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# **MENNEKES** and electric vehicle

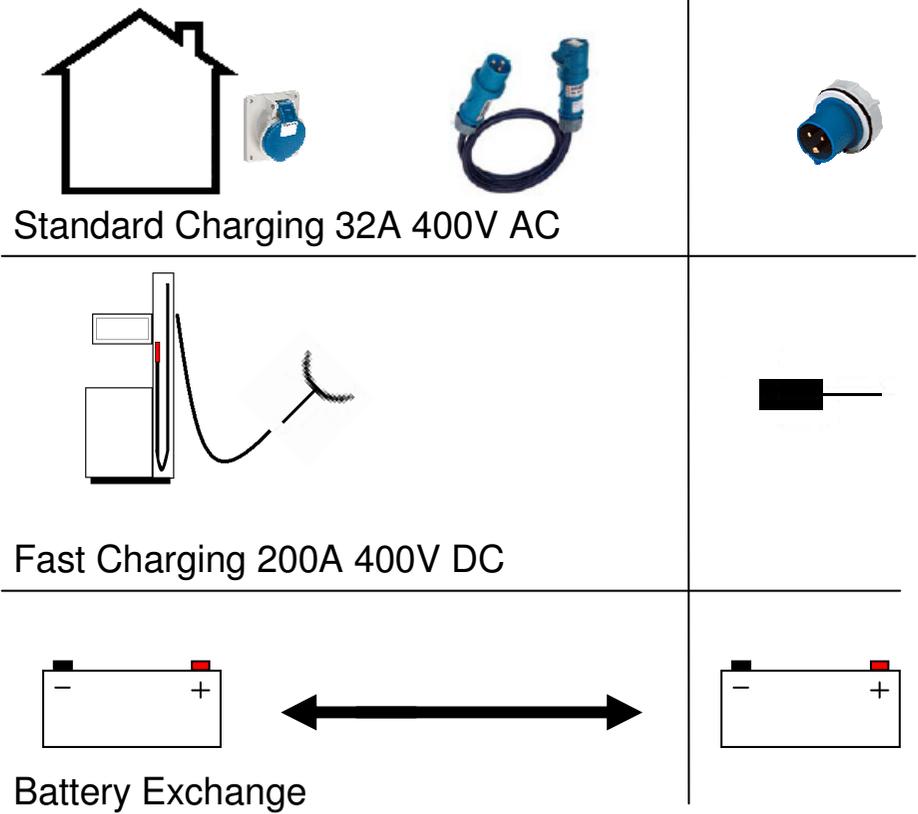
# Systemstructure

It looks so easy ...



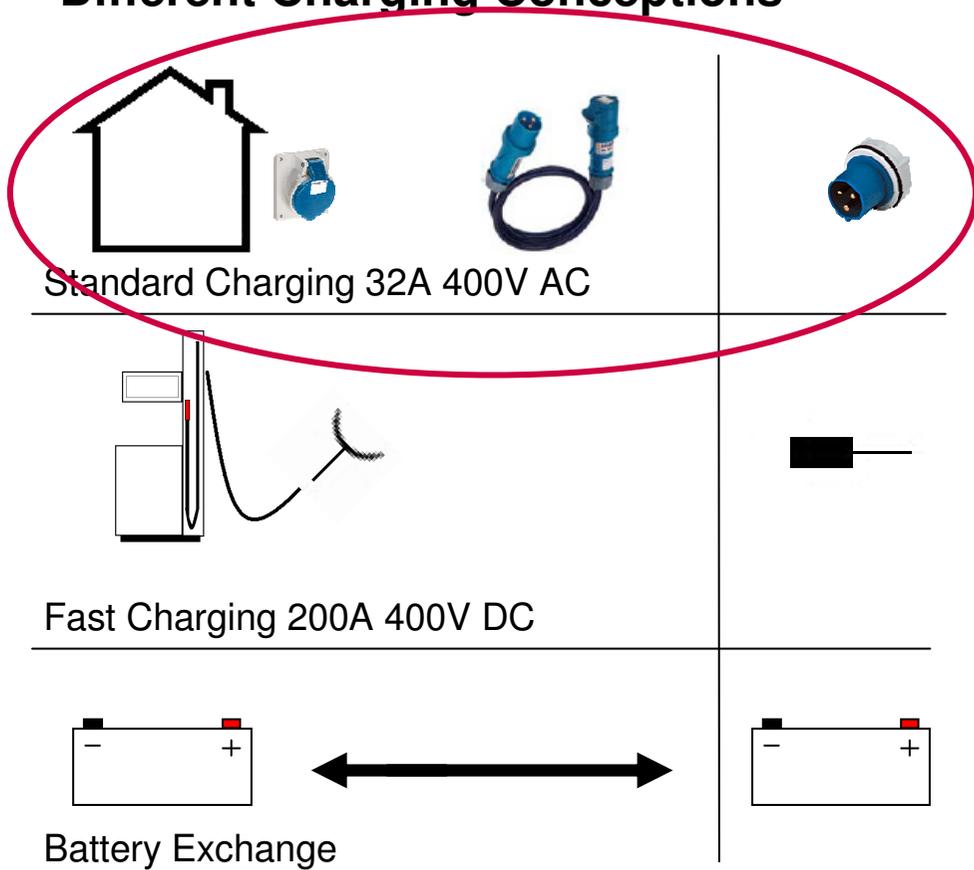
... but it is not.

