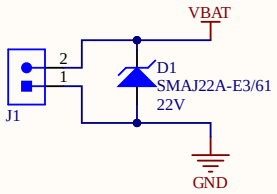
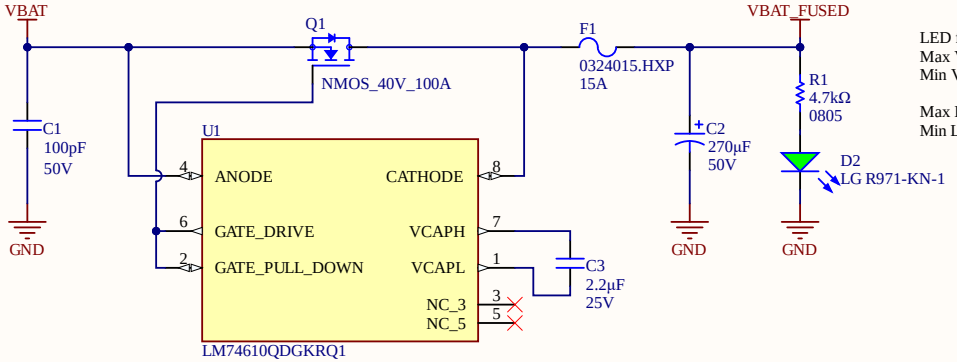
24V Input



Rated Current = 16A

TODO:
- What is the actual rated current?

Reverse Polarity Protection



LED forward drop = 2.0V
Max VBAT = 24V
Min VBAT = 18V

Max LED current = (24-2)/4700 = 4.7mA
Min LED current = (18-2)/4700 = 3.4mA

Title Power Distribution Board Rev2 - Power		Altium Limited L3, 12a Rodborough Rd Frenchs Forest NSW Australia 2086
Size: Letter	Drawn By: Cindy Li	
Date: 2020-10-30	Sheet 1 of 11	
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH1 - POWER.SchDoc		

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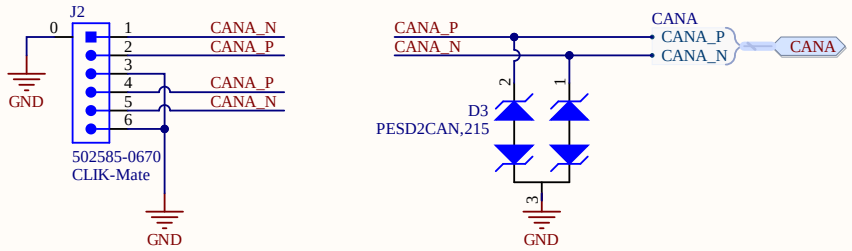
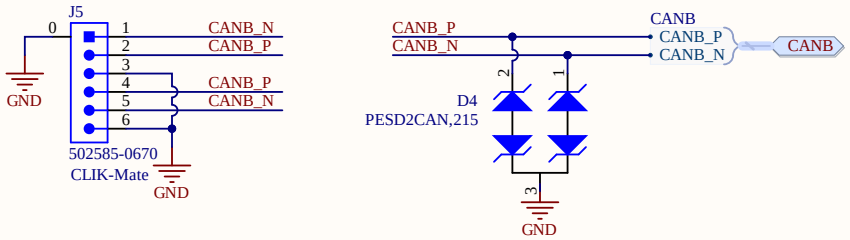
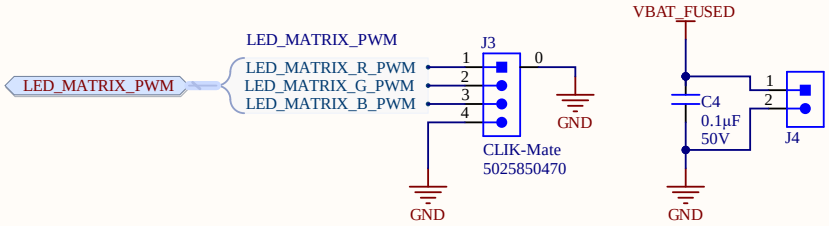
CAN BUS A



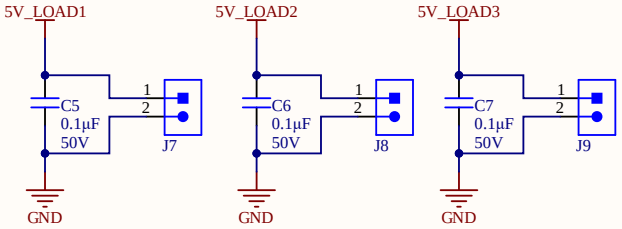
CAN BUS B



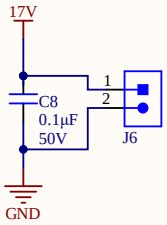
LED Matrix



5V Output



17V Output



TODO:
- add connectors for ultrasonic sensor signals
- check if using correct connectors

