Standalone Power Converter

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Project Introduction

Some populations such as some Navajo families live beyond the grid's reach. Our client, Dr. Venkata Yaramasu, is attempting to develop a standalone power converter that can help deliver electricity to these people.

While there are converters on the market they have some downsides,

- They are fine-tuned to specific loads
- Difficult to adjust
- Expensive
- Inability to adapt to changing consumer needs which results in power being wasted

Our team has been tasked with improving upon the designs of previous teams.

Our Client

Our client, Dr. Venkata Yaramasu, is a research professor for the university and director of the AMPERE laboratory. He has been sponsoring various converter projects as a part of his research into improving the designs of power converters currently available.

Acknowledgments

Special thanks to,

- CEFNS and SICCS for financial support
- Dr. Venkata Yaramasu for guidance
- Arnau Rovira Sugranyes for mentoring our project

Future Works

Our team is currently in the process of writing a paper to be submitted to the IEEE Xplore digital library

- Research

AMPERE Advanced Motors, Power Electronics, and Renewable Energy Laboratory

How it's Made

The first step into developing a power converter is creating the circuits and implementing them within a PCB schematic. This was done utilizing Altium's Designer software.

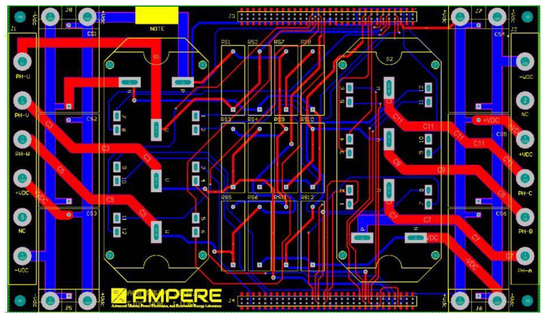

Figure 1: Schematic of Power Board

After finishing designing the PCBs they are then sent to the manufacturer to be built.

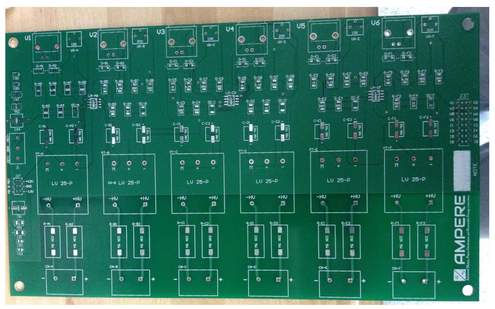

Figure 2: New Voltage Sensor Board

Once all parts have been delivered components are soldered onto the boards.

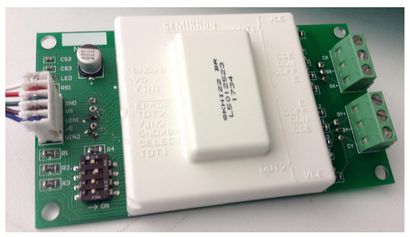

Figure 3: Finished Gate Driver

The final step for the physical converter is to connect all the boards together. Because this converter uses a model predictive scheme to produce output voltages and currents, software must be developed to implement a control scheme.

Using MATLAB's Simulink our predictive voltage and predictive current control schemes were developed.

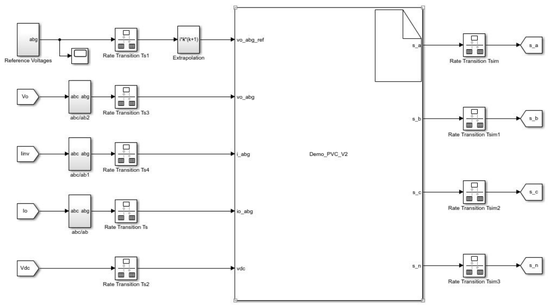

Figure 4: Predictive Control Model in Simulink

In order to have our Simulink files connect to the physical converter Dspace is used to allow for communication between MATLAB and the converter. Dspace also allows for rapid prototyping in real time.

Figure 5: Dspace Control Panel

After connecting the converter to the Dspace control panel signals can be sent to the converter to control how the output waveforms appear. This is done through the Dspace ControlDesk.

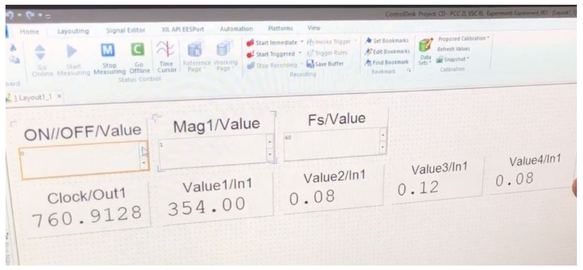

Figure 6: Dspace ControlDesk

For more information please visit
https://www.cefns.nau.edu/capstone/projects/EE/2018/OffgridConverter/home.html

Thanks for reading!

Challenges Faced

The major issue faced during this project was dealing with noise. In our original design the pins connecting our boards were uninsulated and too close to each other.

Figure 7: 60-Pin Connectors

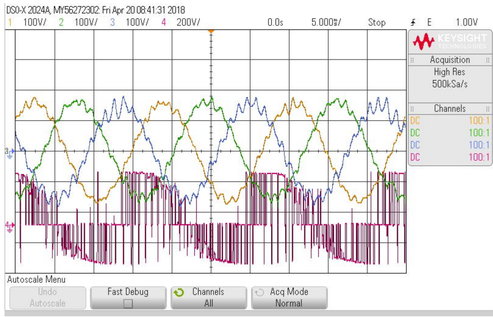

Figure 8: Noise Influenced Waveforms

At high voltages the signals began interfering with each other which caused the waveforms to ripple at peaks and valleys.

Solutions and Results

After changing our gate drivers and adding insulated wiring we no longer had interference between signals.

Figure 9: Insulated Connections

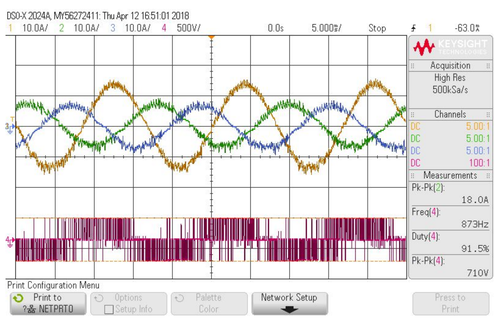

Figure 10: Final Waveforms

Final Product and Conclusions

Our team has successfully created a converter that can run using a predictive current control scheme at 350 volts and 12 amps. However, the converter required new wiring and gate drivers to be functional. The converter shall be left with our client so that he can perform further tests and store the boards and simulation files for future use. The noise issues our team faced will be addressed in one of our client's future capstone projects as he aims to develop a perfect standalone power converter.

Figure 11: Completed Converter