure side.
3. There is a safe communication and protective conductor connection.

If one of these requirements is not fulfilled, the connector is not supplied with voltage.

MENNEKES charging cables

The right MENNEKES charging cables for each type of charging.

The connection between the energy source and the vehicle is established via appropriate charging cables. MENNEKES offers the following types of charging cables for the different charging modes.

For mode 2 charging, the charging cables feature a domestic plug or a CEE plug IEC 309 plug 16A single-phase 230V on the main side and a charging connector on the other side.
An ICCB (incable control box) in the mode 2 charging cable is used as mobile protective equipment including communication interface to the electric vehicle. Connected to a socket, the device independently detects whether the current source is under load and the existence of an earth contact. It also permanently monitors the grounding connection between the ICCB and the socket. The RCD integrated in the device, additionally protects the user from electric shock in case of a system defect.

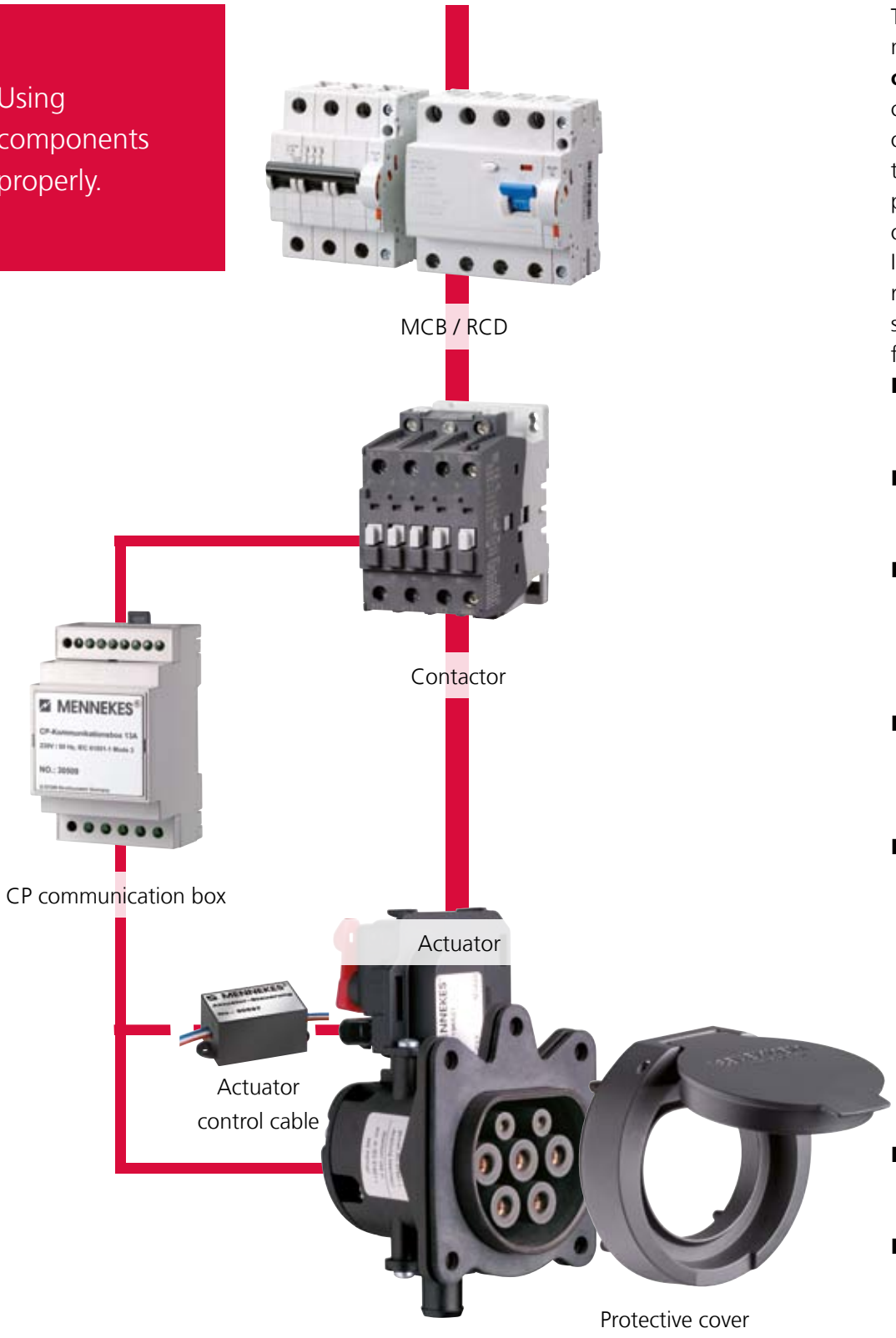
Charging in accordance with mode 3 requires specific charging cables to accommodate certain charge capacities.
These charging cables are initially available in the capacity stages 13A, 20A and 32A.
With resistance coding, the vehicle detects the maximum transmittable charging capacity and can adapt the capacity to be drawn accordingly.
At present, different variants up to 32A three-phase and max. 22 kW charging capacity are available.

