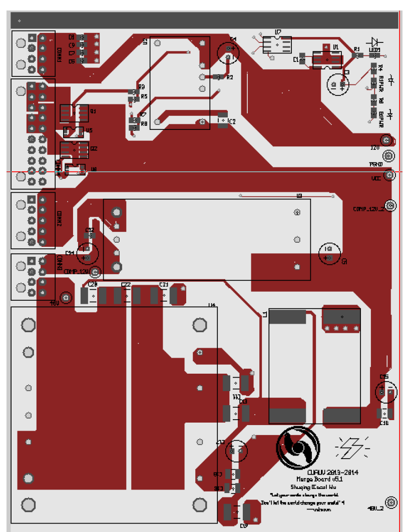
Cornell University Autonomous Underwater Vehicle Team

Fall 2013

Merge Board



Technical Report

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May 10, 2014

Contents

1 Abstract

The main objective for the Merge Board is to take in power from the two battery pods and combine them into one unifed rail. The Merge circuitry compares the two battery pods voltages and draws power from the battery at higher potential and output to the rest of the electrical components on the vehicle. This circuitry also enables hot-swapping capability so that as long as one battery is always powering the vehicle, we can switch out the other battery while the vehicle remains operational. Other than the hot-swapping circuitry, there is a DCDC circuitry on the board, which consists of four DCDCs: a non-isolating 24V to 12V DCDC to provide power for cooling fans throughout the vehicle, an isolating 24V to 12V DCDC for the computer, an isolating 24V to 48V DCDC for the camera, and a 12V to 5V DCDC for the LEDs that indicates from which battery the power is drawn. The second layer of this board is divided into three different grounds on the board: battery ground, camera ground and computer ground.

2 Design Requirements

- The Merge board should draw power from one of the two battery pods to supply power to the whole vehicle.
- Power should be drawn from the battery with higher potential.
- The board needs to output 24V to multiple boards in the vehicle: Two Thruster boards, Actuator board, Sensorpower board and Motor Board.
- The batteries should not be able to recharge each other.
- The electronics in the vehicle should remain functional when only one battery pod is connected to the vehicle.
- The board should isolate 12V power to the new CPU, 24V to the camera, and 12V to the cooling fans.
- LEDs and test points should be included on the board for testing and informational purposes.

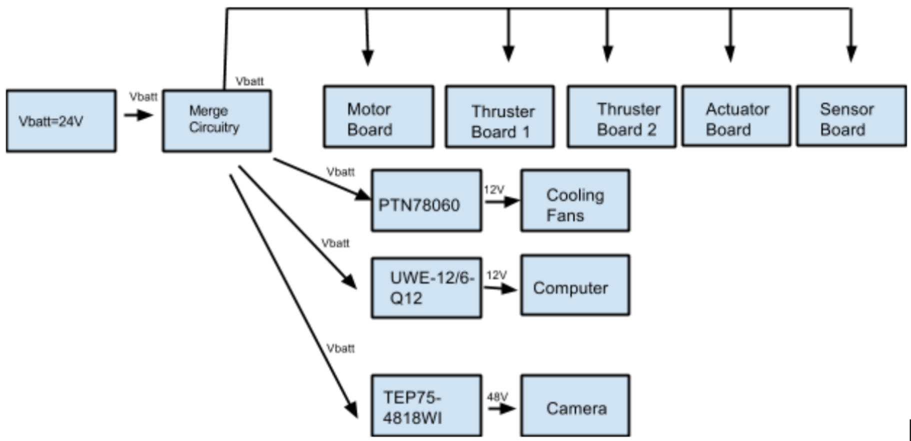


Figure 1: How power is distributed through the merge board

3 Previous Designs

There are several changes made to Merge Board v5.0 compared with the board from last year. First, there are three new DCDCs added to the board. The 24V to 12V DCDC for the fans is changed to PTN78060W in replace of PTN78000WAH to increase the power so that it can support two more fans that are added to the vehicle this year. Second, since the computer is changed to a smaller-sized one and the new computer only requires 12V instead of 15V, the DCDC for the computer is changed to UWE-12/6-Q12, which converts 24V to 12V. Third, due to the addition of camera, there is a new 24V to 48V DCDC added to the board. In addition, this year, all the connections are moved onto the back plane, so all the connectors are switched to BMI connectors including the connectors for the fans, computer, camera and for other devices on the board.

