EE 452 Lab Solar Learning Station

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Dedicated to developing and expanding the current EE 452 solar generation system to benefit students

Project overview

Recent technological advances have made solar and wind generation more economical and thus more common throughout the world. This increased demand of renewable energy produces a greater need for educated Electrical Engineers. Iowa state currently offers EE 452 Mechanical Drives and Machines. This course discusses electromagnetic conversion, which is a key concept in renewable power systems.

Currently the station is disorganized and limits what the students can test and measure. Our Team rebuilt the station and software to give the students a better and safer learning environment. This provides every student an equal chance to collect good and meaningful data. To accomplish this, we had the following goals.

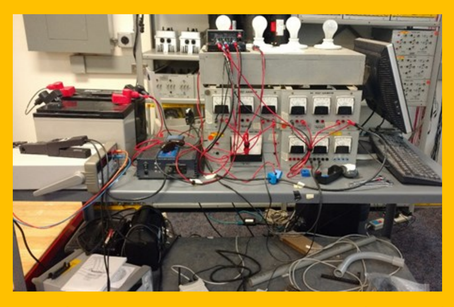
Goals:

- In depth study about solar power
- Improve current work station layout
- Build upon current labs
- Generate new labs using model trains as an enhanced component

Solar panels located in the courtyard of Coover Hall

Improved Setup

- Create a more compact, updated, and user friendly workstation for students to conduct lab
- Cleaner displays and new equipment that is easy to use
- Implemented different loads: train, light bulbs, and 3 phase motor



Team's previous progress. Functional setup, but not polished or safe.

Our progress, refined version. Polished, safe, and functional. Three load types.

Why Solar, Motivation, & Theory

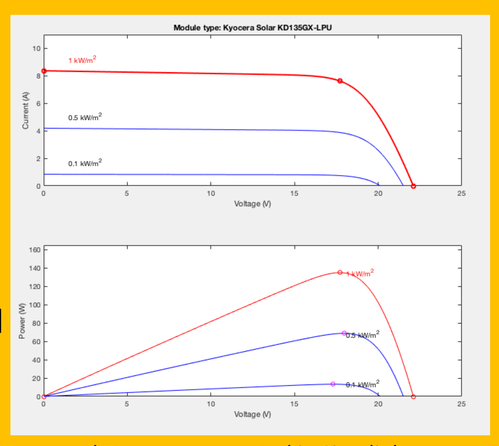
Renewable energy is a growing field that Power Engineers at Iowa State University need exposure too. In solar energy, MPPT is a helpful concept to allow matching soar panel impedances; which we reinforce with Simulink.

MPPT

- Balance of parameters for maximum solar panel performance by responding with varying conditions
- Perturb & Observe is the simplest to understand

Simulink Model

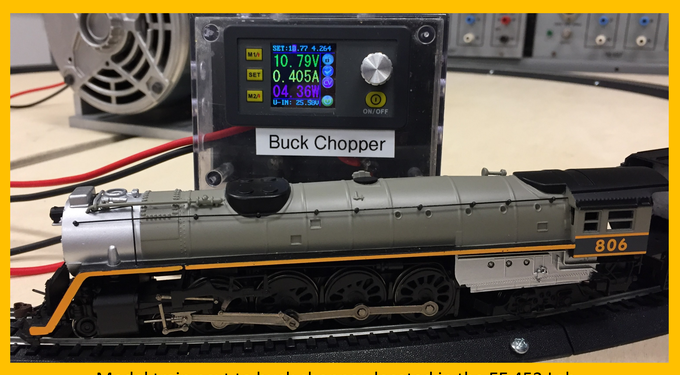
- Provides an in depth understanding of the equipment we will be working with
- Each part of the system can be built and simulated using Simulink
- This can be used by students in lab to aid in the understanding of different applications



IV and PV curve generated in Simulink

Solar Train

- Students will learn and see the effects of MPPT
- DC motors are the main topic of EE 452
- DC motors propel the train around the track
- Find max power on Torque vs Rotational Speed plot
- Calculate battery capacity needed to power trains at night
- Examine different charge controllers to understand how the system receives power at day/night



Model train next to buck chopper, located in the EE 452 Lab.

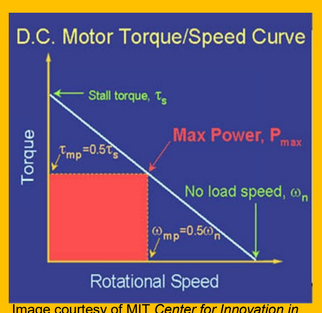


Image courtesy of MIT *Center for Innovation in Product Development*

Technical Details & System Diagram

In a standalone solar system, there are several components that are required; a solar panel array, maximum power point tracking (MPPT), batteries, and a load. These create an environment that can generate 275 Watts from the solar panel and maintain power for an 600 Watt load from the inverter. We focused on each area in order to thoroughly understand the setup.

Learning Components:

- Various Loads
  - DC Train, 1 Phase Light Bulbs, and 3 Phase Motor
- Maximum Power Point Tracking (MPPT)
  - Learn how impedance matching affects the solar panel by using Simulink to model a standalone solar system
- Measurements and losses
  - Observe how power conversions affect the system and what methods are the most efficient