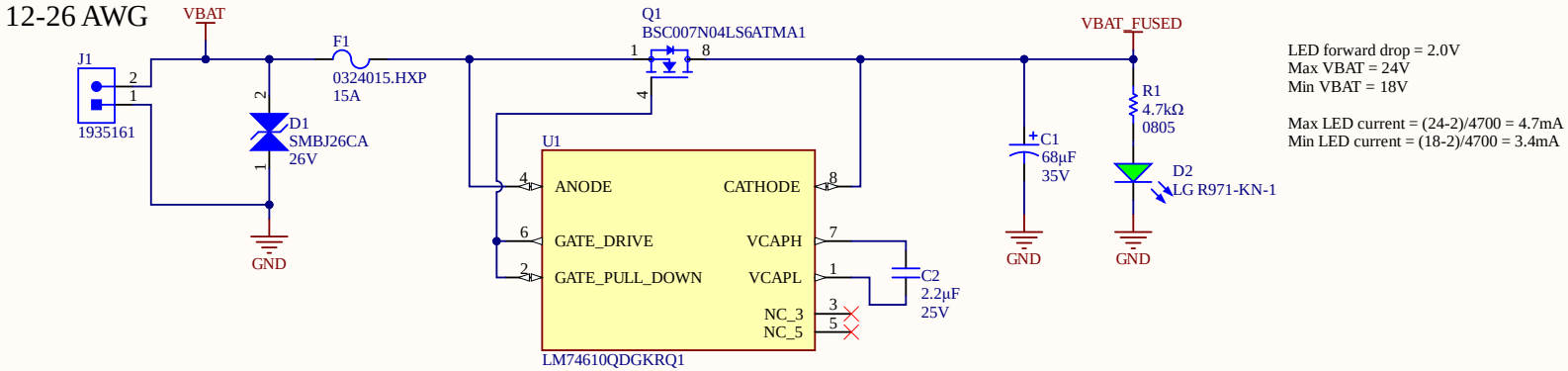
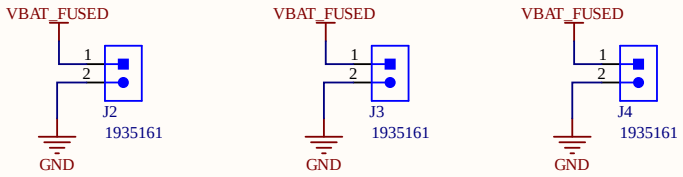
## Battery Input (6s1p)

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<br>200 University Avenue<br>Waterloo<br>Ontario<br>Canada N2L 3G6 |
| Size: Letter | Drawn By: Cindy Li | |
| Date: 2020-11-17 | Sheet 1 of 10 | |
| File: C:\Users\lance\Github\MarsRover2020-PCB\Projects\Power Distribution Board\Rev2\SH1 - POWER.SchDoc | | |

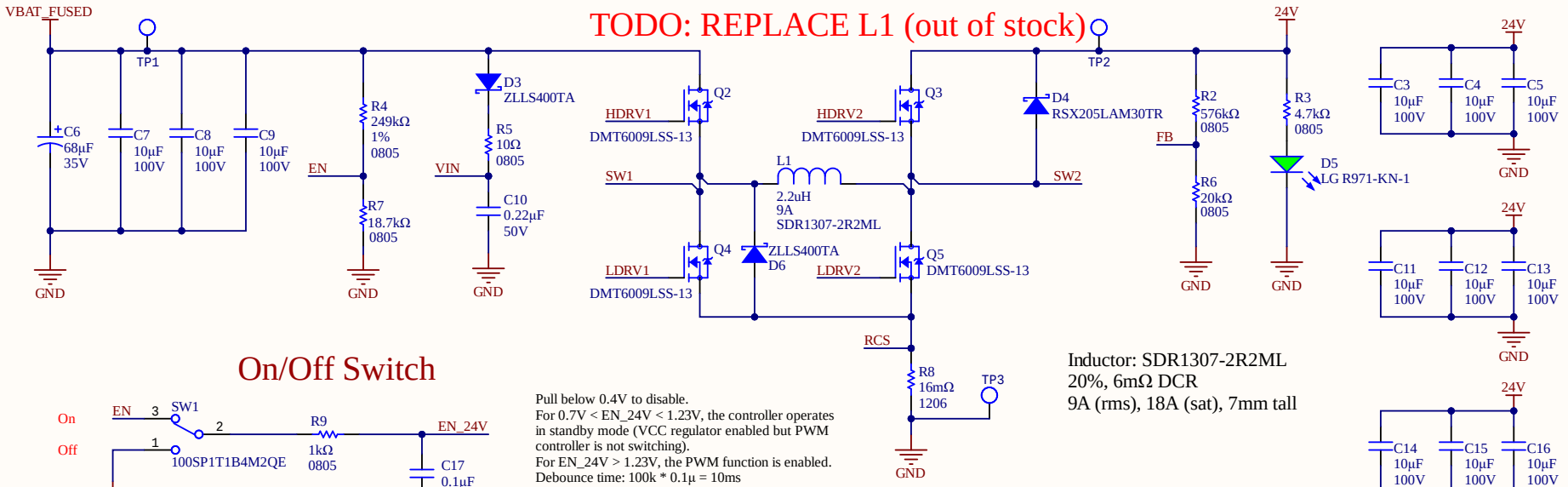
# 24V Buck-Boost Converter @ 3A Max

Input voltage range: 18-25.2V

LED forward drop = 2.0V

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

TODO: REPLACE L1 (out of stock)

