


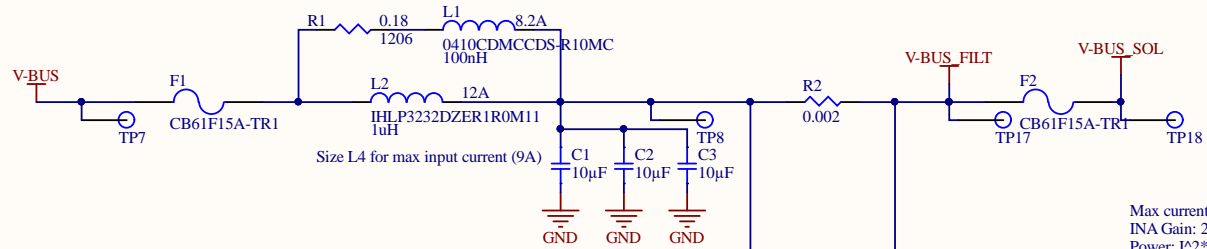
BRAKING IO

POD 5

REV 1

Title <i>Braking IO PCB</i>		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706		
Engineer:		Revision:		
Date: 9/9/2019	Time: 2:18:58 PM	Sheet	of	
File: braking_io.SchDoc				

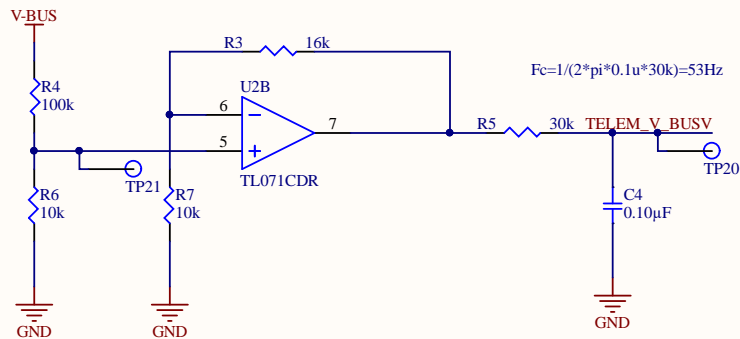
should change upstream fuse to be higher current rating than downstream.



BUS_FILTER

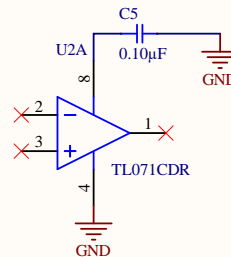
Filter design reference: <http://www.ti.com/lit/an/snva538/snva538.pdf>
<http://ece.colorado.edu/~rwe/papers/APEC99.pdf>

Max current draw: 9A -> $9A \cdot 0.01\Omega = 0.09V$
 INA Gain: 200V/V -> 4.0V at Max current
 Power: $I^2 \cdot R = 4A \cdot 0.01 = 0.04W$




