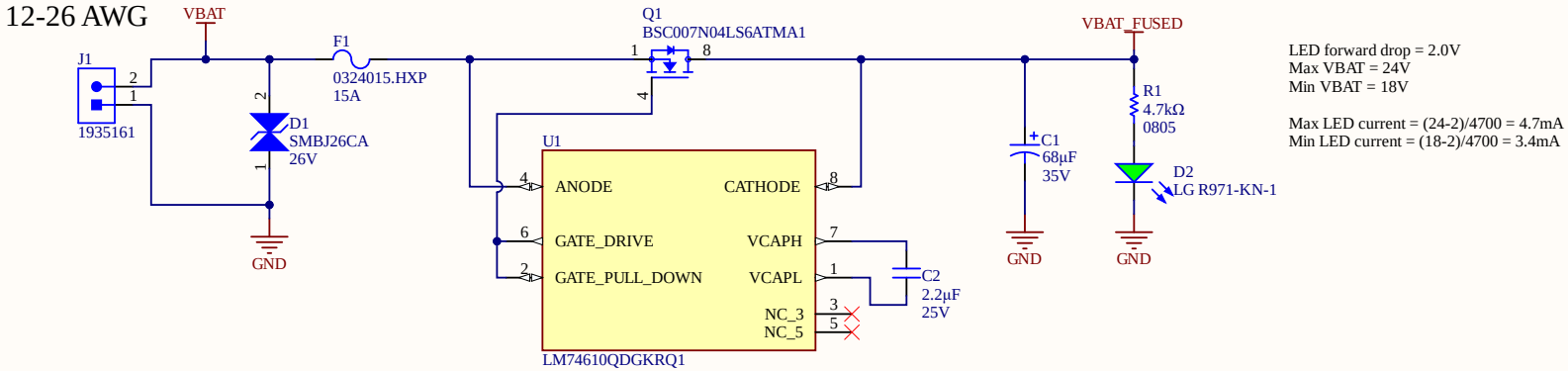
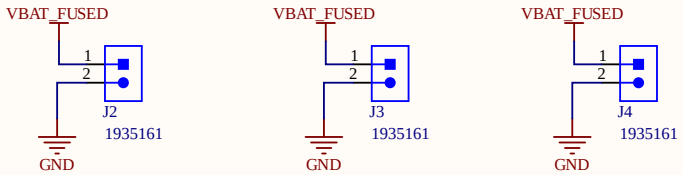
Battery Input (6s1p)

Input voltage range: 18-25.2V

Ideal Diode Controller



VBat (24V) Outputs



VBat (24V) power to LED Matrix board

VBat (24V) power to Arm, Science, Gimbal, or Localization boards (to be decided in Rev3)

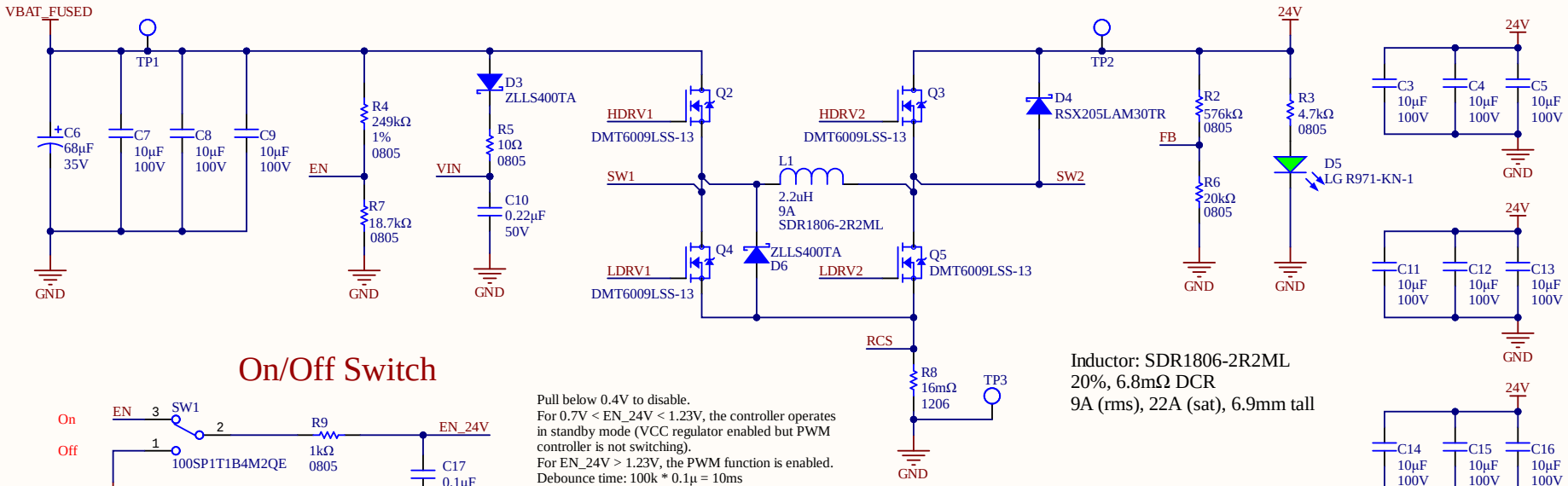
Title Power Distribution Board Rev2 - Power		UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6
Size: Letter	Drawn By: Cindy Li	
Date: 2020-11-25	Sheet 1 of 10	
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH1 - POWER.SchDoc		

