ELECOMP CAPSTONE SUMMIT
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THE UNIVERSITY OF RHODE ISLAND

THINK BIG WE DO℠

Generation-2 SPEC Tester

System Power Extended Cycling

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Project Motivation

DC-DC converters must provide steady power to large processing units and as power demands are increasing, competition to make the most effective and efficient devices pushes innovation forward. Once many of the logistics of a design have been determined, minor modifications can be made in order to further optimize the performance of the design. These could be changes in the layout of MOSFETs on the chip, supporting hardware, or changes in semiconductor structure or doping levels. Testing racks are used to test sets of these chips, each divided into groups. These IC's are placed under heavy demands and held under identical conditions in order to maintain a controlled testing environment. The results of these tests can further the development of these chips. This project is motivated by the need for an efficient, compact, testing rack that can both control the conditions between chips and accurately report data. This will allow Infineon engineers to properly interpret the results and to work towards the best outcome for their DC-DC converters.

Key Accomplishments

Waveform Generator Board:

- Allows for customizable waveform transients to be sent to the load board. Waveforms can be saved to onboard SRAM for later use.
- Sized to plug directly on top of the Cyclone V DE10-Nano FPGA into one of its GPIO headers.
- Powered either by an external supply or directly from the FPGA board.
- Connects to FPGA using SPI controller (see below).
- Circuit was designed by the electrical engineers and then the PCB was designed and fabricated by Infineon.

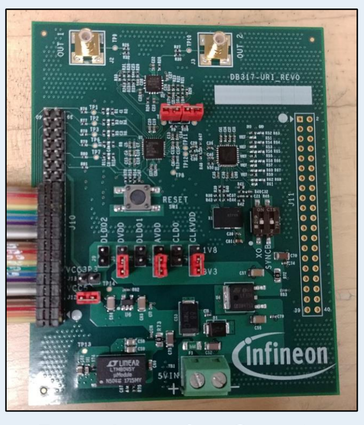

Figure 4: Waveform Generator Board

I2C Controller:

- Communicates with onboard phase controller using custom-made I2C controller written in VHDL.
- Primary purpose is to read telemetry data (voltages, power, currents, etc.) from phase controller and send that data back to the PC GUI.
- Provides a solid foundation in order to facilitate communication with all 60 devices and six neighborhoods.
- See initial test of I2C controller in Figure 2.

SPI Controller:

- Communicates with waveform generator board over SPI (Serial-Peripheral-Interface) bus.
- Communicates directly with the DAC on the waveform generator board in order to define the specifics about the current transients to send to the load board.
- Establishing this communication with the waveform generator board over SPI using the FPGA will allow users to easily send customizable current transients to the load board using our PC GUI.
- See ModelSim simulation of SPI Controller in Figure 3.

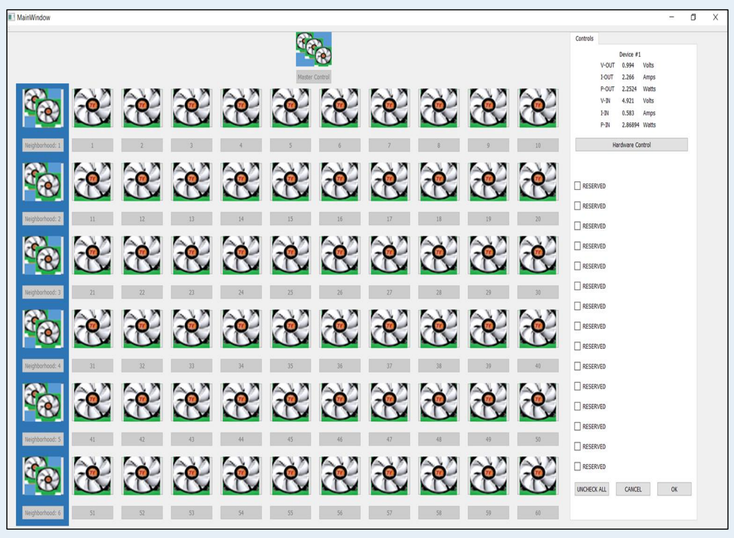

Figure 5: GUI to control and monitor 60 devices

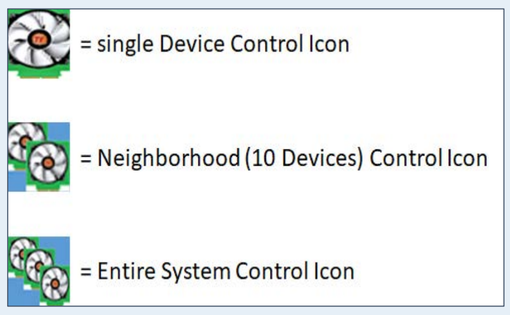

Figure 6: Key for GUI icons

Graphical User Interface (GUI) Development:

- The GUI (Figure 5) provides the end user with a simple way to monitor and control the testing boards in real-time. Clicking on one of the boards displays its data, including, but not limited to, its voltage, current, power consumption and temperature.
- The GUI also offers the user a selection of tests to run on the boards. The user can choose to run tests on individual boards, on ten board testing neighborhoods, or on the entire rack of sixty boards
- If a fault is detected then the corresponding device icon is disabled and a "FAULT" button appears under the icon. The fault detection window that appears if the fault button is pressed. The window displays the exact fault that was detected in the hardware.
- Any data that is received is passed to an excel file for historical lookup.