## Different Charging Conceptions



# Systemstructure

## Different Charging Conceptions



## Details of Standard Charging



**Charging  
Station /  
Socket**



**Charging Cable**



**Vehicle Interface**



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# Vehicle Coupler

## Requirements from the IEC 62196-1

<b>Current:</b>	<b>16A – 32A AC</b>
<b>Voltage:</b>	<b>230V single-phase 400V three-phase</b>
<b>Communication:</b>	<b>necessary from vehicle to charge- station</b>
<b>Plug in cycles:</b>	<b>10.000 times</b>
<b>Approvals:</b>	<b>tested and approved regarding IEC 62196-1</b>

## MENNEKES CEEplus



- The IEC 309-System is standardised all over the world
- CEE plus is complete compatible to the IEC 309-System
- CEEplus is tested and approved as vehicle coupler in regard to IEC 92196-1
- The 16A power contacts are designed also for 32A and the system is available for 1 phase and for 3 phase charging to reduce the charging time.

16A, 3p	1 Phase	3,70 kW	=	100% Ladezeit
32A, 3p	1 Phase	7,40 kW	=	50% Ladezeit
16A, 5p	3 Phasen	11,00 kW	=	33% Ladezeit
32A, 5p	3 Phasen	22,00 kW	=	17% Ladezeit



# Vehicle Coupler

We introduced the System to automotive manufactures and energy suppliers.

**Result: -> Modifications are necessary**

- better ergonomics
- better handling (less mating force)

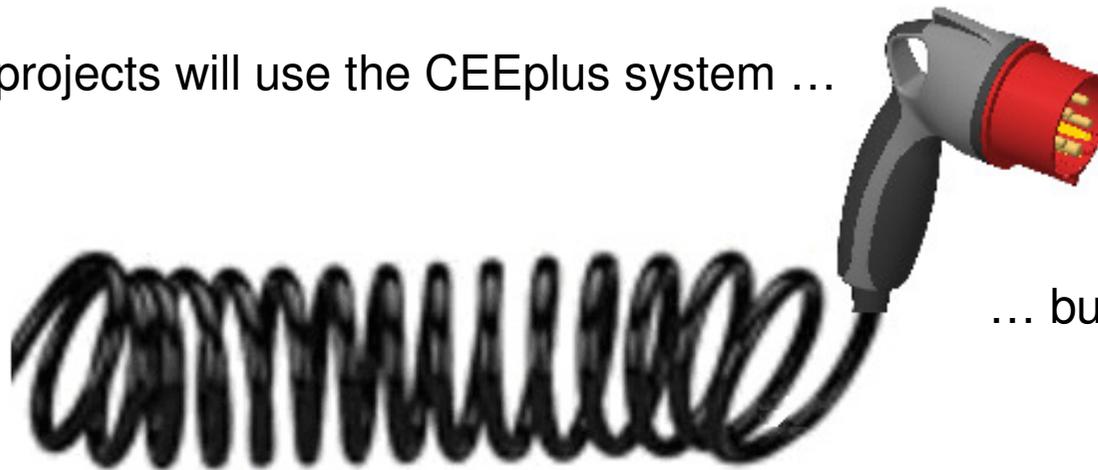


# Vehicle Coupler

## e-mobility Berlin / MINI-E-Berlin



both projects will use the CEEplus system ...



... but for the future there are additional requirements!



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# General System Specifications

## Communication

Between Vehicle and Charging Station communication is necessary. The current standards require additional contact in the plug and socket system, whereas the current developments prefer communication through Powerline.

### - Communication between Vehicle and Charging Station:

- Identification of Vehiclecode (e.g. for assignment of the Vehicle to the account of the owner at the Power Supplier)
- Identification of the Charging System of the Vehicle (what kind of Charging is needed?)
- Identification of accurate connection between Vehicle and Charging Station
- Accomplishment of RCD Control
- Clearance and termination of Charging Process
- Signal for interlocking of Charging System
- Activation of Immobilizer System

### - Communication between Vehicle and Power Supplier:

- Billing of delivered power
- Controlled supply of power
- Provision of different rates
- In the future: Controlled use of Vehicle Battery as power reservoir

## Interlocking

You cannot compare the Electric Charging with the fueling of a vehicle with a combustion engine. The user will especially notice that the charging process takes much more time than fueling. This means that – unlike when fueling – people will leave the car and so an unattended process takes place.

To avoid maloperation and unrequested stops of the charging process, defined interlocking processes are necessary.

### - Electrical Interlocking

The socket of the Charging Station always has to be de-energized, as long as there is no sufficient contact between Plug and Socket. We call this an Electrical Interlocking. This is done by a Contactor, which is checking if there is a sufficient contact between Plug and Socket.

This function ensures on the one hand, that there is no danger of electric shock at the Socket. On the other hand it makes sure, that there will be no plugging or unplugging under load.

# General System Specifications

## - Electro-Mechanical locking

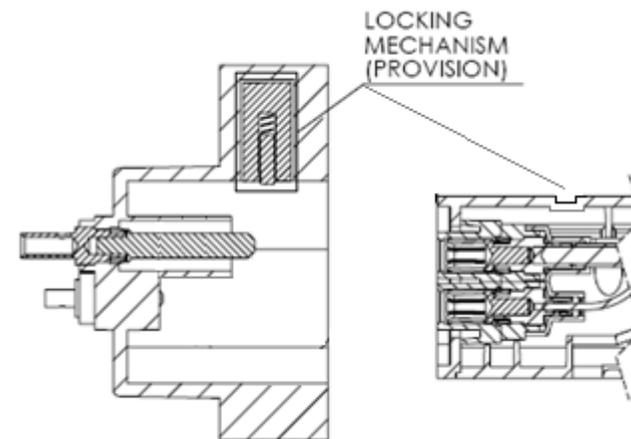
To avoid that the Charging Process is stopped unrequested, e.g. to steal the Charging Cable or maliciously stopping the Charging Process it is necessary that the Plug and Socket of the Charging Cable are mechanically locked in the Charging Station and in the Vehicle.

