ETREL INCH FAMILY

ELECTRICAL INSTALLATION

Document version: 1.2

1 GENERAL INFORMATION ABOUT INSTALLING NEW CHARGING STATIONS

SINGLE PHASE CHARGING STATIONS VS THREE PHASE CHARGING STATIONS

***Important:** Even though your installation currently doesn't support three phase charging it is recommended that three phase charging station is installed and with max power available just to be future proof. The difference in prices are negligible.*

Two options of Etrel INCH charging station exists: Single-phase model and Three-phase model. Which option is used for installation depends on the connection type of the households. In Europe it is quite often the case that households have three phase connection so they have the possibility for installation of three-phase charging station. Three-phase charging stations charge the car using all three phases. Limitations are also on the electric vehicles (EV) side as only EVs that have installed three-phase on board charger can use all three phases for the charging station to charge.

The charging rate of single phase charging station is much slower in comparison to the three-phase station as the car batteries are charged only through one phase. Charging is approximately 3 times slower than when three phase charging stations are used.

***Important:** Electric vehicles that use single phase on board charger can be charged on the three-phase charging station as well*

In that situation only one phase will be used. In case the charging station is part of the cluster of stations it is important that the order of how the phases are connected varies from charge station to station. If all are connected in the same order, unbalance in the phase (e.g. L1) that is used to charge the one-phase cars will happen when more one-phase cars are being charged at the same time. Because of that it is advisable to vary the connection of phases. Cars with three-phase on board charger can also be charged on the one-phase charging station with the third of the max charging power.

PREVENTING OVERLOAD OF THE BUILDING

Building's max. connection power represents a limit which can be used for all loads connected to the same building's connection point. If the limit is exceeded, building can be disconnected from the electrical grid. When installing the charging station, it must be checked whether the max. power of the connection point is sufficient to cover all the existing loads plus the additional new load represented by EV charging. Buildings may have several large loads (water heaters, heat pumps, ovens…) that can use nearly the max. allowed current per phase in the peak hours of the day, so any additional uncontrolled load may exceed the capacity of the building's connection.

CHARGING STATION SETTINGS

Managing the power and setting the limit of charging power/current can be done by simply using the software solution. Every charger has a front end GUI that can be accessed through web app and allows users to interact with charger and change its settings. User can change various settings like basic power management functions and can limit the charging power. User can change the current output, insert the maximum building load capabilities and limit power output of the charger and cluster of chargers. Apart from these simple solutions that can be modified in the app, Etrel Inch charging station also provides more detailed power management. For this to be possible load guard unit needs to be installed in the house installation and communication with the charger needs to be established. This enables the algorithm that can schedule the charging of the EV based on previous schedules, modify the charging based on the price of energy, making the charging of your EV less expensive, predict house load, generation and based on this automatically manipulate charging power and change the charging schedule, shift schedule to the time with the biggest production and distribute power among charging structure in a cluster. All the power management functionalities are described in more details in the Power management document.

LOAD GUARD UNIT CAN BE INSTALLED TOGETHER WITH THE NEW SMART CHARGING STATION. THIS ALLOWS SQUEEZING MAX CURRENT FROM EXISTING INSTALLATION AND GRID CONNECTION POINT BY DYNAMICALLY ADAPTING CHARGING BASED ON OTHER STATIC LOADS IN INSTALLATION.

LOAD COSTUMIZATION USING THE LOAD GUARD

Load guard is responsible to measure the consumption in the building as well as production if the building has production unit installed. Load guard sends the data to the charging station that can, based on the data received, use power management and forecasting methods to schedule the charging so that the max power of the connection point is always below the threshold. Charging station also takes into consideration past charging schedules and users' wishes (charging end time) to optimize the charging schedule.

Alternative to the load guard unit for the households, with not enough power available, is to increase the power limit by replacing the current household fuses with bigger ones. The cost of installing new bigger fuses depends on the country, but it is an additional cost that is not necessary. Additionally there will also be an increase on household's monthly electrical bill as the max installed power represents one part of the electricity bill and also sets an amount paid as a support fee for RES energy sources in some countries.

2 | ELECTRICAL PROTECTION

Vital part of the electrical installation is the protection of all the loads installed in the household, among them also charging station, protection of users using the appliances and protection of electrical installation. Charging station and power supply cable needs to be protected against electrical faults, surges, short circuits that can be harmful to the station as well as to the user. This is why protection needs to be dimensioned and installed before the charging station is installed. Charging station protection is done in three layers:

- Protection of EV user by measuring and tripping the protection based on the residual current.
- Protection of household wiring, power supply cable and charging station with overcurrent protection.
- Protection of charging station against overvoltages.

Grounding of the charging station is main requirement to satisfy the first and third protection measure.

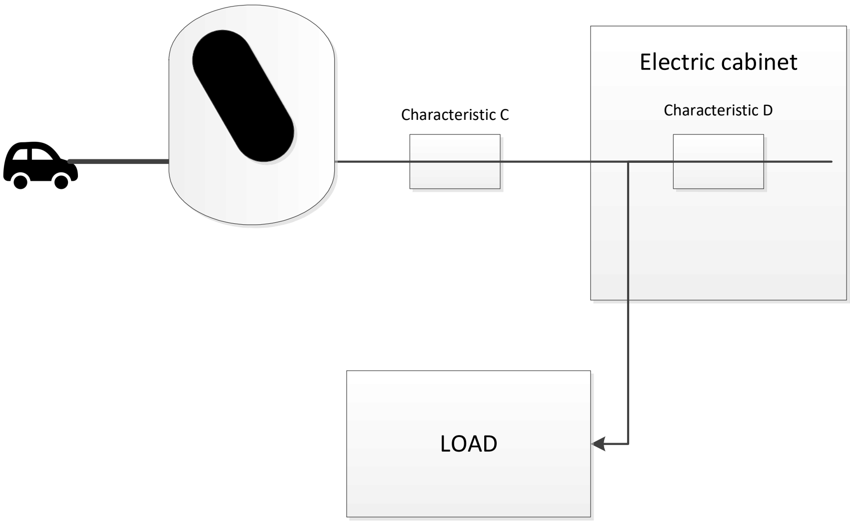
OVERCURRENT PROTECTION/PROTECTION AGAINST SHORT CIRCUITS

Overcurrent protection devices protect against overcurrent and short-circuit currents. Protection devices are available for installation with different characteristics that define switching time at the rated current.

The overcurrent protection is executed using the circuit breakers which protect devices against the instantaneous increase of current (short-circuit) and against overload that happens if the current is too big for a certain amount of time. When it comes to instantaneous tripping characteristic B gives instantaneous tripping when the current is between 3 x I_n and 5 x I_n or more. Characteristic C provides instantaneous tripping of breaker when the current is between 5 x I_n and 10 x I_n or more while the characteristic D is used for the instantaneous tripping current between 10 x I_n and 20 x I_n or more.