MH1
MOUNTING_HOLE_6CM

MH2
MOUNTING_HOLE_6CM

MH3
MOUNTING_HOLE_6CM

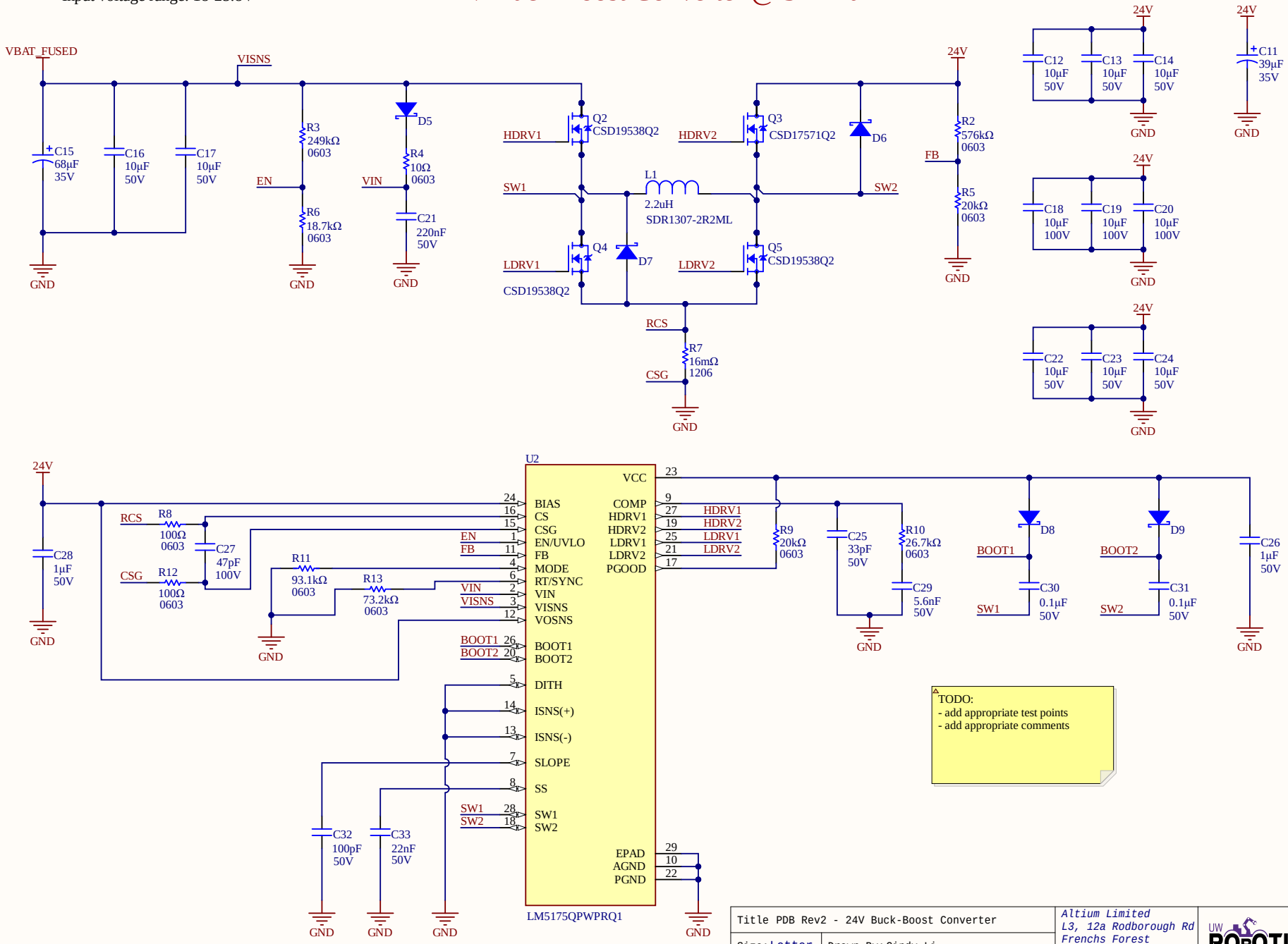
MH4
MOUNTING_HOLE_6CM

Can use 12-26AWG

Title Power Distribution Board Rev2 - Connectors		Altium Limited L3, 12a Rodborough Rd Frenchs Forest NSW Australia 2086
Size: Letter	Drawn By: Cindy Li	
Date: 2020-10-30	Sheet 2 of 11	
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH2 - CONNECTORS.SchDoc		