This Electro-Mechanical Interlocking is released with an electric signal, which is sent as soon as the Charging Process is started.

The Charging Process can be started either automatically by communication between Vehicle and Charging Station, or by operating an input-terminal and the authorization by card system at the Charging Station (like a Customer Activated Terminal for fueling).

When the Charging Process is stopped and the Charging Cable is de-energized, the Electro-Mechanical Interlocking will be released.

To react on system malfunctions, which lead to an unwanted interlocking, an emergency release which is located inside the vehicle is necessary.



## Handling

Charging an Electrical Car should be possible for any person without any problems. This demands, that the systems have to be self-explanatory and handy. For the Standard Charging a Charging Cable is carried in the Vehicle. Therefore it is necessary the the user operates a Plug-and-Socket-System both at the Vehicle and at the Charging Station. This operation should be as simple and handy as possible.

### **Characteristics for Handling:**

- The enclosures of the Plug and Sockets have to be ergonomically designed (slip-proof, no sharp edges, handy, ...)
- A clear orientation of the Plug to the Socket is essential
- The Sockets in the Vehicle and in the Charging Stations should be in an ideal position to ensure an optimal power flow when operating.
- Operating of protection caps and lids should be possible also with delicate hands (eventually with long finger nails). Eventually there will be no need of lids at all.
- The insert- and drawing forces are not allowed to excess a certain force also in a used condition.
- Necessary interlocking and sealing processes have to be done automatically without additional operations.

## Start charging

If the plug is connected to the car and to the charging station the communication starts. After the control of the earth contact and the definition of the type of charging system is done, the charging process starts automatically.

## Stop charging

Charging the batteries stops automatically if the batteries are full or in case of an external stop signal.

The complete charging process is finished if the locking of the plug is released and the plug is pulled out of the car and out of the charging station.

The complete charging process and the locking of the plug has to be interrupted by an external signal. To secure that it is not possible to interrupt the charging process arbitrary, two solutions are available:

- To interrupt the charging process it is necessary to push a button at the inside of the car. So only the car driver can do this.
- To interrupt the charging process it is necessary to push a button which is located in the area of the vehicle interface. It is possible to reach this button from outside, but it works only if the central-car-interlock is released.



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# Specification **Charging Cable**

# Specification Charging Cables



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## Design:

Usually cables, e.g. extension cables have a Plug on the end and a Connector on the other hand. In the area of IEC standard Plugs and Sockets only the Connectors are considered as live parts; therefore only the contacts of the connector have to be protected against contact.



Assuming that in the future also a power extraction from the Vehicle batteries into the network or for external consumers can be done, the non-protected contacts of the Plug are a danger to life and health, as a current flow from the Connector to the Plug will energize the pins of the Plug.

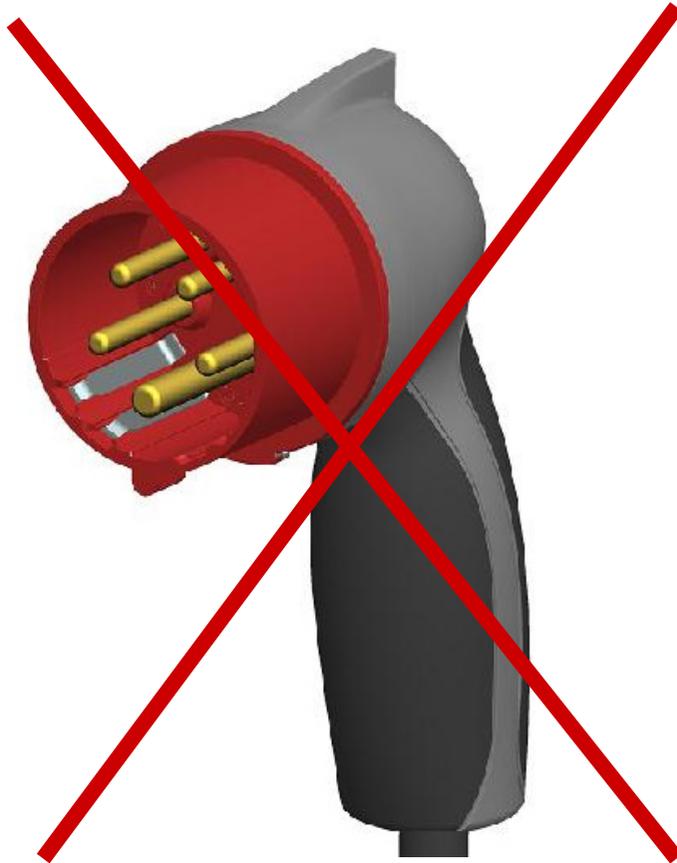
**➔ The known IEC Standards cannot be used any longer!**

If a power extraction from the Vehicle batteries is intended, Plug and Socket Systems which provides both isolated contacts in the Plug and in the Socket.