Mode 2 charging cable with SCHUKO® and charging coupler for the vehicle.

Mode 3 charging cable in accordance with VDE application regulation VDE-AR-E 2623-2 with two identical, finger-safe plugs.

MENNEKES components for charging stations

Using components properly.



Mode 3 charging socket

The charging socket for mode 3 charging is merely **one** component of the charging system. It may only be operated in connection with additional components required for safe operation.
In the minimum configuration, mode 3 charging stations must include the following components:

- Protective equipment like RCD (mandatory) an MCB.
- Contactor for isolating the charge connector from the energy network.
- CP communication box for communication with the vehicle concerning charging parameters and connection monitoring.
- Actuator as part of the charging socket for interlocking and/or releasing the plug in the socket.
- Actuator control cable for activating the interlocking of the infrastructure socket in connection with the CP box.
  Only available from MENNEKES: with integrated unlocking function in case of power failure.
- Mode 3 socket for connecting the charging cable.
- Protective cover to ensure the required IP protection degree (at least IP 44).

Infrastructure components for electric mobility

Charging cables and infrastructure components.

Mode 2 charging cables

Charging cable (Mode 2), up to 13A single-phase including communication interface to the electric vehicle with grounding type plug 1P+N+PE

- Resistance coding 1500 Ohm between PE and PP
- 4 m connection cable 3G2.5 red
- With charging coupler 20° on the vehicle side
- in acc. with IEC 62196-2
- With protective cover on strap
- Communication module in acc. with IEC 61851
- Operating charging current: 13A - 11A - 8A - 6A (downgrading by unser)
- Automatic charging current reduction at excessive heat
- Nominal residual current 30 mA
- Protective type: IP 44
- Ambient temperature: -30°C to +50°C
- Enclosure dimensions: 210 x 80 x 68 mm
- Standby output < 1W

SCHUKO®/grounding type **Part no. *35050**

Charging cable (Mode 2), up to 16A single-phase including communication interface to the electric vehicle with grounding type plug 1P+N+PE

- Resistance coding 680 Ohm between PE and PP
- 4 m connection cable 3G2.5 red
- With charging coupler 20° on the vehicle side
- in acc. with IEC 62196-2
- With protective cover on strap
- Communication module in acc. with IEC 61851
- Operating charging current: 13A - 11A - 8A - 6A (downgrading by unser)
- Automatic charging current reduction at excessive heat
- Nominal residual current 30 mA
- Protective type: IP 44
- Ambient temperature: -30°C to +50°C
- Enclosure dimensions: 210 x 80 x 68 mm
- Standby output < 1W

Part no. *35055

*Charging cables will be available at January 2012.

Mode 3 charging cables

Charging cable (mode 3), 20A with charging plugs and charging connector 1P+N+PE as well as PP + CP

- Resistance coding 680 Ohm between PE and PP
- 4 m connection cable 3G2.5 + 1 x 0.5 mm², red
- Charging plug in accordance with IEC 62196-2, with protective cover
- CP interconnected

Part no. *35110

Charging cable (mode 3), 32A with charging plugs and charging connector 1P+N+PE as well as PP + CP

- Resistance coding 220 Ohm between PE and PP
- 4 m connection cable 3G6 + 1 x 0.5 mm², red
- Charging plug in accordance with IEC 62196-2, with protective cover
- CP interconnected

Part no. *35112

Charging cable (mode 3), 20A with charging plugs and charging connector 3P+N+PE as well as PP + CP