Input voltage range: 18-25.8V

24V Buck-Boost Converter @ 3A Max

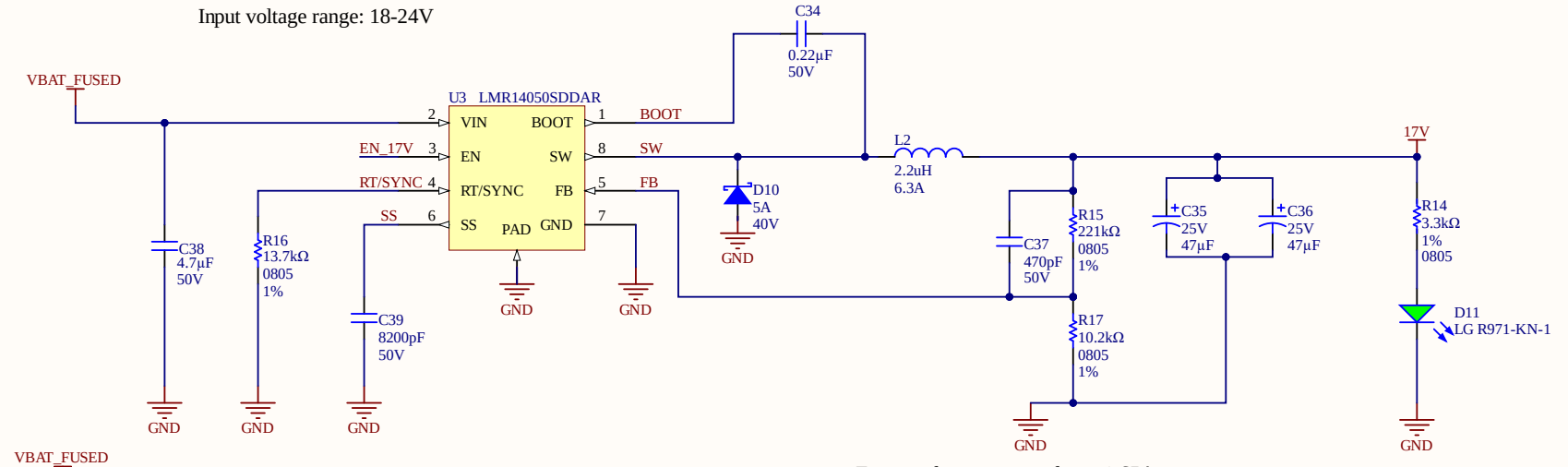


TODO:
- add appropriate test points
- add appropriate comments

Title PDB Rev2 - 24V Buck-Boost Converter		Altium Limited L3, 12a Rodborough Rd Frenchs Forest NSW Australia 2086
Size: Letter	Drawn By: Cindy Li	UW ROBOTICS TEAM
Date: 2020-10-30	Sheet 3 of 11	
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH3 - 24V BUCK-BOOST CONVERTER.SchD		

17V Regulator @ 4A Max

Input voltage range: 18-24V

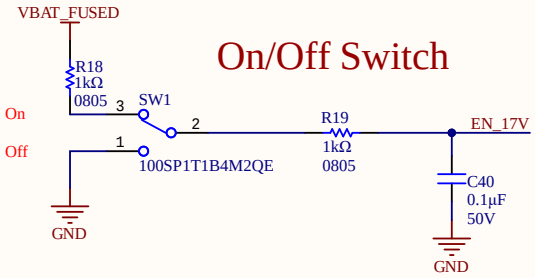


Estimated max current draw: 1.65A
Peak efficiency: 94.8%
Output voltage ripple: 19.45mVpp

LED forward drop = 2.2V

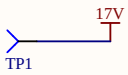
LED current = (17-2.2)/3300 = 4.5mA

On/Off Switch



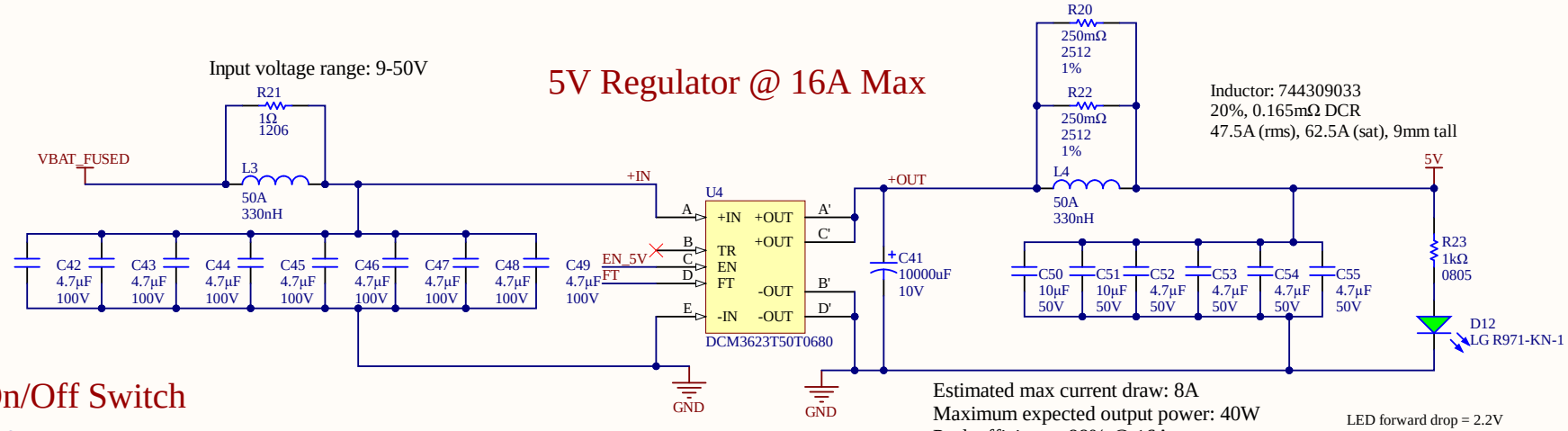
Internally pulled up
Pull below 1.2V to disable.
Float or connect to VIN to enable.
Debounce time: 100k * 0.1µ = 10ms