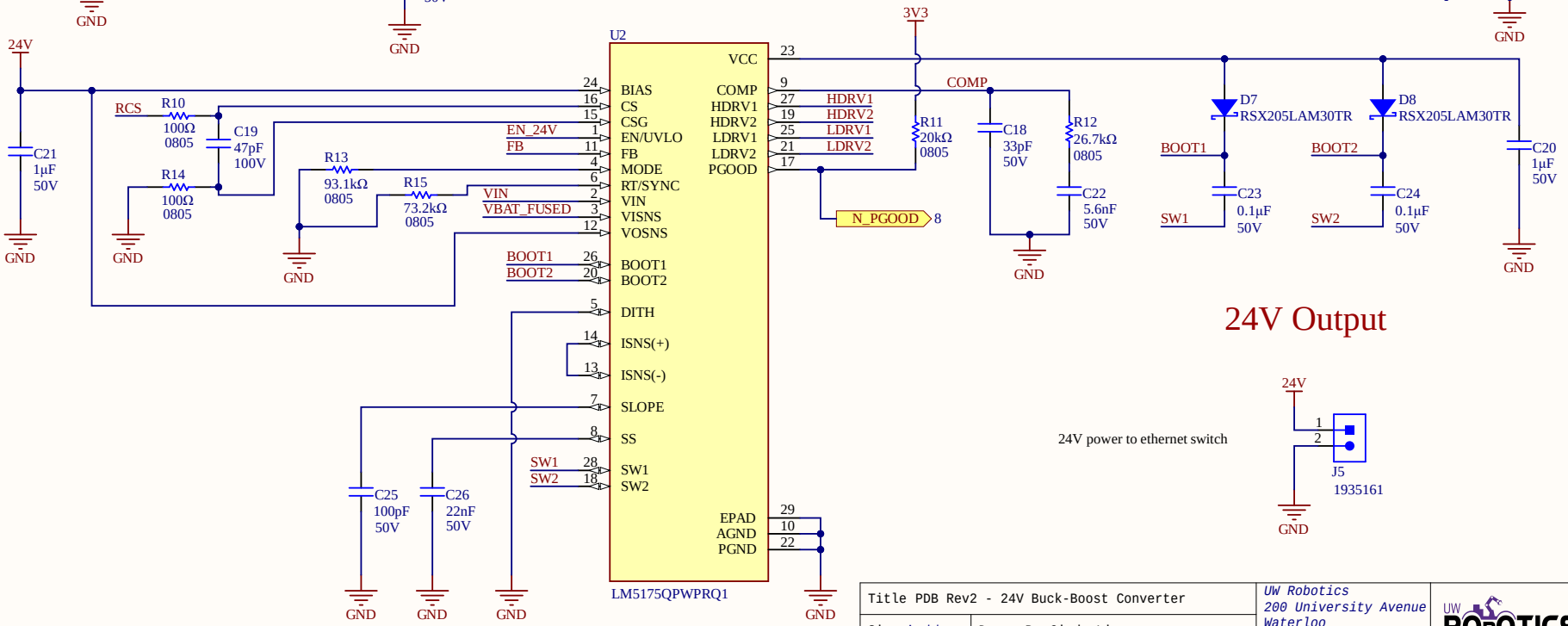



## On/Off Switch




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: SDR1307-2R2ML
20%, 6mΩ DCR
9A (rms), 18A (sat), 7mm tall




## 24V Output

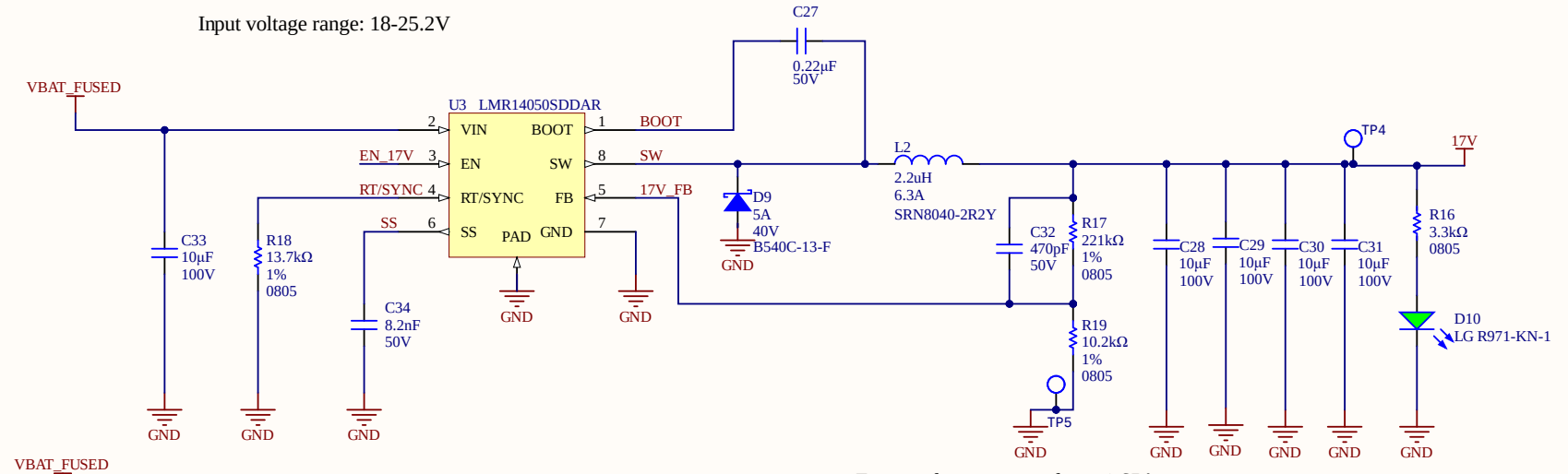
24V power to ethernet switch




| | | |
|---|---|---|
| Title PDB Rev2 - 24V Buck-Boost Converter | | UW Robotics<br>200 University Avenue<br>Waterloo<br>Ontario<br>Canada N2L 3G6 |
| Size: Letter | Drawn By: Cindy Li | |
| Date: 2020-11-17 | Sheet 2 of 10 | |
| File: C:\Users\lance\Github\MarsRover2020-PCB\Projects\Power Distribution Board\Rev2\SH2 - 24V BUCK-BOOST CONVE | | |