# Specification Charging Cables

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# Specification Charging Cables



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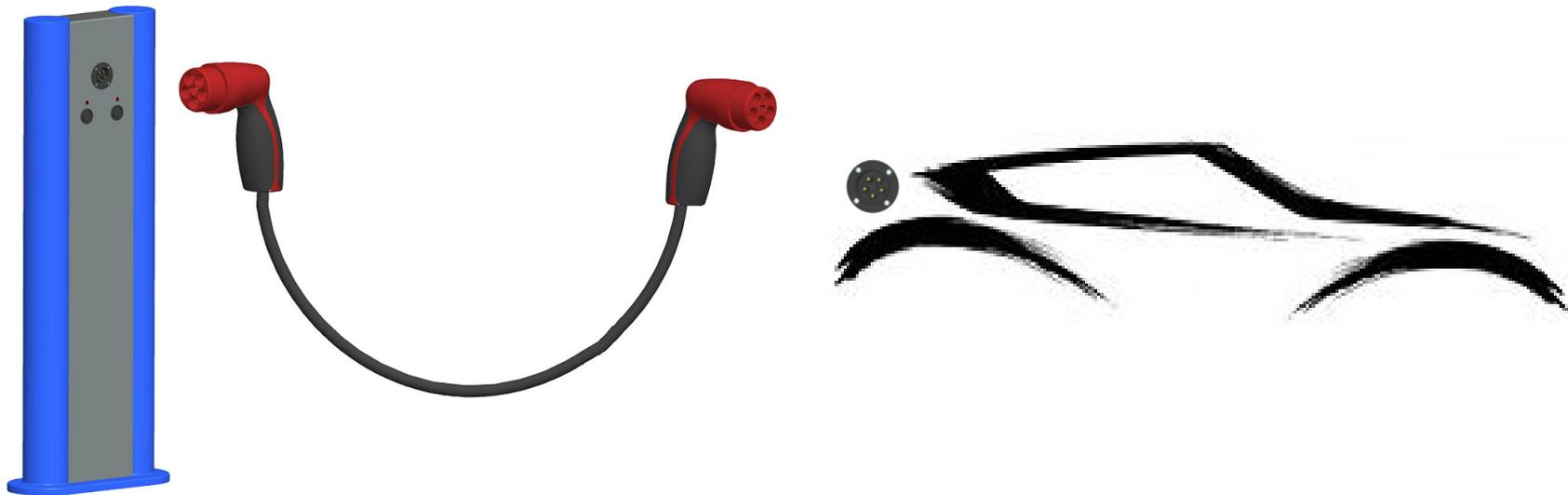
Special Charging Set: Plug and Socket



# Specification Charging Cables

Assuming that also the Plug is protected against contact, the Charging Cable can be equipped with a Plug on both sides and no Connector is needed. I.e. both in the vehicle and in the Charging Station nearly identical Sockets can be used.

- ➔ • Both ends of the Charging Cable are identical → simple and clear handling
- No flap lid on Charging Cable → simple handling / very robust
- Nearly identical sockets both in the vehicle and the Charging Station → simplified system, no appliance inlet necessary



# Specification Charging Cables



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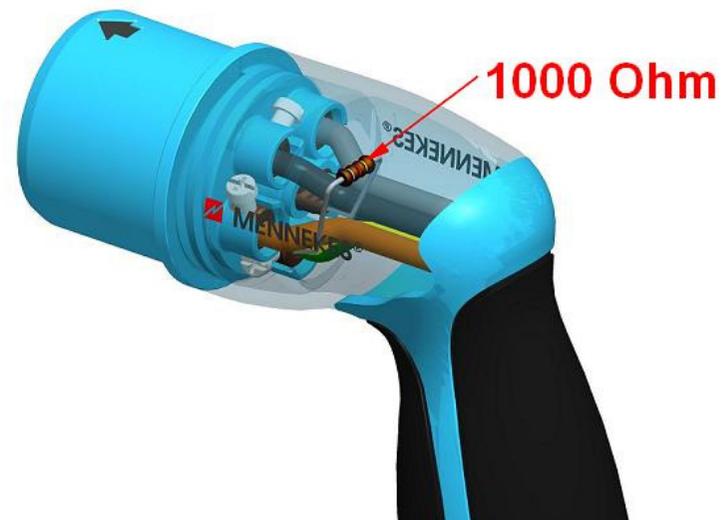
## Encoding

### - Amperage Encoding

The System is rated for 63A. To solve the problems with big cables it is necessary to use cables with different cross sections.

Here we think that the on-board Charging Cables for 32A are equipped with 6 mm<sup>2</sup> cables, whereas Charging Stations for public areas are equipped with fixed cables for 63A with 16 mm<sup>2</sup>.

Therefore it is necessary to identify the cables before charging to avoid the use of a 6 mm<sup>2</sup> cable for 63A power. The identification can be done by different Resistant-Bridges between two signal contacts.



## **Communication**

To fulfill the communication demands, two signal contact and a Hybrid-Cable with an additional 1 x 0,5 mm<sup>2</sup> conductor are needed.

If Powerline is used, the signal contacts are still required but it is not necessary to use a special Hybrid-Cable any longer.

It is also possible to use the “PLC-Charging-Systems“, designed by EDF.

## **Safety**

Charging Cables will be assembled in that way, that they cannot be re-connected again, so that no opening and manipulating can be done.



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# Specification **Charging Station**

# Specification Charging Station



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## Design

According to the definition of the Charging Cable one or more sockets will be built in the Charging Station.