Test Point



Title Power Distribution Board Rev2 - 17V Buck Converter			Altium Limited 13, 12a Rodborough Rd Frenchs Forest NSW Australia 2086
Size: Letter	Drawn By: Cindy Li		
Date: 2020-10-30	Sheet 4 of 11		
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH4 - 17V BUCK CONVERTER.SchDoc			

5V Regulator @ 16A Max

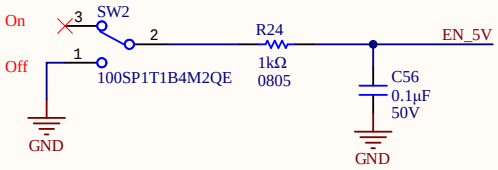


Estimated max current draw: 8A
Maximum expected output power: 40W
Peak efficiency: 88% @ 16A
Output voltage ripple: 277mVpp

LED forward drop = 2.2V

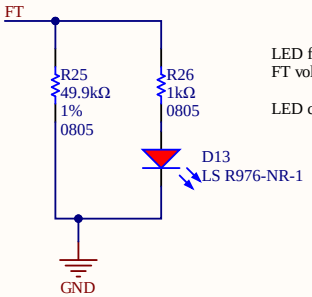
LED current = (5-2.2)/1000 = 2.8mA

On/Off Switch



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

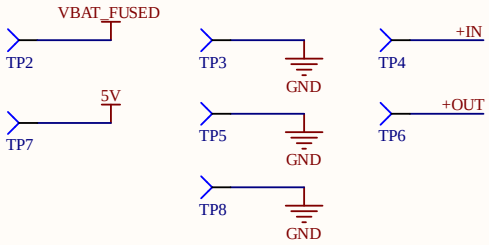
Fault Indicator



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

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

Test Points



Title Power Distribution Board Rev2 - 5V Vicor DCDC			Altium Limited L3, 12a Rodborough Rd Frenchs Forest NSW Australia 2086
Size: Letter	Drawn By: Cindy Li		
Date: 2020-10-30	Sheet 5 of 11		
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH5 - 5V VICOR DCDC.SchDoc			

3.3V Buck Converter

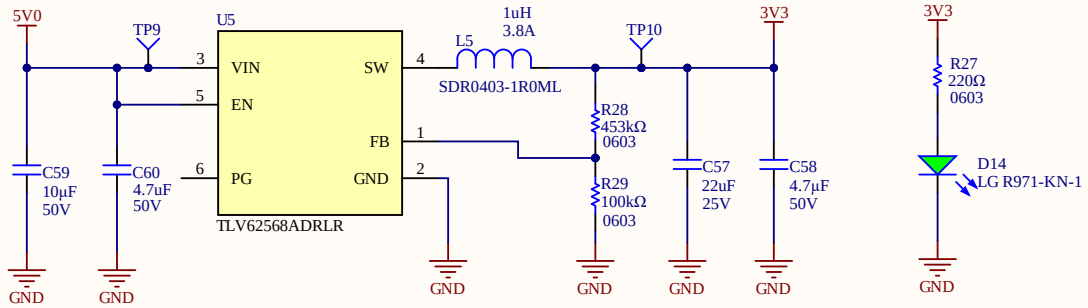
Designed for 3.3V - 5V input

Route for 1A in

Inductor: SDR0403-1R0ML
1uH, 20%, 33mOhm DCR (max)
3.8A (rms), 5.5A (sat), 3.2mm tall

Route for 3A out

Maximum output current = 2A
Maximum output power = 6.6W
Expected efficiency at 1A = 94.3%



Current Calculations

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

Title: Power Distribution Board Rev2 - 3.3V Buck Converter			
Size: Letter	Drawn By: Cindy Li		
Date: 2020-10-30	Sheet 6 of 11		
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH6 - 3.3V BUCK CONVERTER.SchDoc			