# 17V Regulator @ 4A Max

Input voltage range: 18-25.2V

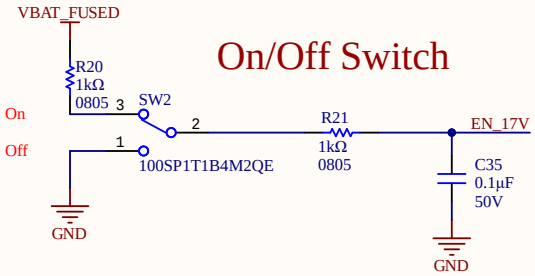



Estimated max current draw: 1.65A
Peak efficiency: 94.8%
Output voltage ripple: 19.45mVpp

LED forward drop = 2.2V

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

## On/Off Switch



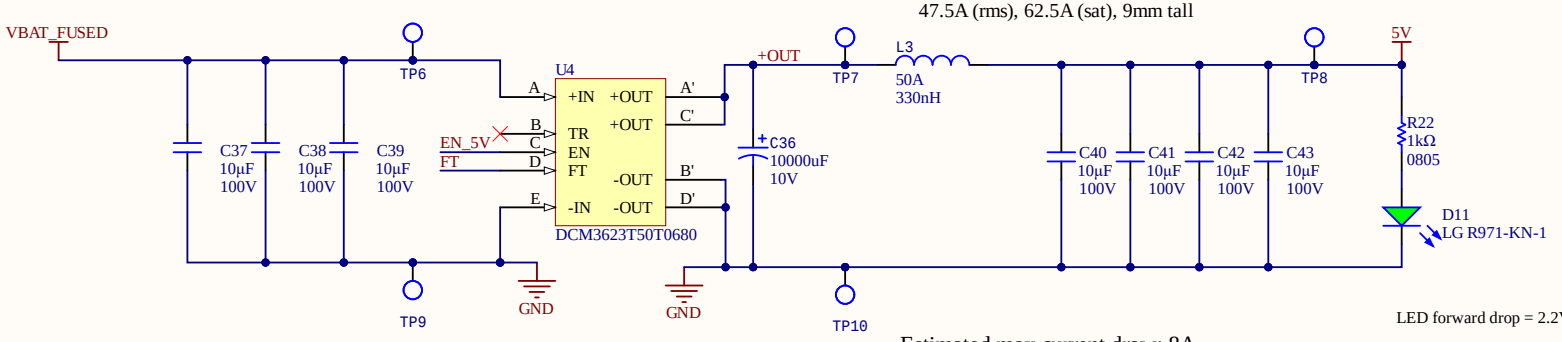

Internally pulled up
Pull below 1.2V to disable.
Float or connect to VIN to enable.
Debounce time: 100k * 0.1µ = 10ms

| | | | |
|---|---|---|---|
| Title: Power Distribution Board Rev2 - 17V Buck Converter | | | UW Robotics<br>200 University Avenue<br>Waterloo<br>Ontario<br>Canada N2L 3G6 |
| Size: Letter | Drawn By: Cindy Li | | |
| Date: 2020-11-17 | Sheet 3 of 10 | | |
| File: C:\Users\lance\Github\MarsRover2020-PCB\Projects\Power Distribution Board\Rev2\SH3 - 17V BUCK CONVERTER.S | | | |

# 5V Regulator @ 16A Max

Input voltage range: 18-25.2V

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

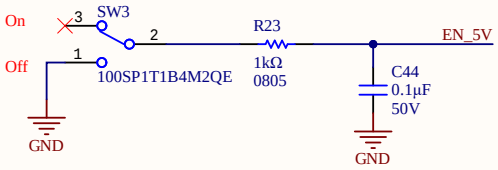



LED forward drop = 2.2V

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

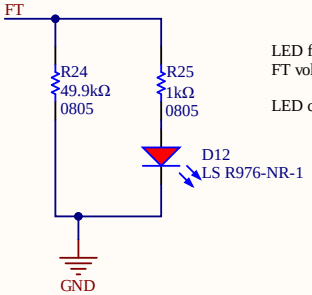
Estimated max current draw: 8A
Maximum expected output power: 40W
Peak efficiency: 88% @ 16A
Output voltage ripple: 277mVpp

## On/Off Switch




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

## Fault Indicator

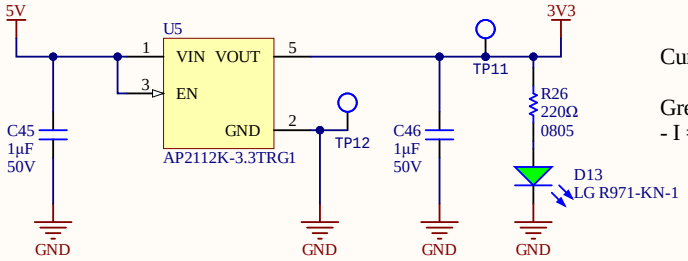



LED forward drop = 2.0V
FT voltage = 3.3V (from internally generated VCC)

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

| | | | |
|---|---|---|---|
| Title Power Distribution Board Rev2 - 5V Vicor DCDC | | UW Robotics<br>200 University Avenue<br>Waterloo<br>Ontario<br>Canada N2L 3G6 | UW ROBOTICS TEAM |
| Size: Letter | Drawn By: Cindy Li | | |
| Date: 2020-11-17 | Sheet 4 of 10 | | |
| File: C:\Users\lance\Github\MarsRover2020-PCB\Projects\Power Distribution Board\Rev2\SH4 - 5V VICOR DCDC.SchDoc | | | |