As the EV is normally a soft load, meaning that it will very rarely trip the instantaneous characteristic, it can however trip the circuit breaker thermal characteristic if the current stays above certain current value for a particular time. Most commonly used characteristic is C, which is advisable if the selectivity can be achieved.

If type C circuit breaker is used then other loads need to be protected using D characteristic to prevent disconnecting other loads in case there is something wrong during the charging.



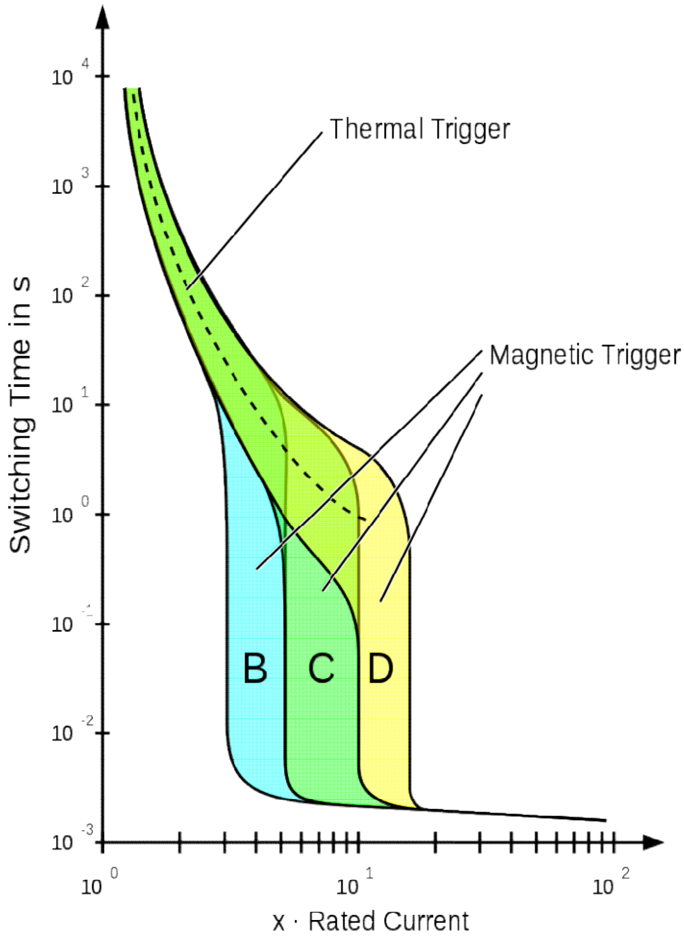


Fig. 1 Overcurrent protection characteristics

Maximum time before the fuse opens is determined by the maximum current, maximum allowed insulation temperature, and temperature of the surroundings.

In Etrel INCH stations, characteristics C overcurrent protection is used for protection of the power supplying cable for permanent current between 16 A and 40 A.

RESIDUAL CURRENT PROTECTION

__Important:__ RCD needs to be tested and reset by pressing the button on the device at least once per year. By doing this, appropriate operation of RCD is ensured. If this is not done the protected device can be dangerous to users and potential malfunction can be life-threatening.

Residual current protection devices protect against faults which happen in case of indirect contact or direct contact and can also prevent fires caused by the ground-fault at a very early stage. Residual current protective devices are used when appropriately grounded protective conductor is connected to the system components and equipment to be protected. Current can then pass through a human body only when two faults occur (interruption of the PE conductor in addition to a fault in the insulation) or when there is unintentional contact between live parts. Residual protective devices installed in Etrel INCH charging station have a rated residual current up to 30 mA.

Residual current protective devices vary one from another based on the suitability for detecting different forms of residual current. Types of residual current protection devices are the following: Type AC, A, F, B and B+. In the Etrel Inch station it is possible to use B and B+. It is recommended that RCD type B is used, as the same is demanded by edition 3.0 of IEC 61851 standard (2017).

Type A

Type A protective devices detect pulsating DC residual current in addition to sinusoidal AC residual currents. Type A also handles the residual current waveforms which can occur in the power supply units of single-phase loads with electronic components. Smooth DC residual currents up to 6 mA do not affect the trip properties unacceptably.

Under the latest IEC 61851 standard, sole Type A RCD protection is not allowed to be used in charging stations.

Type B

Type B RCD detects all residual current types as type A as well as currents from mixed frequencies up to 1 kHz. Type B is also able to cope with the possible residual current waveforms on the output side of single-phase connected frequency converters (e.g. in washing machines, pumps). Smooth DC residual currents up to 10 mA do not affect the trip properties unacceptably. Type B devices are used to detect smooth DC residual currents. RCDs of this type are suitable for use in 50/60 Hz three-phase AC systems, but not in DC voltage systems or where frequencies differ from 50/60 Hz as on the output side of frequency converters. Tripping value is defined up to 2 kHz.

OVERVOLTAGE (SURGE) PROTECTION

Overvoltage protection is used to limit transient overvoltages of atmospheric origin, surges caused by electrostatic discharge, power-frequency overvoltages. and switching surges. Surge protection

***Important:* *If n*ot using an adequate Class 1 and Class 2 overvoltage protection you are risking the potential malfunction of charging station in case of overvoltage occurance.**

devices limit the amplitude of overvoltage to a value that is not hazardous for the electrical installation and appliances.

Overvoltage protection devices can be classified in three main classes and are additionally sorted into 4 classes based on their properties:

- Class 1 overvoltage protection units are designed to protect electrical installation and appliances against partially direct lightning bolts strikes. Protection units are installed in the main electrical box.
- Class 2 overvoltage protection units are designed to protect electrical installation and appliances against indirect lightning bolts strikes and against switching (industrial) overvoltage. The protection units are installed in the electrical cabinet.
- Class 3 overvoltage protection units are designed to limit the overvoltage to the values that would not damage the electrical appliance that is protected by it. They should be installed in the vicinity of the appliance.

Based on their ability, overvoltage protection devices are sorted in the four classes named A, B, C and D:

- Class A is meant for the protection of above ground power line.
- Class B is used for discharging of lightning current. Discharging rate is very high and because of that it is installed to the household connector. Functionality of the protection is based on the spark gap. When the voltage is too high an arc appears that is used to discharge lightning current through the busbar and equalizes the potential to the ground.
- Class C protection units are used to limit the overvoltage of indirect lightning strikes, overvoltage due to lightning bolt magnetic field, and overvoltage due to switching on the power lines. Ability to discharge the current is much lower in comparison to Class B units. They are installed in the distribution switch block. Non-linear elements – varistors are used as class C protection units.
- Class D protection devices are limiting the overvoltage more than class C but their ability to discharge the current is lower. They are installed directly in front of the sensitive loads (TV, computer, …).