There are different application areas, which do have different demands for Charging Stations. These miscellaneous demands are generally defined by the following conditions:

- Application inside or outside
- Application in private or public area
- Standard Charging or Fast Charging
- Only power supply or power supply and billing
- Authorization through Vehiclecode, with Card, with RFID (Radio Frequency Identification), or without any identification.

# Specification Charging Station



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## ”Visiting Grandma“ Charging

The most simple version of a Charging Station is the common domestic style socket in residential buildings. This version always has to be provided, e.g. for charging the Vehicle when visiting your grandma.

As for Charging Processes up to 16A acc. To IEC 61851-1:2001 no communication with the Vehicle is necessary, this Charging can be done with an adaptor between domestic socket and Charging Plug (with integrated RCD).



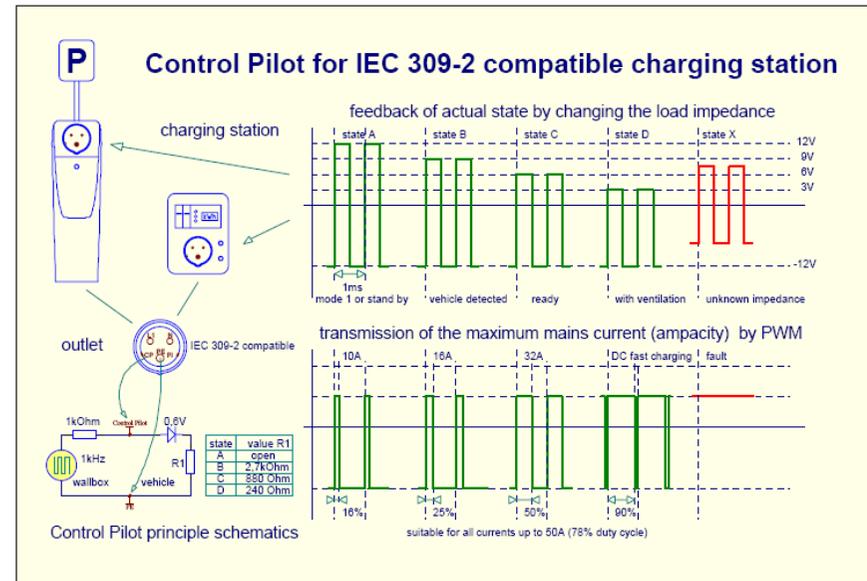
# Specification Charging Station

## Standard Charging

To reduce the Charging Time also at home to an acceptable limit, it makes sense to offer 32A Charging Station for residential buildings.

For this, a communication between Charging Station and Vehicle is mandatory.

The most simple version of communication can be done through a so called **Wallbox**, which communicates through different rectangular signals with the Vehicle; to query the relevant technical frame conditions and to accordingly adjust the Charging Station.



If the communication shall be used for more than only adjusting the Charging Station, e.g. to do billings, a wallbox is not enough. For these application a processor or an Industrial PC if applicable should be used.

The communication itself can be done over additional **Signal Contacts** or by **Powerline**. If Powerline is used, a coupler in the Charging Station and in the Charging Electronic is necessary (A decision about such technology has to be done within the framework of the standardization process).

## Standard Charging in public areas

For a 32A Charging Station in public areas the same demands as in private areas are given, furthermore, the following points have to be considered especially:

- The billing of the Charging Service is mandatory, therefore a Vehicle identification or an authorization by card is necessary.
- The Charging Stations have to be robust.
- The sockets of the Charging Stations have to fulfill all requested demands for the interlocking systems (see General Specifications).
- Standard solutions as well as optically enhanced units should be provided.
- It is preferable that the self-explanatory operation of MCB and RCD can be done by every user without hazards.

# Specification Charging Station

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Standard Charging in public areas - Example



# Specification Charging Station

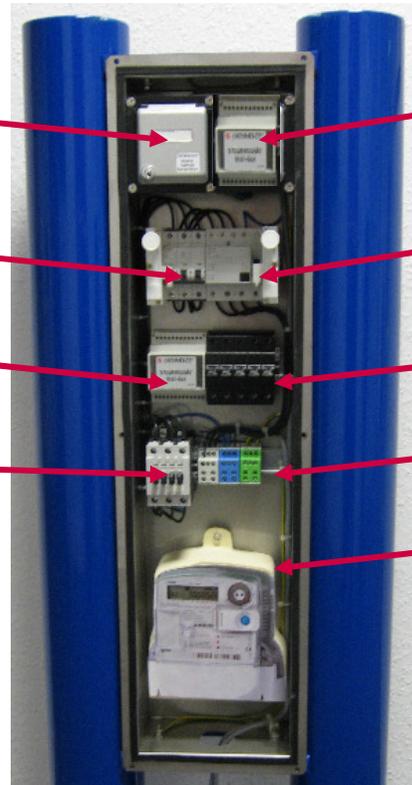
## Basic Principle of the design of a Charging Station

Socket; electrically an electro-mechanically interlocked

MCB with external push button

Wallbox (alternatively to Industrial PC)

Contactor



Powerline Couple (alternatively to additional signal contacts)

RCD with external push button

Industrial PC (alternatively to Wallbox)