GAIN: 1.6V/V
 MIN BUS VOLTAGE: 20V -> 1.82V
 MIN BUS VOLTAGE: 28V -> 2.54V

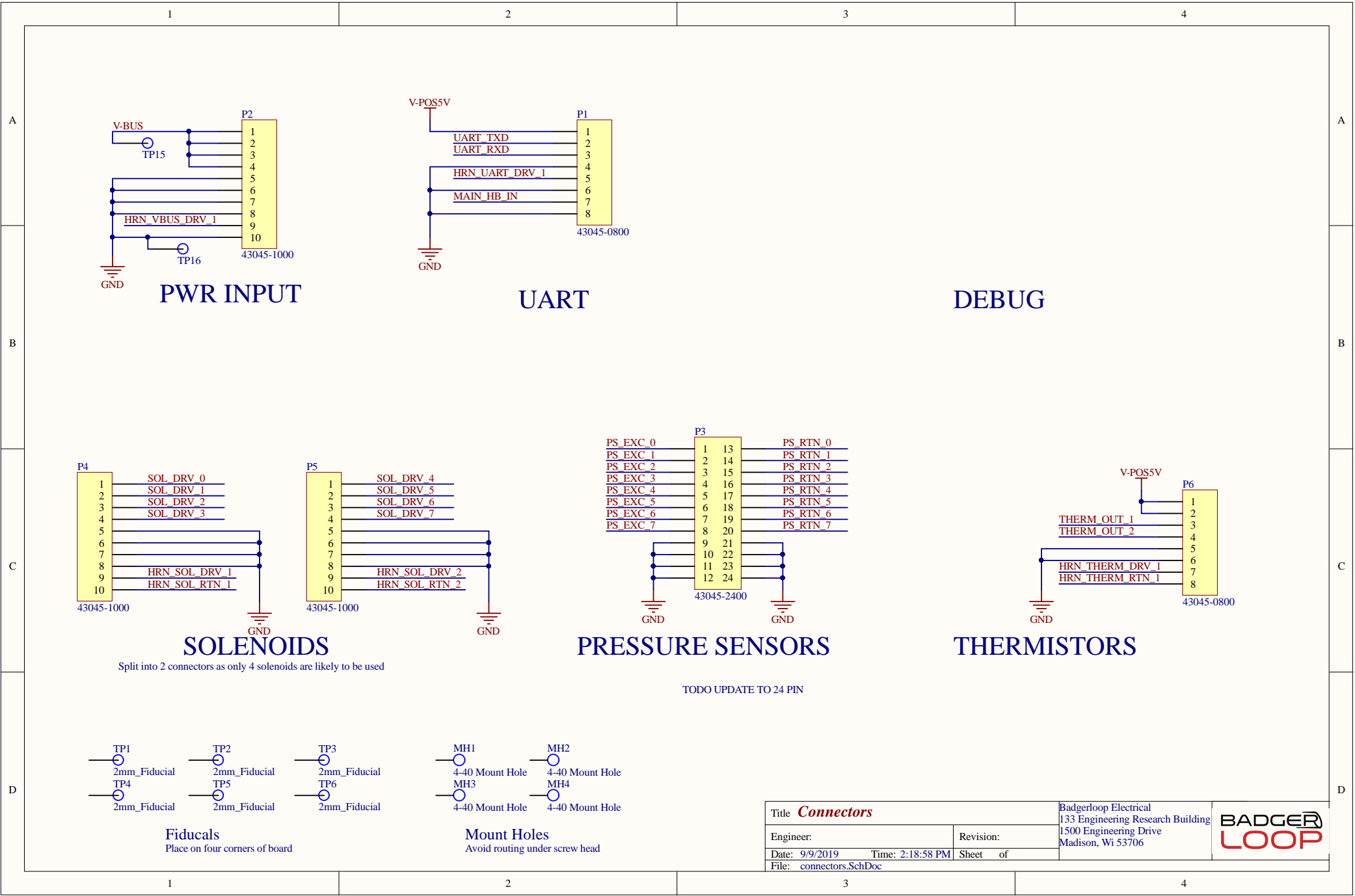
VOLTAGE TELEMETRY

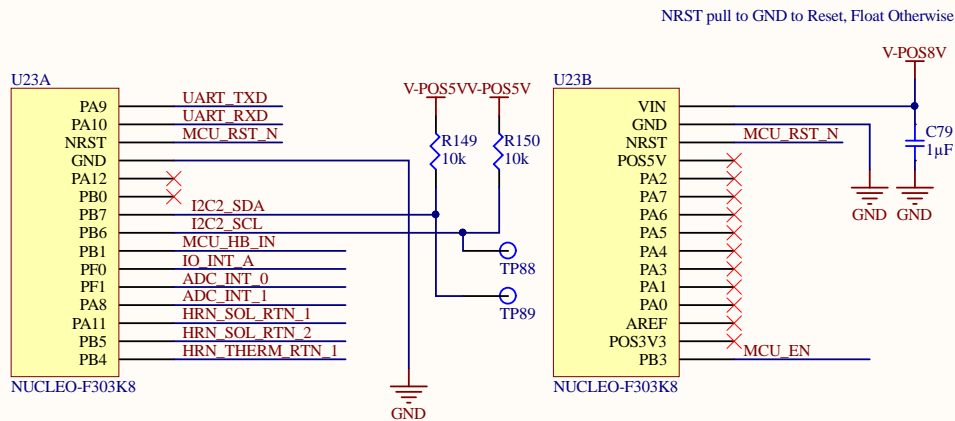


CURRENT TELEMETRY

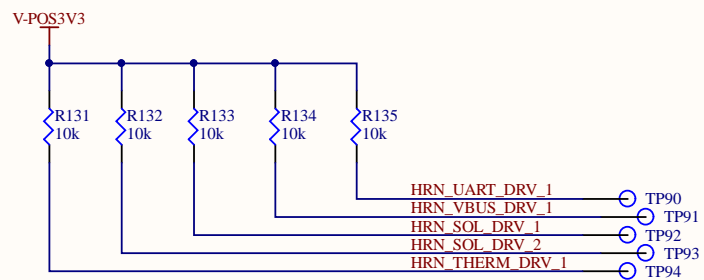
Max current draw: 9A -> $9A \cdot 0.002\Omega = 0.018V$
 INA Gain: 200V/V -> 3.6V at Max current
 Power: $I^2 \cdot R = 4A \cdot 0.01 = 0.04W$

Title			Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706	
Engineer:		Revision:		
Date: 9/9/2019	Time: 2:18:58 PM	Sheet of		
File: bus_filter.SchDoc				

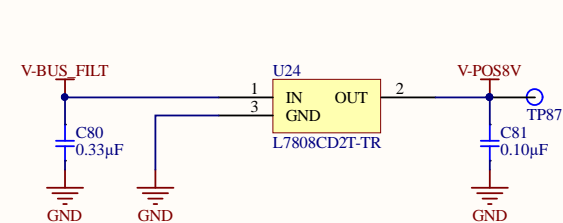




MCU BREAKOUT

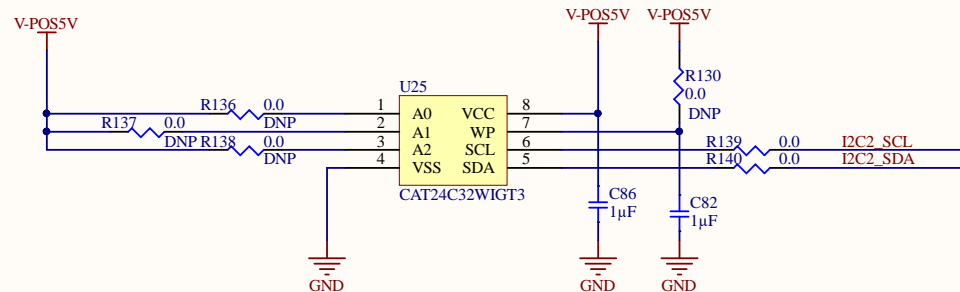


HARNESS ID



Fixed output, 1A Max (MCU 800mA Max)