GROUNDING

Important: *Resistance to the ground should be smaller than 10 ohm or smaller than 8 % of specific resistance.*

Before the charging station is installed at the location it is vital to ensure that the chosen grounding of the station meets all the safety regulations and standards. The primary purpose of grounding is to avoid or minimize the danger of electrocution, fire due to earth leakage of current through undesired path, and to ensure that the potential of a current carrying conductor does not rise with respect to the earth more than its designed insulation. Grounding of the charging station is especially important in order to protect charging station electronics against overvoltages and to protect EV user by measuring and tripping the protection based on the residual current. To avoid this, appliances' parts need to be grounded and charge transferred directly to the earth through a minimum resistance. It is also important to ground other conductive parts around the charging station. Installer has to measure the ground resistance (the resistance between the ground conductor to the charging station and the ground) in order to determine the quality of grounding.

Important: *The cross-section of the grounding conductor should be at least as big as the power supply wires used or bigger.*

WHEN THE CHARGING STATION IS INSTALLED ON THE STANDALONE POLE ADDITIONAL REQUIREMETS FOR GROUNDING ARE NEEDED IF THE POLE IS PLACED ON THE FOUNDATION DIRECTLY IN THE GROUND. IN THIS CASE PROPER LOCAL GROUNDING IS NEEDED TO PREVENT STEP POTENTIAL. IF A FAULT OCCURS, THE CURRENT MAY ENTER TO THE GROUND AND DEPENDING ON THE VARYING RESISTIVITY IN THE SOIL CORRESPONDING VOLTAGE DISTRIBUTION WILL OCCUR. VOLTAGE DROP IN THE SOIL MAY CAUSE DANGER TO THE USER. PROPERLY DESIGNED ELECTRODE SYSTEM (GRID) OR USE OF WIRE MESH SHOULD BE USED TO PREVENT THIS.

Supported grounding systems

The charging station should be properly grounded. Following grounding system are supported: TN-S, TN-C, TN-C-S, and TT under special conditions. Whereever possible, local grounding should be done.

After the charging station and all of its parts have been grounded, measurements of the earth resistance is done to ensure no station's parts that can be accessed by the user are under voltage that could potentially be dangerous.

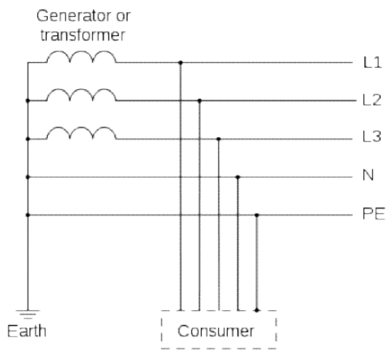


Fig. 2 TN-S grounding system

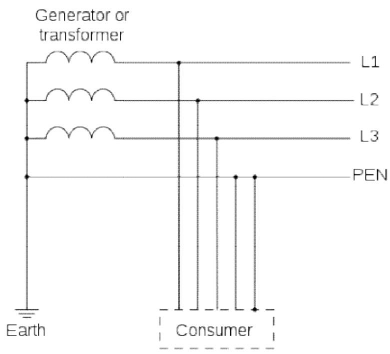


Fig. 3 TN-C grounding system

Important: *IT grounding system is not allowed to be used.*

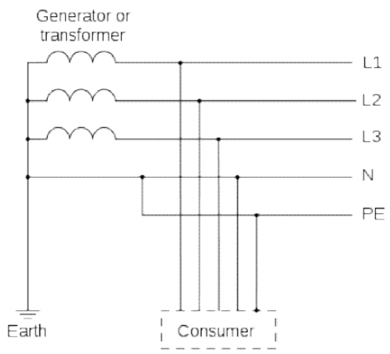


Fig. 4 TN-C-S grounding system

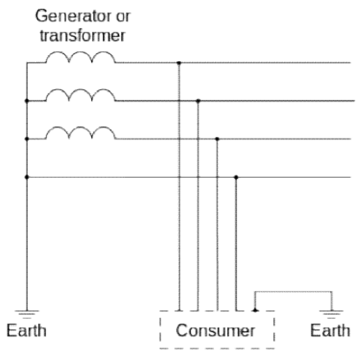


Fig. 5 TT grounding system

CHOOSING THE PROPER CHARGE POINT MODEL BASED ON ELECTRICAL PROTECTION

Important: *Charging station should be protected using differential protection, overcurrent protection and overvoltage/surge protection*

When costumer is ordering his new charging station he has 3 options which model to choose based on the protection unit used. Due to limited size of the enclosure not all of the protective devices can be installed inside the station. Option 1 model that has RCD installed inside the enclosure.. Second option has overcurrent protection embedded inside the charging station and RCD protection inside the electric cabinet. This is the cheapest model. The third option has the MID meter installed inside the enclosure and other protection devices (RCD and overcurrent device) in the electrical cabinet.

Apart from mentioned devices that can be installed either inside the station or in electrical cabinet, overvoltage protection is always installed outside the station in the electric cabinet.

Table 1: Connection device installed inside the charging station

Devices installed	**Protection device**

inside the enclosure	**installed inside the electrical cabinet**
RCD	Overcurrent protection device Overvoltage device MID meter (optional)
Overcurrent protection device	RCD Overvoltage device MID meter (optional)
MID meter	Overcurrent protection device Overvoltage device RCD

Protection and MID meter models

Decision which module will be installed in the charging station is dependent completely on the user wishes. Price of the charging station varies based on which module is installed in the station.

These modular solutions are available for all Etrel Inch charging stations that use new smaller MID meter, which can be fitted inside the station. Installing MID meter outside of the charging station allows user and maintenance crew easier access to the MID meter and measurements. When MID is installed in the electric cabinet it must be connected to the charging station using Ethernet cable. This is used to communicate the values from the station to the meter. Additional switch needs to be used in order to connect charging station and MID meter to the network. More about communication is written in the Communication guide document.

Models:

1. Model 1: RCD protection is installed in the charging station while MID(optional), overcurrent protection and surge protection are installed in the electrical cabinet.

Important: *Overcurrent protection should protect at max 40 A in order to also protect the wiring inside the charging station, which have dimension of 6mm*^{2}.

