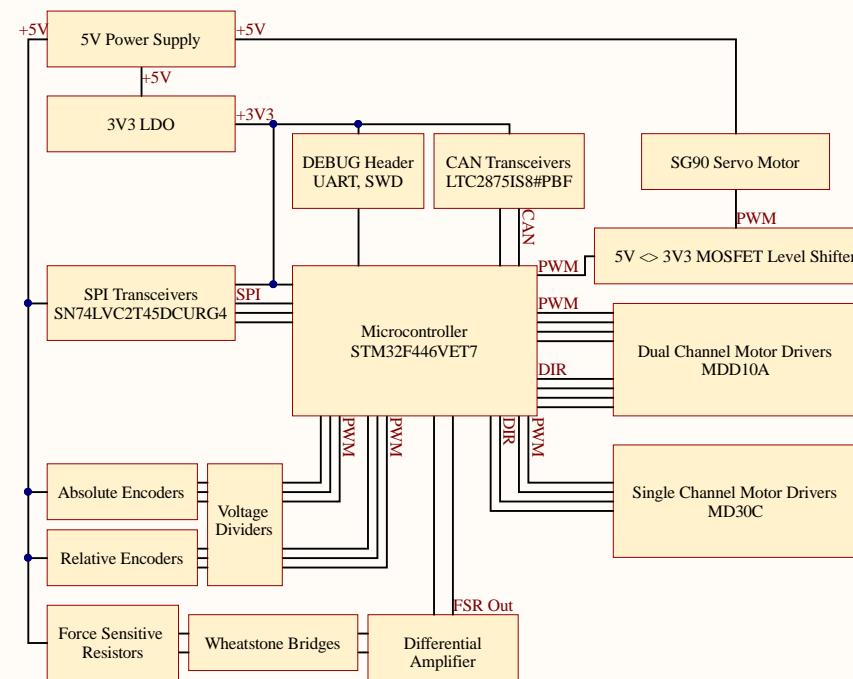
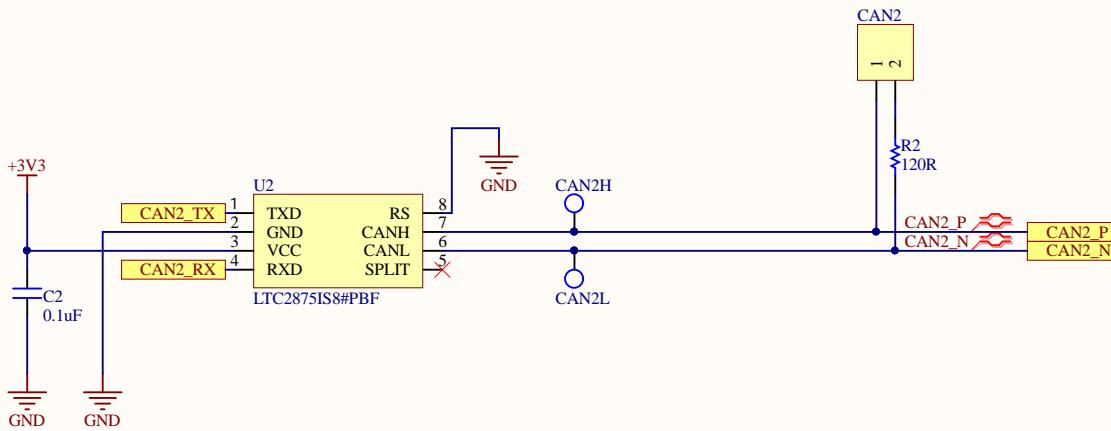
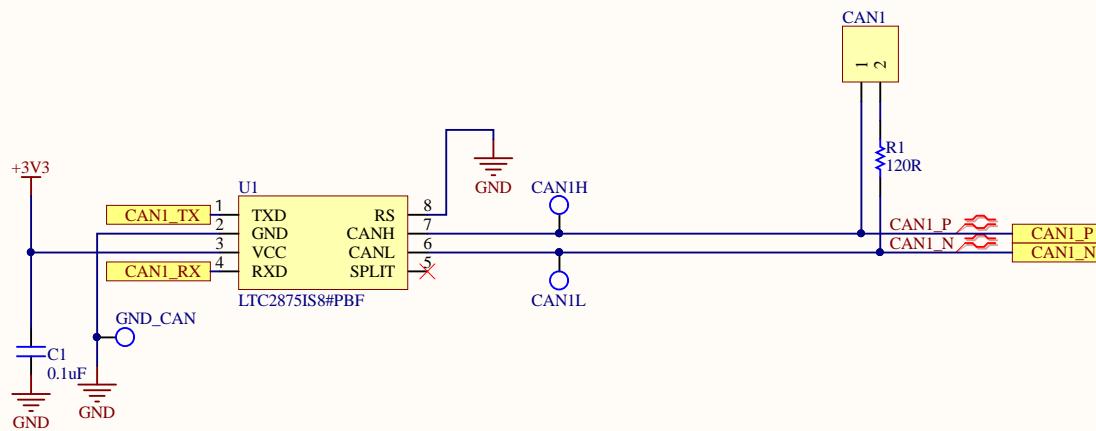