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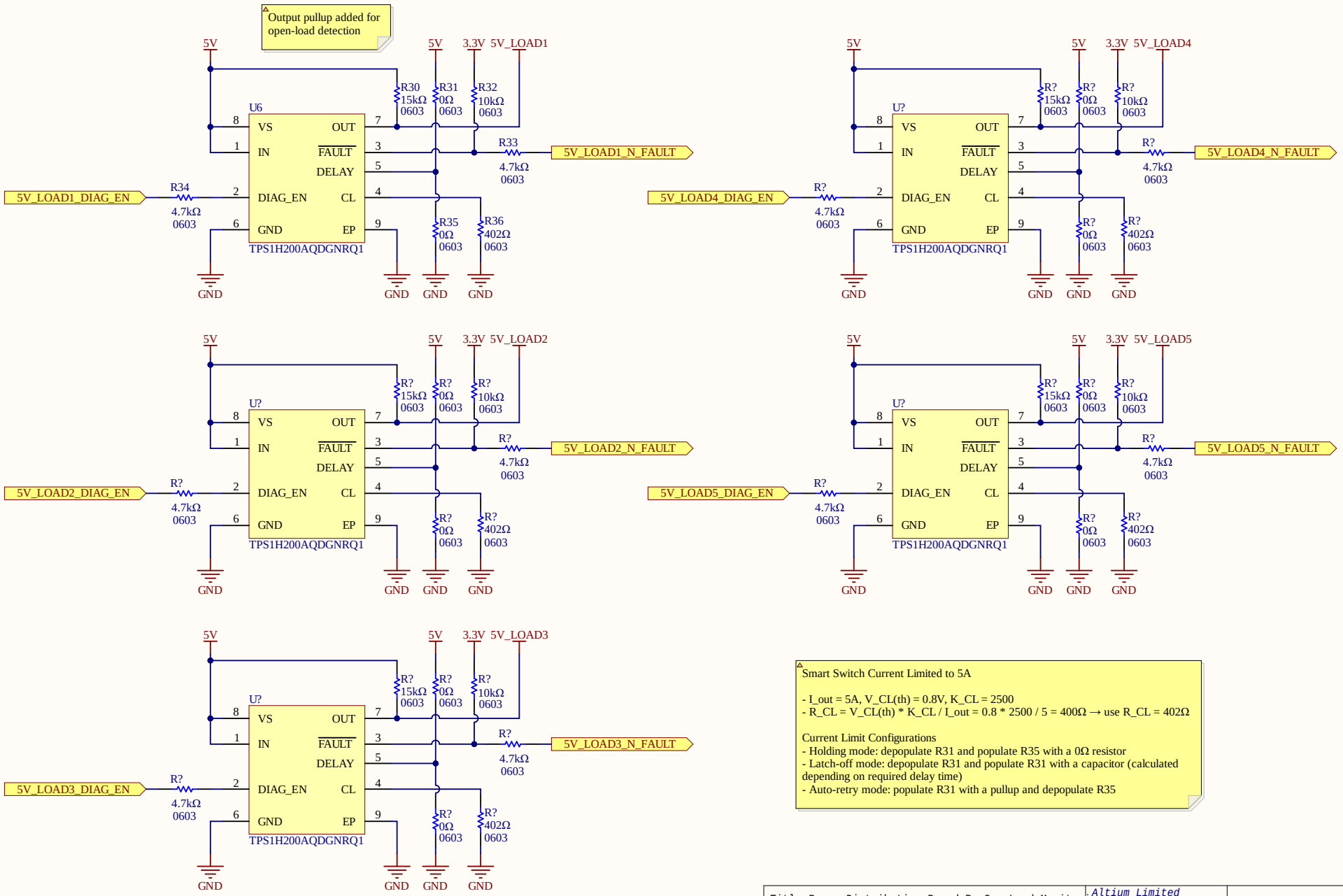
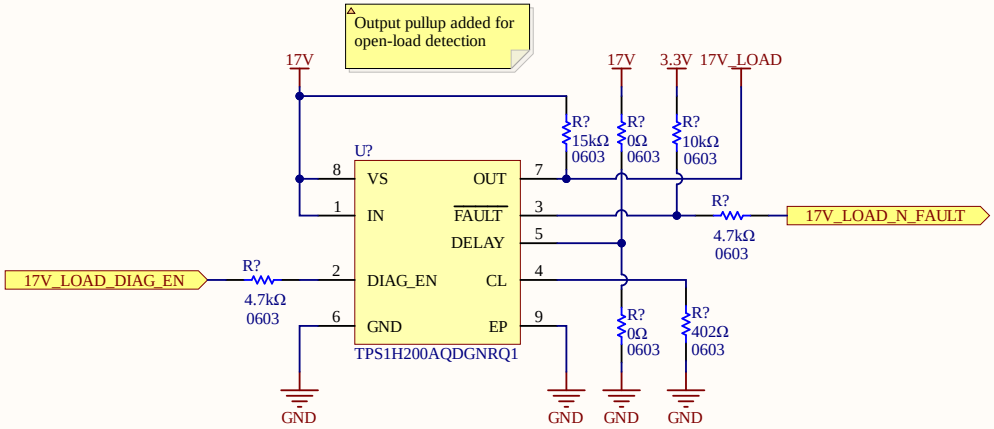
5V Loads Smart Switches



Title Power Distribution Board Rev2 - Load Monitoring 1		Altium Limited L3, 12a Rodborough Rd Frenchs Forest NSW Australia 2086
Size: Letter	Drawn By: Cindy Li	UW ROBOTICS TEAM
Date: 2020-10-30	Sheet 7 of 11	
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH7 - LOAD MONITORING 1.SchDoc		

Jetson Smart Switch

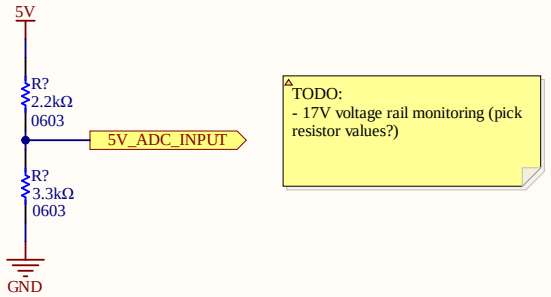


Smart Switch Current Limited to 5A

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

Current Limit Configurations
- Holding mode: depopulate R31 and populate R35 with a 0Ω resistor
- Latch-off mode: depopulate R31 and populate R31 with a capacitor (calculated depending on required delay time)
- Auto-retry mode: populate R31 with a pullup and depopulate R35