Distribution Terminal Block

„Smartmeter“ Meter Reader



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# The MENNEKES Development

# Vehicle Coupler

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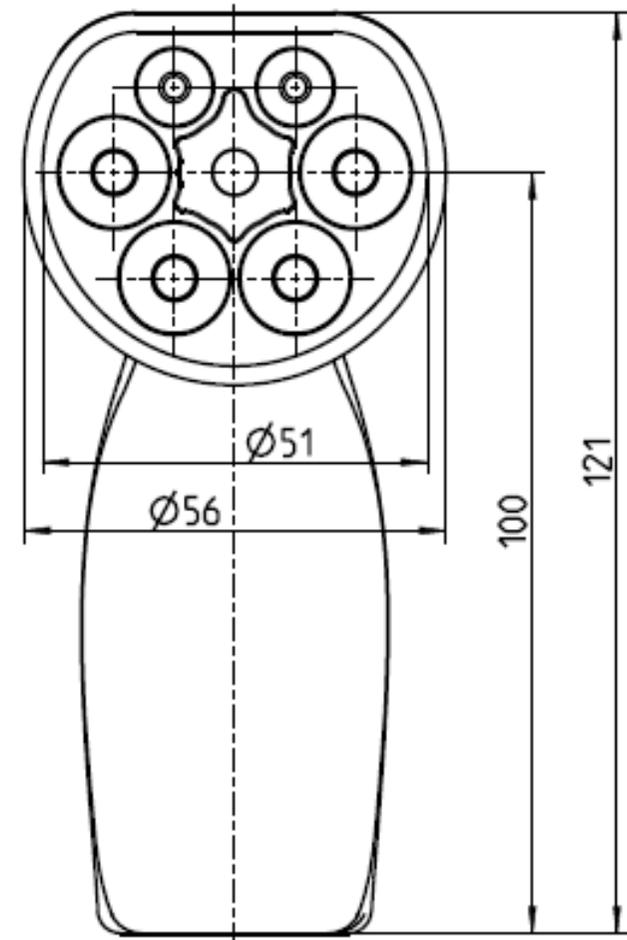
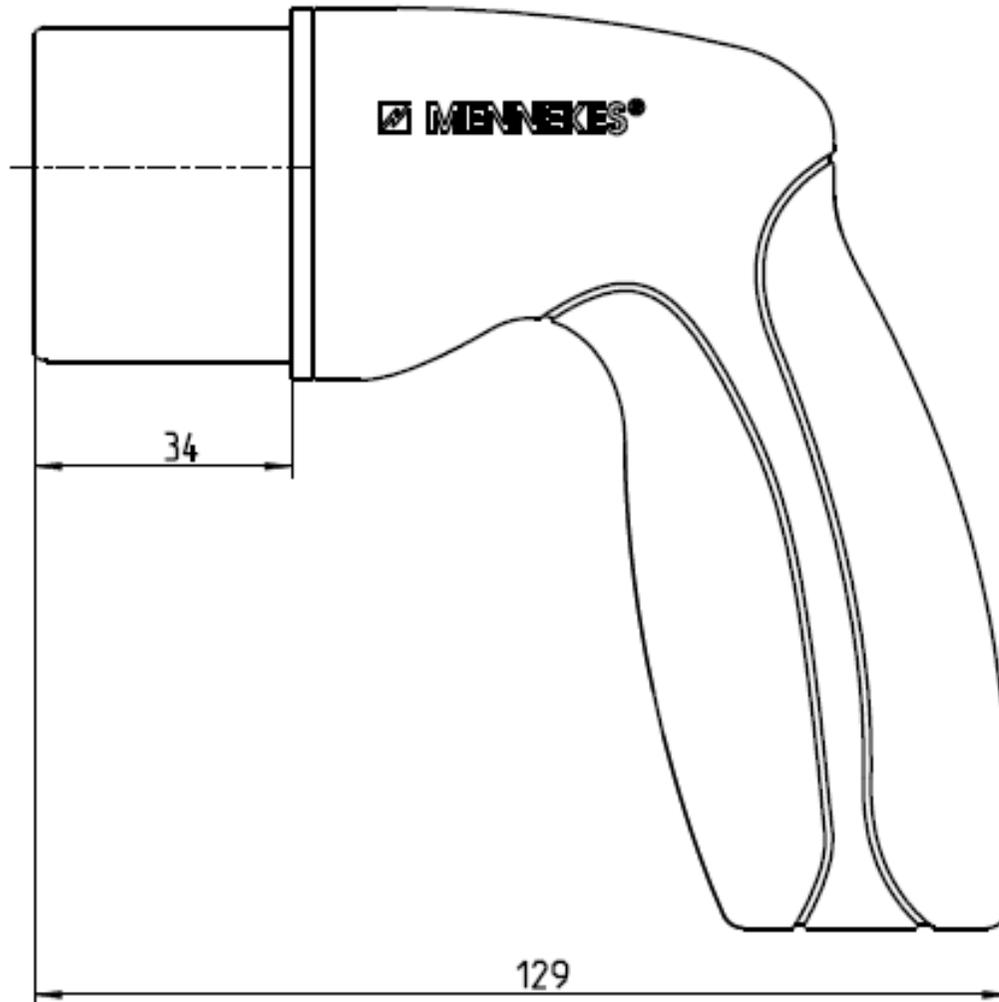
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# Vehicle Coupler