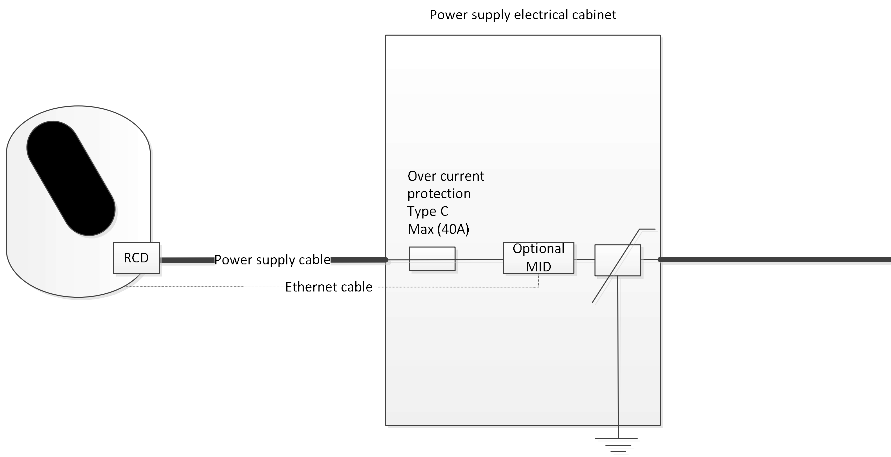


Fig. 6 Istallation of RCD in the charging station and MID in el. cabinet

Fig. 7 G7 station with installed RCD protection unit

2. Model 2: Overcurrent protection is installed in the charging station while MID meter (optional), RCD, and surge protection are installed in the electrical cabinet together with overcurrent protection for the protection of supply cables.

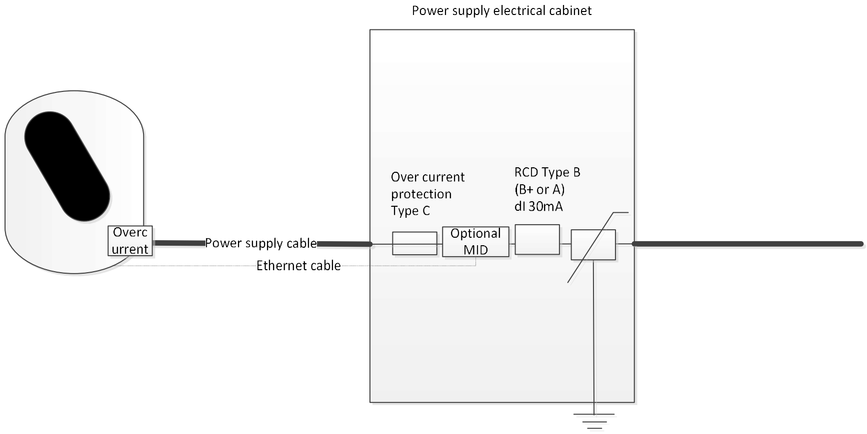


Fig. 8 Installation of Overcurrent protection inside the charging station

Important: *When overcurrent protection is installed inside the charging station it must be installed also in the electrical cabinet. This way selectivity is ensured. Overcurrent protection inside the station is responsible for the protection of cable and the overcurrent protection inside the electrical cabinet is responsible for the protection of the cabinet's elements, installation, and other loads in the household. This is why usually characteristic C is used in the charging station and characteristic D in the cabinet or bigger current limit must be set in the cabinet.*

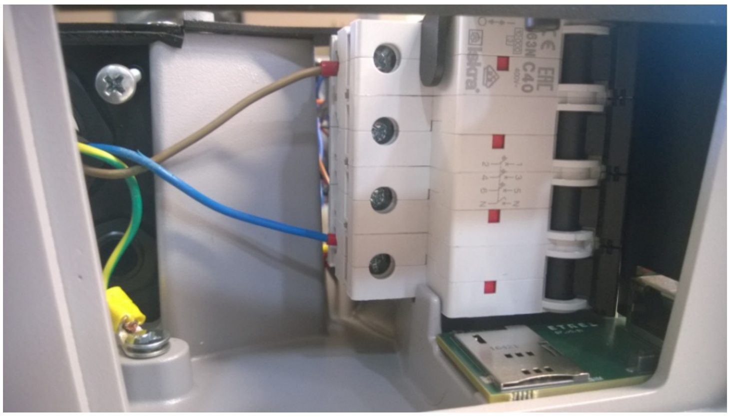


Fig. 9 G7 station with installed Overcurrent protection unit

3. Model 3: MID meter is installed in the charging station while RCD, overcurrent protection and surge protection are installed in the electric cabinet.

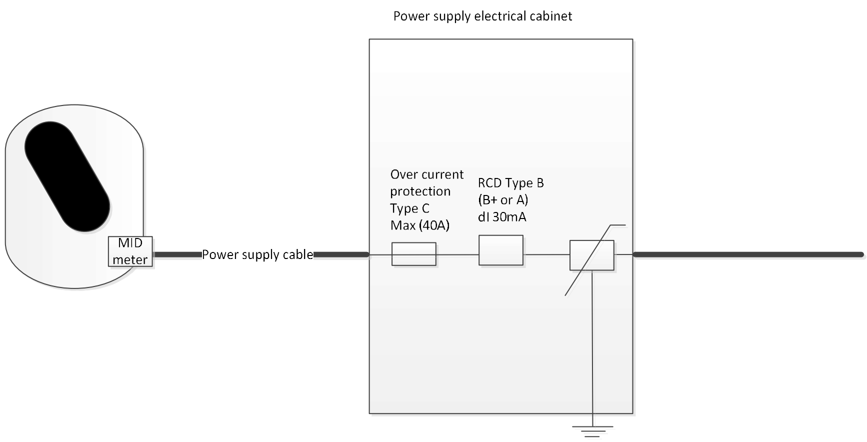


Fig. 10 Instalaltion of MID meter inside the charging station

Fig. 11 G7 station with installed MID meter

Electrical meter that has MID markings on them represents the meter that passed the specific conformity assessment procedures defined by the European Union directive. Aim is to create a single market in measuring instruments for the benefit of manufacturers and consumers across Europe.

In model 1 and 2 when the MID meter is installed in the electric cabinet, additional Ethernet cable must be used to connect MID to the network. Switch also needs to be used in this case if you want both appliances to be connected to the network. In this case MID meter and charging station are both connected to the switch and from the switch to router.

In scenario 3 one cable to connect MID and charging station to the network is enough.

Connection of multiple charging stations

When connecting multiple charging stations to the electrical cabinet it is important that each charging station is connected with separate power supply cable directly to the cabinet as shown in the figure below. This way selectivity of protection is ensured.

