Unit N: Battery Charger

Overview

The charger can considerably affect the life of the batteries in an EV. Older technology chargers were simply AC-DC converters. They were large and inefficient and took a long time to charge. These older chargers were not "smart", in that they ran continuously without sensing the state of the battery pack receiving their voltage. The ran until they were shut off, without any regard to the condition or safety to the batteries.


Figure 17

The technology used in our vehicle is an on-board "smart" charger. It uses technology called SMPS (Switching Mode Power Supply) which has better performance, smaller size and "intelligent" switching. These features give us faster, more efficient charging with a smaller physical size of the charger. The charger also has a charging profile that maximizes the batteries' life and performance. It charges quickly at first, slows down near the end of the charge cycle, and then maintains a full pack until the EV is used. It will not overcharge the batteries if left plugged in.

The charger sends as much current as it can without raising battery temperature too much. We want to charge our system with maximum current to the batteries up through 80 percent of their capacity, and then cut the current back to some preset level for the final 20 percent. This prevents the charger from overheating the batteries. The Zivan Ng3 charger in our conversion is a "smart" charger that senses the condition of the battery pack and adjusts accordingly. The charger is factory configured specifically for the battery being used. Its charging curve consists of multiple charging phases. Figure 17.

We maintain the charger on-board so our vehicle can be charged at any 110v 20a outlet with the use of a 10 gauge grounded extension cord. Our charging system will monitor battery voltage, current flow and battery temperature to minimize charging time. Our charger can work with most household current. Normal household 120-volt outlet typically has a 15-amp circuit breaker, meaning that the maximum amount of energy that the car can consume is about 1,500 watts (1.5 kilowatt-hours) per hour. Since our battery pack needs 12 to 15 kilowatt-hours for a full recharge, it can take 10 to 12 hours to fully charge the vehicle using your home (or school) circuit.

The charger can also be programmed to use a 240-volt circuit (such as the outlet for an electric dryer). This would allow the EV to receive 240 volts at 30 amps, or 6.6 kilowatt-hours per hour. This results in much faster charging, four to five hours, but limits the number of locations we can plug in.

Stages of Charging

The battery charger uses an algorithm to charge the battery pack through various phases of charge.

- The Bulk Stage works up to a point where each cell is charged to 2.43 volts per cell.
- The Absorption Stage takes each cell to 2.5 volts per cell.
- The Equalization Stage charges each cell for 30 seconds at 2.75, shuts off for 30 seconds, then repeats for 30 minutes.
- The Float Stage provides 2.1 volts per cell as long as the charger stays plugged in.

The charger has visual indicators that display the different parts of the charging cycle. The RED light on the charger indicates that the charger is in its initial charging phase. The YELLOW light indicates the battery pack is at 80% of charge. The GREEN light show that the charge cycle is complete and the battery pack is at 100% of charge. Figure 18.

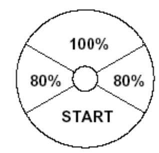

Figure 18

Different battery charger technologies provide varying charging results and indications of state of charge during the various phases. A simple plug-in charger will run until you unplug it. Some "smart chargers" can actually read the condition of the batteries as they go through the charge cycle and provide different levels of output to fine tune the level of current needed for optimal performance.

GFI, Safety Regulations and Requirements

Battery Charger safety is an important consideration. There are two key warning symbols on the labeling for the charger. The lightning flash with the arrow inside the triangle indicates a presence of "uninsulated dangerous voltage" inside the component. This is voltage that may have sufficient magnitude to risk electrical shock to people.

The exclamation point inside the triangle alerts the user to the presence of important operating and maintenance instructions for service. You should always read all of the operating and warning instructions that come with the charger before opening, installing or using it. Care should be taken with any other devices or locations that show these warning symbols. Figure 19.