24V Buck-Boost Converter @ 3A Max

Input voltage range: 18-25.2V

LED forward drop = 2.0V

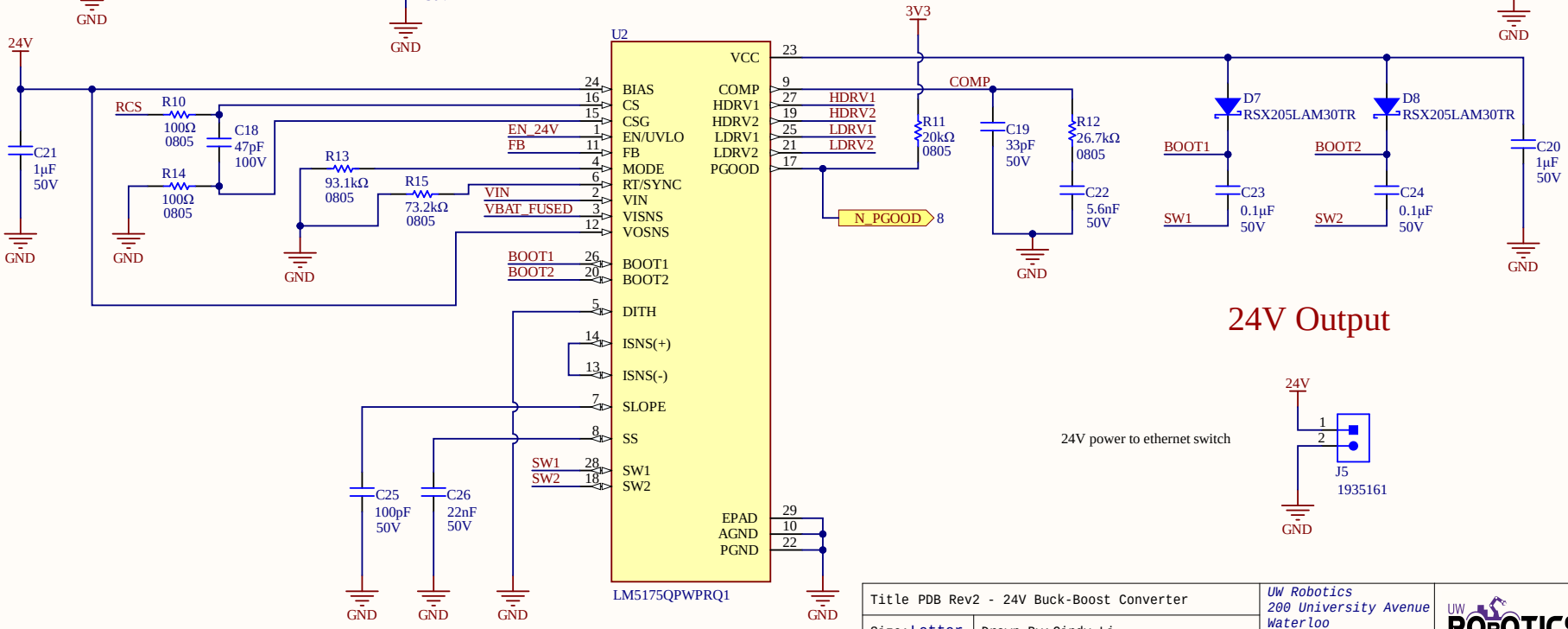
LED current = (24-2)/4700 = 4.7mA



On/Off Switch

Pull below 0.4V to disable.
For 0.7V < EN_24V < 1.23V, the controller operates in standby mode (VCC regulator enabled but PWM controller is not switching).
For EN_24V > 1.23V, the PWM function is enabled.
Debounce time: 100k * 0.1µ = 10ms

Inductor: SDR1806-2R2ML
20%, 6.8mΩ DCR
9A (rms), 22A (sat), 6.9mm tall



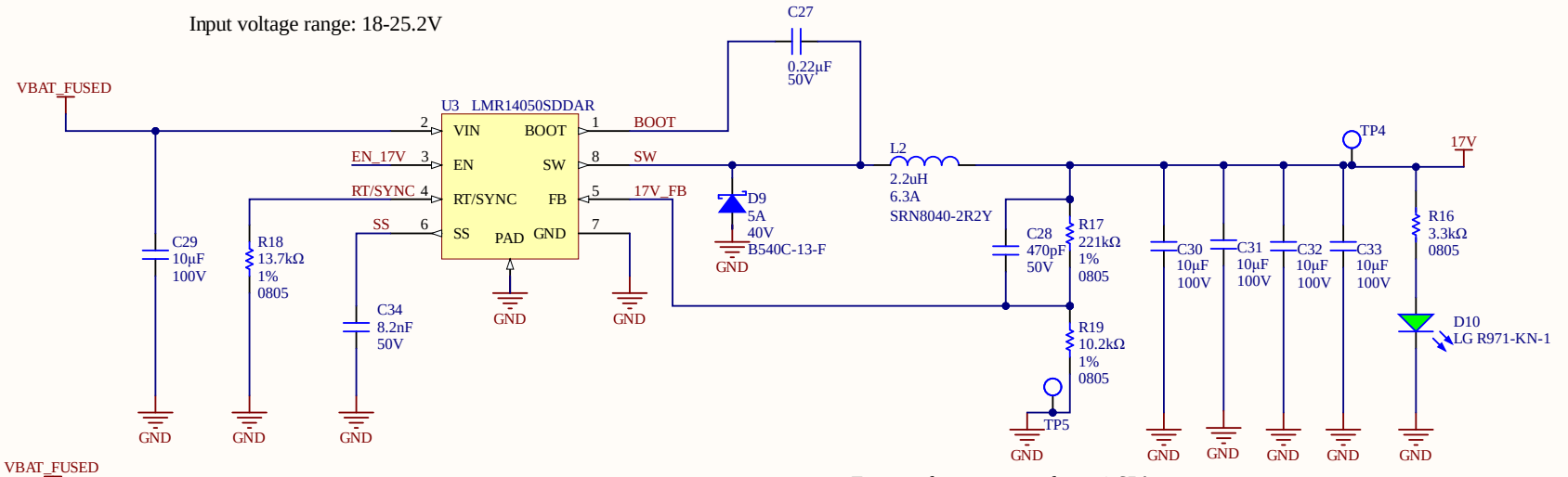
24V Output

24V power to ethernet switch

Title PDB Rev2 - 24V Buck-Boost Converter		UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6
Size: Letter	Drawn By: Cindy Li	
Date: 2020-11-25	Sheet 2 of 10	
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH2 - 24V BUCK-BOOST CONVERTER.SchD		