# 3.3V LDO @ 600mA Max



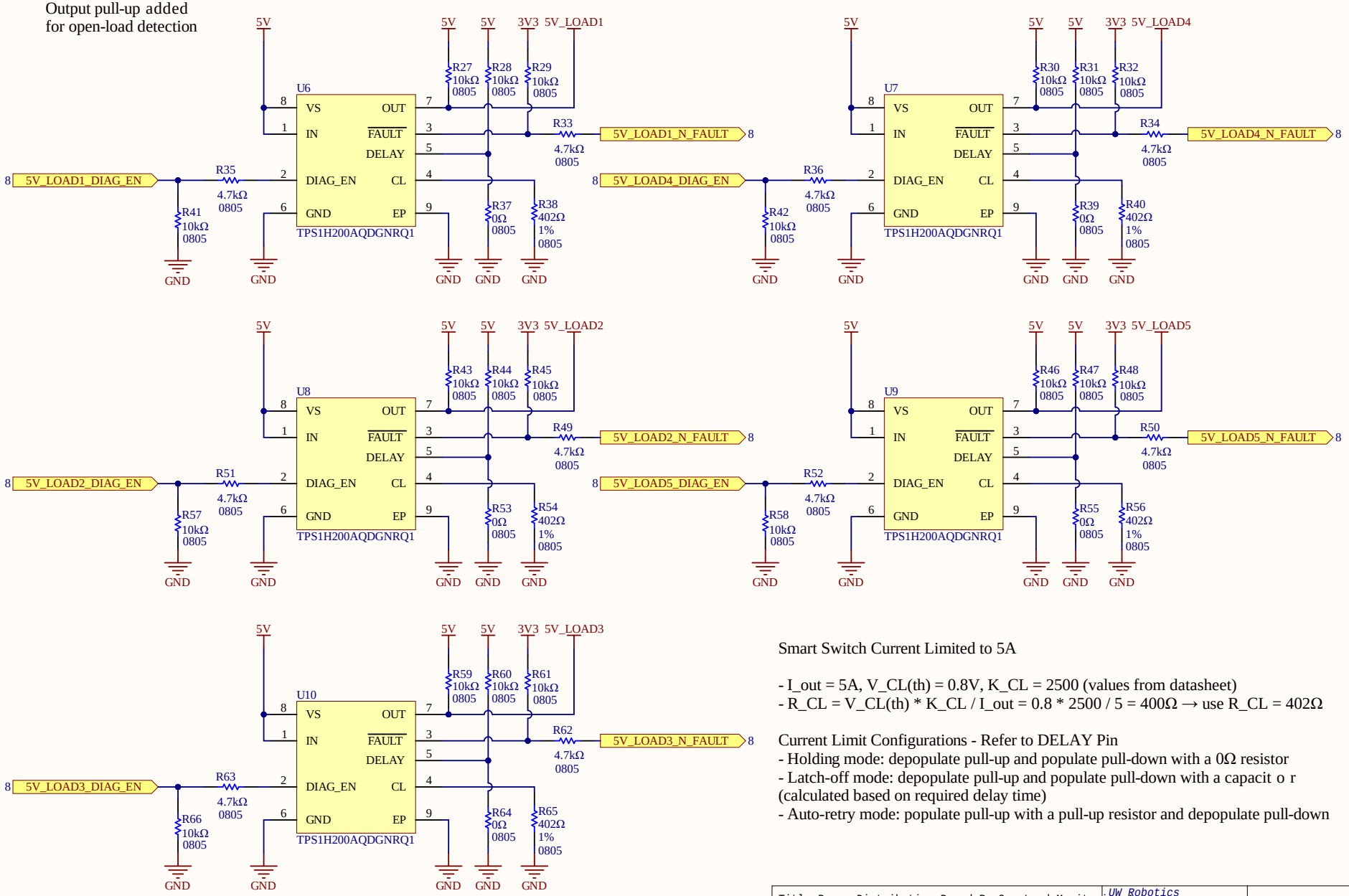

Current Calculations

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

| | | |
|---|---|---|
| Title: Power Distribution Board Rev2 - 3.3V Linear Regulator | | UW Robotics<br>200 University Avenue<br>Waterloo<br>Ontario<br>Canada N2L 3G6 |
| Size: Letter | Drawn By: Cindy Li | |
| Date: 2020-11-17 | Sheet 5 of 10 | |
| File: C:\Users\lance\Github\MarsRover2020-PCB\Projects\Power Distribution Board\Rev2\SH5 - 3.3V LINEAR REGULATO | | |

# 5V Loads Smart Switches

Output pull-up added
for open-load detection



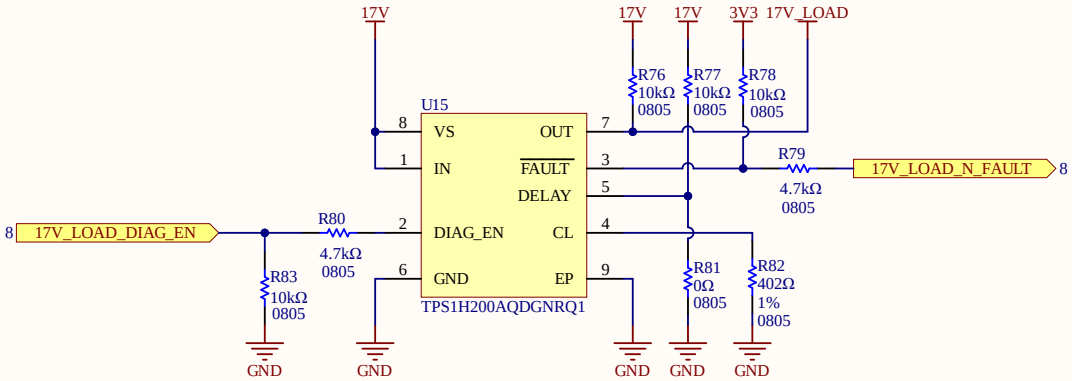

Smart Switch Current Limited to 5A

- 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

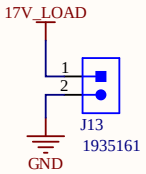
Current Limit Configurations - Refer to DELAY Pin
- Holding mode: depopulate pull-up and populate pull-down with a 0Ω resistor
- Latch-off mode: depopulate pull-up and populate pull-down with a capacit o r (calculated based on required delay time)
- Auto-retry mode: populate pull-up with a pull-up resistor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