8V LDO



I2C Address: 0x50h

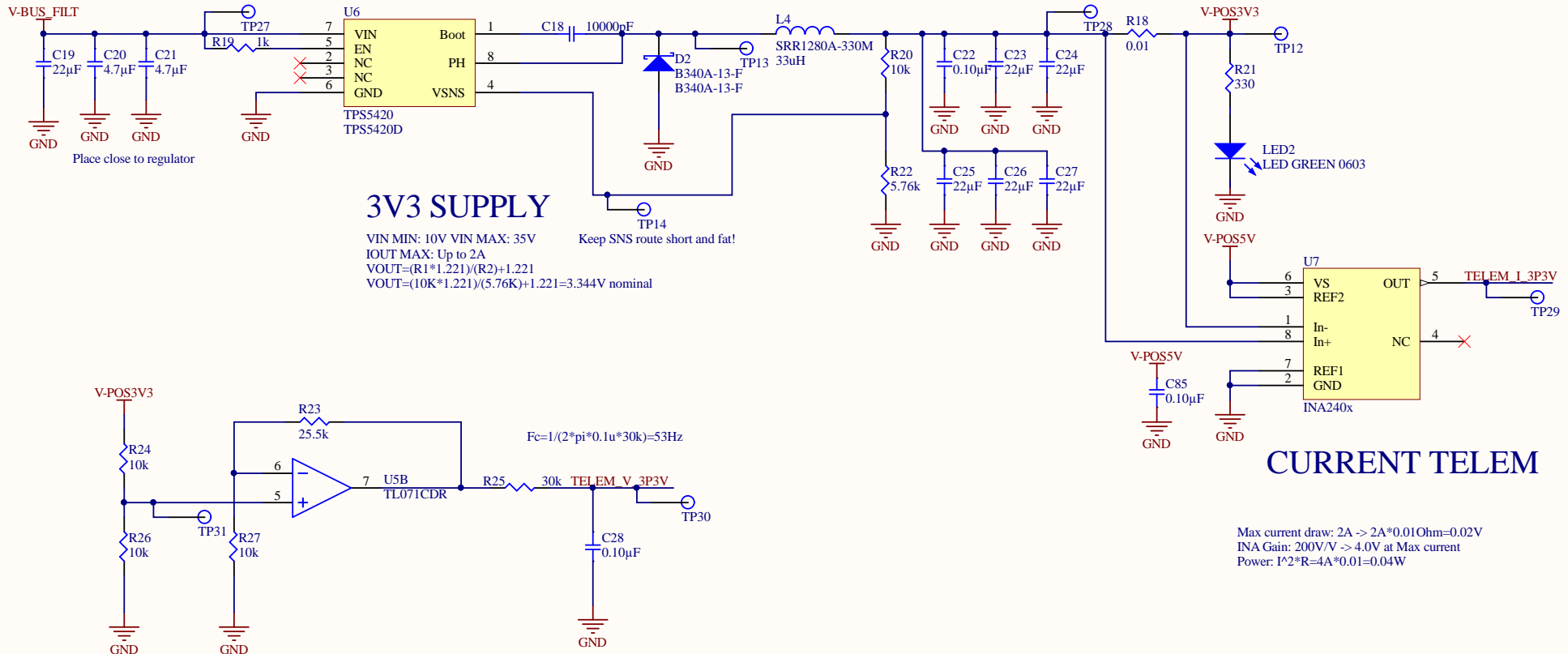
I2C EEPROM

Title Microcontroller		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706	
Engineer:	Revision:		
Date: 9/9/2019	Time: 2:18:58 PM		
File: mcu.SchDoc	Sheet of		

Notes:
Follow layout reference design
Place bypass caps close to regulator
Keep hot loops as short as possible
Possible to replace ceramic bulk cap with a tantalum.

Replace with Tantalum?
Place close to regulator
See https://github.com/badgerloop-software/hardware/tree/master/braking_io/design

TODO: Spec new inductor



3V3 SUPPLY

VIN MIN: 10V VIN MAX: 35V
IOUT MAX: Up to 2A
 $VOUT = (R1 * 1.221) / (R2) + 1.221$
 $VOUT = (10K * 1.221) / (5.76K) + 1.221 = 3.344V$ nominal


Keep SNS route short and fat!