Arm Block Diagram



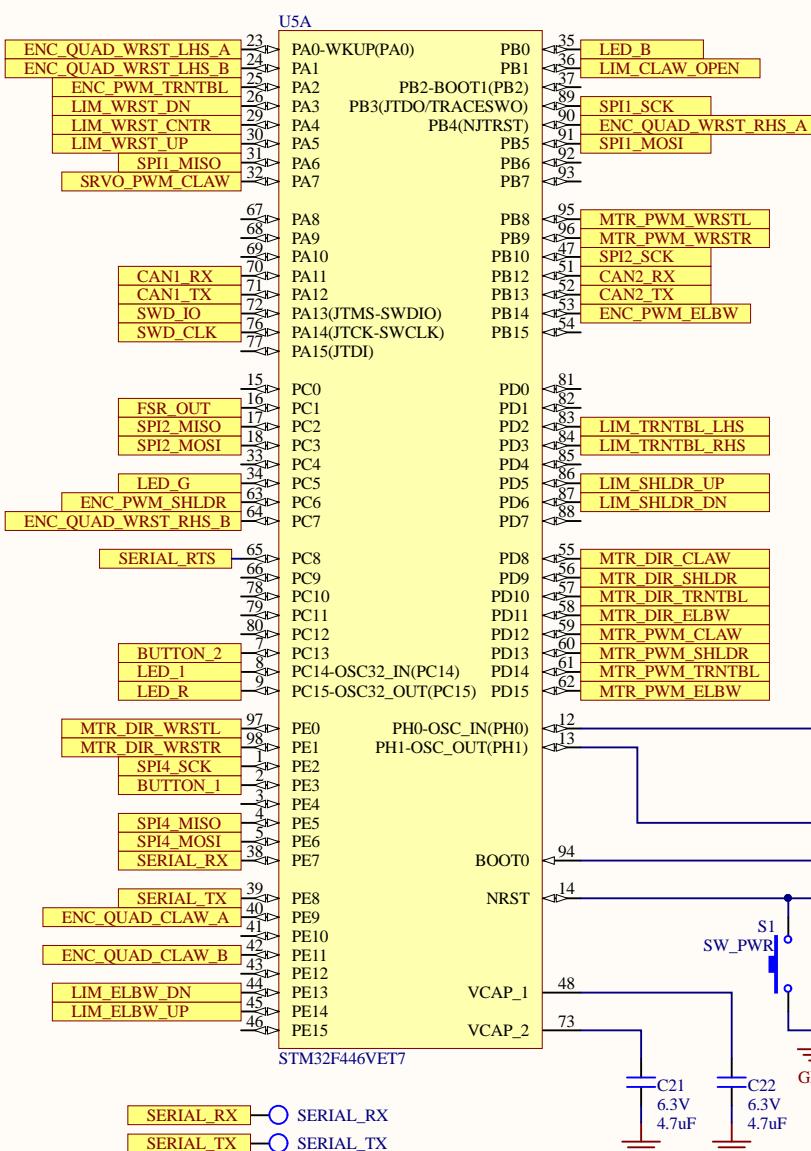
Title: Arm - Block Diagram		UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6
Size: Letter	Drawn By: K. Hong	UW ROBOTICS TEAM
Date: 3/16/2020	Sheet 1 of 9	
File: C:\Users\kyleh\Desktop\Works\UWRTR\marsRover2020-PCB\Projects\Arm\Rev2\Block Diagram.SchDoc		

