ELECOMP CAPSTONE
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THE UNIVERSITY OF RHODE ISLAND

THINK BIG WE DO™

PODAS

Power **O**utput **D**river **A**utomated **S**ystem for Integrated Circuits over Time

ON Semiconductor

Team Members: Nicholas Amore (ELE), Alex Cressman (CPE), Robert Robinson (ELE), Luke Thoden (CPE)

Technical Directors: Frank Kolanko & Robert Davis

Project Motivation

When a driver integrated circuit with an inductive load is turned off, the system will try to maintain the current using the energy stored in the inductor. Since the driver is turned off, the voltage will begin to change on the output pin. The current created through the inductor with the voltage will create power dissipation in the IC. That power multiplied by time is the Clamping Energy. Drivers have a maximum rating specified for Clamping Energy. Part of testing is taking data in the lab for this parameter. To do this, a circuit is set up with a large inductor and a function generator that controls the pulse width. A pulse is sent, the circuit is excited, and the energy value is recorded. The pulse width is increased, and the subsequent value is recorded. This continues until the device fails. An automated test system is needed to streamline this process.

Key Accomplishments

Output Switch: The ICs under test have multiple outputs. In order to fully automate this test, the system needs to be able to test each output individually. Using a relay, each output can be selected without requiring the user to manually change which is under test.

Safety Switch: The IC under test fails in a short. This will force a large current through the system. If left in this state for an extended period of time, it runs the risk of damaging the system. The safety switch acts as a disconnect from the power supply, preventing damage to the system.

Temperature Sensor: As the part is tested, there is more power dissipated with each increasing pulse. This raises the temperature of the part. By using delays between pulses, the overall temperature will continue to increase. This will result in premature failures due to temperature and provide poor data. To address this issue, a temperature sensor is used which takes advantage of thermal characteristics of the body diode to monitor die temperature during the test.

Fail Detection: In order for the system to safely test every output of the device, it must be able to determine when an output has failed, so it can iterate to the next one. By taking advantage of the voltage characteristics of the part when it is being tested, the Arduino can easily monitor outputs to determine whether to continue testing the part or move to the next output.

High-Side Driver Operation: The parts being tested are not only low-side but also high-side drivers. Our system needs to be able to handle the differences between both styles of this part. The fail detection and temperature sensor are the same conceptually, but are implemented differently for high-side. The other features work the same for both high and low-side. All the user must do is push a button to configure the system. This and the previous accomplishments are illustrated in Fig. 1.

PCB Development: The automation system needs supporting hardware in order to function properly. The final board incorporates all the features that have been developed along with supporting circuitry into a sleek design as seen in Fig. 3. The final board had a drastic reduction in size from the prototype allowing for a cleaner workspace.

Pulse Width Control: Automation of varying length pulse widths has been achieved using an Arduino. The user is currently able to adjust initial pulse width, set the increment between pulses, and change max allowable pulse width using push buttons.

OLED Displays: Two OLED Displays show programming and test results. The programming OLED displays initial pulse width, increment amount, and max pulse width. The test results OLED displays test configuration, current pulse width, and test status. Both OLED screens can be seen in Fig. 2.

Oscilloscope Data Extraction: Automated data extraction from the Oscilloscope has been achieved using Oscilloscope built-in autosave feature. This feature collects all the signals displayed on the screen and exports it as a CSV file.

Python Application: To analyze the files saved by the Oscilloscope, the user is provided with a Capstone Flash Drive which contains a Python Application and the necessary folders and libraries required to run it. The application displays the CSV file names and the peak values of that file where the device fails. The GUI displays the maximum current and energy values of the entire test and allows the user to graph any of the CSV files. An example of what the user would see can be found in Fig. 4.

User Manual: The user manual was created to assist anyone looking to run the system. It provides the user with a list of necessary materials required to set up the system, as well as, step by step instructions for setting up both boards, the Oscilloscope and how to use the Python Application.

Anticipated Best Outcome

The Anticipated Best Outcome of the project is to take the existing test board and fully automate it to measure the Clamping Energy of a device. The delivered product needs to be a fully developed system that can iterate through every output of an IC, detect failures, monitor temperature, and extract data from the oscilloscope. The data needs to be presented clearly and provide the user rapid feedback. The system should be simple to use, and independent of a PC. The user should be able to walk up to the system and run the relevant tests with no hassle.

Project Outcome

The Anticipated Best Outcome was achieved.

We also included several additional key features to improve the function of the automated system.

