ABSTRACT
A design is presented for a battery charger using lithium iron phosphate (LiFePO₄) chemistry. These batteries will be used in a hybrid vehicle to be entered into the SAE Formula Hybrid International Competition at Dartmouth. The charger is designed to protect the user from potential hazards such as electric shock in addition to protecting the battery cells themselves from damage due to overheating or over charging. The goal is to provide an easier and safer charge for the hybrid battery cells than a typical “off the shelf” battery charger, which simply charges without regard to individual cell status.

Software Theory of Operation
A Controller Area Network (CAN) signal comes from the car, which contains information on temperature and voltage for each cell. A current sensor provides current information, and a GFI unit detects faults. These levels are compared to predefined warning levels, sending a cutoff signal if any warning conditions are met. If there are no problems detected, the controller sends a pulse width modulation (PWM) whose period is determined by the number of cells and the overall charge on the battery packs.

Hardware Theory of Operation
Ground fault interrupter (GFI) circuitry sends a signal to the controller if a current leakage is detected. Full wave rectification of 120VAC results in 170VDC. A filter eliminates noise from this rectified voltage. The controller has access to a fused switch to allow power termination in fault conditions. A DC voltage regulator provides reference voltage for a current sensor, which in turn provides feedback to the controller. A variable DC/DC converter controls charging voltage, with PWM to adjust the current.

DESIGN REQUIREMENTS
• Accept a 120V AC, 15A power input.
• Charge 75% of the battery in under 4 hours.
• Light enough for a single person to move, with simple connector plugs for power and logic.
• Reduce the output current when the cells are shunted by the battery monitoring boards.
• Contain a 20A fuse and a GFI able to detect a leakage current of at least 15mA.
• Remove power to the battery within 1 second during a critical fault situation.
• Decimal number format for voltage, current, and temperature levels.
• Display specific errors including loss of CAN signal, over-current, and over-temperature.

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