17V Regulator @ 4A Max

Input voltage range: 18-25.2V

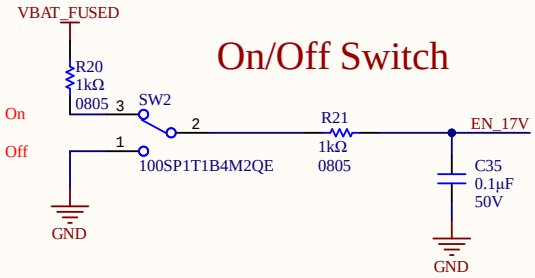


Estimated max current draw: 1.65A
Peak efficiency: 94.8%
Output voltage ripple: 19.45mVpp

LED forward drop = 2.2V

LED current = (17-2.2)/3300 = 4.5mA

On/Off Switch



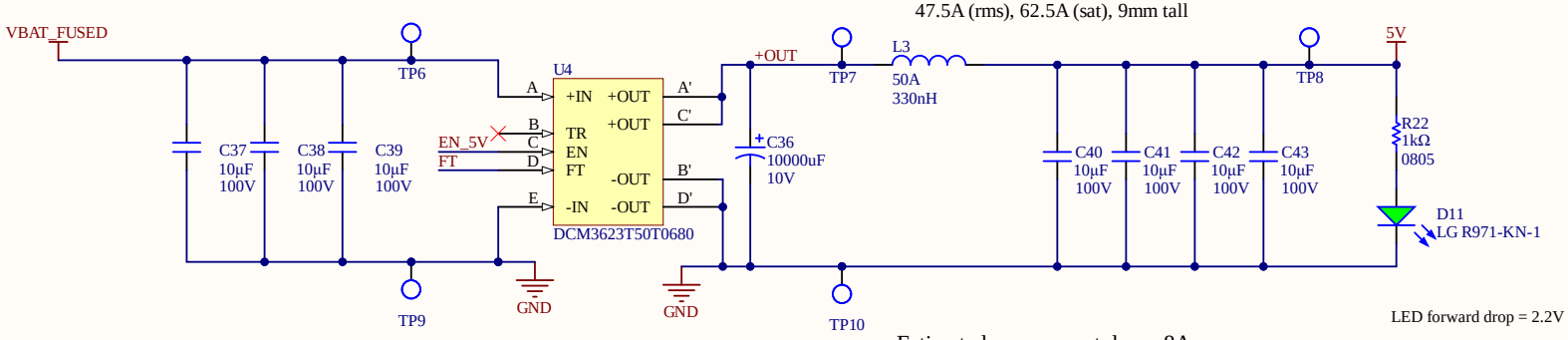
Internally pulled up
Pull below 1.2V to disable.
Float or connect to VIN to enable.
Debounce time: 100k * 0.1µ = 10ms

Title Power Distribution Board Rev2 - 17V Buck Converter			UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6
Size: Letter	Drawn By: Cindy Li		
Date: 2020-11-25	Sheet 3 of 10		
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH3 - 17V BUCK CONVERTER.SchDoc			

5V Regulator @ 16A Max

Input voltage range: 18-25.2V

Inductor: 744309033
20%, 0.165mΩ DCR
47.5A (rms), 62.5A (sat), 9mm tall

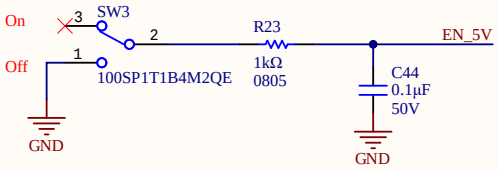


Estimated max current draw: 8A
Maximum expected output power: 40W
Peak efficiency: 88% @ 16A
Output voltage ripple: 277mVpp

LED forward drop = 2.2V

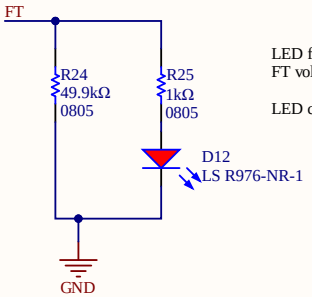
LED current = (5-2.2)/1000 = 2.8mA

On/Off Switch



Internally pulled up to VCC
Debounce time: 100k * 0.1µ = 10ms

Fault Indicator

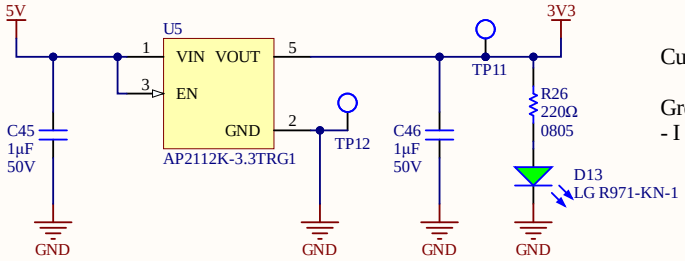


LED forward drop = 2.0V
FT voltage = 3.3V (from internally generated VCC)