CURRENT TELEM

Max current draw: 2A -> $2A * 0.01\Omega = 0.02V$
INA Gain: 200V/V -> 4.0V at Max current
Power: $I^2 * R = 4A * 0.01 = 0.04W$

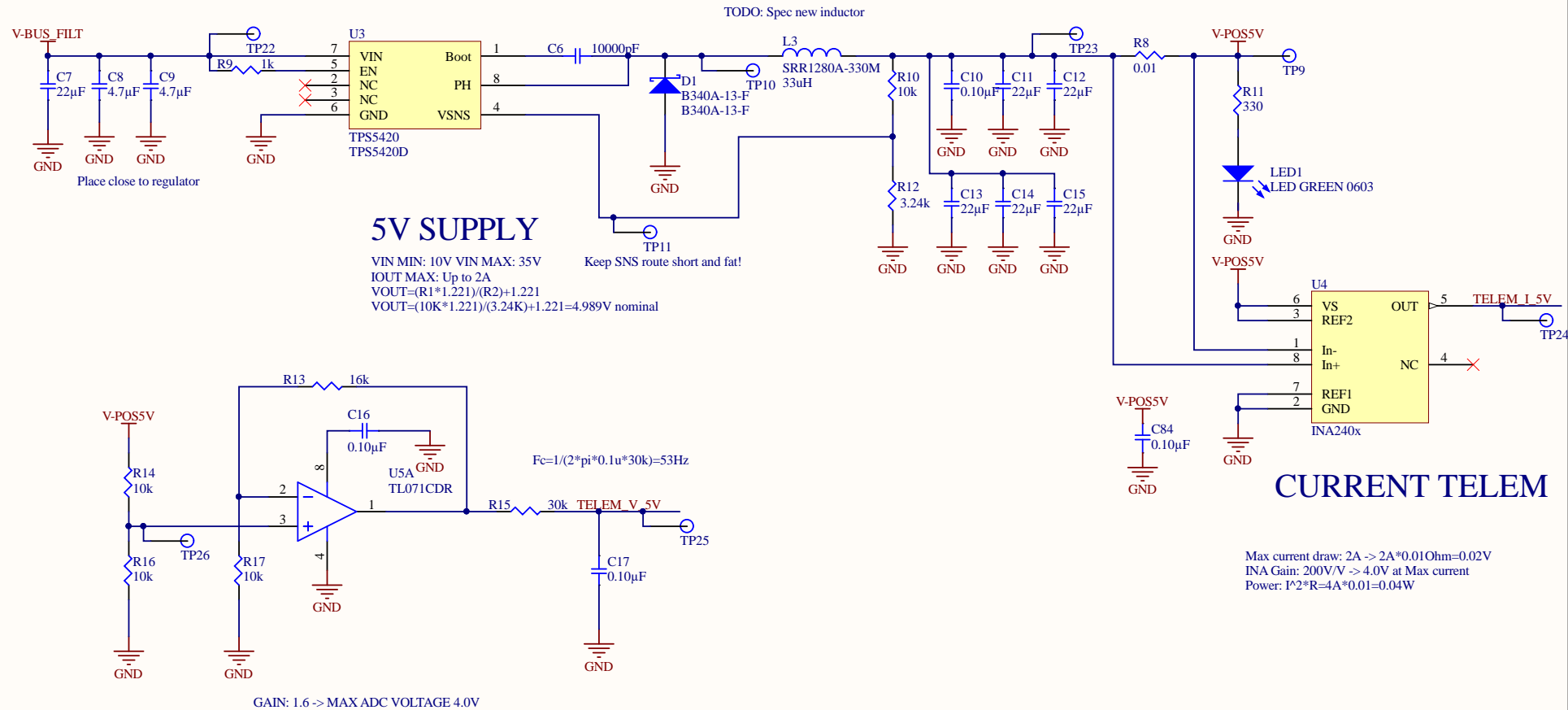
GAIN: 2.55 -> MAX ADC VOLTAGE 4.21V

VOLTAGE TELEMETRY

Title 3V3 SUPPLY			Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706		
Engineer:		Revision:			
Date: 9/9/2019	Time: 2:18:58 PM	Sheet	of		
File: power_3V3.SchDoc					