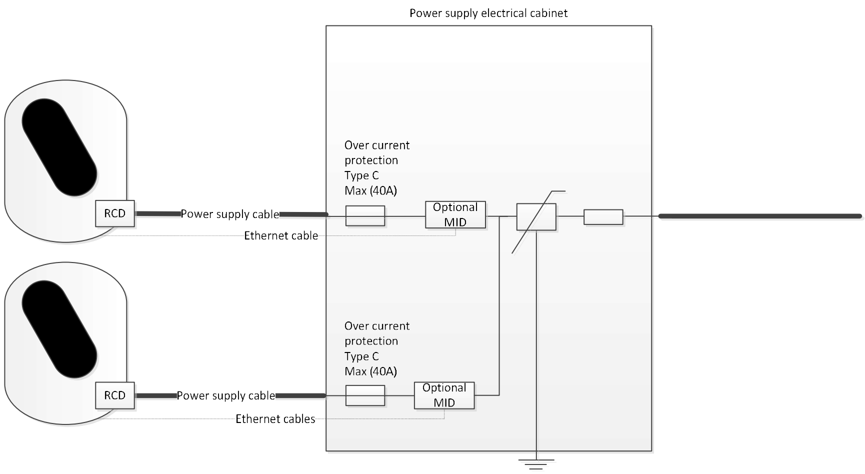


Fig. 12 Connection of multiple charging stations

3 CONNECTIONG CHARGING STATIONS TO ELECTRICAL INSTALLATION – VARIOUS SCENARIOS

Scenarios how clusters are connected to the households will be presented in this part of the document.

MULTIPLE THREE-PHASE CHARGING STATION CONNECTED TO BUILDING

Potential problems

Biggest problem when installing multiple three-phase charging station to the building is the load values of the phases on which the charging station will be installed. Load of any of the three phases can exceed the connection point power limit. Charging station load can exceed the max connection point power limit.

Power balancing problem between the phases can occur when multiple EVs with single-phase on board charger are charging at the same time and when three-phase and single-phase EVs are charging at the same time.

Solutions

Certified electrician must measure loads of every phase to determine what the load values of all the appliances are before the charging stations are installed. If the maximum power of charging station can exceed the power limit of connection point, connection point limit can be increased by replacing the connection fuses with bigger ones. This will increase initial investment cost to the charging station owner as well as this will increase monthly electrical bill due to part of the bill being constructed from the installed power. Changing the fuses can be avoided by limiting the charging station power using the software that is issued with the charging station or by installing load guard unit. Load guard main function is to measure the load of the building and load of the EV that is currently charging. Real time measurements are sent to the charging station that can run power management algorithms and can modify the charging power based on the measurements and charging schedule that is created for the EV user.

Single-phase EVs can be normally charged on the three-phase charging station but for the charging only first phase connected to the charging station is used this is why when connecting phases to the charging station order of phases must vary. For example first charging station will have L1 connected first, charging station 2 will have L2 connected first and so on.

Balancing of power between phases when EV with three-phase and single-phase on board chargers are charging at the same time is done by charging station's algorithm.

a.) Building has multiple three-phase charging station installed and on it connected multiple EVs with single-phase or three-phase on board charger.

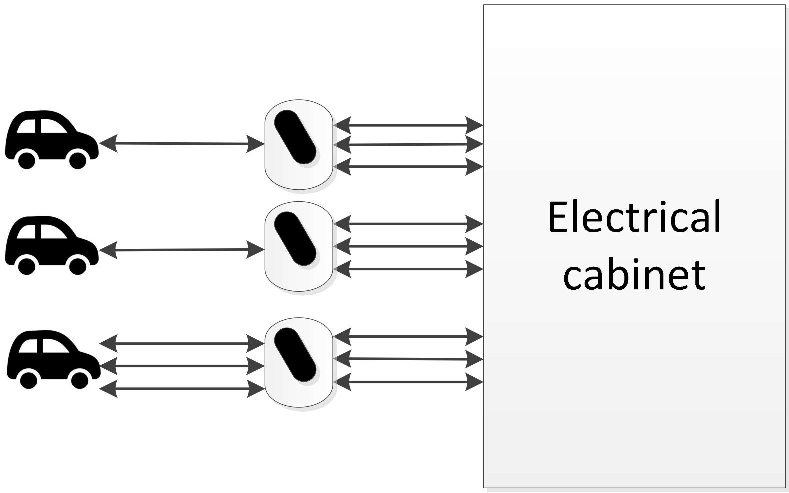


Fig. 13 Cluster of chargers with 3-phase and 1-phase EVs connected

b.) Building has multiple three-phase charging station installed and on it connected multiple EVs with single-phase or three-phase on board charger. Additionally building uses the load guard to acquire load measurement, provide power management algorithm to the user and keep consumption of all loads beneath the limitation point.

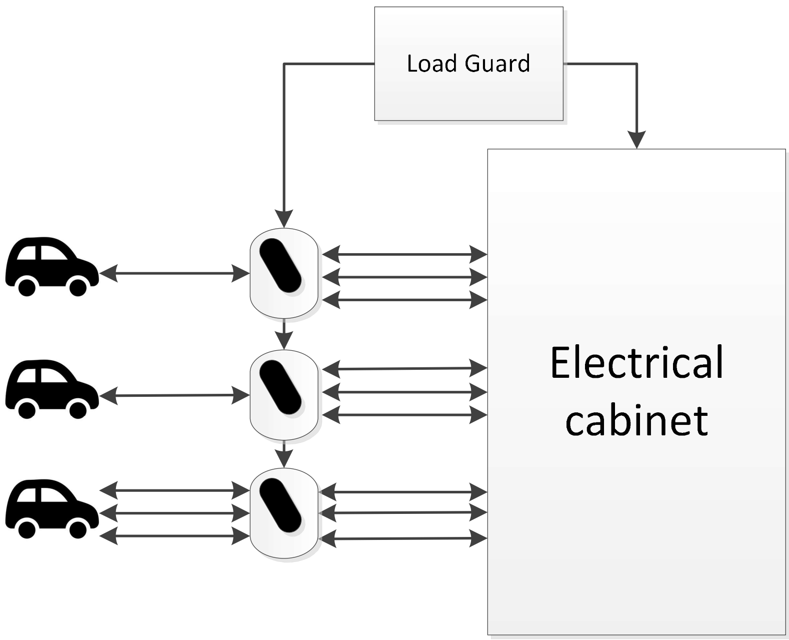


Fig. 14 Cluster of chargers with 3-phase and 1-phase EVs connected with additional load guard installed

MULTIPLE SIGLE-PHASE CHARGING STATION CONNECTED TO BUILDING

Problems

Biggest problem when installing multiple single-phase charging stations in the building is the load values of the phase on which the charging station will be installed. Charging station load together with the load of building's appliances can exceed the max connection point power limit.

Solutions

Certified electrician must measure loads of phase to determine what the load value of all the appliances is before the charging stations are installed. If the maximum load of all charging stations together with load of all building's appliances can exceed the power limit of connection point, connection point limit can be increased by replacing the connection fuses with bigger ones. This will increase initial investment cost to the charging station owner as well as this will increase monthly electrical bill due to part of the bill being constructed from the installed power. Changing the fuses can be avoided by limiting the charging station power using the software that is issued with the charging station or by installing load guard unit which can be seen in the scenario 5b. Load guard main function is to measure load of the building and load of the EV that is currently charging. Real time measurements are sent to the charging station that can run power management algorithms and can modify the charging power based on the measurements and charging schedule that is created for the EV user.