LED current = (3.3-2)/1000 = 1.3mA

Title Power Distribution Board Rev2 - 5V Vicor DCDC		UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6	UW ROBOTICS TEAM
Size: Letter	Drawn By: Cindy Li		
Date: 2020-11-25	Sheet 4 of 10		
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH4 - 5V VICOR DCDC.SchDoc			

3.3V LDO @ 600mA Max



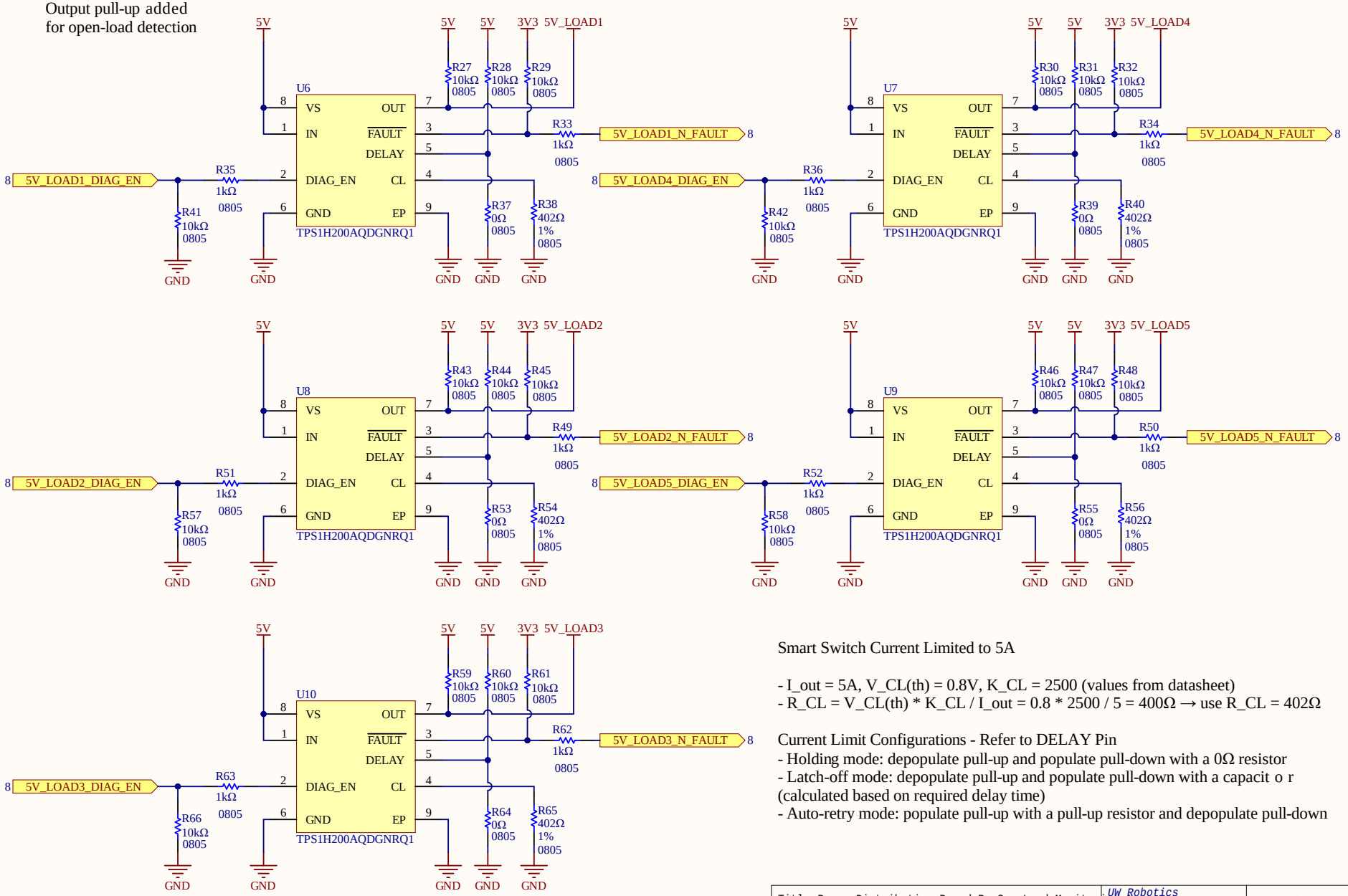
Current Calculations

Green LED voltage drop: 2.2V
- I = (3.3-2.2V)/220 = 5mA

Title: Power Distribution Board Rev2 - 3.3V Linear Regulator			UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6
Size: Letter	Drawn By: Cindy Li		
Date: 2020-11-25	Sheet 5 of 10		
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH5 - 3.3V LINEAR REGULATOR.SchDoc			

5V Loads Smart Switches

Output pull-up added
for open-load detection



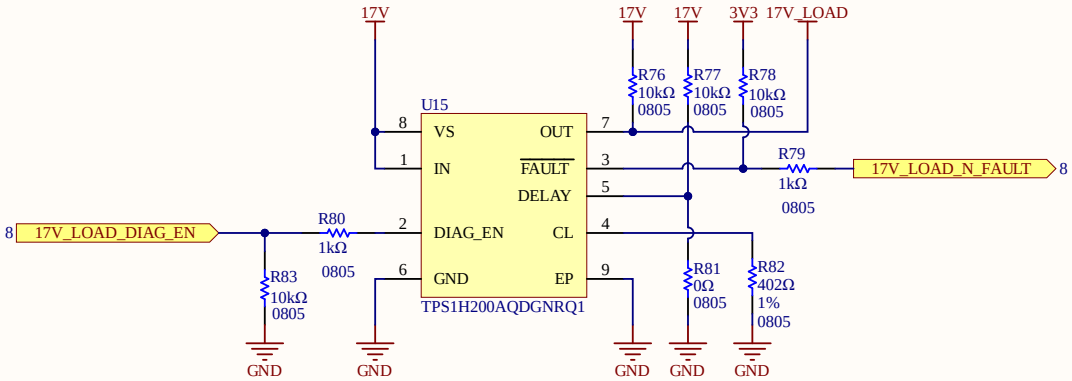
Smart Switch Current Limited to 5A

- I_out = 5A, V_CL(th) = 0.8V, K_CL = 2500 (values from datasheet)
- R_CL = V_CL(th) * K_CL / I_out = 0.8 * 2500 / 5 = 400Ω → use R_CL = 402Ω