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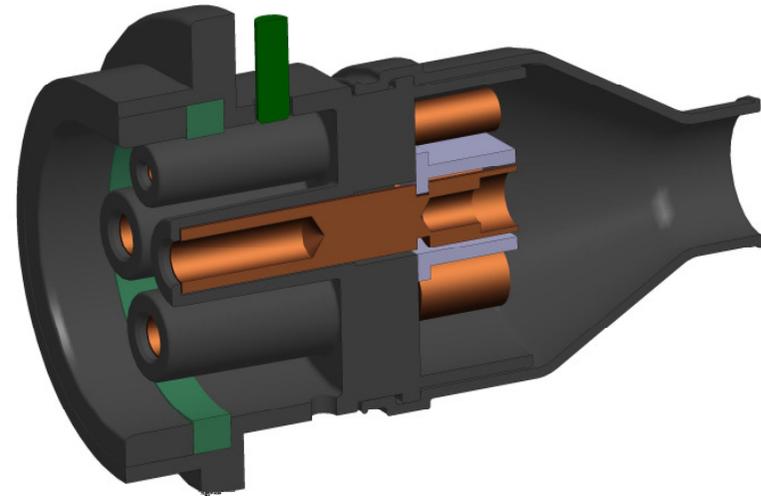
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# Vehicle Coupler

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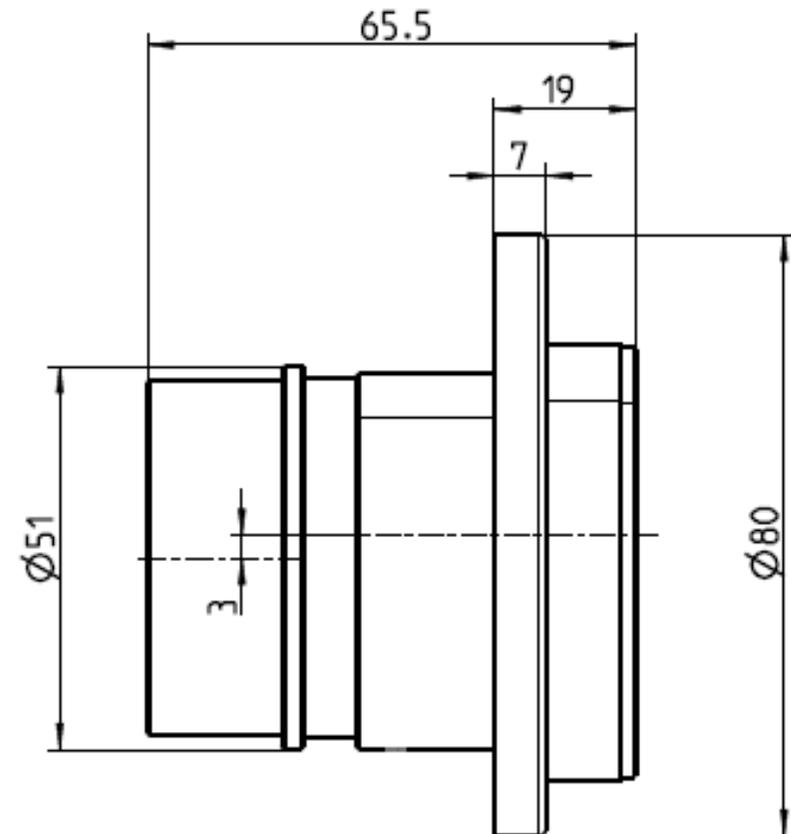
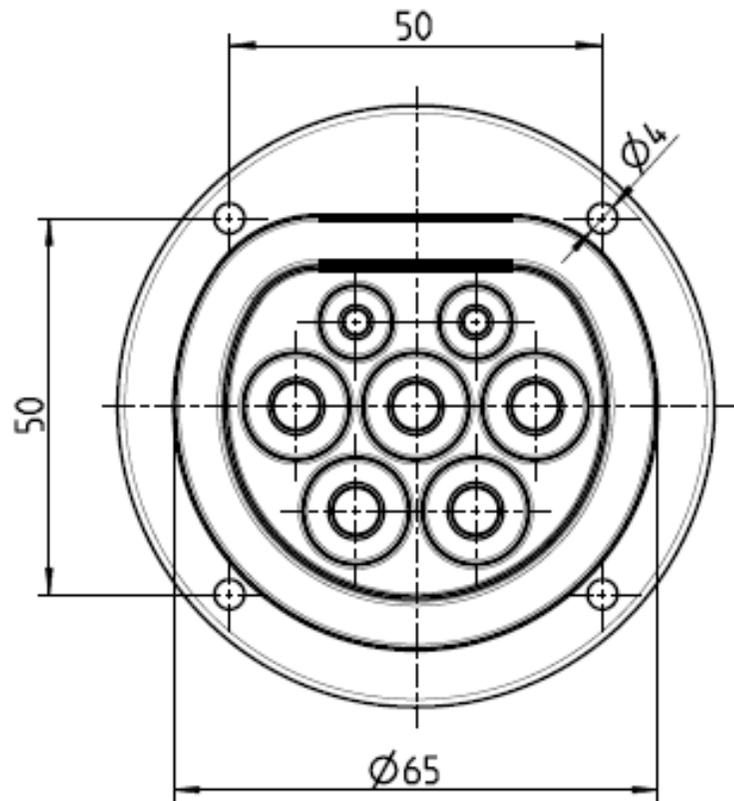
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# Vehicle Coupler