Anticipated Best Outcome

By April 30th, 2018, we anticipated to have implemented a system capable of monitoring and managing one neighborhood of the SPEC (System Power Extended Cycling) testing platform. In general, our initial aspirations for the project were very ambitious and did not leave room for error or delays. We had initially planned to be able to communicate and control all 60 I2C devices but we reduced this figure and planned to be able to communicate and control 10 devices (one mainboard). There were also a number of extraneous features that we will not be including simply due to time constraints. Regardless though, we do believe that project was overall a success and we believe that we have left the project in a good state for the next URI team to pick-up from. We have essentially laid the groundwork and have completed the majority of the backend work necessary for this system to be able to function as initially planned.

Project Outcome

The Anticipated Best Outcome was not achieved. VHDL designs created to communicate with SPEC platform using FPGA; also developed PC-based GUI to display telemetry data; developed backend software for communication between GUI and FPGA.

Figures

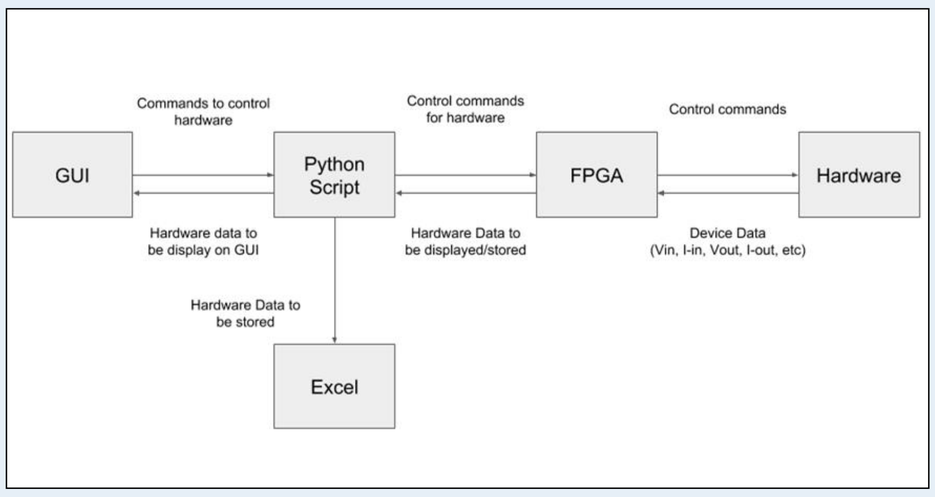

Figure 1: System flowchart of final deliverable product

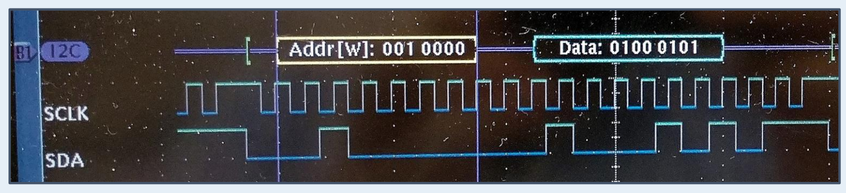

Figure 2. Oscilloscope Capture of I2C Controller Test

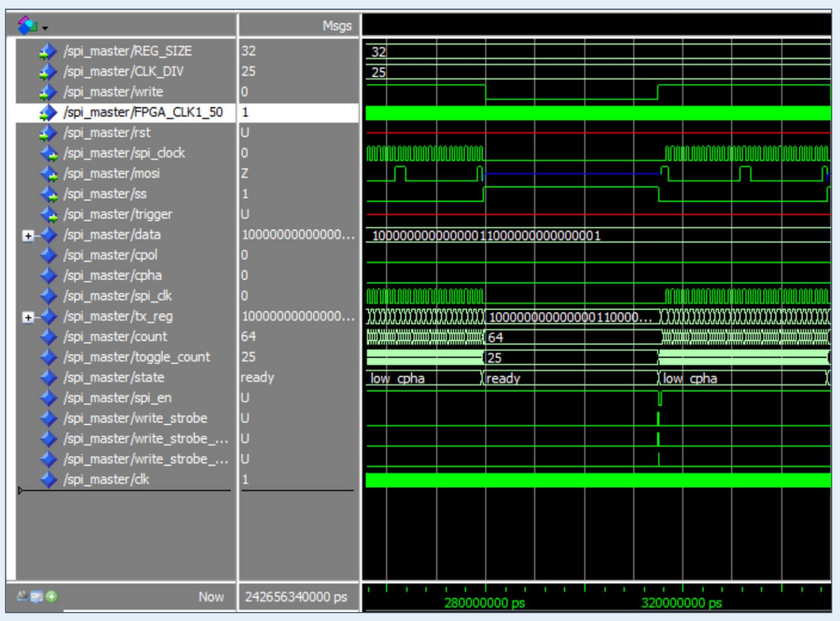

Figure 3: ModelSim Simulation of SPI Controller

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