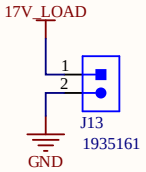
Current Limit Configurations - Refer to DELAY Pin
- Holding mode: depopulate pull-up and populate pull-down with a 0Ω resistor
- Latch-off mode: depopulate pull-up and populate pull-down with a capacit o r (calculated based on required delay time)
- Auto-retry mode: populate pull-up with a pull-up resistor and depopulate pull-down

Title Power Distribution Board Rev2 - Load Monitoring 1		UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6
Size: Letter	Drawn By: Cindy Li	
Date: 2020-11-25	Sheet 6 of 10	
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH6 - LOAD MONITORING 1.SchDoc		

17V Load Smart Switch

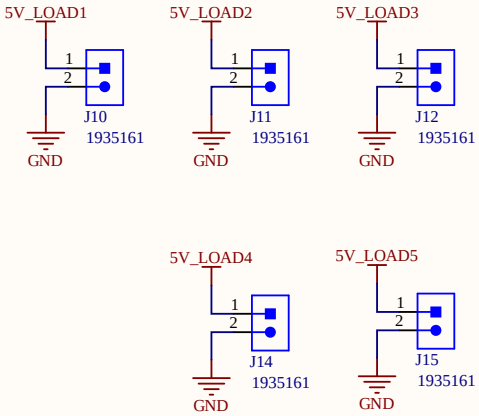


17V Output



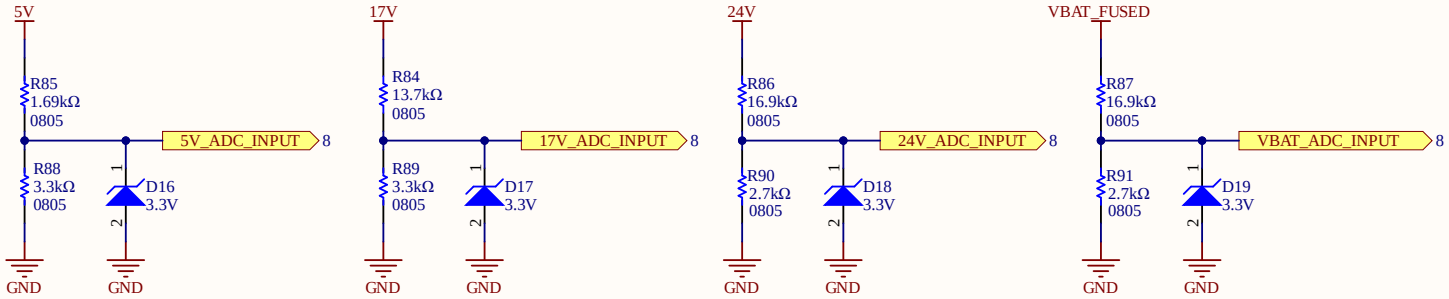
17V power to Nvidia Jetson board

5V Outputs



5V power to Arm, Science, Gimbal, and Localiztion boards (plus one spare)

Power Rail Voltage Monitoring



Divides 5V to 3.3V

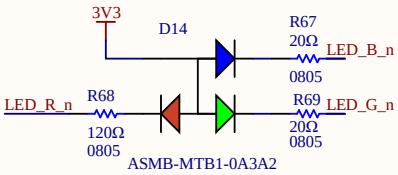
Divides 17V to 3.3V

Divides 24V to 3.3V

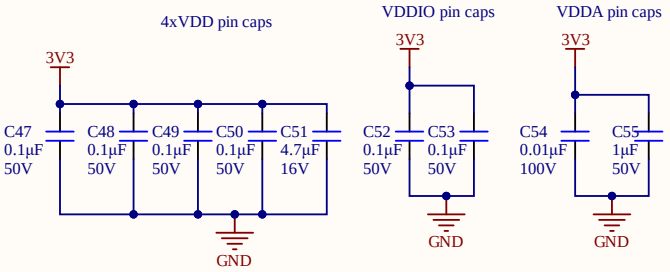
Divides 24V to 3.3V

Title Power Distribution Board Rev2 - Load Monitoring 2		UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6
Size: Letter	Drawn By: Cindy Li	
Date: 2020-11-25	Sheet 7 of 10	
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH7 - LOAD MONITORING 2.SchDoc		

