

Electric vehicles charging standards

The electric vehicles charging standards are governed by the International Electrotechnical Commission (IEC). The main standard is IEC 62196, which defines types of sockets (and plugs) and charging modes. It is important to understand, that the electric vehicle traction (main) battery is producing direct current (DC). But our electrical network uses an alternating current (AC). If You charge the car on AC station , electric vehicle onboard charger transforms AC to DC , with which the traction battery should be charged. In this case, the electric vehicle charging speed is defined by the power of the onboard charger. Usually, this parameter is specified by the car manufacturer. For example, in the case if the 22 kW AC station is used and onboard charger has 3,6 kW power , the electric vehicle traction battery will be charged at 3,6 kW. Then only 20 % of charging station power will be used. To define the time, requiring to charge the specific electric vehicle from AC, it is necessary to divide the traction battery useful capacity into onboard charger power . For example, in case of charging Nissan Leaf battery which capacity is 24 kWh with 3,6 kW onboard charger , will be required $24/3,6=6,66$ hours. In reality there will be slightly more time required , because of lithium-ion battery charging process isn't linear and in the charging course there are always a small losses.

When electric vehicle is charging from the DC station (fast or “super” charging), onboard charger is switched off. Nowadays AC stations can be called as the standard charging stations , DC stations – as express charging complexes or fast charging stations. Usually, modern fast charging stations have 500 V voltage with currents above 200 A, therefore it isn't difficult to count power: $500\text{ V} * 200\text{ A} = 100\text{ kW}$.

Charging modes and cables

The admissible charging modes are described in the IEC 62196 standard section 1, which defines the following possible options:

Mode 1 – charging with AC from a household network;

Mode 2 – charging with AC from a household network, using protection system in the cable;

Mode 3 – one or three-phase charging, using AC special socket where electric vehicle charging protection and control system is used;

Mode 4 – fast charging with DC.

Mode 1 is not applied on serial electric vehicle since it doesn't ensure the demanded safety level.

Mode 2 represents the regular cable for electric vehicle charging from a household network, which is delivered with any serial electric vehicle.



Figure 1. Cable with integrated protection MODE2 - TYPE1

"Box" in a figure 1 has a protection system. When cable is connected to the simple household socket, this system ensures a good grounding, short circuit or cable overheating protection, also limits charging current up to 16 A . Most electric vehicle manufacturers call it “mobile cable”, it goes together with electric vehicle. The MODE 2 cable isn't absolutely convenient for everyday use, however in order to avoid unexpected situations with charging on a trip, it is always recommended to take it with yourself.

The Mode 3 requires use of AC charging station and special one or three-phase cable. Charging station communication with the electric vehicle carry out through special-purpose cable contacts.



Figure 2. MODE 3 22 kW charging station with TYPE2 locking socket

The AC charging stations applied in Europe usually use the socket Type 2. With those charging stations it is possible to charge the electric vehicle equipped both the socket Type 2, and the socket Type 1. Possible - because of the cable. In pictures given below you can see Type 2 — Type 1 and Type 2 — Type 2 cables.



Figure 3. Single-phase 16 A cable with TYPE 2 TYPE 1 sockets



Figure 4. Three-phase cable with both TYPE2 sockets

Existence of such cable in your electric vehicle luggage compartment will significantly expand charging possibilities in the way, and, above all – will accelerate this process.

Mode 4 assumes DC charging stations to use. Because of such equipment high price it is inaccessible to use them in life. Fast charging stations are usually mounted on public platforms or at big commercial objects. Today there are two types of such stations – CHAdeMO and CCS (Combined Charging System). For data exchange between charging station and electric vehicle

CHAdeMO and CCS use different socket types and communications protocols: CHAdeMO uses CAN and CCS — PLC. Nevertheless, today express charging systems presented in both of these standards are combined in one device.



Figure 5. ABB concern fast charging station (It stands in Vevis at A2 highway). Apparently, the station provides charging both AC in MODE 3 and DC in MODE 4 by both standarts)

At this fast charging station Nissan Leaf will be charged in 20-30 minutes. Both kinds of Mode 4 provide maximum power up to 100 kW, however practically in the market 20, 44 and 50 kW power equipment is presented.

Tesla Motors developed their own express charging complexes network – Tesla Supercharger. Tesla’s vehicle supports the IEC 62196 standard when charging AC in the MODE 2 and MODE 3 also.