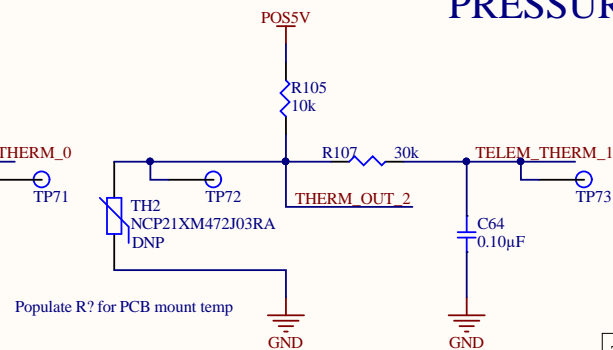
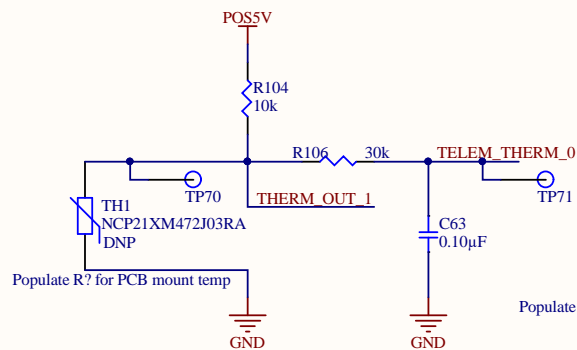
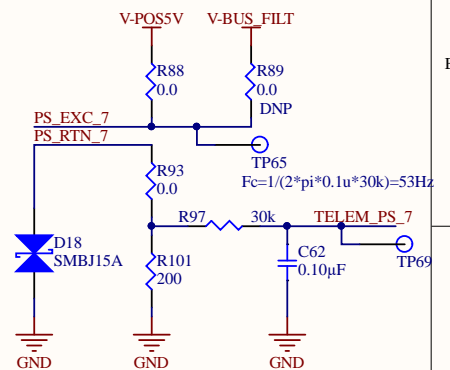
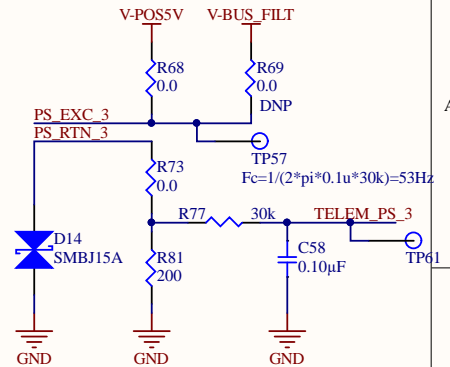
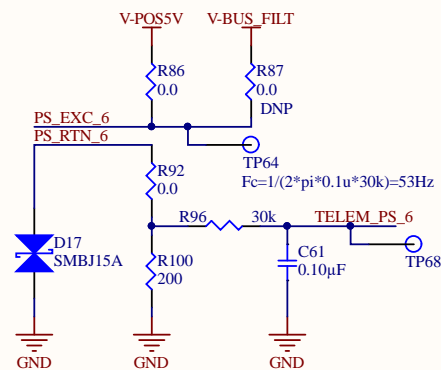
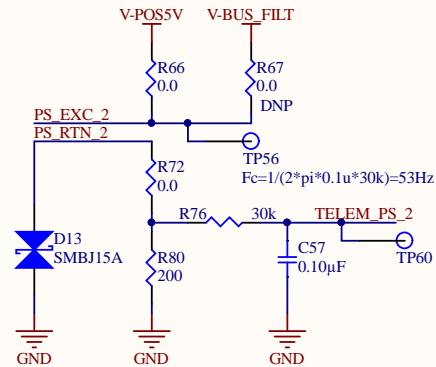
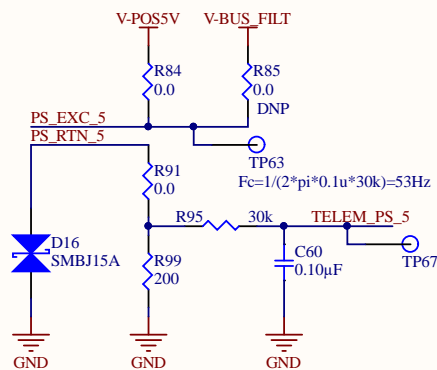
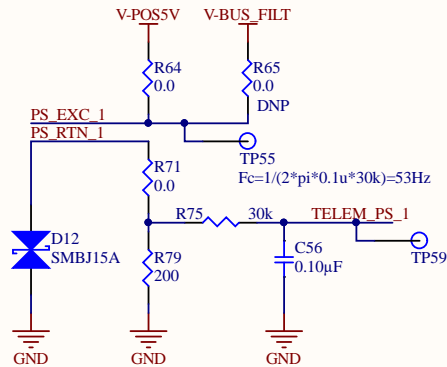
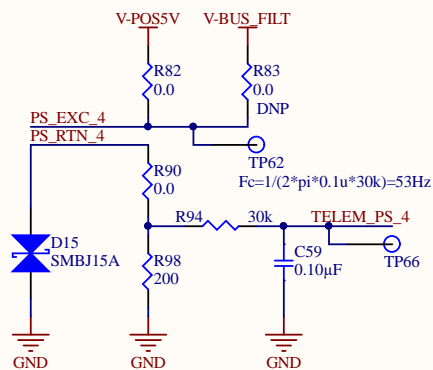
Notes:
 Follow layout reference design
 Place bypass caps close to regulator
 Keep hot loops as short as possible
 Possible to replace ceramic bulk cap with a tantalum.

Replace with Tantalum?
 Place close to regulator
[See https://github.com/badgerloop-software/hardware/tree/master/braking_io/design](https://github.com/badgerloop-software/hardware/tree/master/braking_io/design)



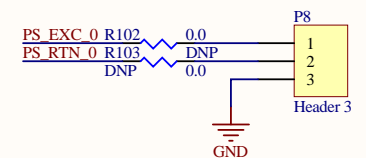
VOLTAGE TELEMETRY

Title		Badgerloop Electrical		
Engineer:		133 Engineering Research Building		
Date: 9/9/2019	Time: 2:18:59 PM	1500 Engineering Drive		
File: power_5V.SchDoc		Madison, WI 53706		
Revision:		Sheet of		