4 High Level Description

There are two main functional divisions of the Merge Board:

- The merge circuitry
- The DCDC circuitry (LEDs, fans, computer and camera)

4.1 Merge Circuitry

The main function of the Merge Board is to draw in 24V from the battery pod with higher potential and distribute it to:

- Actuator board
- Two Thruster boards
- Sensorpower board
- Motor board

The merging of power is done through two chips connected to each battery pod: LTC4375 (an ideal diode controller) and a Si4456DY (a high power NMOS transistor). If the voltage detected at pin OUT of the LTC4375 is lower than the voltage detected at pin IN, it outputs a high signal to the MOSFET to turn on and draw power from that battery pod. Since this takes place at both battery pods at the same time, the power supply keeps switching between the two pods so that one battery pod is prevented from charging the other. The full 24V is then supplied to the actuator board, two thruster boards, sensor power board, motor board, and three DCDCs. Two LEDs are also used to indicate which battery is currently drawing power.

4.2 DCDCs

The 24V from the batteries is converted to 12V using a PTN78060 DCDC. The new 12V line is distributed among the four fans. To accommodate the computer change this year, the UWE-12/6-Q12 DCDC is added to convert 24V to 12V. Also, the TEP75-4818WI DCDC is added to convert 24V to 48V to supply power for the camera. Although not a DCDC, the linear regulator LM2931 is the 5V power supply to the LEDs and the comparator in the merge circuitry.

5 Implementation

5.1 Merge circuitry

Voltage from the two battery pods comes in from the 2x10 BMI connector. Both battery pods are connected to separate sets of LTC4375 and Si4456DY chips. The LTC4375 ideal diode controller takes input from the battery pod and the Vcc output. It compares the two inputs and then outputs a high