Status LED



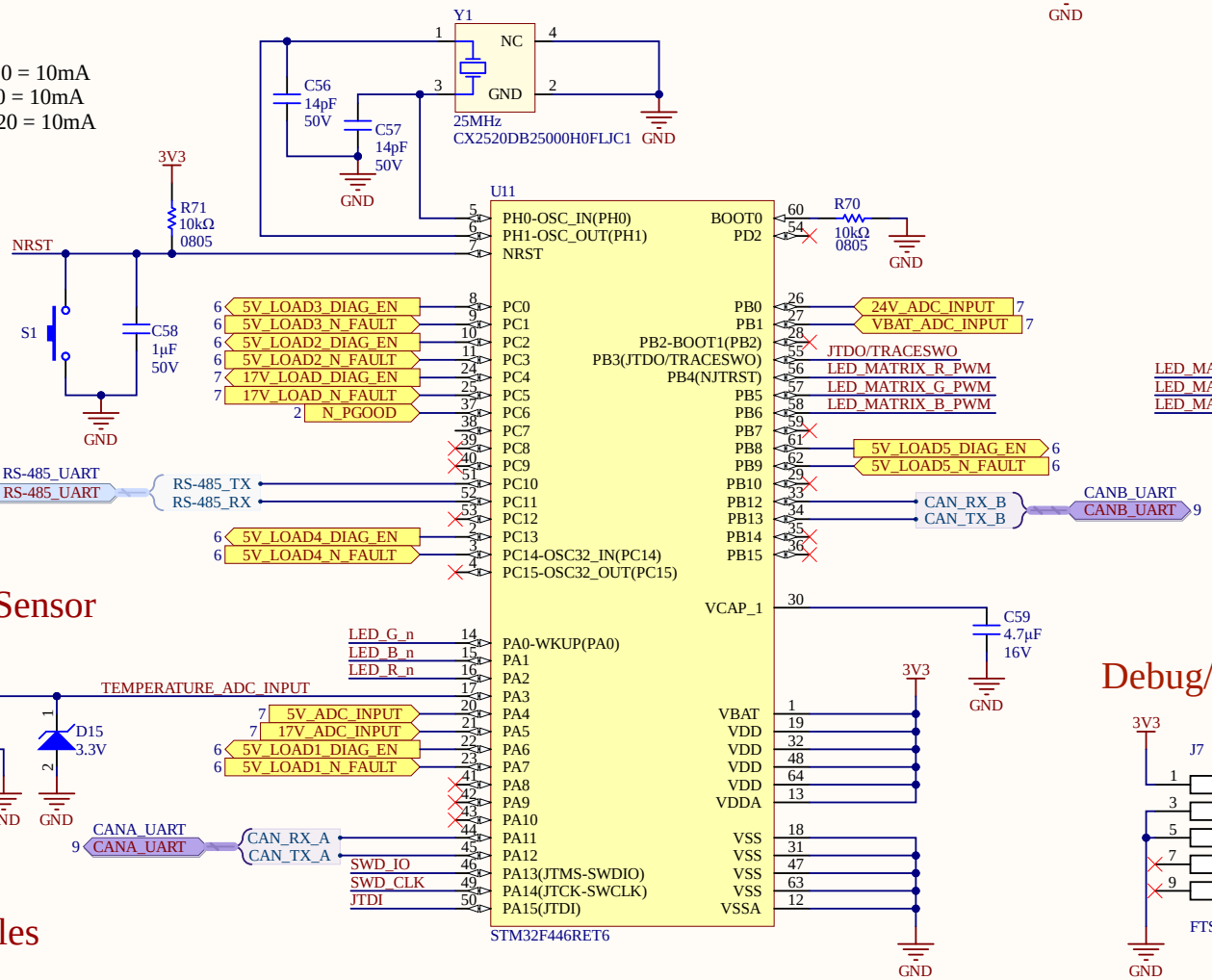
Decoupling Caps



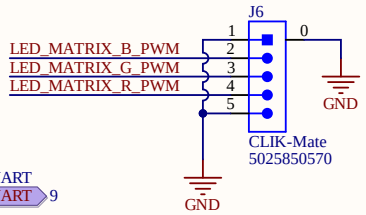
Current Calculations

RGB LED voltage drops:
- Red: 2.1V: I = (3.3-2.1V)/120 = 10mA
- Blue: 3.1V: I = (3.3-3.1V)/20 = 10mA
- Green: 3.1V: I = (3.3-3.1V)/20 = 10mA