| | | |
|---|---|---|
| Title: Power Distribution Board Rev2 - Load Monitoring | | UW Robotics<br>200 University Avenue<br>Waterloo<br>Ontario<br>Canada N2L 3G6 |
| Size: Letter | Drawn By: Cindy Li | |
| Date: 2020-11-17 | Sheet 6 of 10 | |
| File: C:\Users\lance\Github\MarsRover2020-PCB\Projects\Power Distribution Board\Rev2\SH6 - LOAD MONITORING 1.Sc | | |

# 17V Load Smart Switch

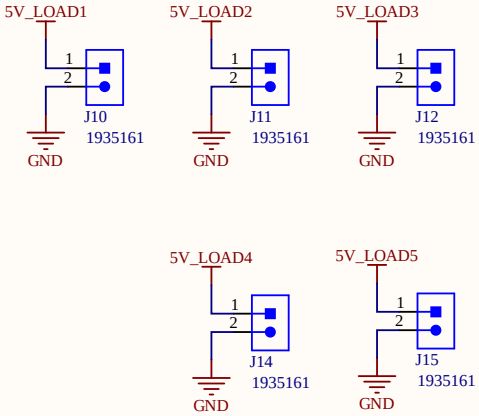



# 17V Output



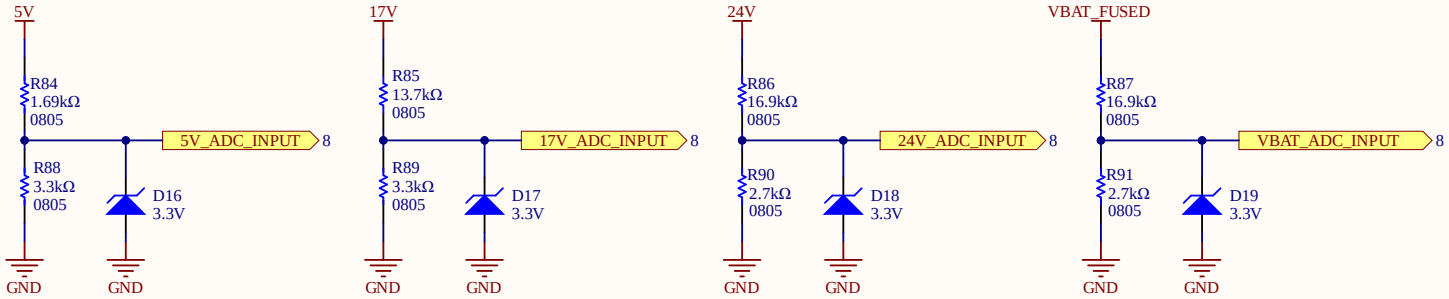

17V power to Nvidia Jetson board

# 5V Outputs




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

# Power Rail Voltage Monitoring




Divides 5V to 3.3V

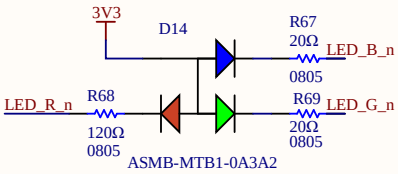
Divides 17V to 3.3V

Divides 24V to 3.3V

Divides 24V to 3.3V

| | | |
|---|---|---|
| Title: Power Distribution Board Rev2 - Load Monitoring | | UW Robotics<br>200 University Avenue<br>Waterloo<br>Ontario<br>Canada N2L 3G6 |
| Size: Letter | Drawn By: Cindy Li | |
| Date: 2020-11-17 | Sheet 7 of 10 | |
| File: C:\Users\lance\Github\MarsRover2020-PCB\Projects\Power Distribution Board\Rev2\SH7 - LOAD MONITORING 2.Sc | | |