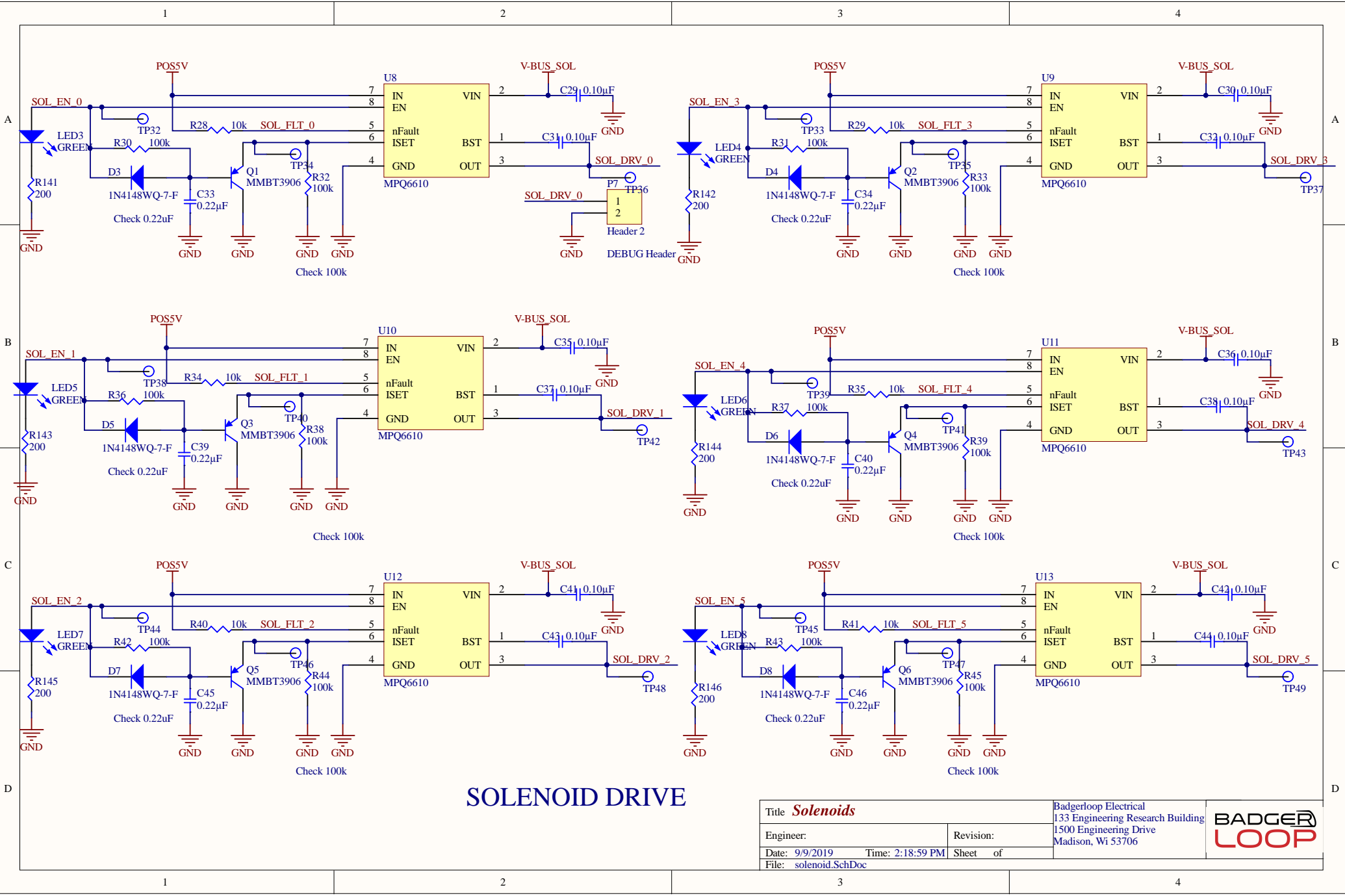
PRESSURE SENSORS

Populate Bottom resistor for current output
Current Min Output: $4\text{mA} \times 200 = 800\text{mV}$
Current Max Output: $20\text{mA} \times 200 = 4.0\text{V}$
Voltage Min Output: 0.5V
Voltage Max Output: 4.5V



TEMPERATURE

Title <i>Pressure Sensors</i>		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706		
Engineer:		Revision:		
Date: 9/9/2019	Time: 2:18:59 PM	Sheet	of	
File: pressure.SchDoc				