Figures

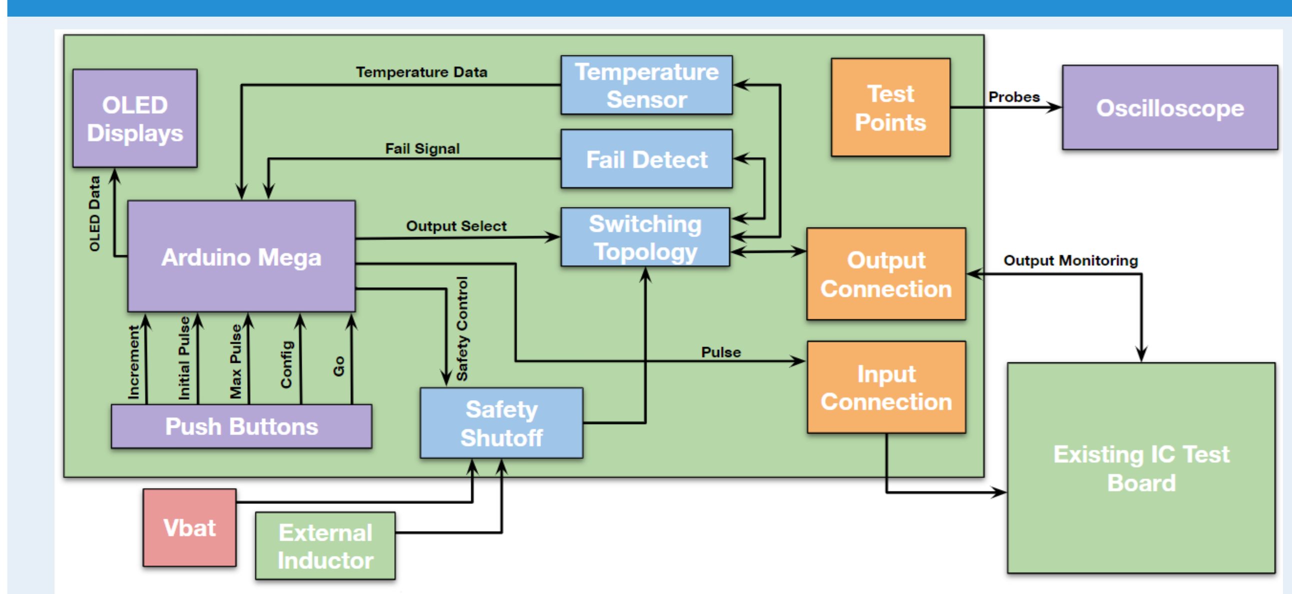

Fig. 1: Block Diagram of PODAS System with all Relevant Features.

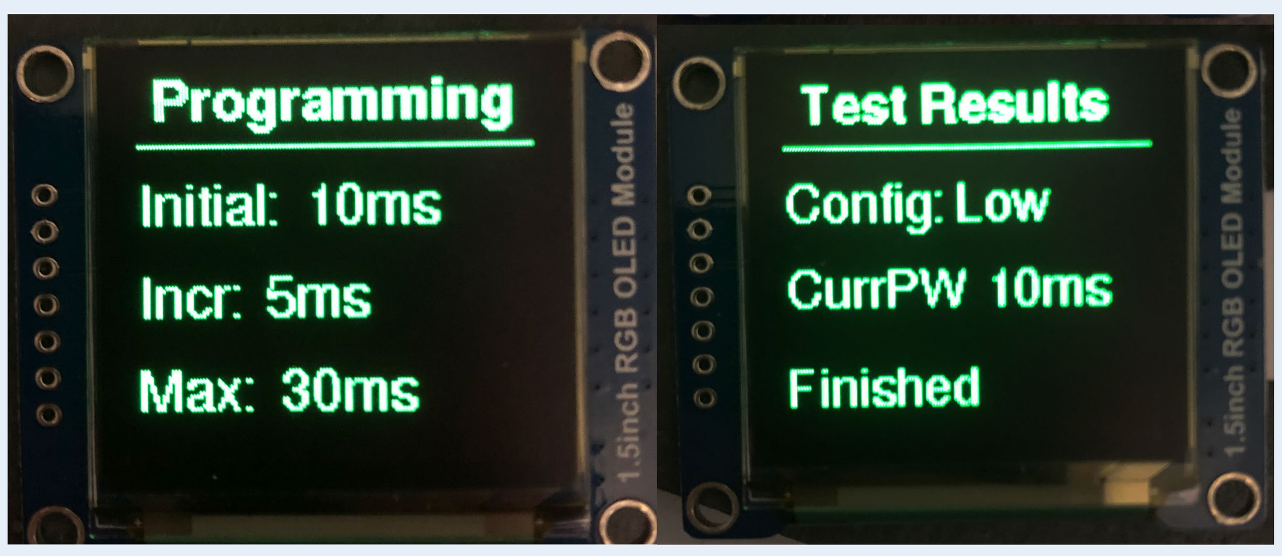

Fig. 2: OLEDs Displaying Input and Output Information.