Three-phase EVs can be normally charged on the single-phase charging station but for the charging time will be approximately three times longer as the EV will be charged using only one phase.

a.) Building has multiple single-phase charging stations installed and on it connected multiple EVs with single-phase or three-phase on board charger.

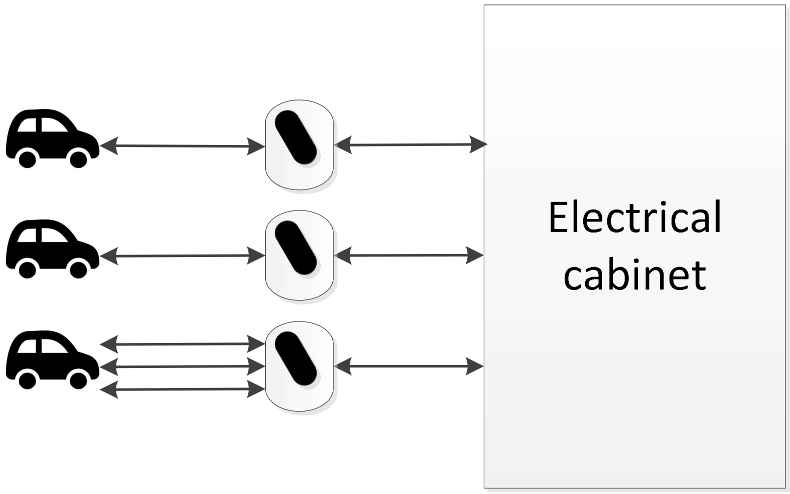


Fig. 15 Cluster of charging stations with 1-phase charging station where 1-phase and 3-phase EVs are charging

b.) Building has multiple single-phase charging stations installed and on it connected multiple EVs with three-phase on board charger and single-phase on board charger. Additionally building uses the load guard to acquire load measurement, provide power management algorithm to the user and keep consumption of all loads beneath the limitation point.

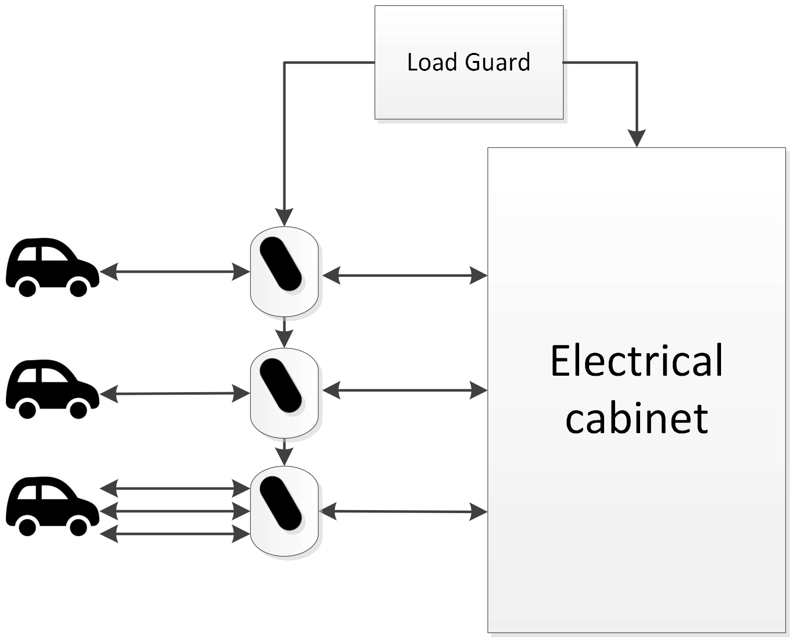


Fig. 16 Cluster of charging stations with 1-phase charging station where 1-phase and 3-phase EVs are charging. Additional load guard unit installed that can prevent overloading the household pwoer limit.

MULTIPLE THREE-PHASE CHARGING STATIONS CONNECTED DIRECTLY TO GRID

Problems

Biggest problem when installing multiple three-phase charging stations to the grid is that load shouldn't exceed the max connection point power limit on any phase.

Power balancing problem between the phases can occur when multiple EVs with single-phase on board charger are charging at the same time and when three-phase and single-phase EVs are charging at the same time.

Solutions

If the maximum power of charging stations can exceed the power limit of connection point, connection point limit can be increased by replacing the connection fuses with bigger ones. This will bring additional investment cost to the charging stations owner as well as this will increase monthly electrical bill due to part of the bill being constructed from the installed power. Changing the fuses can be avoided by limiting the charging stations power using the software that is issued with the charging stations or by running the power management algorithms on charging stations that can modify the charging power based on the measurements and charging schedule that is created for the EV user.

Single-phase EVs can be normally charged on the three-phase charging station but for the charging only first phase connected to the charging station is used this is why when connecting phases to the charging station order of phases must vary. For example first charging station will have L1 connected first, charging station 2 will have L2 connected first and so on.

Balancing of power between phases when EV with three-phases and single-phase on board chargers are charging at the same time is done by charging stations' algorithm.

a.) Multiple three-phase charging stations are connected directly to the grid and on it are connected multiple EVs with three-phase or single-phase on board charger.

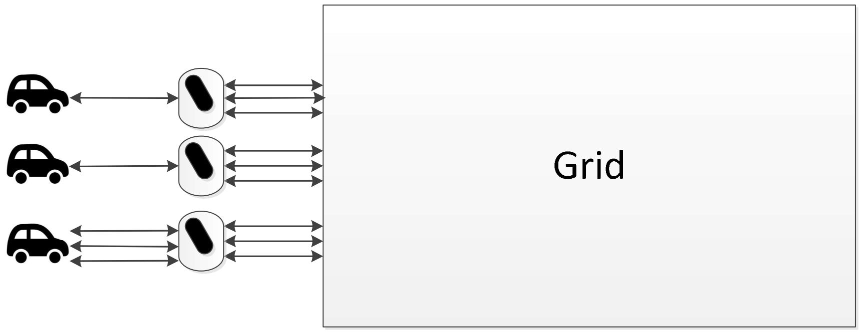


Fig. 17 Cluster of 3-phase charging stations with 1-phase and 3-phase EVs connected to them