CAN Transceivers

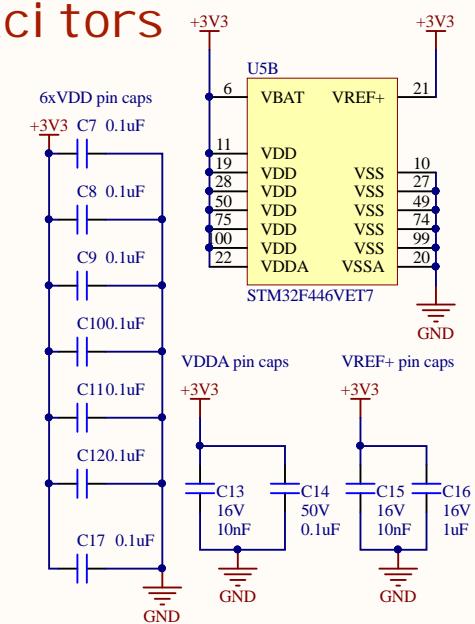


Title: Arm - CAN Transceivers		UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6
Size: Letter	Drawn By: P. Onaifo, K. Hong	
Date: 3/16/2020	Sheet 2 of 9	
File: C:\Users\kyleh\Desktop\Works\UWRT\MarsRover2020-PCB\Projects\Arm\Rev2\CAN.SchDoc		UW ROBOTICS TEAM

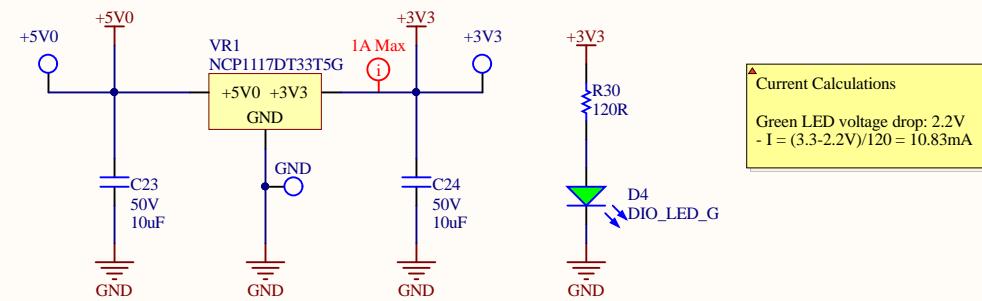
STM32F446VET7



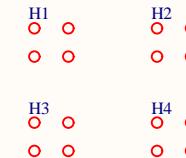
Bypass Capacitors



5V-3.3V LDO



Title: Arm - Power		UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6
Size: Letter	Drawn By: K. Hong	
Date: 3/16/2020	Sheet 5 of 9	
File: C:\Users\kyleh\Desktop\Works\UWRT\MarsRover2020-PCB\Projects\Arm\Rev2\POWER.SchDoc		UW ROBOTICS TEAM



