PCB Design, Assembly and Manufacturing of a Power Distribution Board

Group 4 - Ethan Janus, Peter Sun, Zheng Feng, Riley Wong

Faculty Supervisor: Hong-Chuan Yang

Background

Electronic devices are becoming more important in people's daily lives. From a simple light bulb lighting our life to CPU powering our smartphone, electronic devices are becoming more complex. These devices require strict management of voltages and current in their circuits. With a well-design power distribution board, electronic devices can have a longer working life-span and work stably. Therefore power distribution boards use widely in electronic devices such as drones.

This project will design a fully functional modular power distribution board that can deliver the power from batteries to an avionic aircraft's onboard system. To improve the stability, the design of power distribution board will be divided into five different modules:

1. 12V to 3.3V converter
2. 12V to 5V converter
3. 12V to 8V converter
4. 12V to 24V converter
5. Voltage selector

Objective & Goals

(i) Design a modular power distribution system that provides 3.3V, 5V, 8V and 24V to unmanned aircrafts subsystems

(ii) Voltage Selector that prioritizes auxiliary input over battery input and supplies power to voltage converters

(iii) Optional: Include a voltage and current sensing capabilities for each voltage converter

(iv) Required specifications of the voltage converters are listed in the following table 1

Table 1: Voltage convert board requirement specification

Objective	Minimum	Typical	Maximum
Voltage in (V)	11	12	13
Efficiency at full load	80%	-----	-----
Full load current (A)	2	-----	-----
Ripple Voltage at typical voltage in	-----	-----	5% of output
Transient overshoot voltage at typical voltage in	-----	-----	120% of output voltage
Transient undershoot voltage at typical voltage in	80% of output voltage	-----	-----
Current sensing sensor output maximum voltage	----	----	5V
Current sensing accuracy	5%	----	----
Cost (USD$) per board	----	----	40.00
Temperature (C)	-40	----	+85

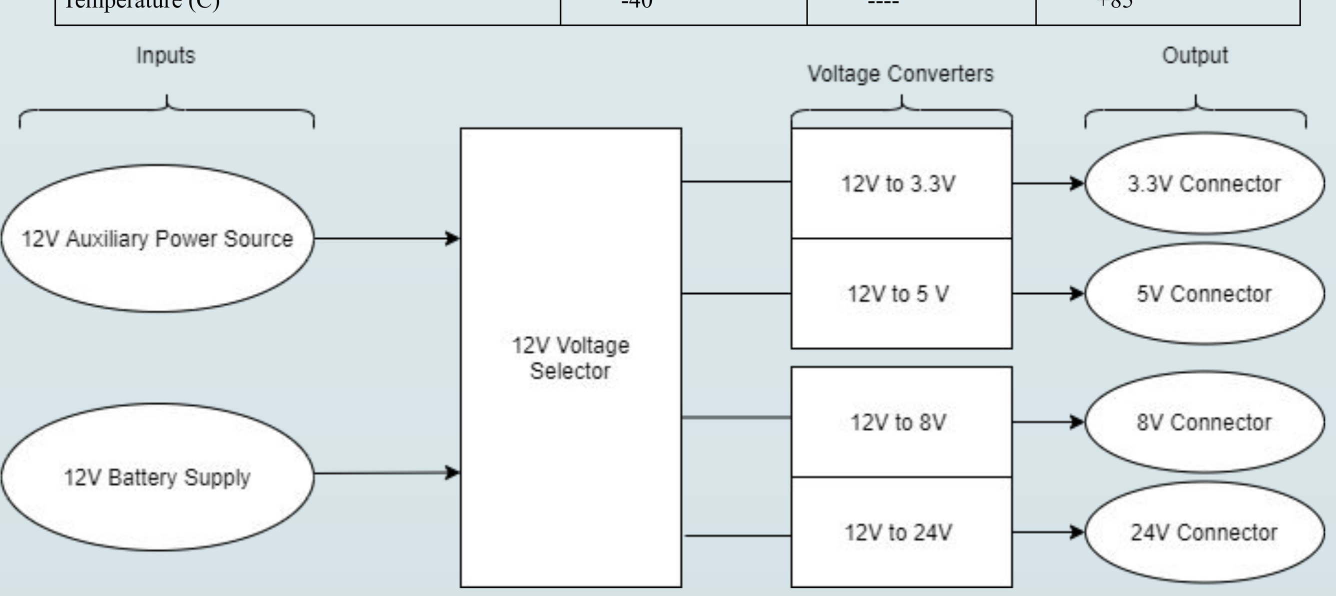

Figure 1: Block diagram of the overall design layout

Methods

The design is split up into 5 boards:

- Voltage selector board
- 4 Voltage converters with a integrated hall effect sensor for current measurement

Voltage Selector:

- Designed using the LTC4416 as MOSFET Controller
- Uses two PMOS MOSFETs for switching states
- Selection ability between 2 inputs
- Able to supply up combined 40A to 4 outputs

Voltage Converters:

- Buck or boost converter used to convert 12V input to 3.3V, 5V, 8V, or 24V output
- Used Webench to generate schematics for voltage converters
- Output current maximum of 2-4 Apms

Hall Effect Sensor:

- Uses ACS722LLCTR-10AB to measure output current using the Hall effect
- Has one output to measure current and one output to measure voltage
- Produces 132mV per A from output so current can be read by a microcontroller

Results

The voltage converters were simulated using Webench and the specifications achieved can be found in table 2:

The PCB boards were designed:

Voltage selector board

180mm x 60mm

4.2mm mounting holes at corners 4mm offset from the edges

2 inputs

4 outputs

Voltage Converters

60mm x 60mm

4.2mm mounting holes at corners 4mm offset from the edges

1 input

1 output

The finalized PCB designs can be seen below in figure 2 to 6.

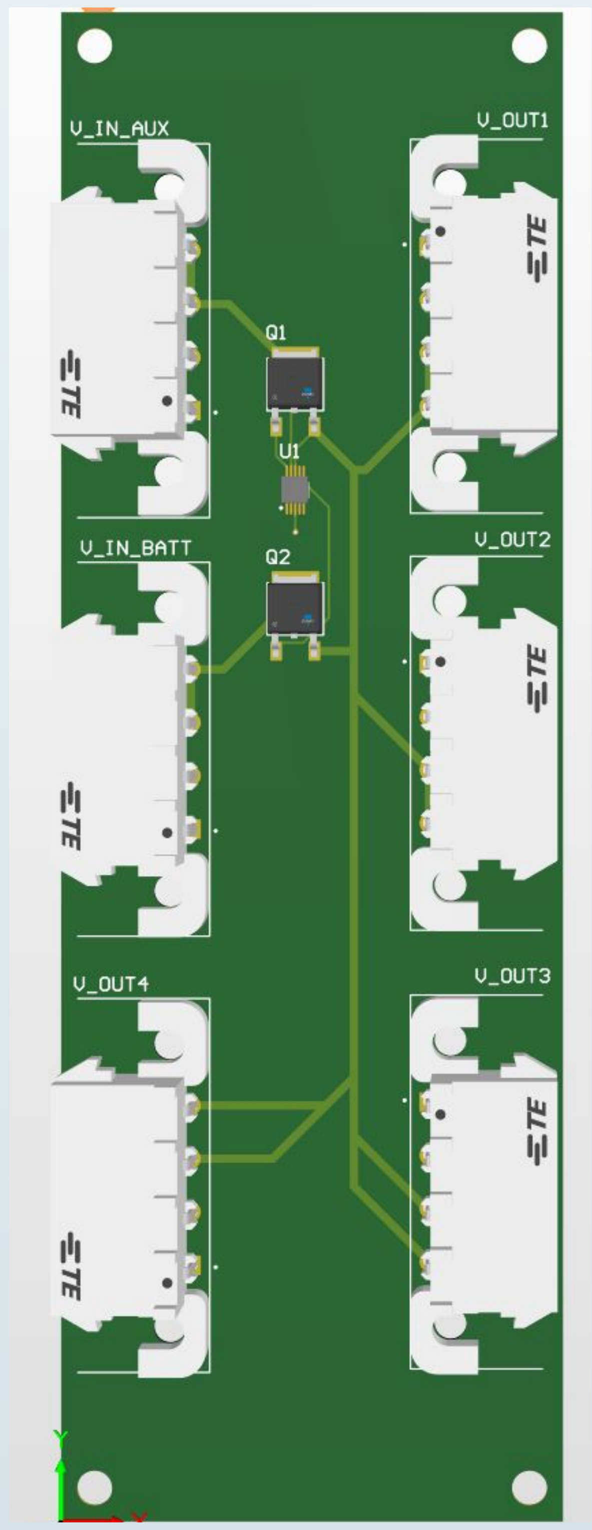

Figure 2: Voltage Selector

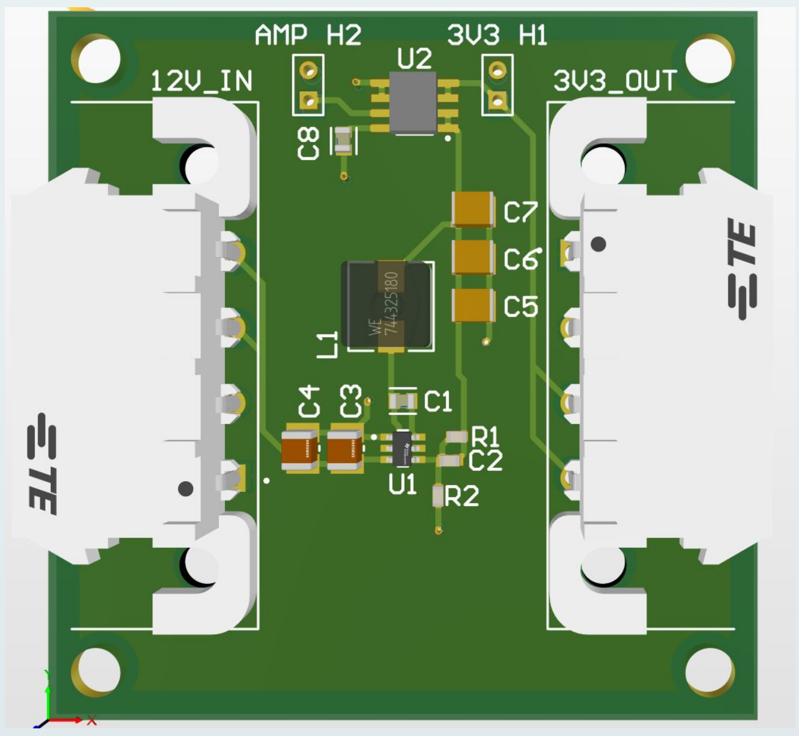

Figure 3: 3.3V Converter

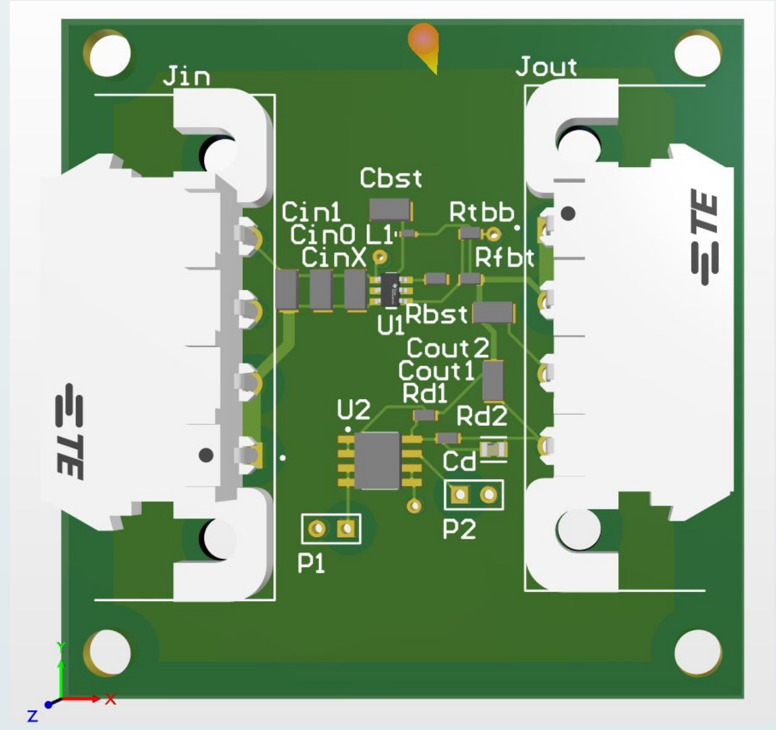

Figure 4: 5V Converter

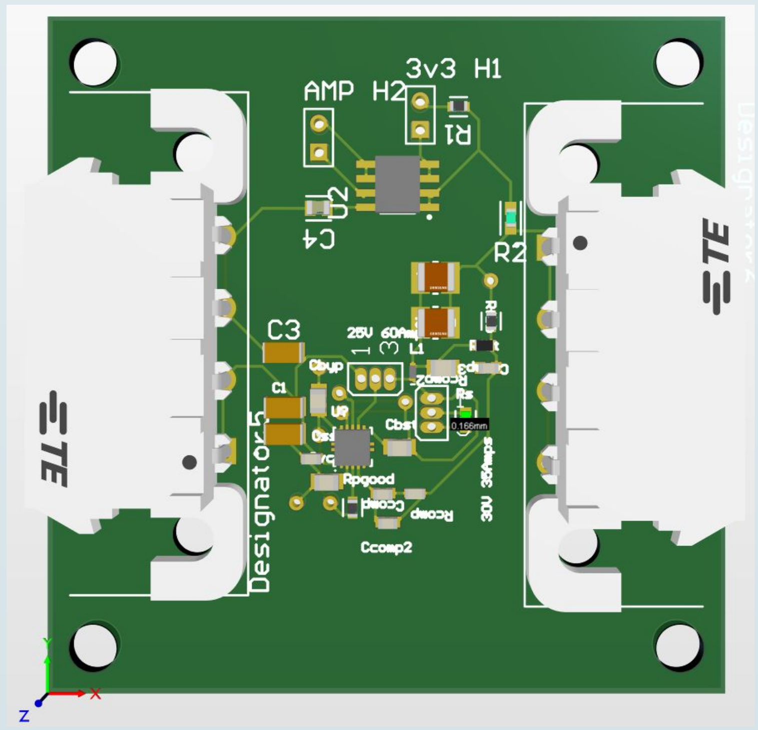

Figure 5: 8V Converter

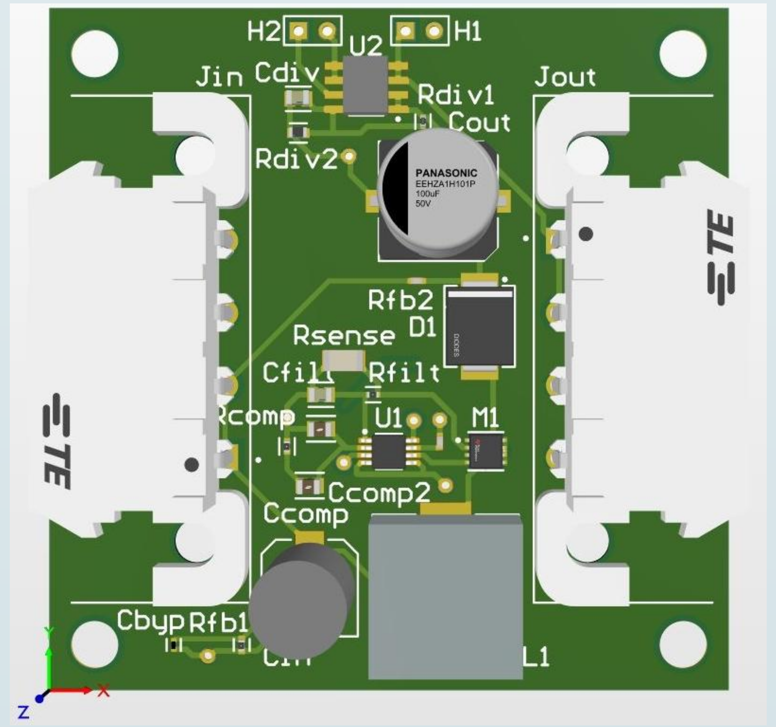

Figure 6: 24V Converter

Conclusions

Project Creation Results:

- Voltage Selector created and simulated successfully
- Voltage Converters created and simulated successfully
- Hall Effect Sensor created and simulated successfully

Project Statements:

- Design objectives for each board were all met
- Each project component was thoroughly simulated
- No physical prototype were made for the project

Table 2: Simulated results of converters and selector

Objectives	12V to 3.3V converter	12V to 5V converter	12V to 8V converter	12V to 24V converter	Voltage Selector
Input voltage range (V)	10-22	10-14	11-13	10-14	6-36V
Efficiency at full load and input voltage at 12V	87.5%	95.2%	96.5%	95.7%	98.65%
Full load current (A)	3	2	4	2	40
Voltage out actual (V) voltage in at 12V	3.322	4.98V	8.04	24.15	N/A
Ripple voltage (V) at voltage in at 12V	5.92mV	14.30 mV	21.76mV	300 mV	N/A
Transient overshoot voltage (V) at voltage in at 12V	80mV	90mV	200mV	400mV	N/A
Transient undershoot voltage (V) at voltage in at 12V	90mV	100mV	260mV	100mV	N/A
Current sensor maximum output (V)	3.3	3.3	3.3	3.3	N/A
Current sensor accuracy	3%	3%	3%	3%	N/A
Board total component cost (USD$)	17.31	11.85	13.96	14.86	27.26