Power Rail Voltage Monitoring



Title: Power Distribution Board Rev2 - Load Monitoring 2			
Size: Letter	Drawn By: Cindy Li		
Date: 2020-10-30	Sheet 8 of 11		
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH8 - LOAD MONITORING 2.SchDoc			

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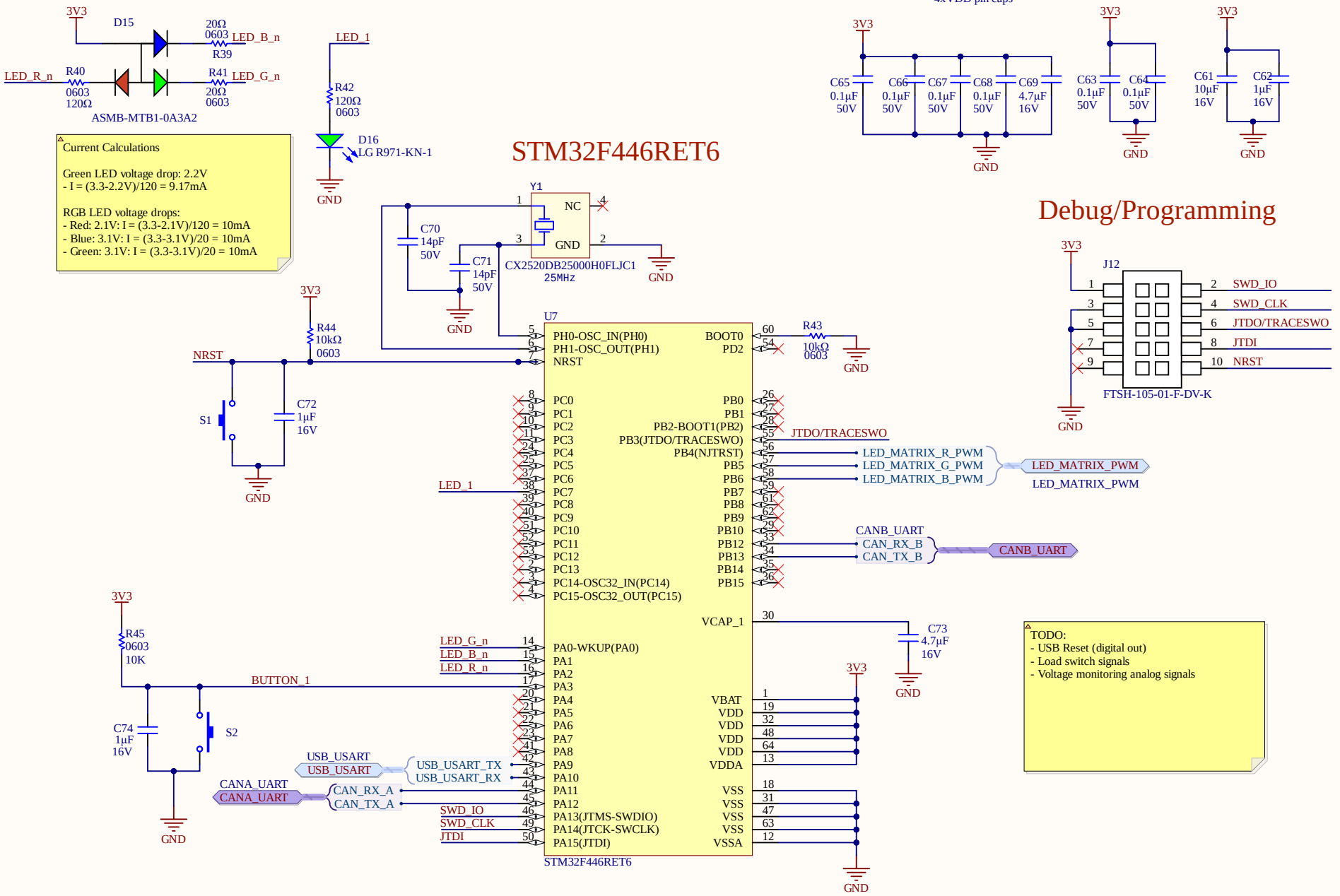
Status/Debug LEDs
3V3
D15
20Ω
0603
LED_B_n
R39
LED_R_n
R40
0603
120Ω
R41
20Ω
0603
LED_G_n
ASMB-MTB1-0A3A2
LED_1
R42
120Ω
0603
D16
LG R971-KN-1
GND
Current Calculations
Green LED voltage drop: 2.2V
- I = (3.3-2.2V)/120 = 9.17mA
RGB LED voltage drops:
- Red: 2.1V: I = (3.3-2.1V)/120 = 10mA
- Blue: 3.1V: I = (3.3-3.1V)/20 = 10mA
- Green: 3.1V: I = (3.3-3.1V)/20 = 10mA
STM32F446RET6
Decoupling Caps
4xVDD pin caps
VDDIO pin caps
VDDA pin caps
C65 0.1µF 50V
C66 0.1µF 50V
C67 0.1µF 50V
C68 0.1µF 50V
C69 4.7µF 16V
C63 0.1µF 50V
C64 0.1µF 50V
C61 10µF 16V
C62 1µF 16V
Y1
NC
GND