A

A

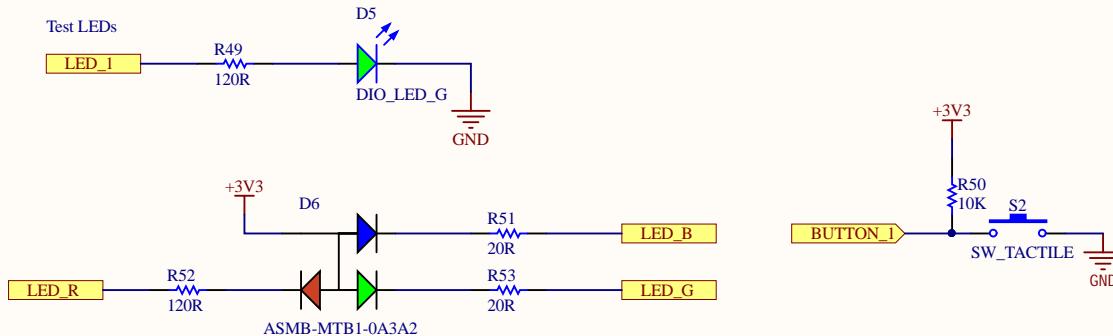
Test LEDs

Test Button

Current Calculations

Green LED voltage drop: 2.2V
 $- I = (3.3-2.2V)/120 = 10.83mA$

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; $I = (3.3-3.1V)/20 = 10mA$



B

B

C

C

D

D

Title: Arm - Support

Size: Letter | Drawn By: N. Chapman, K. Hong

Date: 3/16/2020

UW Robotics
 200 University Avenue
 Waterloo
 Ontario
 Canada N2L 3G6

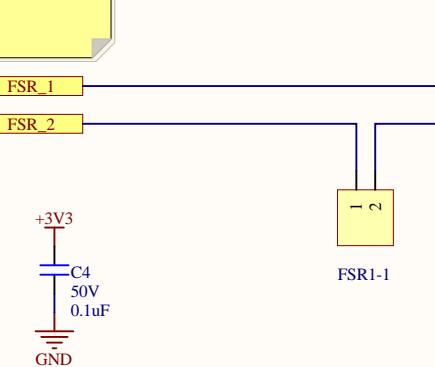


File: C:\Users\kyleh\Desktop\Works\UWRT\MarsRover2020-PCB\Projects\Arm\Rev2\Support.SchDoc

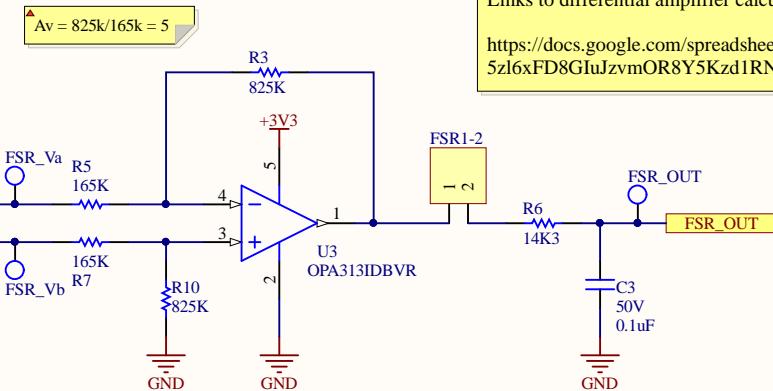
Force Sensitive Resistor

Sensor:
 Manufacturer: Interlink Electronics
 Manufacturer Part Number: 30-81794
 Supplier: Digi-Key
 Supplier Part Number: 1027-1001-ND
<https://cdn.sparkfun.com/assets/8/a/1/2/0/2010-10-26-DataSheet-FSR402-Layout2.pdf>
 Resistance at 20N = 800 ohms
 Resistance at 100N = 250 ohms