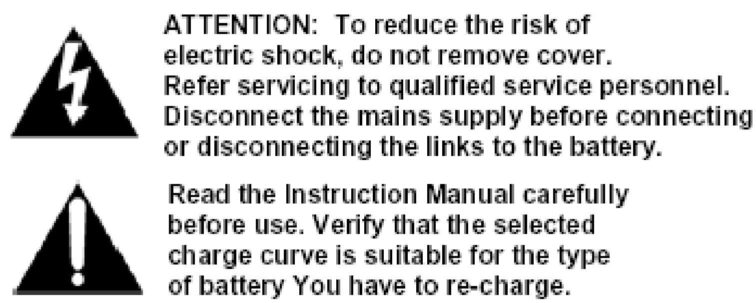

Figure 19

Any voltage between the pack and the chassis is a potential shock hazard and will trigger the GFI to stop the charge. A fault is detected whenever the supplied current does not match the returned current within a specified level of tolerance. The tolerance level is designed to be less than that which would cause harm to a person. A GFI protected circuit should always be used for charging.

Installing the Charger

The battery charger should always be mounted to a stable surface by using the mounting holes in its flanges. For proper cooling, the charger should be installed with fans facing horizontally or upwards. Never install the charger with the fans facing down. Do not block any of the ventilation ports or put the charger near other sources of heat. It is important to have sufficient ventilation and access to the wiring/cabling sockets. The area around the charger should be cool, dry and free from any outside weather elements.

Voltage and electrical characteristics should match those described on the charger nameplate. Do not try to use other voltages or other power factors than those identified on the charger. The charger has a 3-prong safety plug so that it will only work with a properly grounded outlet. Do not try to defeat this safety feature. Always disconnect the charger from the AC supply while servicing the batteries or connecting it to the battery pack.

Match the output voltage of the charger to the appropriate pack voltage. Never use the charger with non-rechargeable batteries. Do not attempt to service the charger, opening it can expose the technician to shocks or other hazards. Unplug the charger from source power and the battery pack immediately if it becomes damaged.

DC-DC Converter

The conversion uses other accessories and safety features that use power. Most of these devices run on 12V DC power, just like they would in an ICE vehicle. We will utilize the 12V system, with a 12V accessory battery, to power these features. Since we no longer have an alternator, we need to charge this battery a new way. The device that provides this charge is the DC-DC converter.

The DC-DC converter charges the auxiliary 12V battery by reducing the voltage from the 144 volt traction battery pack to a voltage suitable for the single 12V battery. The auxiliary battery needs to be charged or the vehicle will not run. The DC-DC converter also keeps the accessories running (lights, horn, wipers, radio, etc). Figure 20.

Figure 20

The converter takes in the DC power from the main battery pack at 144 volts DC and converts it down to 12 volts to recharge the accessory battery. When the car is on, the accessories get their power from the DC-to-DC converter. When the car is off, they get their power from the 12-volt battery as in any gasoline-powered vehicle. The DC-to-DC converter on the S-10 is in its own enclosure under the hood, but sometimes this box is built into the controller.

An advantage of using a DC-DC converter over simply having a secondary 12 volt AC charger is that the 12 volt battery voltage is constantly maintained while the EV is in operation. With an AC 12 volt charger the 12 volt battery would run down during operation and then get its recharge only with the EV plugged into an AC line source.

The "Smart" Electrical Grid

Electric Vehicles provide a unique opportunity for engineers to optimize the electrical grid. Smart battery chargers can fill up EVs at night when energy costs are the lowest. This could provide thousands of fully charged battery packs that could theoretically provide stored energy for use in the daytime. This "load-leveling" would help electric companies by eliminated their need to make extra capacity, and allow them to sell their produce around the clock. It would help electric customers by eliminating brownouts and blackouts and keeping energy costs lower. Their EVs could even provide rebates to their energy bills by selling back EV energy when it was needed by other electric customers.

Smart switching technology could allow this all to be controlled by the internet. Mobile technology could even be involved, allowing you to charge your EV remotely by calling it with your smartphone.