РАЗДЕЛ XXVI. ЭЛЕКТРОТЕХНИКА

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Comparison and adaptation of operating modes of a mobile charger for electric vehicles

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doi: 10.18411/trnio-11-2021-223

Abstract

The article deals with the operating modes of a mobile charger for electric vehicles and their external power sources adaptation. Mains voltage-versus-charge current curve is given. Besides, the authors of the article consider important advantages and disadvantages of the charger operating modes.

Keywords: charger, electric vehicle, charging mode, alternating current, direct current, voltage drop.

Аннотация

Статья посвящена режимам работы мобильного зарядного устройства для электромобилей и их адаптации к внешним источникам питания. Приводятся график зависимости напряжения сети от тока заряда. Рассматриваются основные преимущества и недостатки режимов работы зарядного устройства.

Ключевые слова: зарядное устройство, электромобиль, режим зарядки, переменный ток, постоянный ток, падение напряжения.

The increasingly widespread use of electric vehicles makes the issue of prompt charging of such vehicles urgent. Vehicle charging device manufacturers adapt them for modern life and produce vehicle charging devices containing several operating modes.

Charger operating modes

Charging Mode 1, the most common and easiest way to charge an electric vehicle, requires the simplest type of connection, namely, direct connection of the vehicle to the alternating current mains using a non-dedicated power socket. In other words, it is charging from a common household socket with a simple cable connected to a single-phase mains. Charging Mode 1 assumes charging from the AC mains directly without additional protective devices that makes such a mode not 100% safe. There's always an element of risk in this kind of charging from thermal overload to short circuit. This charging mode takes a lot of time. The time for a full charge in this way is 24 hours [1, 2].

Charging Mode 2 is essentially the same as in the first case but requires the presence of a specific safety system between the point of connection to the electrical network and the car in charge. This mode is implemented by connecting the vehicle to the AC power supply using a non-dedicated power socket. Charge control cable provides thermal and surge protection and grounding the portable charger [2]. Mode 2 can be used with both domestic and industrial sockets.

Charging Mode 2 ensures an average security level and is an acceptable norm when recharging the vehicle. However, manufacturers recommend using this mode on rare occasions. As in the first case, the time for a full charge in this way is 24 hours.

Charging Mode 3 is a direct type of connection of the vehicle to the alternating current mains using a dedicated power socket with a built-in charge monitor that has an instrument panel and a dedicated cable with additional conductors. This is a quick charge that takes 3 to 8 hours to charge the vehicle to the full [2]. This is the most common charging mode used in parking lots, gas stations and other public places.

Charging Mode 4 (fast charging mode) is an indirect type of connection of the vehicle to the mains using an external direct current charger with a built-in charge control device via a dedicated attached cable. The charger in this case is a component of the direct current charging system rather than a component of the car. This is a quick charge that takes 20-30 minutes to charge an electric vehicle up to 80% [1, 3].

There are single-phase and three-phase power grids. A single-phase circuit is for limited power. Therefore, a three-phase power grid is used to increase power. In this case, the power can be increased to the values required for charging, since the controller installed in the charger will limit it in order to avoid overheating and failure of the batteries [4].

To extend batteries service life, chargers use an energy management system that sets the power limit value, controls the parameters of power consumption by electric vehicles, avoids power outages (voltage drop) by limiting the charge current feeding the vehicle [1].

Figure 1. Dependent characteristics of the mains voltage on the charging current

Thus, the charger reduces electricity power supplying electric vehicles (Figure 1) for power needed that exceeds the maximum set level and for the continuous charger operation [1].

It can be concluded that it is necessary to adapt electric vehicle chargers to external power sources by combining several charging modes in one device, from the simplest to high-tech that allow charging the battery of an electric vehicle in a short period of time under conditions of continuous operation of the charger and the power grid.

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