Wheatstone Bridge



Differential Amplifier



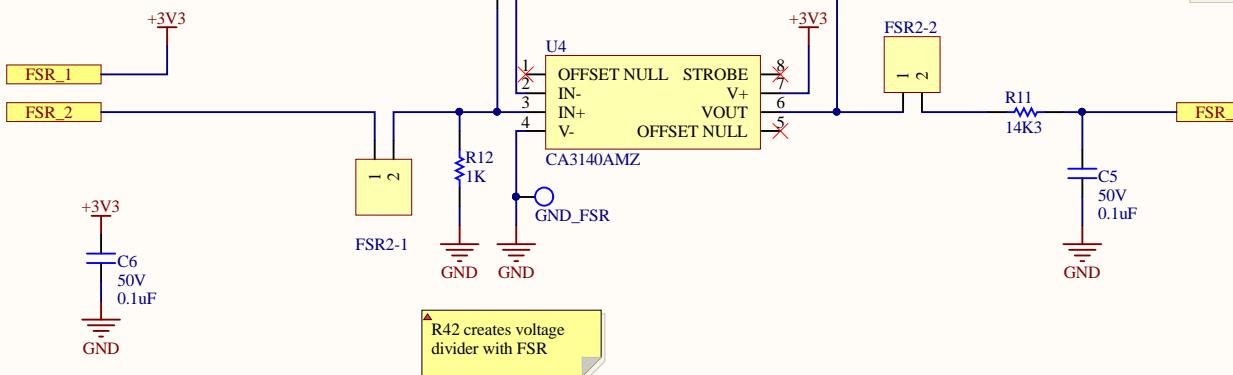
Differential amplifier gain:
 $Av = 825k/165k = 5$

Wheatstone bridge voltage output values:
 At 20N, $V_{out} = 3.2V$
 At 100N, $V_{out} = 0.5V$

Low pass filter cutoff frequency:
 $f_c = 1/(2\pi R1 * 14.3k * 0.1u) = 111.30 \text{ Hz}$

Links to differential amplifier calculations and documentation
<https://docs.google.com/spreadsheets/d/1JzRwpCH-aMdlyAMp5zl6xFD8GIuJzvmOR8Y5Kzd1RN0/edit#gid=0>