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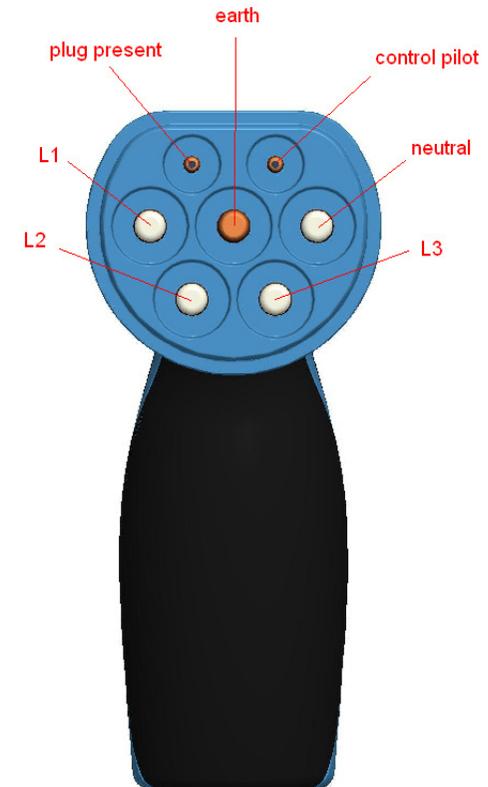
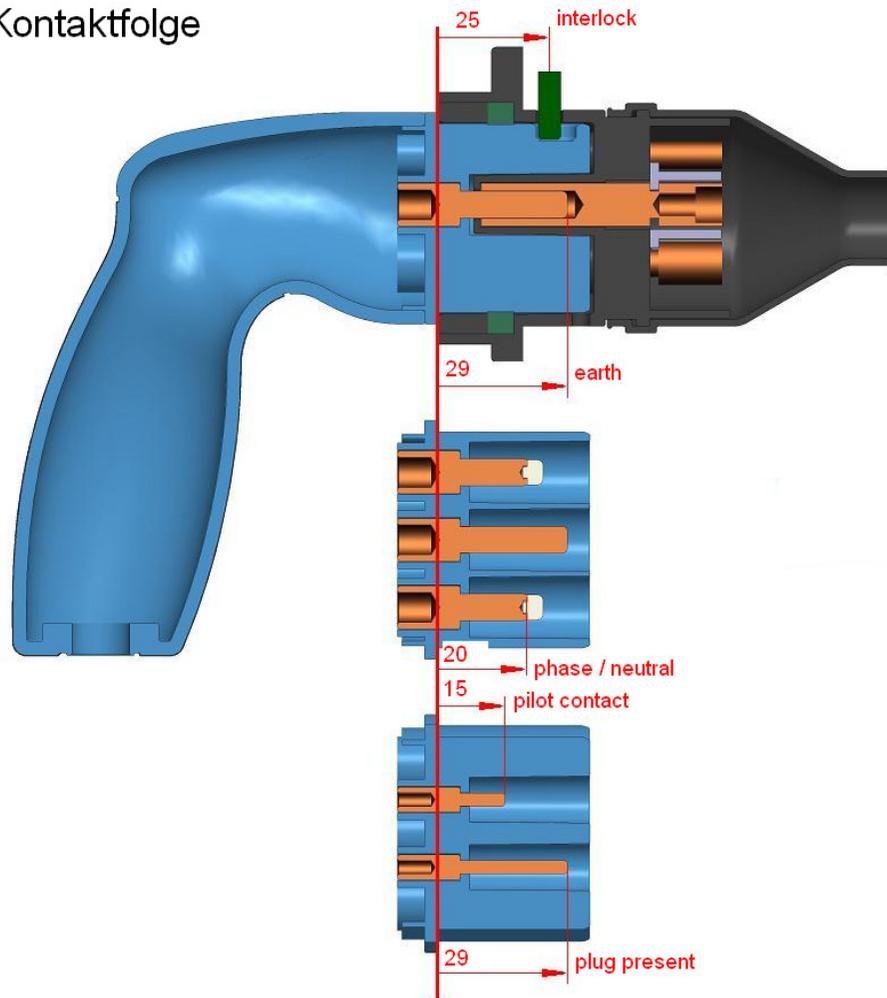


# Vehicle Coupler



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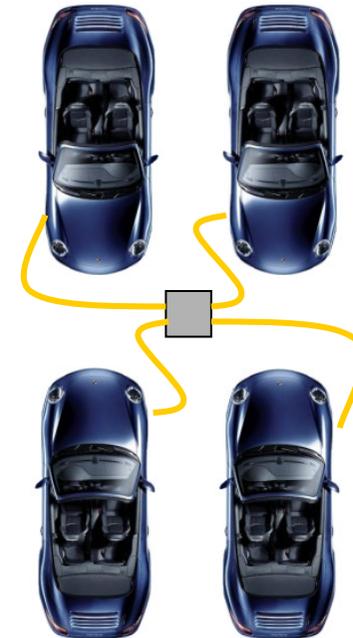
Kontaktfolge



# Charging Station

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# Charging Station

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# MENNEKES Solution

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System-Area	Charging Station	Cable	Electric Vehicle
Component	Infrastructure Socket 	The same plug on both sides 	Vehicle Socket 
Spezifikation	Current: max. 63A Power Contact: 3p + N + PE Signal Contact: 2p Interlock: elektromechanic IP Grade: IP 44 Cover: lid Dimension: 55 mm	Current: max. 63A Power Contact: 3p + N + PE Signal Contact: 2p Interlock: - IP Grade: IP 44 Cover: - Dimension: 55 mm	Current: max. 63A Power Contact: 3p + N + PE Signal Contact: 2p Interlock: elektromechanic IP Grade: IP 65 Cover: Screwed cover Dimension: 55 mm

# MENNEKES Charging Systems

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