INSTALLED PHOTOVOLTAIC (PV) UNITS

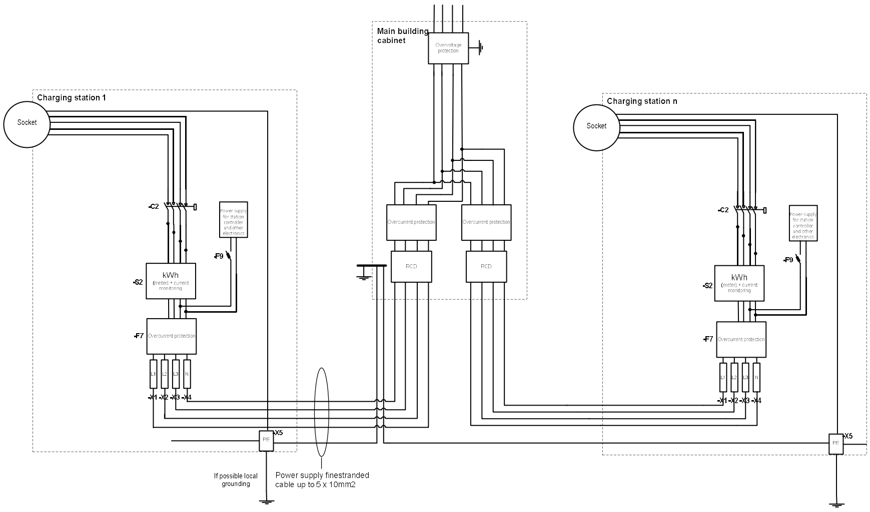
Scenario is only relevant when PV plant is part of the installation and is connected to the same connection point as are charging stations. Production from PVs should be so big that can't be used fully and it is returned back to the grid. If this often happens when the EVs are charging EVs should increase the charging to use the excess production for charging.

It is advisable that load guard is installed and connected so that the PV production, all loads from building's appliances and load from charging stations is measured by it. In this case all the PV production is deducted from the building and charging loads and in case when the production is bigger than the sum of all loads negative values will be measured by load guard. This will indicate to the charging stations that there is extra unused production available that can be used for charging of EVs. Charging stations will in this case change the charging schedule so that the production is used as much as possible and if this is a regular occurrence charging station is capable to predict when this will happen and apply this to future charging schedule.

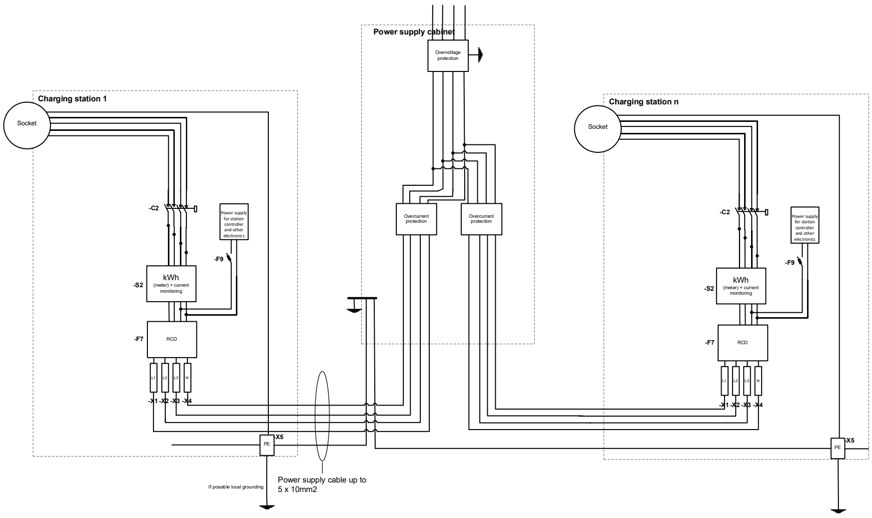
DETAILED CONNECTION SCHEMES

In this chapter simplified schemes for different combination and installation of protection devices will be shown. Scenarios with clusters will be shown but the connection solutions are practically identical if only one charging station is installed in the system.

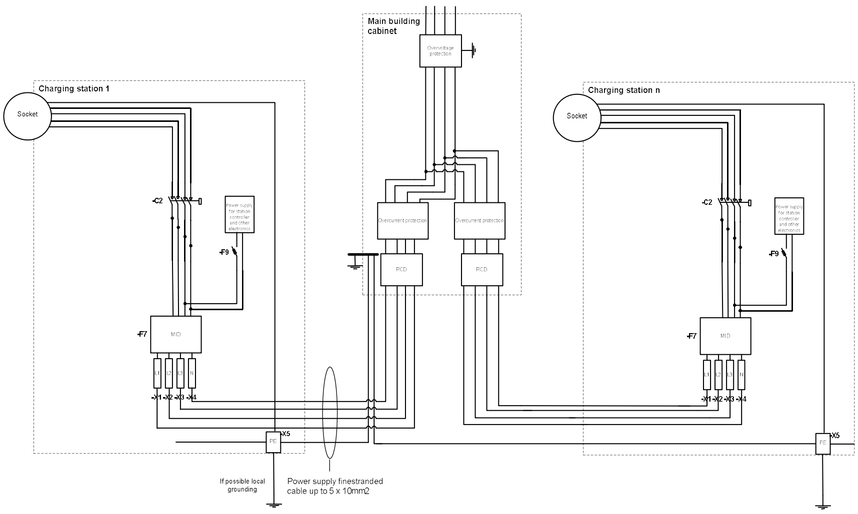
Main circuit-3f-Overcurrent in the charging station



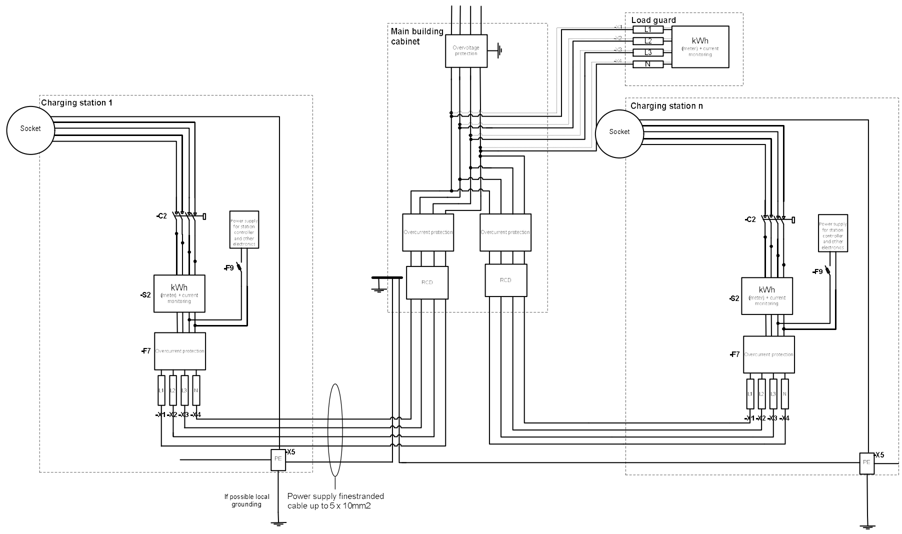
Main circuit-3f-RCD in the charging station