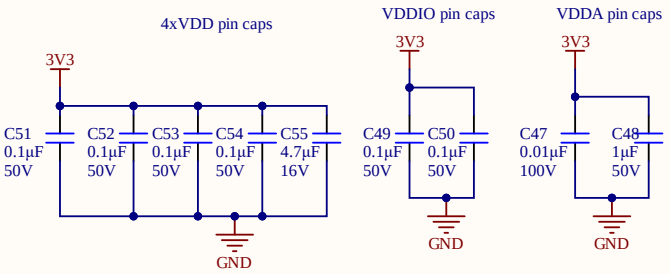
## Status LED



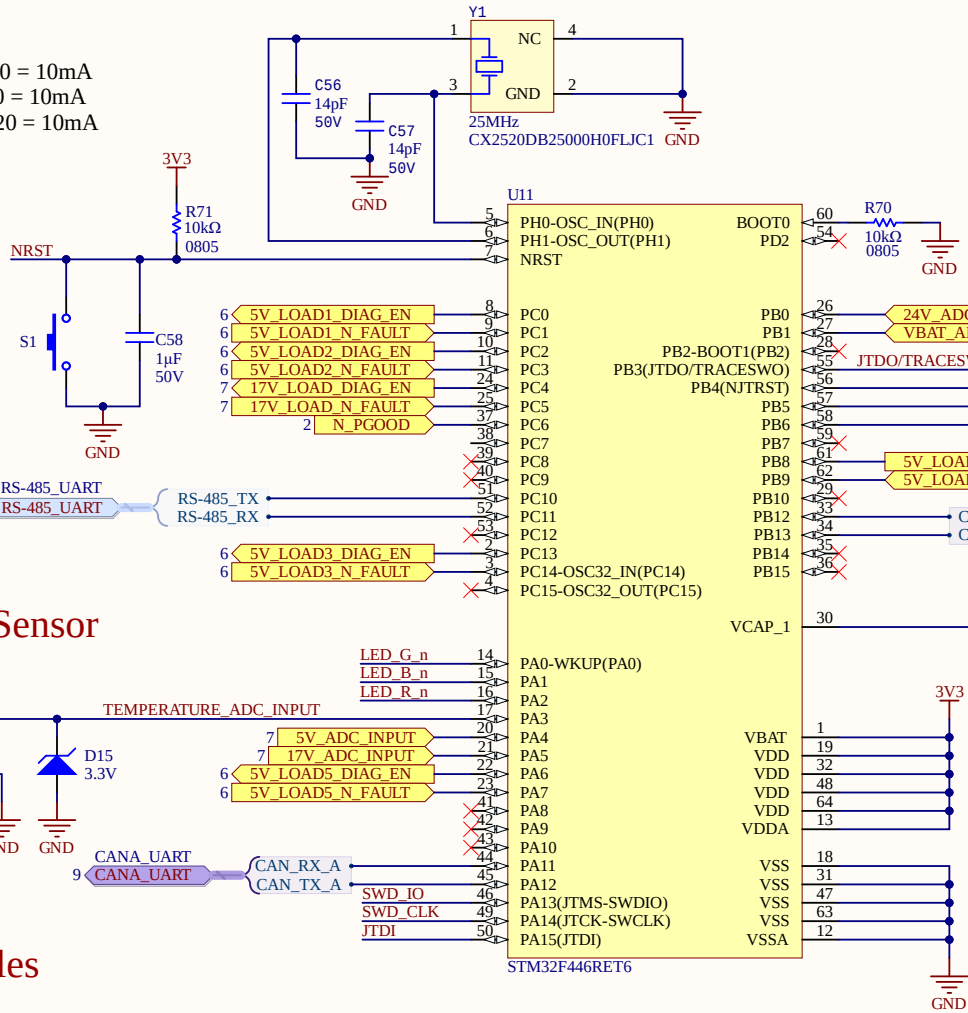

Current Calculations

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

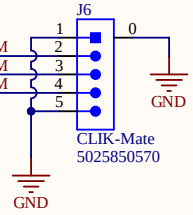
## Decoupling Caps



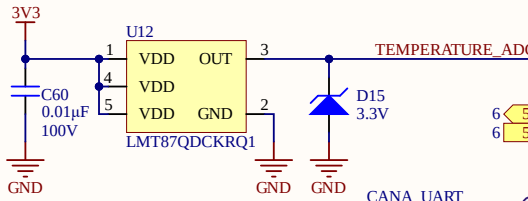

## STM32F446RET6



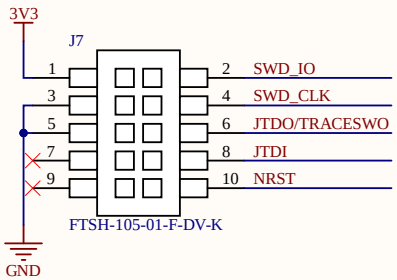

## LED Matrix




## Temperature Sensor




## Debug/Programming

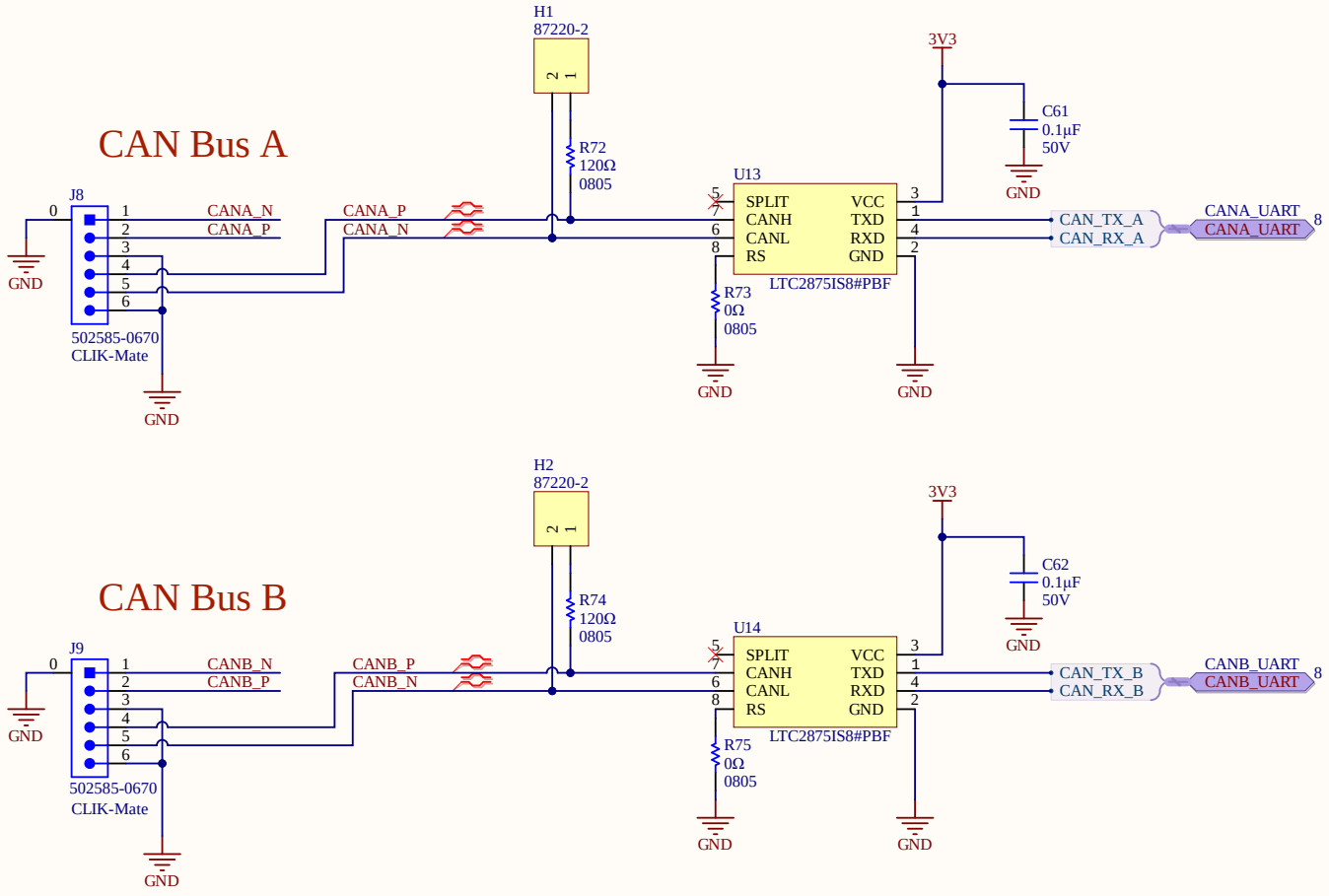



## Mounting Holes

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

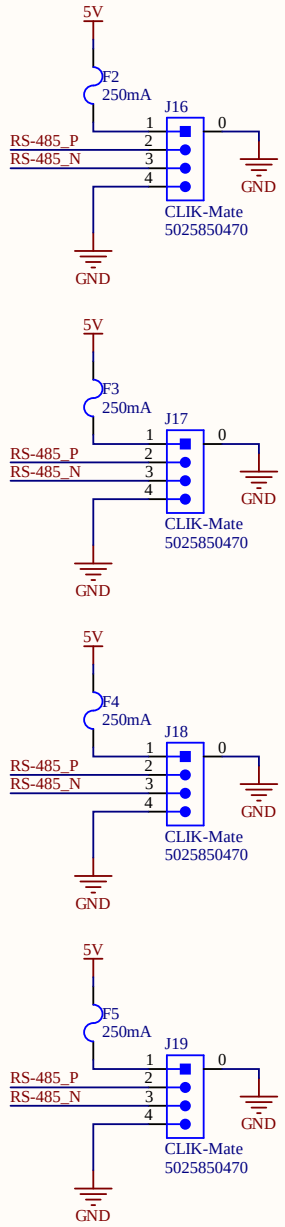
| | | |
|---|---|---|
| Title Power Distribution Board Rev2 - MCU | | UW Robotics<br>200 University Avenue<br>Waterloo<br>Ontario<br>Canada N2L 3G6 |