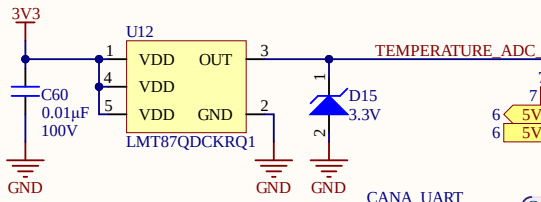
STM32F446RET6



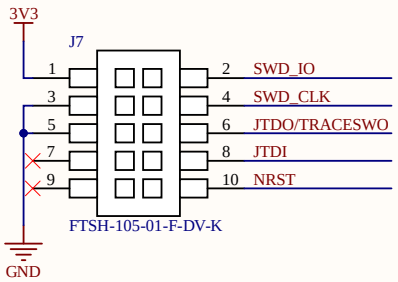
LED Matrix



Temperature Sensor



Debug/Programming

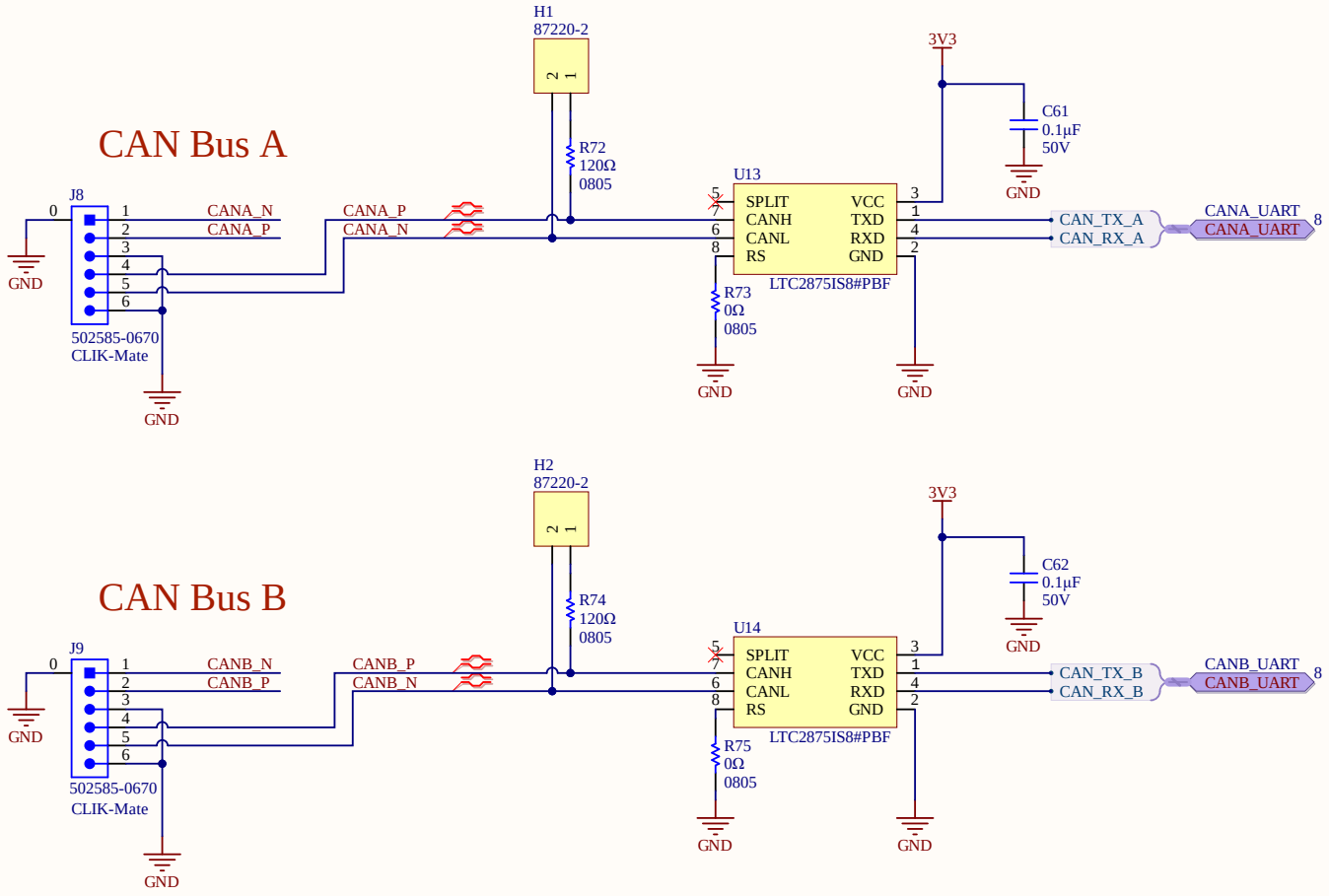


Mounting Holes

MH1 MOUNTING_HOLE_5/32
MH2 MOUNTING_HOLE_5/32
MH3 MOUNTING_HOLE_5/32
MH4 MOUNTING_HOLE_5/32

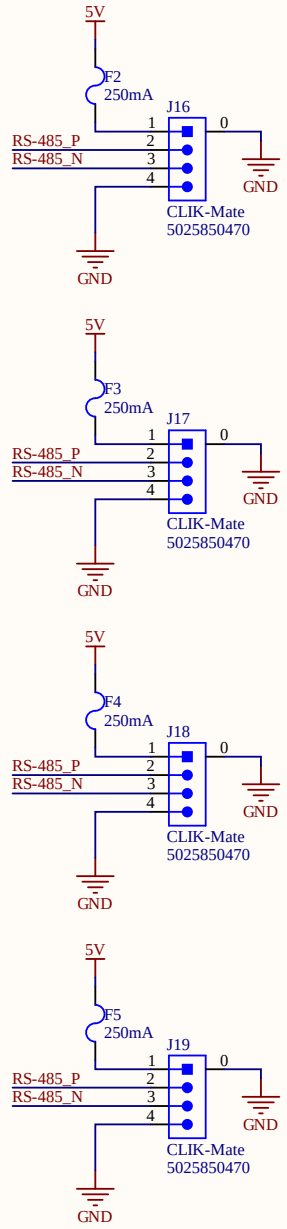
Title Power Distribution Board Rev2 - MCU		UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6
Size: Letter	Drawn By: Cindy Li	
Date: 2020-11-25	Sheet 8 of 10	
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH8 - MICROCONTROLLER.SchDoc		