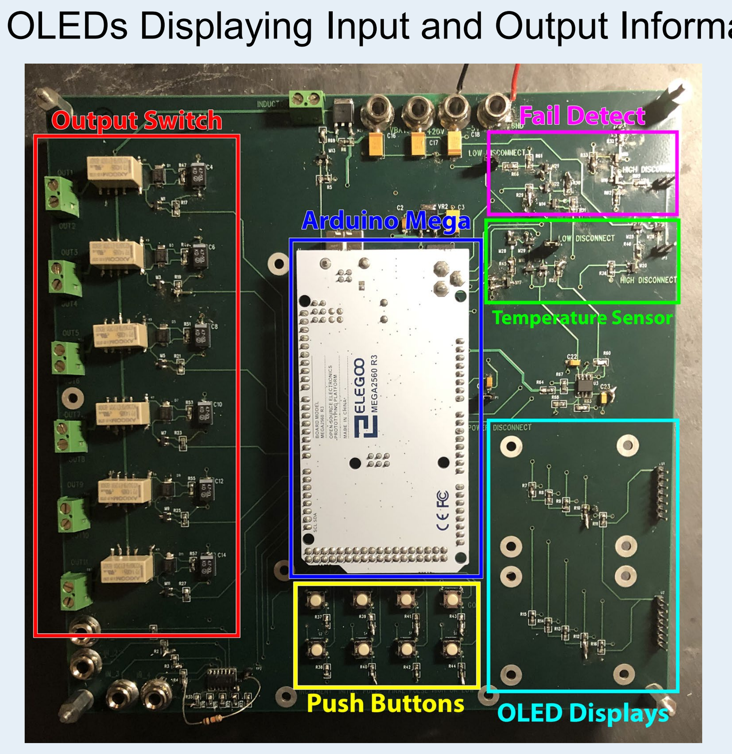

Fig. 3: Fully Assembled Final PCB.

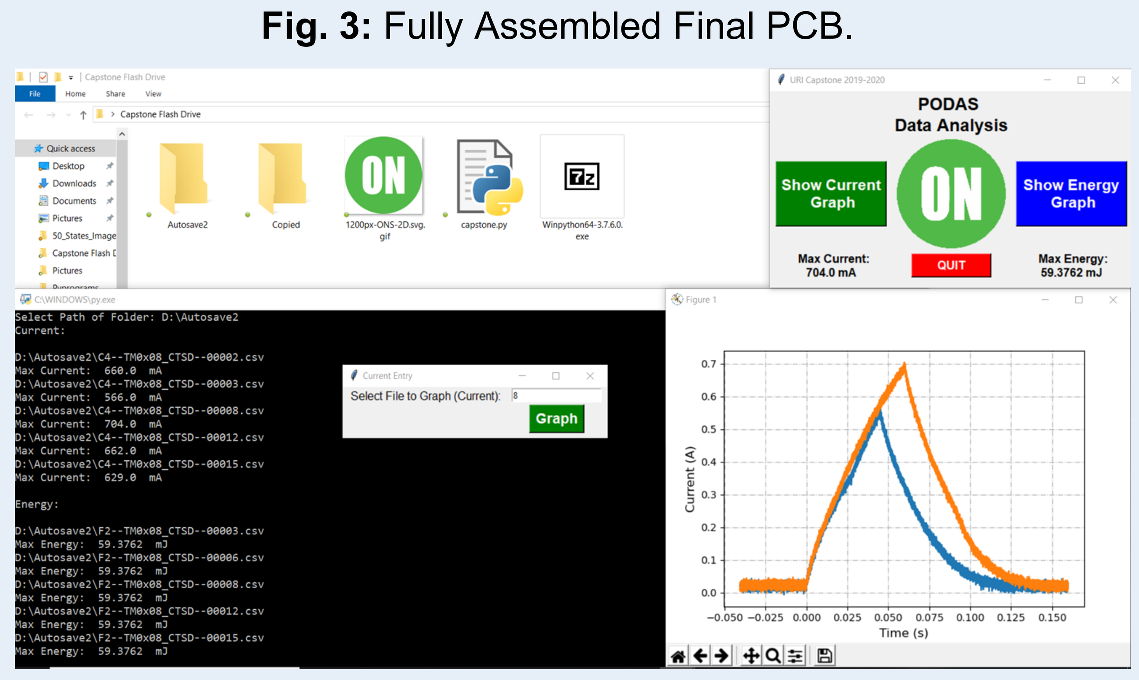

Fig. 4: Data Analysis Software.

ELECOMP Capstone Program Director: Professor Harish R D Sunak

email: sunak@ele.uri.edu telephone: 401-874-5859

ELECOMP Website: https://uri.edu/elecomp-capstone