| Size: Letter | Drawn By: Cindy Li | |
| Date: 2020-11-17 | Sheet 8 of 10 | |
| File: C:\Users\lance\Github\MarsRover2020-PCB\Projects\Power Distribution Board\Rev2\SH8 - MICROCONTROLLER.SchDoc | | |

# CAN Transceivers

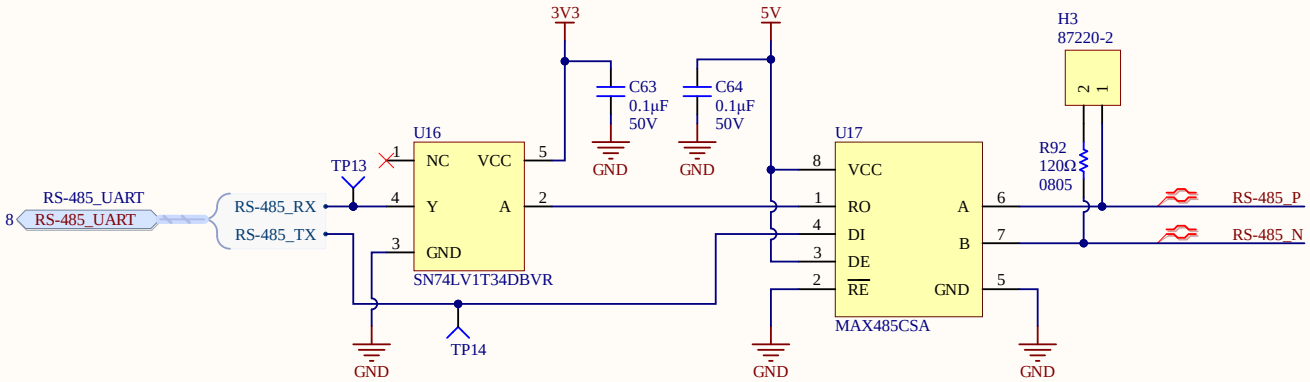



| | | | |
|---|---|---|---|
| Title Power Distribution Board Rev2 - CAN | | UW Robotics<br>200 University Avenue<br>Waterloo<br>Ontario<br>Canada N2L 3G6 | UW ROBOTICS TEAM |
| Size: Letter | Drawn By: Cindy Li | | |
| Date: 2020-11-17 | Sheet 9 of 10 | | |
| File: C:\Users\lance\Github\MarsRover2020-PCB\Projects\Power Distribution Board\Rev2\SH9 - CAN.SchDoc | | | |

