Hybrid Vehicle PEC Charger System

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The Challenge

Our customer requires a Power Electronics Carrier (PEC) battery charger unit. A PEC is part of a vehicle hybrid system. A Hybrid vehicle is engineered to be more fuel efficient than a conventional combustion vehicle. Hybrid systems are designed to provide fuel savings during acceleration and braking. Upon initial acceleration, the electric motor uses the power stored in the battery to assist the move of the vehicle. When the vehicle comes to a stop, the electric motor helps slow the vehicle and simultaneously charges the battery. This process reduces wear on the brakes.

The PEC is a collection of batteries, relays and other components with the capability to communicate via CAN protocol. These components insure proper interface and function within the Hybrid system. The PEC batteries are stored inside a warehouse after use on a vehicle. A battery charger system is needed to charge the batteries before being installed on another vehicle to provide optimum performance.

The requirements for the PEC charger are as follows:

- Ability to charge up 350 VDC, 5 Amps until the state of charge reaches a specified percentage.
- Ability to send different control voltages (12 VDC or 24 VDC) to the relays based on a part lookup database.
- Ability to read and write to the PEC via CAN protocol.
- Ability to store charge information into a database that can be easily backed up, restored, maintained, and loaded on another machine.
- Ability to scan the serial and model number barcode from the PEC to store into the database
- Ability to show the charge steps in the automated test sequence.
- Built-in safety interlocks to prevent output of high voltages

The Solution

To accomplish this task, RE designed a system using a standard computer combined with National Instruments hardware and LabVIEW for the software platform. The system serves as a central location for communication between various hardware, controls relays, and automates the test sequence. A power supply with Ethernet capability was integrated to allow remote control of the charge voltage and current to the PEC battery.

A Symbol alphanumeric barcode scanner was used to allow the operator to scan the serial and model barcode numbers. A database was created with Microsoft Excel, a standard spreadsheet software tool. Software and hardware features were added to comply with safety interlock requirements. An analog input sensor was added to the output of the high output voltage relay, which allows the system

to detect voltages from the PEC battery and warn the user.

System Background

The main components of the PEC charger include the following: a computer, a barcode scanner, a high voltage power supply, and a UPS (Uninterruptible Power Supply). The power supply requires 240 VAC input and outputs up to 400 VDC and 10 Amps for battery charging. Two cables are provided from the charger station to the PEC battery – a high voltage connector and a low voltage connector.

The PEC battery has two main connections and a service disconnect. One connection is for the high voltage connector and the other is for the low voltage connector. The high voltage connector provides charge voltage and current to the PEC battery. The low voltage connector is a harness that controls various relays, reads signals, transmits and receives CAN messages. The service disconnect is a manual switch to ensure there is no voltage supplied from the battery.

System Design Overview

The core controller of the system is a computer that runs on a Windows 7 operating system. It has an NI PCI CAN card that communicates with the PEC battery via CAN protocol. It also has a multifunctional DAQ card that reads the PEC battery voltage, controls the 9-Pin connector, E-Stop chain, and watchdog timer. A watchdog timer module is used to detect if the computer software is in operational mode. If the watchdog timer does not receive a pulse train signal from the computer, it will open the contact for the high power connector, disabling any output voltages.

The Symbol alphanumeric barcode scanner is used to scan the PEC model and serial number. It communicates with the computer through a serial port. The PEC charger software reads the barcodes into the system through VISA and stores the information into the database.

A Sorensen high power supply was used to charge the battery. It communicates with the computer via Ethernet. Output voltage, current, and limits can be controlled over Ethernet. Input voltage, current, and over voltage protection is fed back from the power supply.

The UPS is a backup battery for the system in case power outage occurs. If power outage is detected, it commands 0 VDC and Amps to the power supply, stops the test sequence, opens the high voltage contact, safely shuts down the software, and then shuts the computer off.

PEC Database

To meet the requirements of the customer, RE created a database using Microsoft Excel, a standard and commonly used spreadsheet software. It contains all the batteries that were charged on the station and their corresponding charge parameters. The part numbers and fan control voltage are stored in the database as well.

PEC Software

The PEC charger software was programmed in National Instruments LabVIEW 2009. Features included in the software are:

- Administrative Privileges – A user can log in as an administrator or operator. When logged in as an administrator, the user has access to all the screens, configure setups, and run in manual mode. When logged in as an operator, the user has access only to the fault screen, graph display screen, and automated test sequence screen.
- UPS Setup – The UPS setup screen allows the administrator to configure system shutdown upon loss of power.
- Channel Setup – This screen allows the administrator to create new channels and define system limit faults. The software offers 200 channels for monitoring.
- CAN Setup – The CAN setup screen allows the administrator to load different CAN databases and configure the CAN signals to read and CAN frames to write.
- Digital IO Utility – This utility allows the administrator to manually turn certain relays on/off on the PEC battery.
- Faults – This screen shows the current system faults.
- Graph Display – This screen allows the user to configure the channels to view on a time based graph.

Every component in the system is programmed in a modular format. Their control and feedback parameters are stored into shared variables and all merged into the channel setup. This will allow scalability of the software. The software setup is flexible such that the administrator can manually troubleshoot the PEC battery. What allows this is the option to toggle relays and send CAN messages manually.

The system is built with an automated test sequence. The charger will take a PEC with a low state of charge and charge the PEC to specified state of charge. This is done by connecting the PEC to the charger, entering a serial number, pulling the service disconnect out on the PEC, completing the charge, pushing in the service disconnect, and disconnecting the charger.

During charging, the tester will communicate with the PEC via CAN to insure there is no fault codes returned and the PEC is operating properly. The software allows the user to define the CAN fault codes to shut down the system.

Once the charge is complete, the relays will be opened and the power supply turned off, allowing for decay of the high voltage out of the charger power supply. The charge parameters will be recorded into the database.

Summary

RE's PEC Charger system was built with flexibility – allowing the user to load different CAN databases, defining the messages to read and write, defining the system limits for faults, setting different battery charge voltage, current and state of charge, and manual troubleshooting. With its flexibility, it can easily meet any battery charger specification. The software was programmed with National Instruments LabVIEW, which allows the software to be modular and expandable.

Customer Background

Our customer is a global technology leader in diversified power management solutions. They are a manufacturer for automotive, aerospace and military sectors. They specialize in electrical components, power quality, hydraulics, pneumatics, drivetrain and powertrain systems.

About Revolutionary Engineering

Revolutionary Engineering, Inc. (RE) was established in 2001 to provide companies with a dynamometer system integration resource and testing facility that responds to their needs. Our services and products are designed to provide the customer with cost effective solutions tailored to their requirements.

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