Buffer

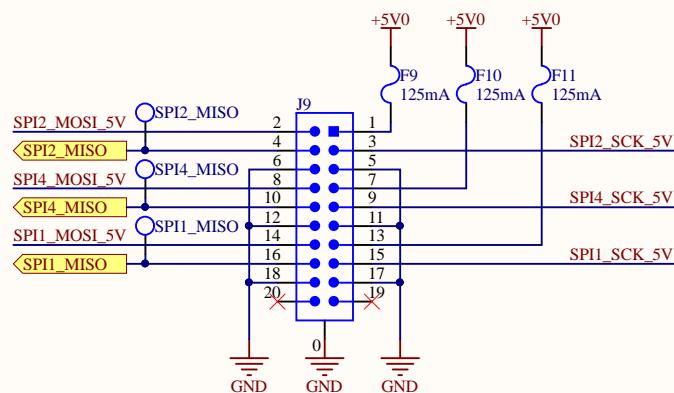


$\Delta V = 3.3V/(2^{12}-1)$
 $= 805.86 \mu V$

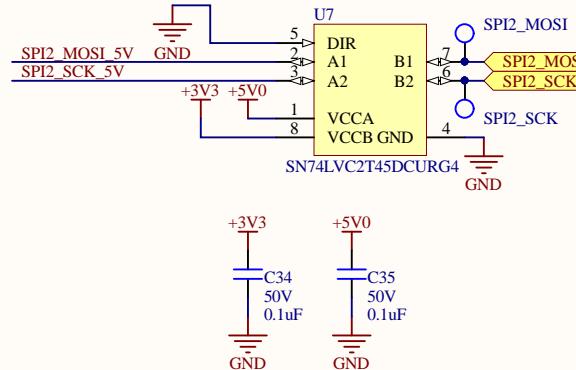
R42 creates voltage divider with FSR

A

SPI Encoders



B

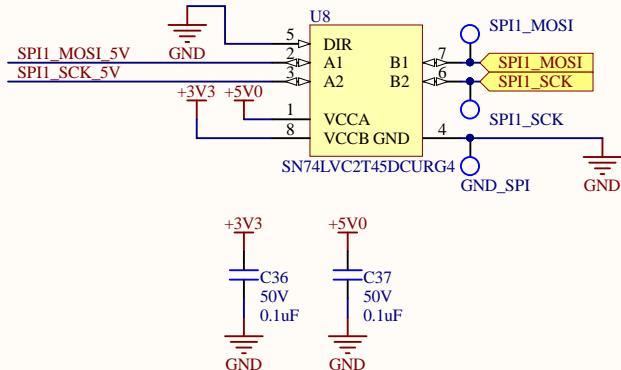


A

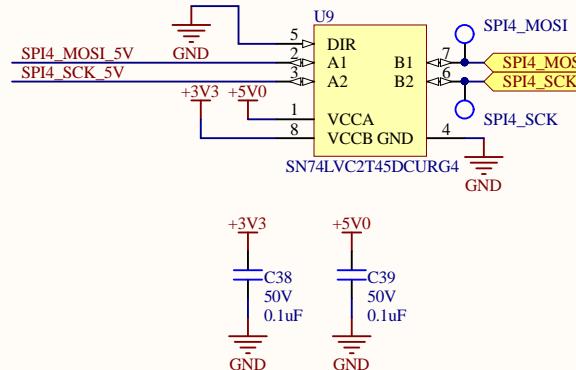
Encoder manufacturer: Broadcom
Encoder part number: AEAT-6012-A06

Did not level shift MISO signals since the STM32 SPI peripheral is 5V tolerant

C



C

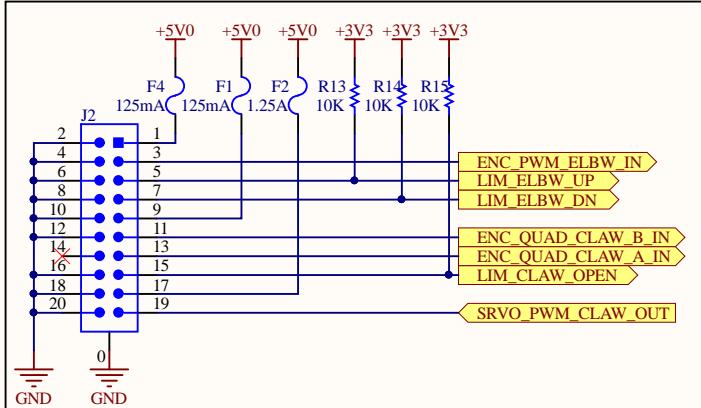


D

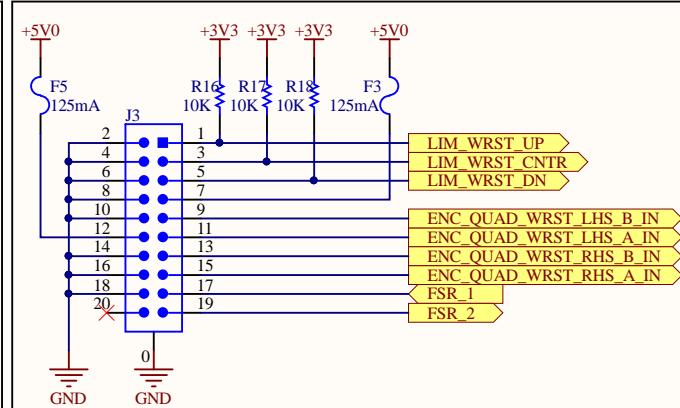
Title: Arm - SPI Encoders	UW Robotics 200 University Avenue Waterloo Ontario Canada N2L 3G6
Size: Letter	Drawn By: N. Chapman, K. Hong
Date: 3/16/2020	Sheet 9 of 9
File: C:\Users\kyleh\Desktop\Works\UWRT\MarsRover2020-PCB\Projects\Arm\Rev2\SPI_Encoders.SchDoc	UW ROBOTICS TEAM