C70 14pF 50V
C71 14pF 50V
CX2520DB25000H0FLJC1
25MHz
Debug/Programming
J12
SWD_IO
SWD_CLK
JTDO/TRACESWO
JTDI
NRST
FTSH-105-01-F-DV-K
U7
PH0-OSC_IN(PH0)
PH1-OSC_OUT(PH1)
NRST
BOOT0
PD2
R43
10kΩ
0603
R44
10kΩ
0603
S1
C72
1µF
16V
PC0
PC1
PC2
PC3
PC4
PC5
PC6
PC7
PC8
PC9
PC10
PC11
PC12
PC13
PC14-OSC32_IN(PC14)
PC15-OSC32_OUT(PC15)
PB0
PB1
PB2-BOOT1(PB2)
PB3(JTDO/TRACESWO)
PB4(NJTRST)
PB5
PB6
PB7
PB8
PB9
PB10
PB12
PB13
PB14
PB15
LED_MATRIX_R_PWM
LED_MATRIX_G_PWM
LED_MATRIX_B_PWM
LED_MATRIX_PWM
CANB_UART
CAN_RX_B
CAN_TX_B
VCAP_1
C73
4.7µF
16V
R45
0603
10K
BUTTON_1
S2
C74
1µF
16V
PA0-WKUP(PA0)
PA1
PA2
PA3
PA4
PA5
PA6
PA7
PA8
PA9
PA10
PA11
PA12
PA13(JTMS-SWDIO)
PA14(JTCK-SWCLK)
PA15(JTDI)
VBAT
VDD
VDD
VDD
VDD
VDDA
VSS
VSS
VSS
VSS
VSSA
USB_USART
USB_USART_TX
USB_USART_RX
CANA_UART
CAN_RX_A
CAN_TX_A
TODO:
- USB Reset (digital out)
- Load switch signals
- Voltage monitoring analog signals
Title Power Distribution Board Rev2 - MCU