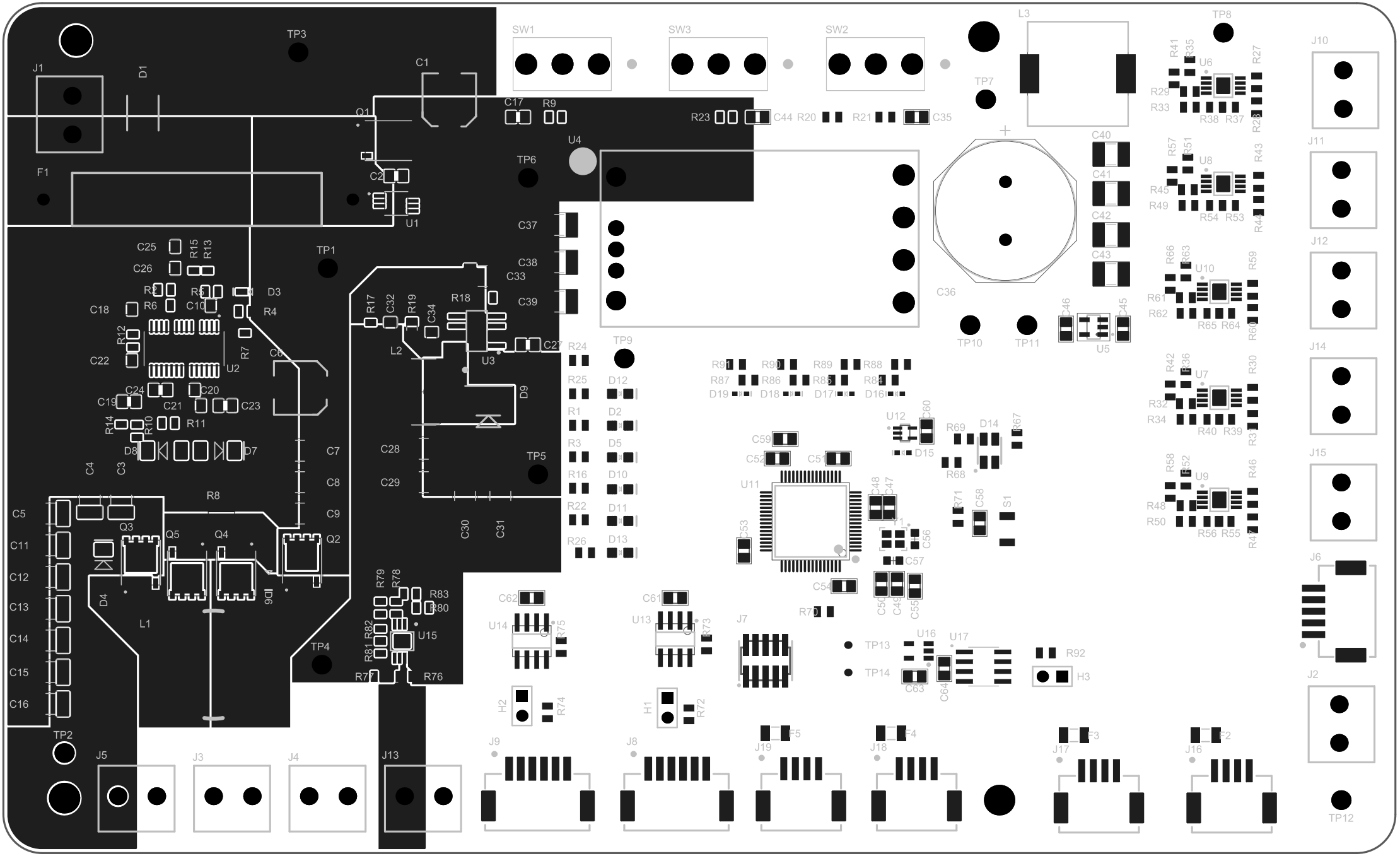
# URM04 Ultrasonic Sensors




## RS-485 Transceiver




| | | | |
|---|---|---|---|
| Title Power Distribution Board Rev2 - RS-485 | | | UW Robotics<br>200 University Avenue<br>Waterloo<br>Ontario<br>Canada N2L 3G6 |
| Size: Letter | Drawn By: Cindy Li | | |
| Date: 2020-11-17 | Sheet 10 of 10 | | |
| File: C:\Users\lance\Github\MarsRover2020-PCB\Projects\Power Distribution Board\Rev2\SH10 - RS-485.SchDoc | | | |


J1
D1
TP3
C1
Q1
C17
R9
R23
C44
R20
R21
C35
SW1
SW3
SW2
U4
TP6
C2
U1
F1
C37
C38
C33
C39
C27
TP1
C25
C26
R15
R13
R2
R5
D3
R4
C18
R6
C10
R12
C22
R7
C6
U2
C24
C20
C19
C21
C23
R14
R10
R11
D8
D7
C4
C3
C7
C8
C9
R8
C5
C11
C12
C13
C14
C15
C16
Q3
Q5
Q4
Q2
D4
D6
L1
TP4
R79
R78
R83
R80
R82
R81
U15
R77
R76
TP2
J5
J3
J4
J13
R17
C32
R19
C34
R18
L2
U3
D9
C28
C29
C30
C31
TP5
TP9
R24
R25
R1
R3
R16
R22
R26
D12
D2
D5
D10
D11
D13
C62
U14
R75
H2
R74
C61
U13
R73
H1
R72
J9
J8
J19
J18
F5
F4
J7
TP13
TP14
U16
U17
C63
C64
R92
H3
F3
F2
J17
J16
L3
TP7
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C41
C42
C43
C36
TP10
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C45
U5
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R87
R86
R85
R84
D19
D18
D17
D16
U12
C60
R69
D14
R67
D15
R68
C59
C52
C5
U11
C48
C47
C53
C56
C57
C54
C50
C49
C55
R71
C58
S1
R70
TP8
U6
R41
R35
R27
R29
R33
R38
R37
R28
J10
J11
U8
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R51
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R49
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R53
R44
J12
U10
R66
R63
R59
R61
R62
R65
R64
R60
J14
U7
R42
R36
R30
R32
R34
R40
R39
R31
J15
U9
R58
R52
R46
R48
R50
R56
R55
R47
J6
J2
TP12