Consolidated Connectors

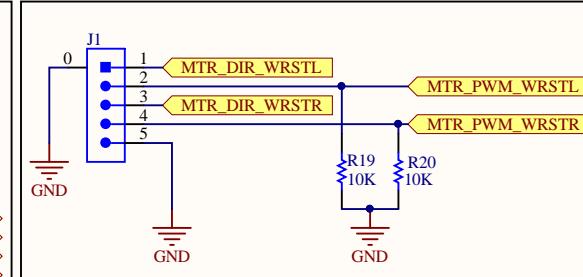
Elbow and Claw



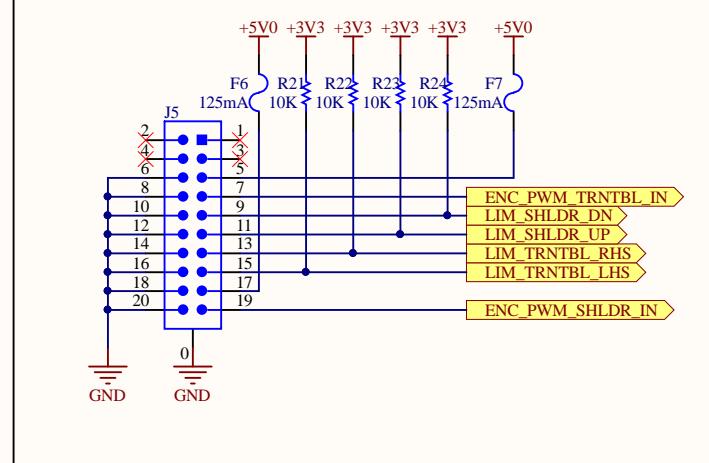
FSR and Wrist



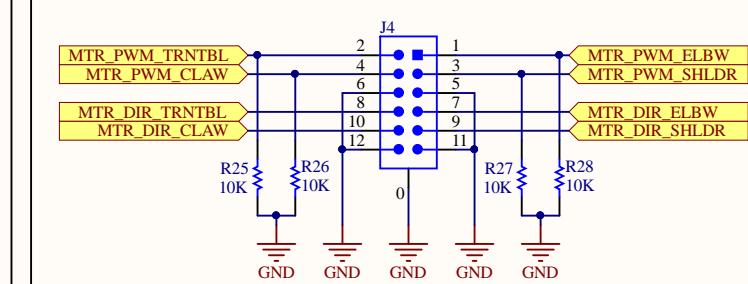
Wrist Motor Driver Connector



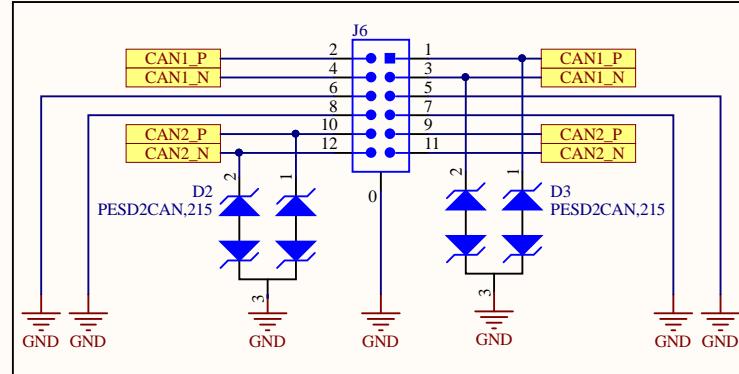
Shoulder and Turntable



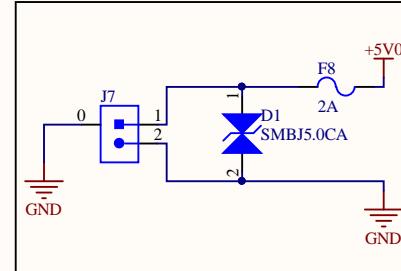
Cytron Motor Driver Connectors



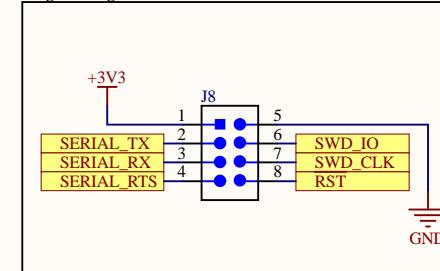
CAN Connections



+5V0 Power



Programming Connector

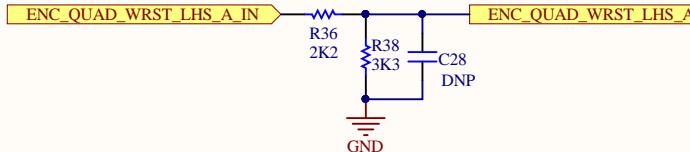
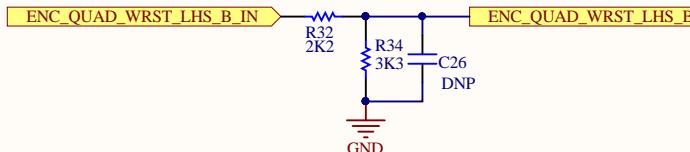
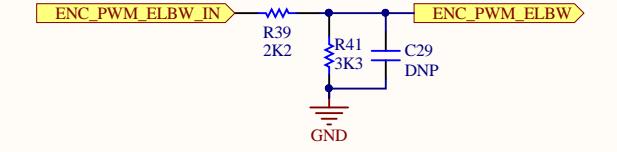
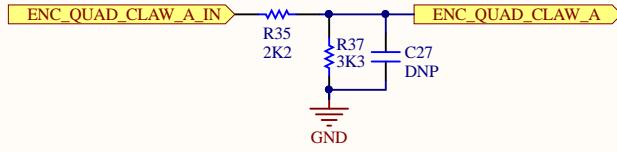
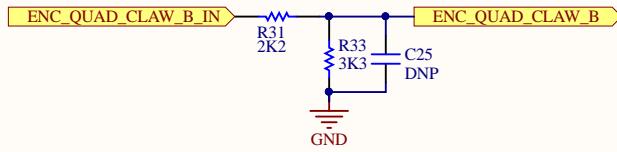


Acronyms Explained