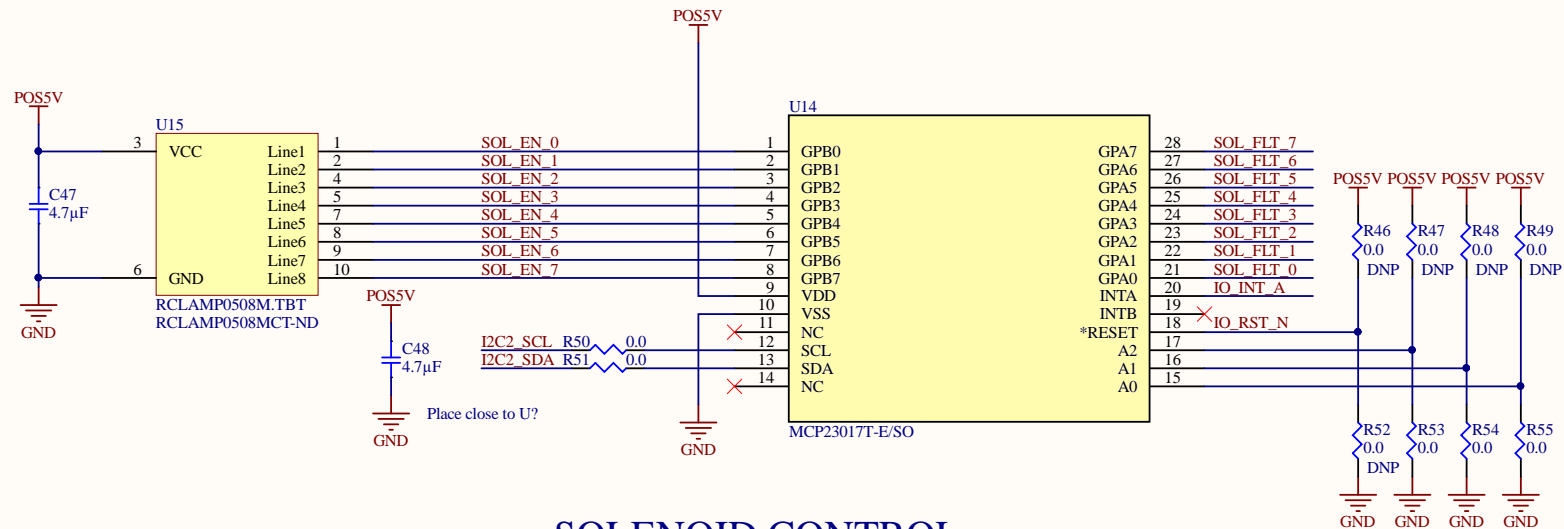


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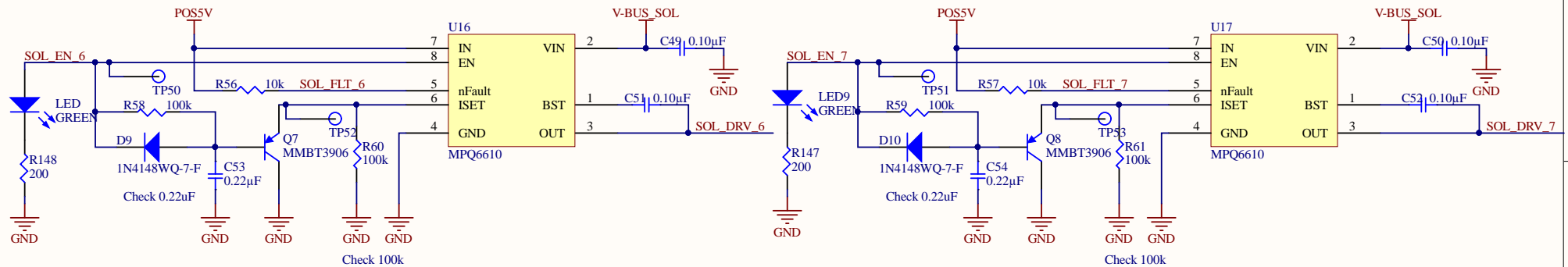
2

3


4



SOLENOID CONTROL



SOLENOID DRIVE

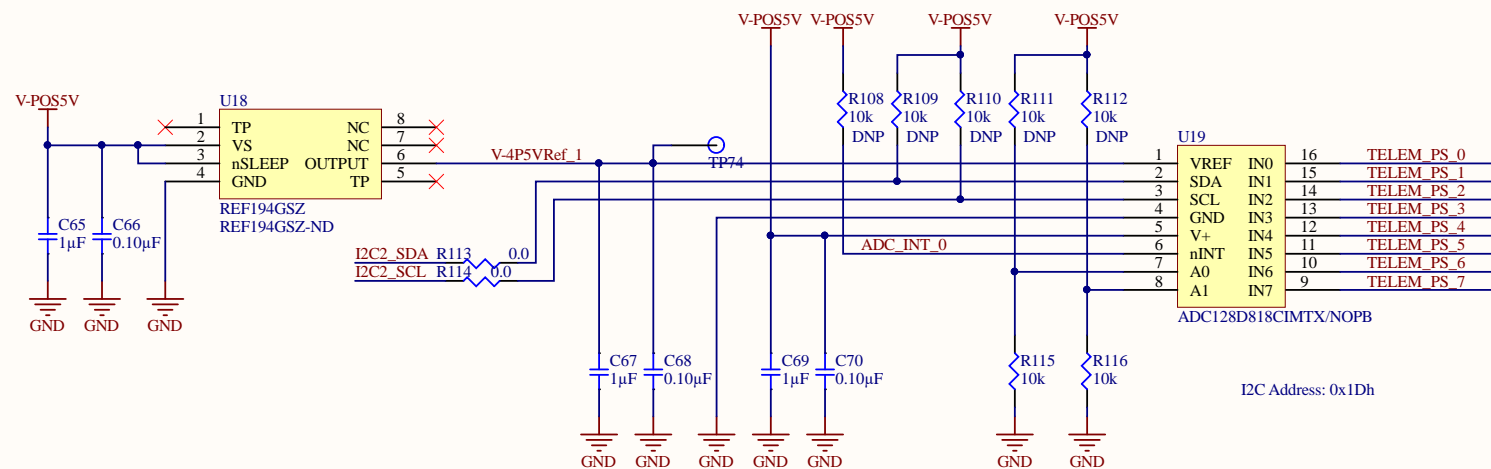
Title <i>Solenoid Control</i>		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706		
Engineer:		Revision:		
Date: 9/9/2019	Time: 2:18:59 PM	Sheet	of	
File: solenoid_drv.SchDoc				