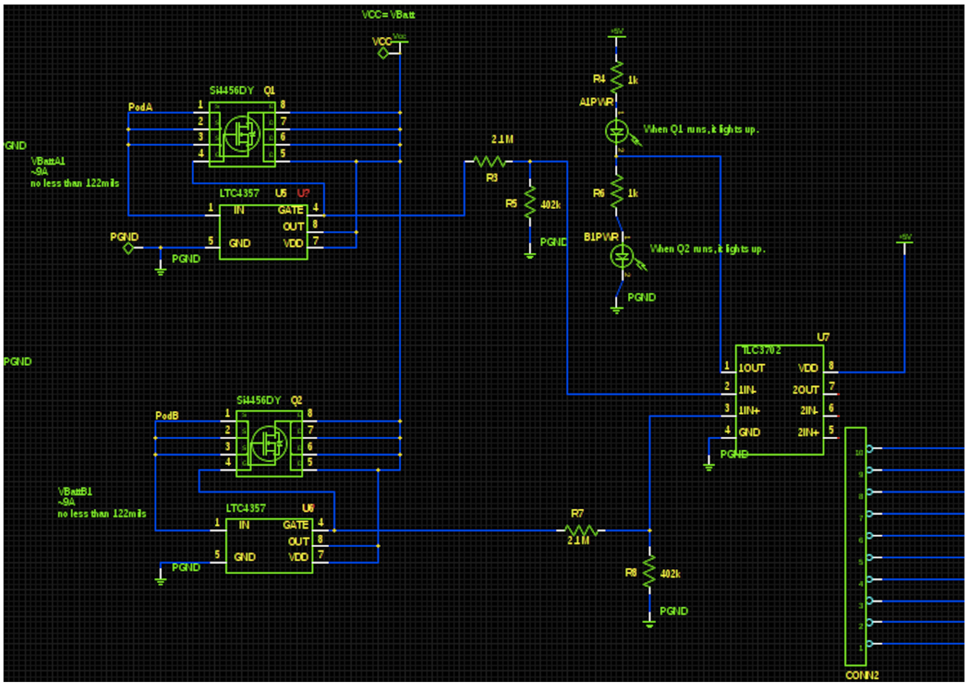


Figure 2: Merging is done through a high power NMOS and an ideal diode

signal to the high power NMOS Si4456DY if the Vcc output voltage detected is lower than the battery pod voltage connected to the ideal diode. If the LTC4375 outputs a high signal then the NMOS will be turned on and the battery pod with the higher voltage will be connected to output. This is why the power traces connected to the NMOS has to be thick because up to 20 amps of current can flow through it.

Both signal outputs from the ideal diode used to drive the NMOS are also connected to a comparator TLC3701. Depending on which of the two inputs is higher, the comparator will output a high or low voltage. Then this output is connected to 2 LEDs, one connected to the drain of the LED and one connected to the source of the LED. The LED with the output as drain is connected to a 5V source, and the other one is connected to PGND. This way altering the output from the comparator will turn on the LEDs according to the corresponding battery voltage.

5.2 DCDCs

The UWE-12/6-Q12 DCDC is used to power the new computer which requires 12V. The DCDC is simply connected to the 24V input and then outputs isolated 12V through a BMI connector connected to the computer.

The camera shares the BMI connector with the computer. The TEP75-4818 DCDC is used to power the camera by converting 24V to 48V. The DCDC is connected to 24V battery input and outputs through the BMI connector to the camera.

The PTN78060 DCDC is used to provide 12V of power to a 2 by 4 BMI connector connected to four cooling fans for the vehicle. It also supplies power to the linear regulator LM2931, which provides 5V for the comparator and LEDs.

The LM2931 regulator converts 12V to 5V to power the three LEDs on the board to indicate the working condition of the board as well as from which battery the power is drawn.

6 Known Issues

There are no known probems with the version 5.0 merge board so far.

7 Current Status

The version 5.0 merger board has been sent out for manufacturing.

8 Future Improvements

The layout could be optimized a little bit more, this could possibly decrease the size of the board.