FSR: Force Sensitive Resistor
CLAW: Claw
WRST: Wrist
SHLDR: Shoulder
ELBW: Elbow
TRNTBL: Turntable
DIR: Direction for motors

Servo motor and PWM Encoders

A

Encoder RC filter & Voltage divider



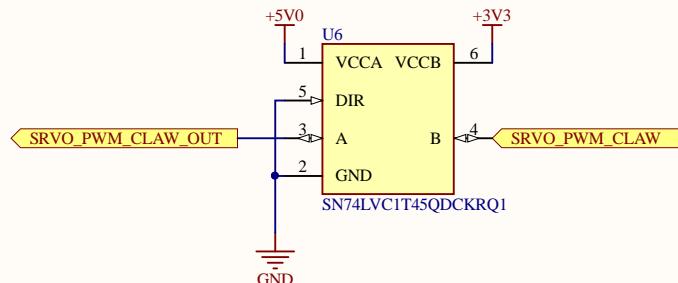
Low pass filter cut-off frequency:
 $f_c = 1/(2\pi \cdot 3.3k) = ? \text{ Hz}$

Voltage divider:
 $V_{out} = 5(3.3k/(2.2k+3.3k)) = 3V$

To be done:
 Spec RC filter capacitor for encoder outputs and redo calculation
 Add filter to level shifter io?

C

Servo level shifter



Title *	*
Size: Letter	Drawn By: Kyle Hong
Date: 3/16/2020	Sheet * of *
File: C:\Users\kyleh\Desktop\Works\UWRT\MarsRover2020-PCB\Projects\Arm\Rev2\Servo and Encoders.SchDoc	*