1

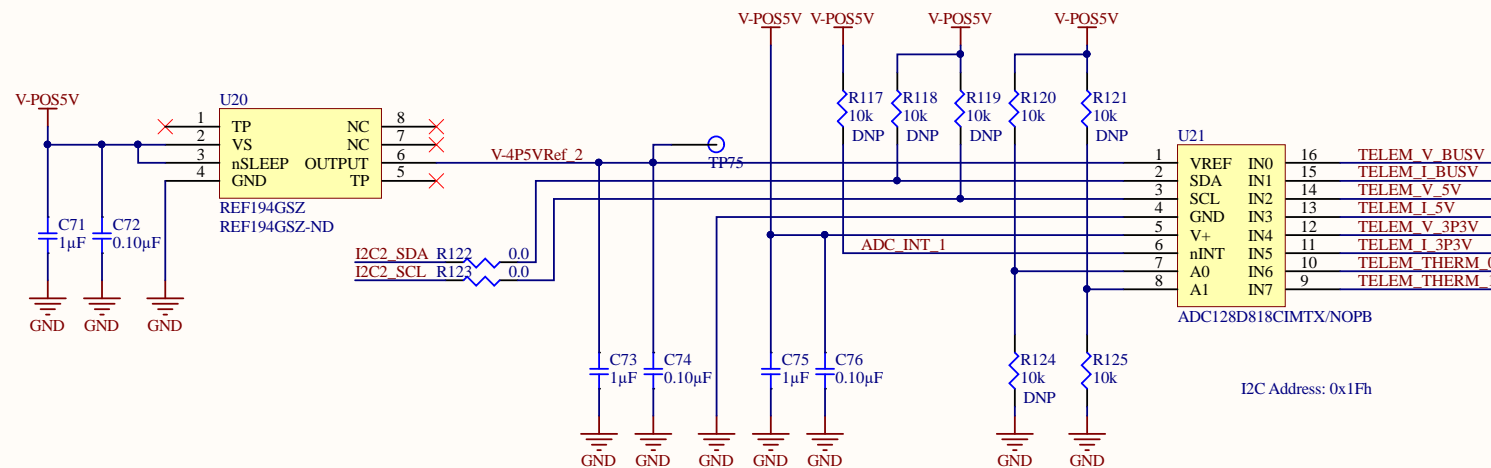
2

3


4

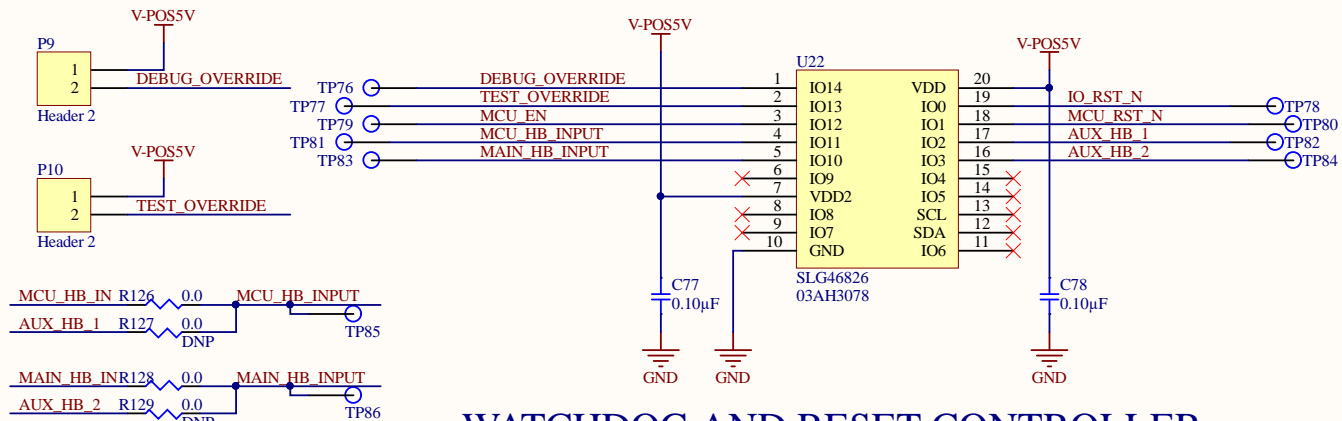


PRESSURE



RAIL AND TEMPERATURE

Title		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706		
Engineer:		Revision:		
Date: 9/9/2019	Time: 2:19:00 PM	Sheet	of	
File: telemetry_adc.SchDoc				



WATCHDOG AND RESET CONTROLLER

DEBUG

IO pin selection is arbitrary. Can be adjusted internally for better layout
Currently- Inputs on Left, outputs on right

Modes of operation:

Debug: EN signal is always on when SLG has power

Populate Jumper 1

Test: 10Hz signal internal signal is recirculated to mimic heartbeat

Populate Jumper 2


Operation: U? expects 10Hz heartbeat. If no heartbeat for 1s after 20s Power on reset

MCP RST_N will fall and MCU RST_N will pulse for 200ms

Silego Image here:

<https://github.com/badgerloop-software/hardware/blob/master/silego/watchdog.gp6>

Silego Image PDF Outputs:

Title <i>Watchdog</i>			Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706		
Engineer:		Revision:			
Date: 9/9/2019	Time: 2:19:00 PM	Sheet of			
File: watchdog_SchDoc					