Main circuit-3f-MID in the charging station

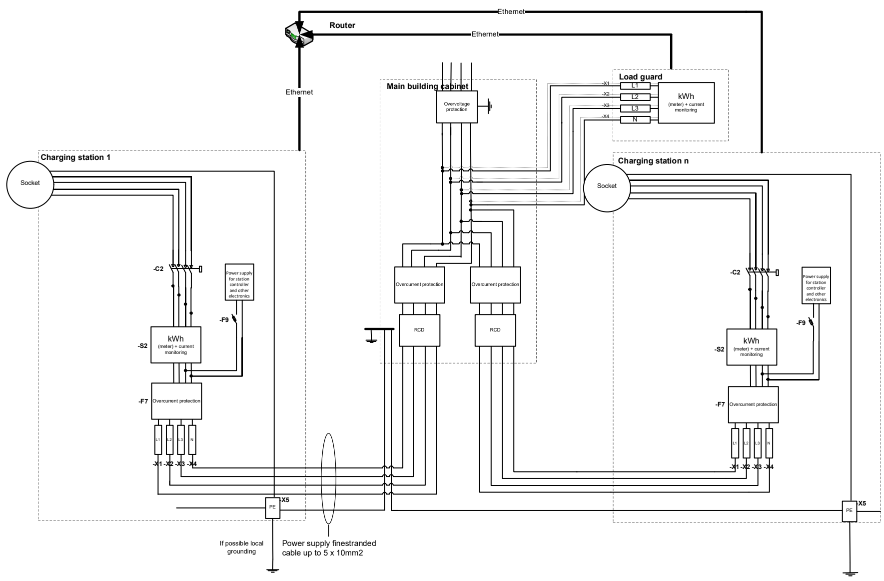


Main circuit-3f-Overcurrent in the charging station with connected PLC Load guard



This is just the example where charging station has installed overcurrent protection inside the charging station. Other possible protection configuration (RCD or MID in the station) have the same scheme how load guard is connected in the system. Load guard is connected in the main building cabinet so that the values of all loads connected to the household grid can be measured and send using the PLC connection to the charging station.

Ethernet connection example



Example of ethernet connection is done where the charging station has overcurrent protection installed, but other solutions have the same connection with the ethernet and with it to the communication platform-backend.

4 | PYSHICAL CONNECTION TO THE INSTALLATION

Based on the chosen scenario described, installation procedure of charging station must be modified slightly. Certified electrician must do the load measurements of every phase that the household is connected to determine which phases to use for the connection of the charging station.

CHOOSING THE RIGHT CABLE DIMENSIONS

Based on all the measurements of maximum current and load in each phase cables for the connection of the charging station can be chosen. When cables are being dimensioned it is vital that safety, reliability, economics and delivered energy quality are taken into consideration. Dimension of cable should be based on the distance between charger and power supply cabinet. In order to connect cables to the charging station only fine-stranded cables should be used. Bigger cables will be difficult to connect to the limited opening.

Cross section of cables defines the max current load through cable as well as voltage drop along the length of the cable. Both values, allowed current and voltage drop, must be within the defined margins so that the operation of charging station is still safe and that the quality of supply is not affected. The material used for cables affects the max current at a specific cross section. In the table below you can see values of cable cross section and max current in a particular cable installation type. Copper is the most suitable material for the cables as it can withstand bigger current within the same cross section in comparison to other materials. Below you can see the table with appropriate cable dimension for particular wires. Description of the installation types is displayed in the Table 3.

Table 2: Cable dimensions

Installation Type *Descriptions in Table 3	**A**		**B1**		**B2**		**C**		**E**	
Number of loaded	2	3	2	3	2	3	2	3	2	3

wires										
Cross section [mm²]	Cu cables with PVC isolation. Max current [A] in the outside temperature of 30 °C									
1.5	15.5	13.0	17.5	15.5	15.5	14.0	19.5	17.5	20.0	18.5
2.5	19.5	18	24	21	21	19	26	24	27	25
4	26	24	32	28	28	26	35	32	37	34
6	34	31	41	36	37	33	46	41	48	43
10	46	42	57	50	50	46	63	57	66	60
16[1]	61	56	76	68	68	61	85	76	89	80

Where:

Table 3: Description of installation types

Installation type	Installation description

[1] Only possible in certain circumstances. It is difficult to connect cables with such dimensions to the charging station.

A	Installation in the thermally insulated walls
B1	Installation guides in installation ducts and channels on/in the wall
B2	Installation of cables in the installation pipes and ducts on
C	Direct installation on a wall, under the plaster…
E	Free installation in the air with an unobstructed cooling

Voltage drops become important when the cable length becomes elongated. Excessive voltage drop can cause the loss of efficiency of the charging station. Voltage drops can be avoided by selecting the appropriately dimensioned wire. Simplest way to reduce the voltage drop is to increase the cable diameter, which lowers the resistance of the cable. In the table below you can see the resistance for a particular cable dimension.

Table 4: Cable resistance for a particular cable dimmension

Size		Diameter	Resistance at 25 °C
AWG	Metric mm^2	mm	Ohm/km
20	0.518	0.938	34.000

18	0.823	1.182	21.400
16	1.309	1.491	13.400
14	2.081	1.880	8.450
12	3.309	2.371	5.320
10	5.261	2.989	3.340
8	8.366	3.770	2.100
6	13.302	4.753	1.320
4	21.151	5.994	0.831
2	33.631	7.558	0.523
1	42.408	8.487	0.415
0	53.475	9.530	0.329

Below you can see the figure that shows relationship between the cable length and cross section for different types of current.

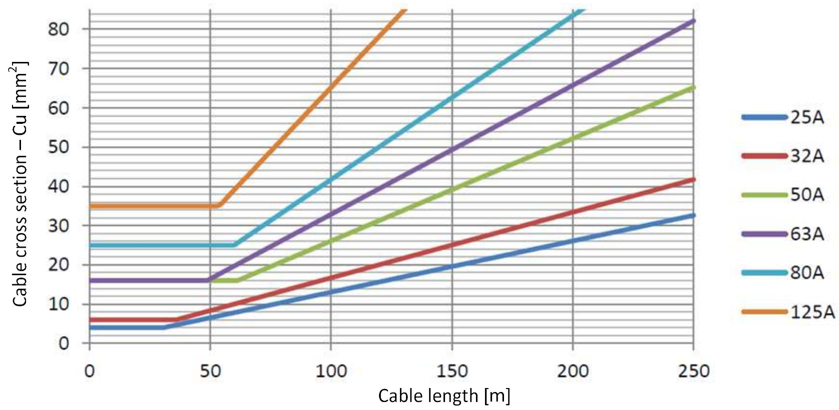


Fig. 18 Relationship between cable length and cross section