Evaluation 1: Group DD16
Wide-Range Temperature Control and Diode Characteriser

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SYSTEM DIAGRAM

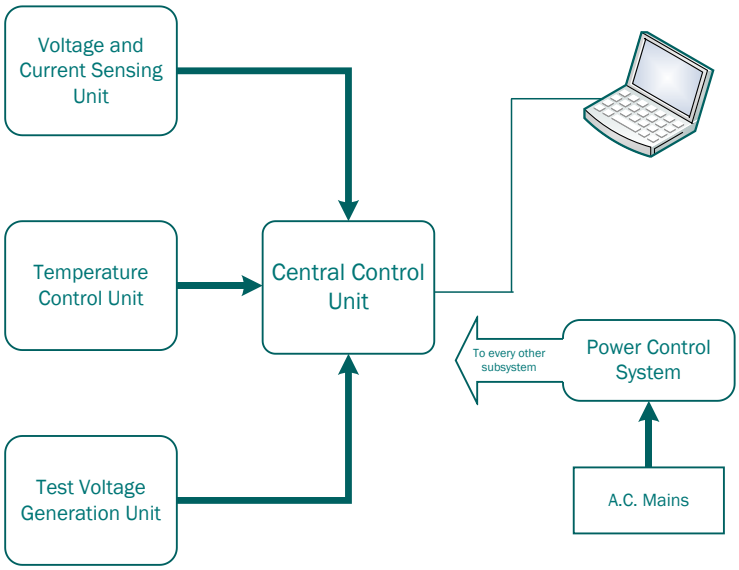

Figure 1

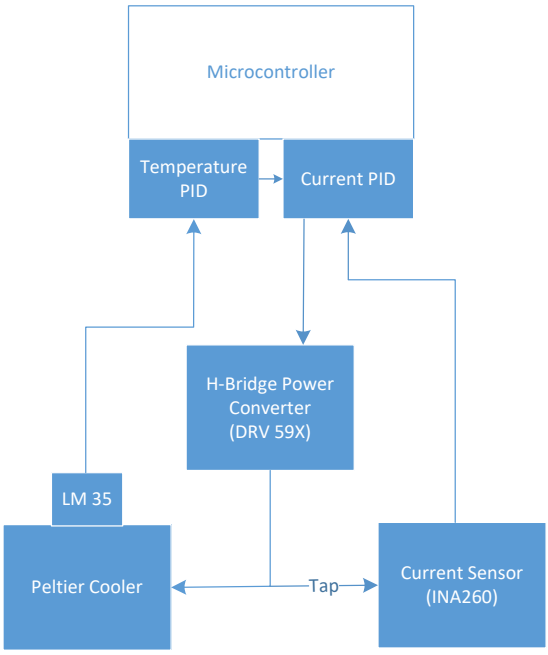

Figure 2

TEMPERATURE CONTROL SYSTEM

Figure 2 represents the currently planned implementation of the Peltier cooler setup. We had started out with an aim of building a voltage controlled current source using a simple Op-Amp and BJT Circuit.

- Testing was performed for a low current requiring variable load (Potentiometer Resistor) using off the shelf components like UA741 and BC547
- Testing was successful and enough control and constancy was obtained. Data available.
- Problems Faced: Unable to scale to the current requirement of the Peltier cooler.
  - Resistors required of biasing of the transistor, would dissipate large amounts of heat
  - Power BJTs that could replicate the characteristics of BC 547 at high currents weren't easily available
  - Darlington BJTs did not provide control over a wide range on currents
- Also after going through other similar projects, we found that the most common and effective way was to use an H Bridge and a current sensor pair to form the current source using a control loop

DRV595

- DRV595 is used as H Bridge IC. We have designed and printed the test board based on the IC specifications.
- The IC takes in an analog voltage input and produce PWM voltage & rippled current output. Therefore, a filter is also required after the output of the IC to smooth out the current and potentials.

- Problems faced during the design:
  - Unavailability of suitable inductors for reducing the ripples produced. This is required because the TEC element must not be exposed to high ripple input.
  - First PCB printed was smaller(scaled) due to software problems (incompatibility between Softwares). This was later resolved by trial and error.
- Alternative to DRV595: DRV592
  - It also takes in PWM voltage input but gives a scaled version of PWM output.
  - The reason of not choosing this is the range of output voltage provided is only 5.6V and hence it cannot drive more than one TEC element.

INA260

- INA260 is used as a current sensing IC. It can measure current, input and power with high precision.
- It can be visualized as a combination of shunt resistor (of very small value), an ADC and an I2C bus.
- This IC was required as the availability of the low power dissipation precision shunt resistor was an issue. This issue arises due to the very high current which flows through the element.

SOFTWARE

To reduce dependence of external development boards like Arduino we chose to use the Tiva C board. The choice was also fuelled by the ability of the TM4C processor to run faster (required for the small signal analysis) and its extensive peripheral interface support to communicate with the various ICs.

But this also introduced a new component into our project which took some time to configure and run. Hence to temporarily test out our ICs and small systems we coded in Arduino to get an idea of the problems we might face later.

- To test the Current Sensor a code was written for Arduino which would use the I2C interface to extract the current data for the INA260 IC
- Necessary configuration instructions were also written to get a more accurate representation of the current
- The code can be readily translated to a code for Tiva C given the functions to implement the protocol

Tiva C and PC

- Targeted: Complete Temperature Control Loop
  - Get actual temperature reading from lm35 (Temperature Sensor)
  - Measure current flowing through cooler and calculate error from set point
  - Update PWM duty cycle to adjust current value accordingly
- Problems Faced
  - Getting started with completely new family of devices
  - Deciding required communication peripherals for different sensors and host
- Completed Tasks
  - Device Application
    - USB: Main data transfer protocol to exchange data and commands
    - UART: Mostly as a debug protocol
    - I2C: Peripherals such as INA
    - SPI: Peripherals such as PGA
  - Host Application
    - Sample GUI application to send and receive data and instructions
    - Separate threads for Data transmission, Data Receiving and GUI and Computation

EVALUATION 2 GOALS

By the evaluation to in mid-March we hope to have accomplished

- Complete current control loop using the circuitry as mentioned before by acquiring the necessary components
- Start with a rudimentary IV Characteristic plotter without temperature variation
- Get the code running on Tiva C