- Resistance coding 680 Ohm between PE and PP
- 4 m connection cable 5G2.5 + 1 x 0.5 mm², red
- Charging plug in accordance with IEC 62196-2, with protective cover
- CP interconnected

Part no. *35111

Charging cable (mode 3), 32A with charging plugs and charging connector 3P+N+PE as well as PP + CP

- Resistance coding 220 Ohm between PE and PP
- 4 m connection cable 5G6 + 1 x 0.5 mm², red
- Charging plug in accordance with IEC 62196-2, with protective cover
- CP interconnected

Part no. *35113

*Charging cables will be available at January 2012.

Infrastructure components

REG. no. D486

Charging socket up to 32A 3P+N+PE as well as PP + CP with mounting ring with hinged lid

- 4-point fixing
- Screw connection
- Water drain
- Interlocking actuator

VDE tested

Part no. 31023

REG. no. D486

Charging socket up to 32A 3P+N+PE as well as PP + CP with mounting ring with protective cover

- 4-point fixing
- Screw connection
- Water drain
- Interlocking actuator

VDE tested

Part no. 31024

Charging socket up to 32A 3P+N+PE as well as PP + CP

- 4-point fixing
- Screw connection
- Water drain
- Interlocking actuator

VDE tested in connection with mounting ring 30010 or 30012

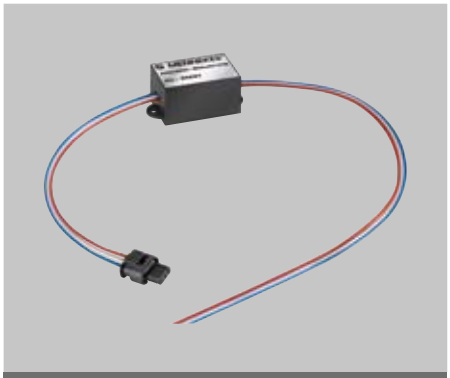
Part no. 31016

Actuator control cable

For activating the interlocking of the infrastructure socket, we recommend the actuator control cable in connection with the MENNEKES CP box.

Only available from MENNEKES: with integrated unlocking function in case of power failure.

Infrastructure components

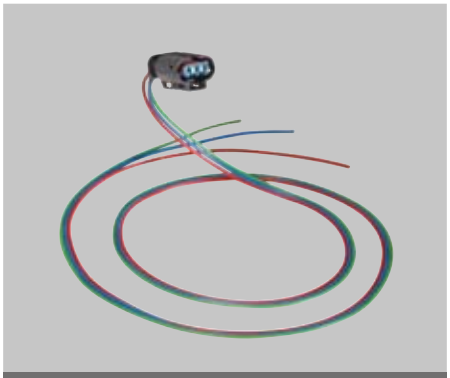


Actuator control cable

- For activating the interlocking of the infrastructure socket in connection with the CP box.
- Actuator plug with 3 crimped-on single conductors on one side, soldered to conductor board
- Other side 3 single conductors, open end, soldered to conductor board
- Cable length on both sides 50 cm

Only available from MENNEKES: with integrated unlocking function in case of power failure.

Part no. 30537



Actuator connection cable

- Consisting of:
- Actuator plug with 3 individual conductors (1 m)

Part no. 30019

Water drain hose

- 1.25 m long
- Incl. fixing material and alternative water drainage muff 90°

Part no. 30101

Mounting ring with hinged lid

- IP 44
- 4-point fixing

Part no. 30012

Mounting ring with protective cover

- IP 44
- 4-point fixing

Part no. 30010

Infrastructure components

CP communication box 13A

Modular device with an overall width of 3 modules
- Mode 3 communication with the vehicle
- Contactor activation

Part no. 30509

CP communication box 16A

Modular device with an overall width of 3 modules
- Mode 3 communication with the vehicle
- Contactor activation

Part no. 30510

CP communication box 32A

Modular device with an overall width of 3 modules
- Mode 3 communication with the vehicle
- Contactor activation

Part no. 30511

Sample charging plug

- With 0.5 m cable (not connected)
- Demonstration sample, without function

Part no. *32002

*Charging cables will be available at January 2012.

MENNEKES®

Plugs for the world

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