Size: Letter
Drawn By: Cindy Li
Date: 2020-10-30
Sheet 9 of 11
Altium Limited
L3, 12a Rodborough Rd
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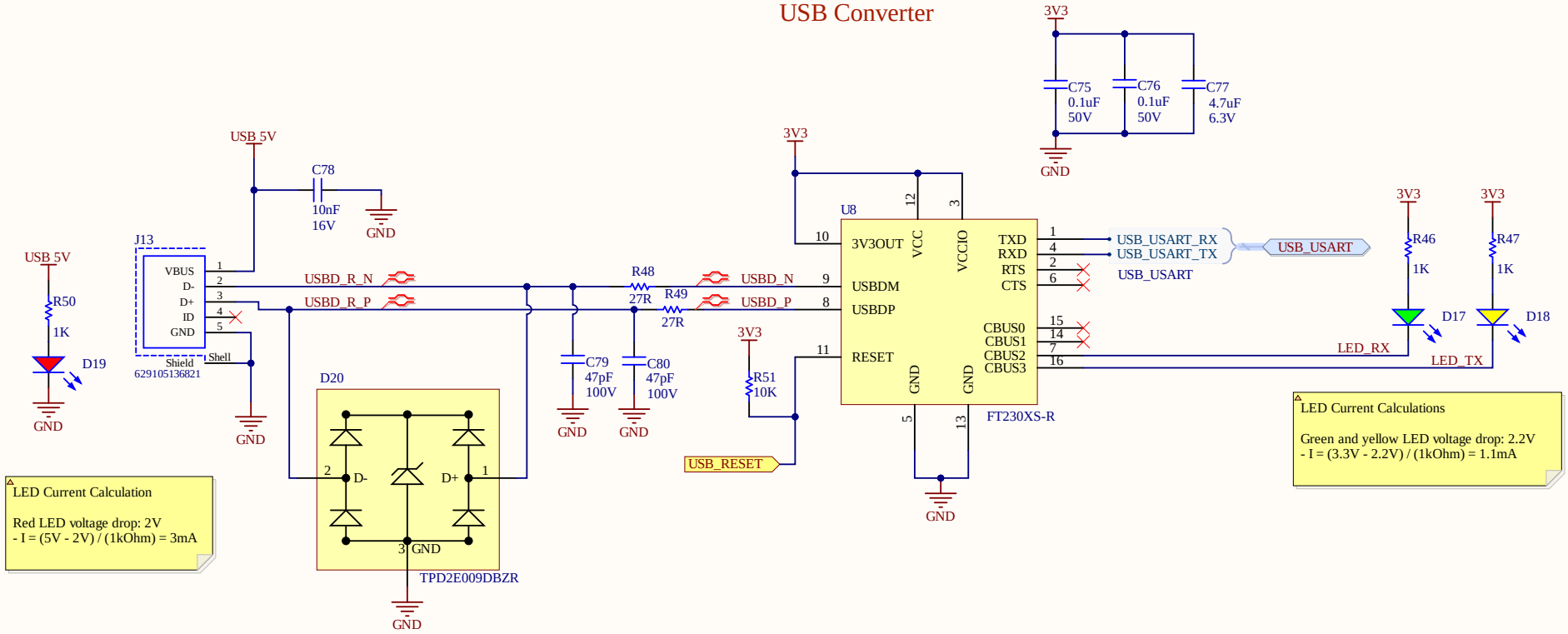
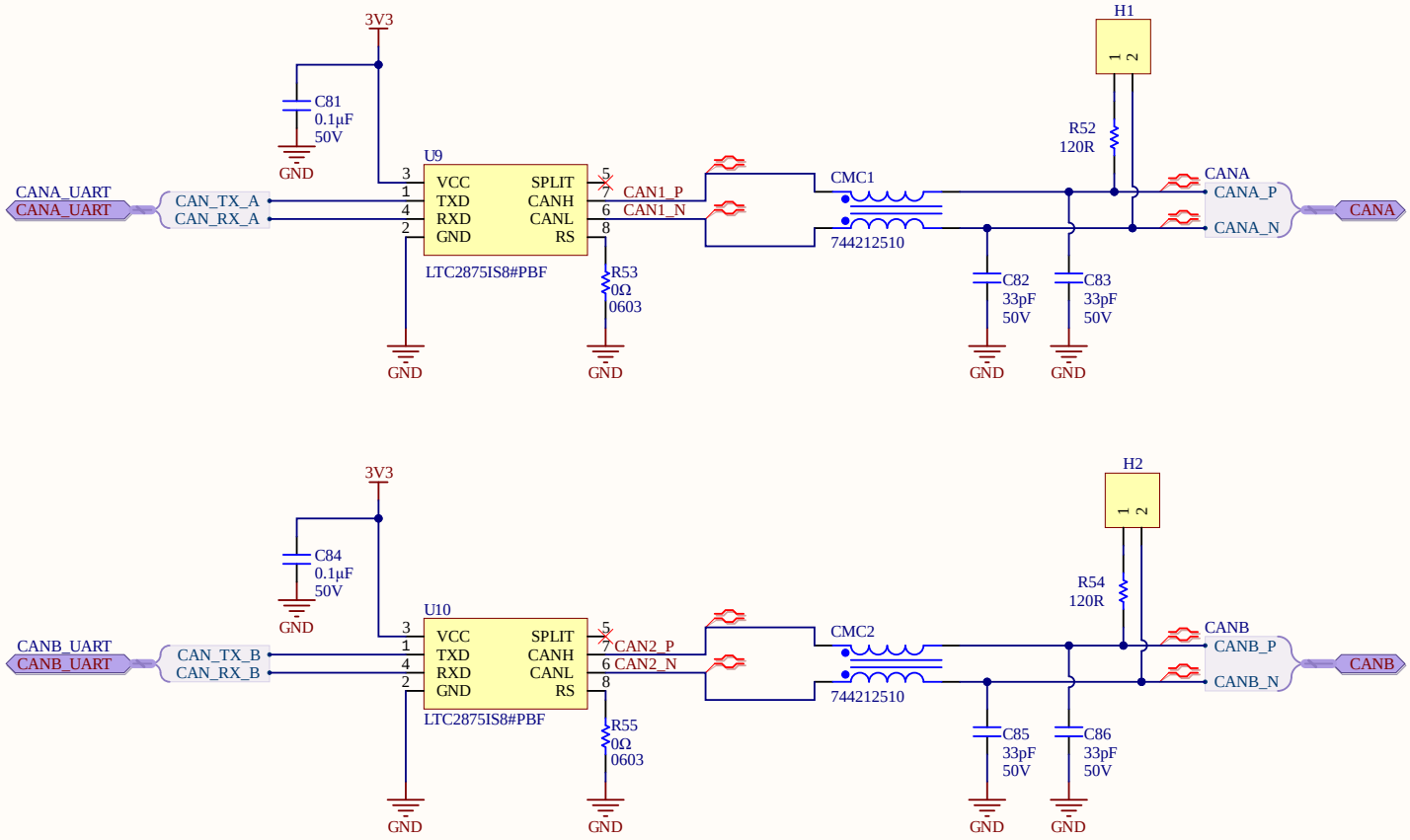
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH9 - MICROCONTROLLER.SchDoc



Title Power Distribution Board Rev2 - USB		Altium Limited L3, 12a Rodborough Rd Frenchs Forest NSW Australia 2086	UW ROBOTICS TEAM
Size: Letter	Drawn By: Cindy Li		
Date: 2020-10-30	Sheet 10 of 11		
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH10 - USB.SchDoc			

CAN Transceivers



Title Power Distribution Board Rev2 - CAN Transceivers			Altium Limited 13, 12a Rodborough Rd Frenchs Forest NSW Australia 2086
Size: Letter	Drawn By: Cindy Li		
Date: 2020-10-30	Sheet 11 of 11		
File: C:\UWRT\MarsRover2021-hardware\Projects\Power Distribution Board\Rev2\SH11 - CAN.SchDoc			