CAN Transceivers

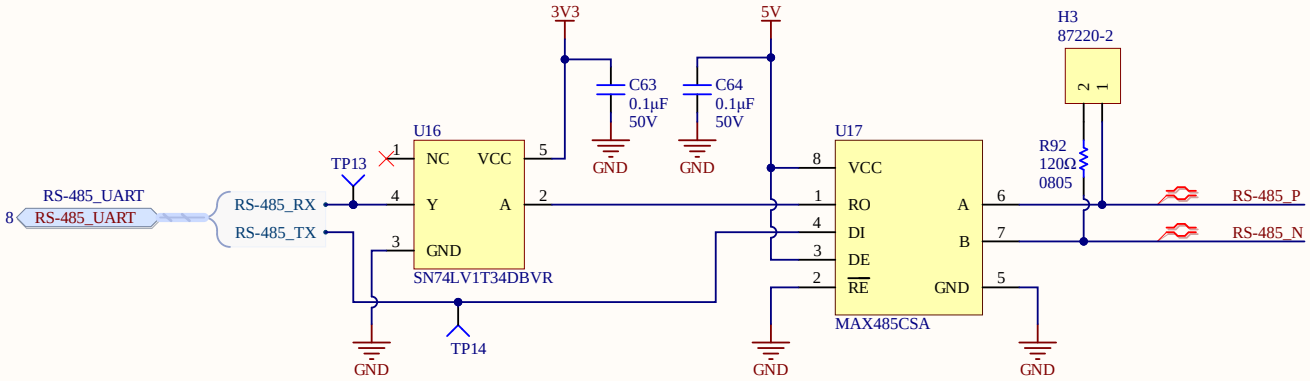


Title Power Distribution Board Rev2 - CAN		UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6	UW ROBOTICS TEAM
Size: Letter	Drawn By: Cindy Li		
Date: 2020-11-25	Sheet 9 of 10		
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH9 - CAN.SchDoc			

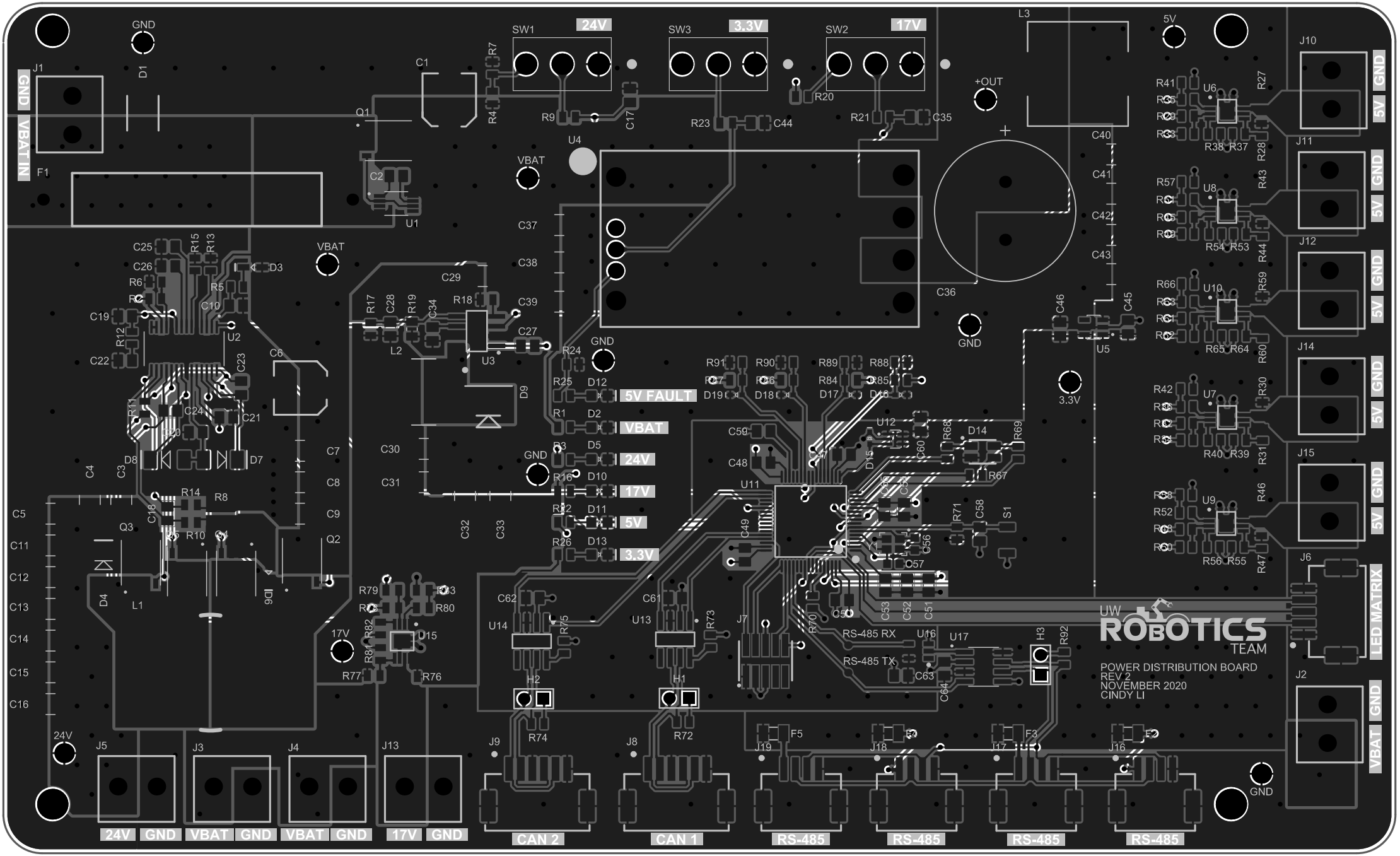
URM04 Ultrasonic Sensors



RS-485 Transceiver



Title Power Distribution Board Rev2 - RS-485		UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6	UW ROBOTICS TEAM
Size: Letter	Drawn By: Cindy Li		
Date: 2020-11-25	Sheet 10 of 10		
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH10 - RS-485.SchDoc			


GND
VBAT IN
SW1
24V
SW3
3.3V
SW2
17V
+OUT
5V
VBAT
5V FAULT
24V
17V
5V
3.3V
GND
RS-485 RX
RS-485 TX
UW
ROBOTICS
TEAM
POWER DISTRIBUTION BOARD
REV 2
NOVEMBER 2020
CINDY LI
LED MATRIX
24V
GND
VBAT
GND
VBAT
GND
17V
GND
CAN 2
CAN 1
RS-485
RS-485
RS-485
RS-485