A Appendix

A.1 Pinouts

A.1.1 Battery Pod Connector

4,5 and 13-15	Pod B
1-3 and 11,12	Pod A
6-10 and 16-20	Battery Ground

A.1.2 Camera and Computer Connector

1,2	+12V
5,6	-12V
3,4	- 48V
7,8	+48V

A.1.3 Fan Connector

1-4	Battery Ground
5-6	12V

A.1.4 Connector for other devices

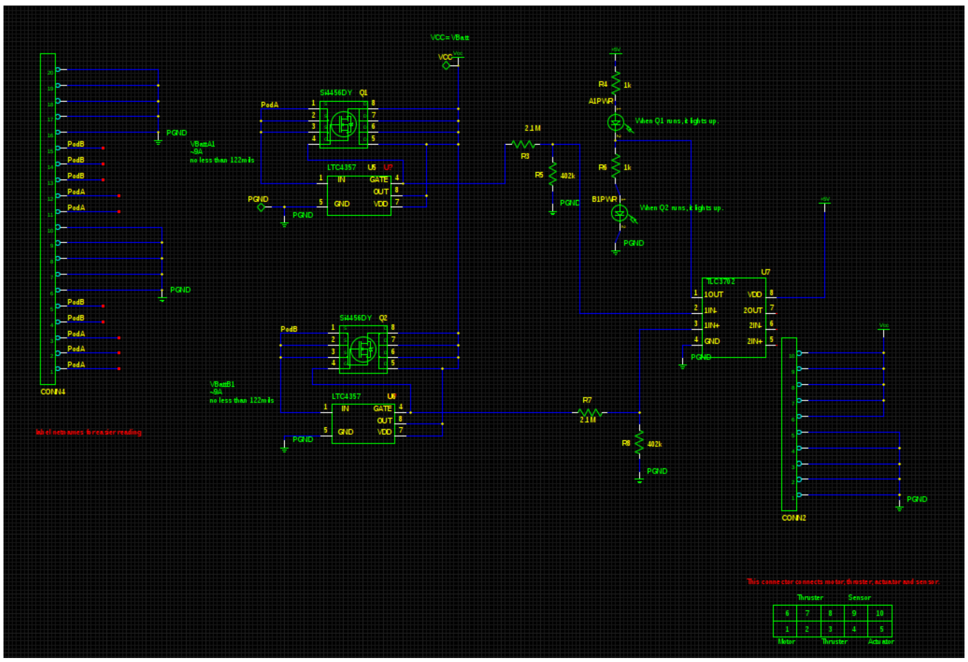
1-5	Battery Ground
6-10	Vcc

A.2 Part References

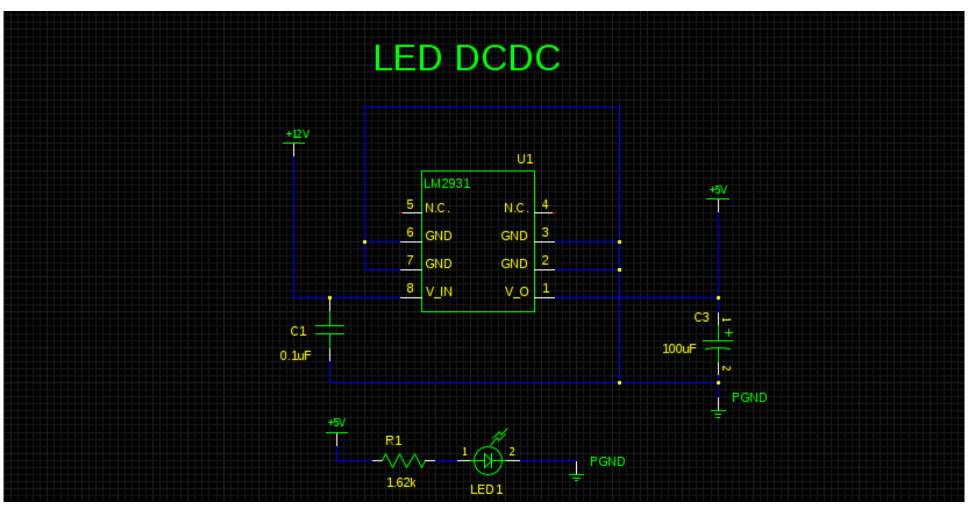
LM2931	LM2931 Datasheet
PTN78060	PTN78060 Datasheet
UWE-12/6-Q12	UWE-12/6-Q12 Datasheet
TEP75-4818WI	TEP75-4818WI Datasheet
Si4456DY	Si4456DY Datasheet
LTC4357	LTC4357 Datasheet
TLC3702	TLC3702 Datasheet

