Artemis ModuPower 15DC
Sponsor – WestGen Technologies

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Motivation

The global energy revolution aims to shift from a carbon-intensive and polluting system to a sustainable one. Renewable energy solutions and energy storage systems play a crucial role in reducing GHG emissions, increase energy efficiency, and promoting sustainable development.

Our team is honored to have partnered with WestGen Technologies, whose patented EPOD technology is at the forefront of the revolution, aligning with our mission and motivation.

WestGen Technologies currently uses a generator alongside a solar inverter to supply power to an air compressor used to actuate pipeline valves on remote wellsites. The group was tasked with developing an external modular DC Power Storage/ Supply to replace the existing lead acid batteries in WestGen's EPOD offering, allowing for increased energy storage efficiencies and reduced emissions.

WESTGEN TECHNOLOGIES

WestGen Technologies' EPOD that the ModuPower is being developed for, pictured above

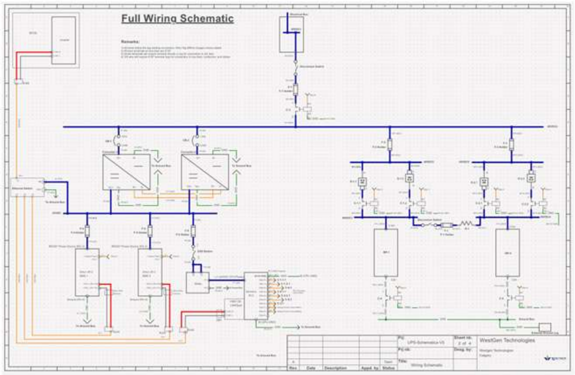
Objective

Our team was tasked with creating the electrical and battery design for the ModuPower, which includes developing controls, communication, and protection systems. The solution needs to be fully modular and must be able to handle temperatures ranging from cold Alberta winters to scorching Texas summers.

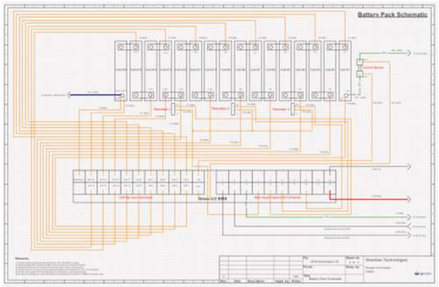
The engineering design needs to be economical and sustainable in nature, so the team was required to complete an engineering economic feasibility analysis to justify battery selection and design.

All designs must be ready for WestGen to build, and must include a bill of materials, wire tagging, and detailed wiring diagrams. The team was also expected to complete PLC and BMS control narratives and control flow charts.

Design and Schematics



Full Wiring Schematic of the ModuPower 15DC



Battery Wiring Schematic

Battery Technology:

•Three different lithium-ion battery chemistries were analyzed: Lithium Iron Phosphate, Nickle Magnesium Cobalt Oxide, and Lithium Titanate based on their characteristics in existing static and dynamic energy storage systems.

•Two reports analyzing battery systems were developed. The primary report covered several factors including cell/chemistry selection, expected lifetime cycles for different cell loadings, depths of discharge, battery packs to BMS ratio, failure and financial analysis, chemistry technology outlook, heat dissipation, and carbon emissions.

Controls & Communication:

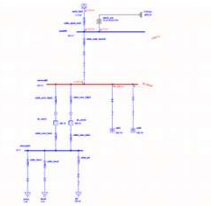
•The main control devices utilized in our system are the Siemens S7-1200 PLC and the Orion Jr. 2 Battery Management System (BMS).

•The communications protocol being used by our system will be CANOpen. This will allow our system to communicate with the EPOD and within itself.

•4 main control situations were designed: Initialization, Charge, Discharge, and Shutdowns (including ESD situations).

Orion BMS Pictured above, at the top left and the Siemens S7-1200 PLC pictured above, at the top right

One Line Diagram with 48V Bus Shorted for protective devices sizing



Protection:

•Architecture consists of circuit breakers, fuses, DC-DC Converters, and Contactors. Load Flow Analysis and Short Circuit Analysis were performed on ETAP to find the maximum operational current and maximum fault contribution of each line. These values were then used to size protective devices for Continuous Current and Instantaneous Current ratings. I2t curves were produced .

Results

Battery Economic Engineering Report:

The result of the primary report was finalizing of the chemistry, which was selected to be Lithium Iron Phosphate.

The supplementary report focused on Lithium Iron Phosphate battery cells with varying energy storage requirements and included cell-specific end-of-life (EOL) compensations, battery cycle efficiencies, and temperature compensations and the final solution was a 15KWh 2-pack design utilizing 280ah Lithium Iron Phosphate cells.

ETAP Protection Analysis:

A combination of Class J, T, and CC fuses were selected based on the fault currents calculated. Miniature Circuit Breakers (MCBs) were also utilized.

Controls and Communications Development:

After an in-depth study into the inputs and outputs of the controls devices, several operating conditions and phases were finalized based on collaboration with the sponsor.

Based on sponsor requirements, Control Narratives and I/O lists are completed to ensure devices control equipment as designed and the system functions as required, with programs designed for faults and errors.

Design Integration:

Once all the teams and designs were completed and met sponsor requirements, the team assembled a bill of materials including all electrical equipment required. Integration included building wiring diagrams with tags, completing electrical related design.

Future Considerations

As energy storage systems continue to evolve and become more widely adopted across various industries, several future considerations will need to be considered:

Integration with Renewable Energy Sources: Energy storage systems like the ModuPower are often used in conjunction with renewable energy sources like solar power and wind. As more renewable energy sources come online, it will be important to design energy storage systems that can integrate with these sources seamlessly.

Cost Effectiveness: These systems are becoming increasingly cost-effective as new technologies emerge and production costs decrease.

Scalability: As energy storage demand continues to grow, it is important to design these systems to be easily scaled up or down to meet changing energy and industry demands. This means developing modular systems that can be easily expanded or contracted as needed

Looking forward, the future of energy storage systems is promising, with continued advancements in technology and increasing demand driving innovation and growth in the industry.