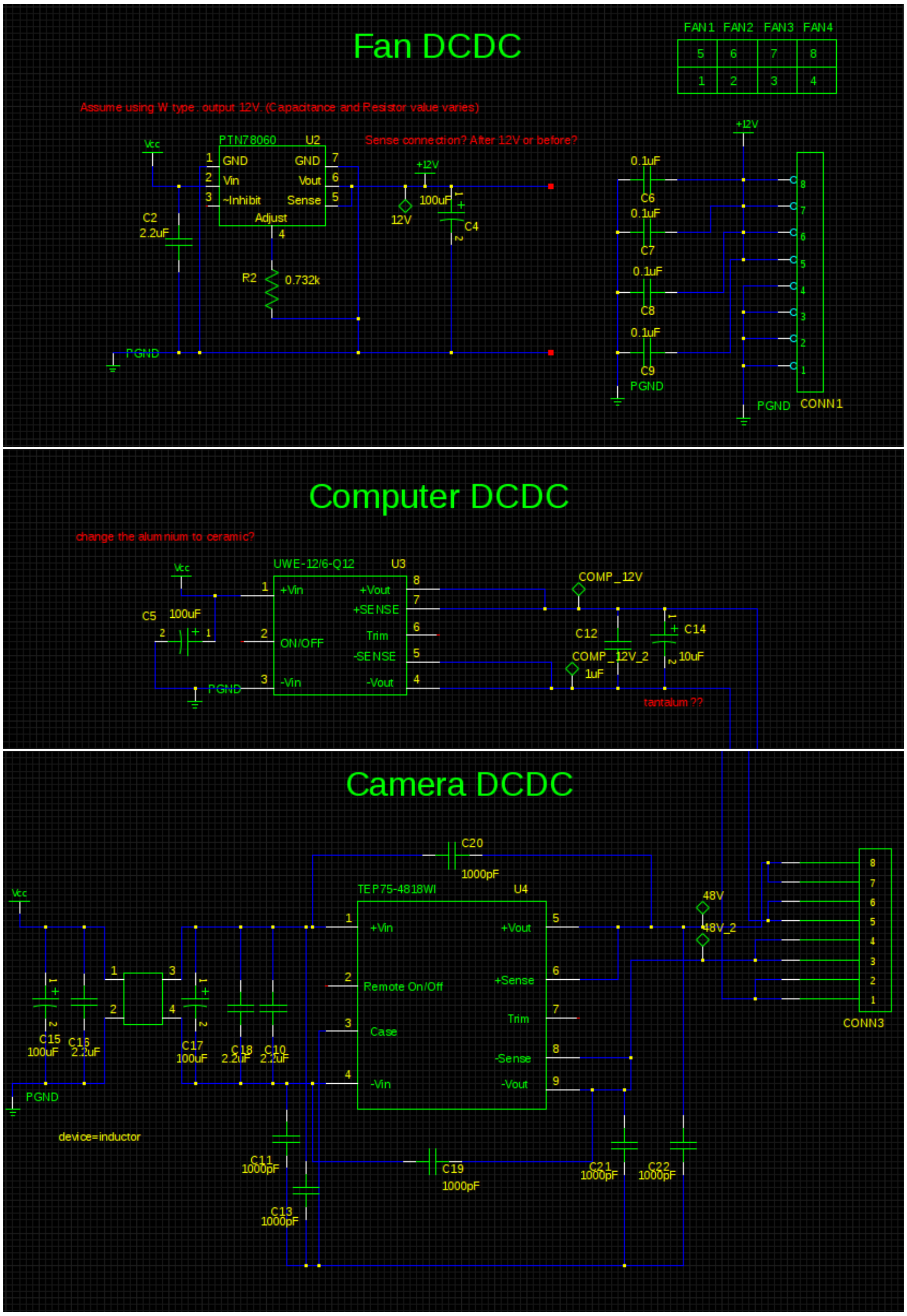
A.3 Schematics

A.3.1 Merge Circuitry



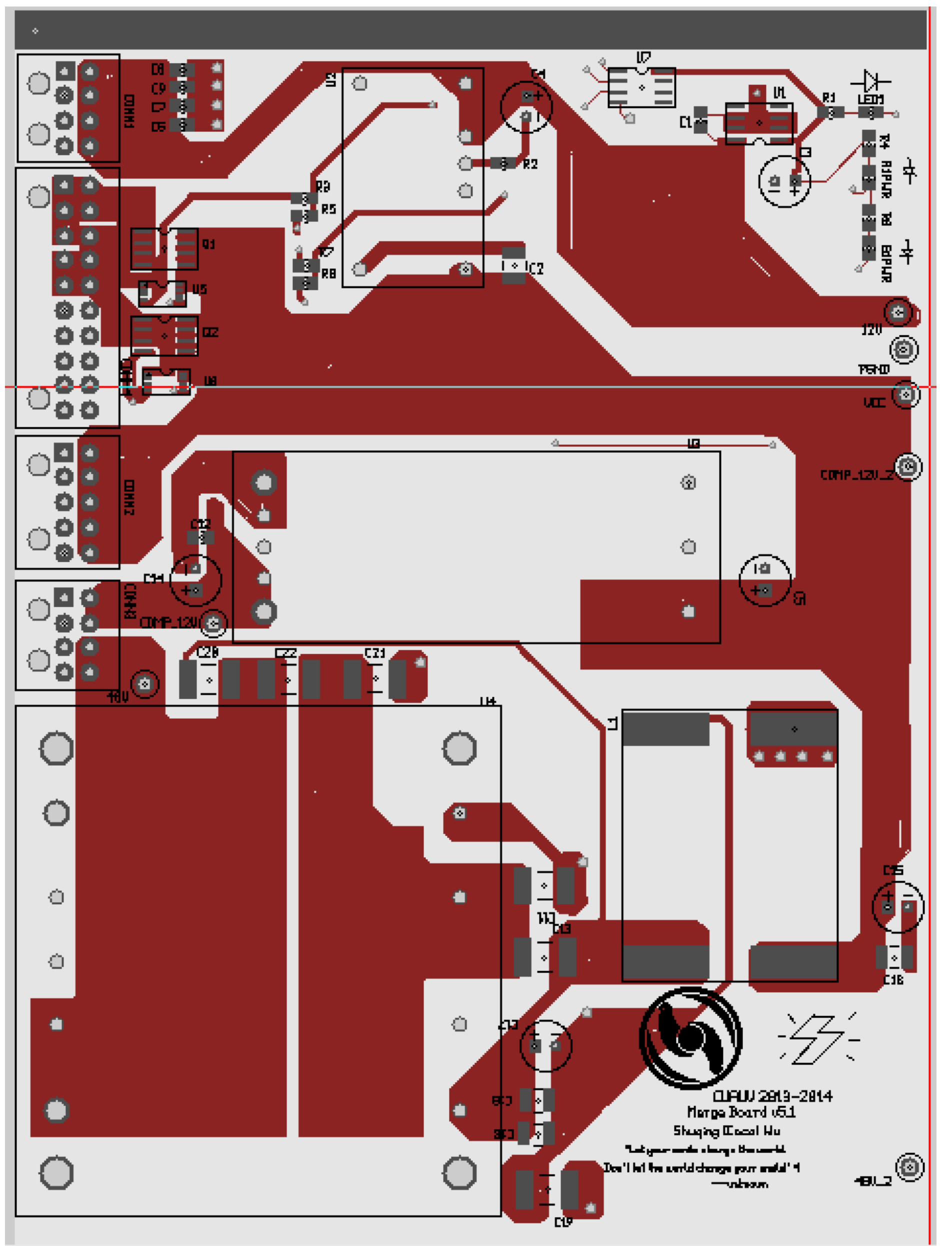
A.3.2 DCDC Circuitry




Fan DCDC
FAN1 FAN2 FAN3 FAN4
Assume using W type, output 12V. (Capacitance and Resistor value varies)
PTN78060 U2
Sense connection? After 12V or before?
GND
Vin
~Inhibit
Adjust
Vout
Sense
Vcc
C2 2.2uF
R2 0.732k
100uF
C4
12V
+12V
PGND
0.1uF C6
0.1uF C7
0.1uF C8
0.1uF C9
CONN1
Computer DCDC
change the aluminium to ceramic?
UWE-12/6-Q12 U3
+Vin
ON/OFF
-Vin
+Vout
+SENSE
Trim
-SENSE
-Vout
C5 100uF
COMP_12V
COMP_12V_2
C12 1uF
C14 10uF
tantalum ??
Camera DCDC
C20 1000pF
TEP75-4818WI U4
+Vin
Remote On/Off
Case
-Vin
+Vout
+Sense
Trim
-Sense
-Vout
48V
48V_2
C15 100uF
C16 2.2uF
C17 100uF
C18 2.2uF
C10 2.2uF
device=inductor
C11 1000pF
C13 1000pF
C19 1000pF
C21 1000pF
C22 1000pF
CONN3

A.4 Layout

A.4.1 Component Side



A.4.2 Solder Side