

1 2 3 4

A


BRAKING IO

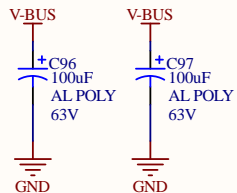
B

POD 5

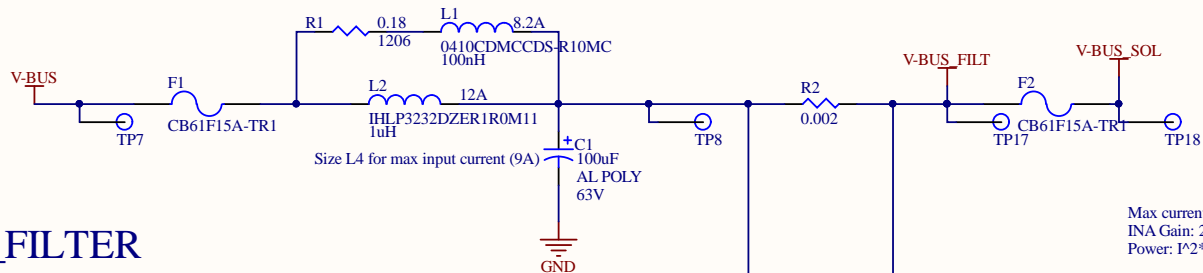
C

REV 1

Title <i>Braking IO PCB</i>		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706		
Engineer:		Revision:		
Date: 9/14/2019	Time: 11:10:59 PM	Sheet	of	
File: braking_io.SchDoc				



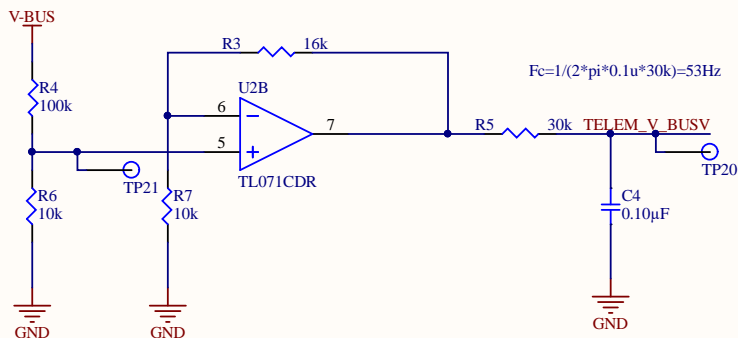
should change upstream fuse to be higher current rating than downstream.



BUS_FILTER

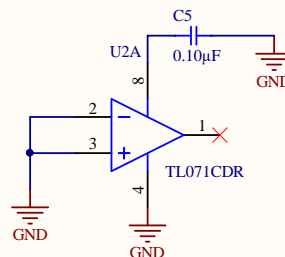
Filter design reference: <http://www.ti.com/lit/an/snva538/snva538.pdf>
<http://ece.colorado.edu/~rwe/papers/APEC99.pdf>

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



GAIN: 1.6V/V
 MIN BUS VOLTAGE: 20V \rightarrow 1.82V
 MIN BUS VOLTAGE: 28V \rightarrow 2.54V

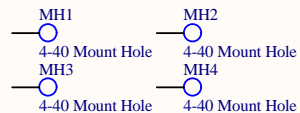
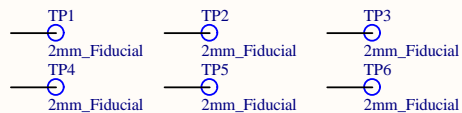
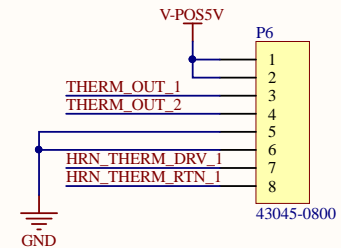
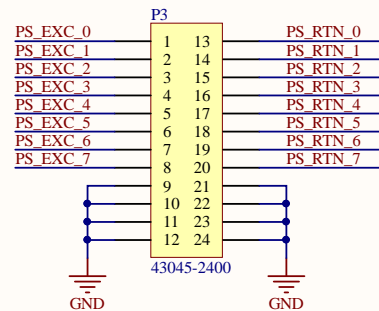
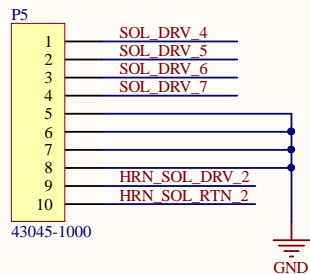
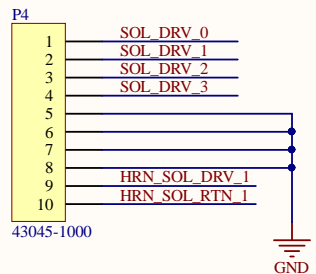
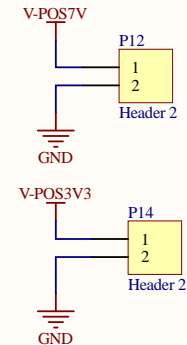
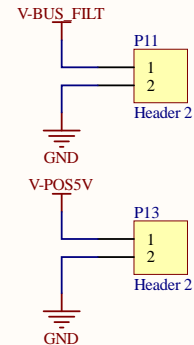
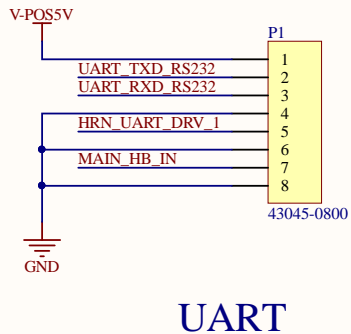
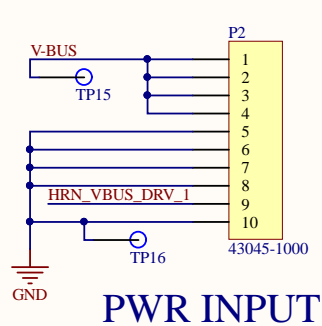
VOLTAGE TELEMETRY



CURRENT TELEM

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

Title Bus Filter		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706	
Engineer:		Revision:	
Date: 9/14/2019	Time: 11:10:59 PM	Sheet	of
File: bus_filter.SchDoc			

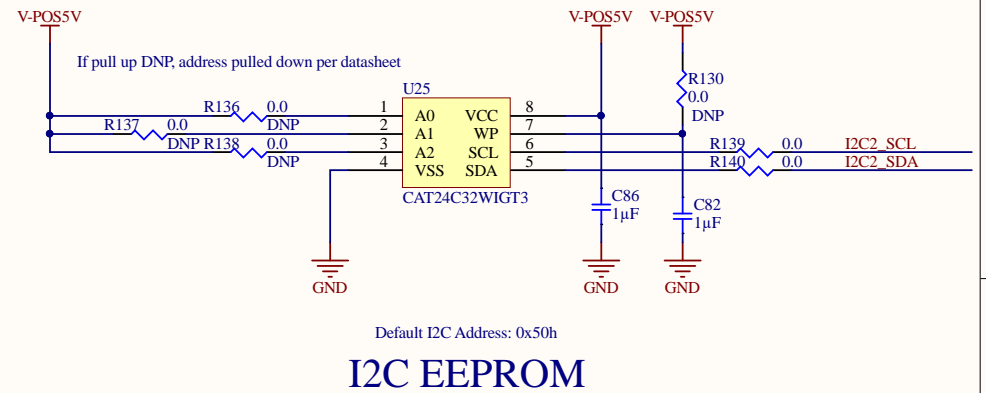
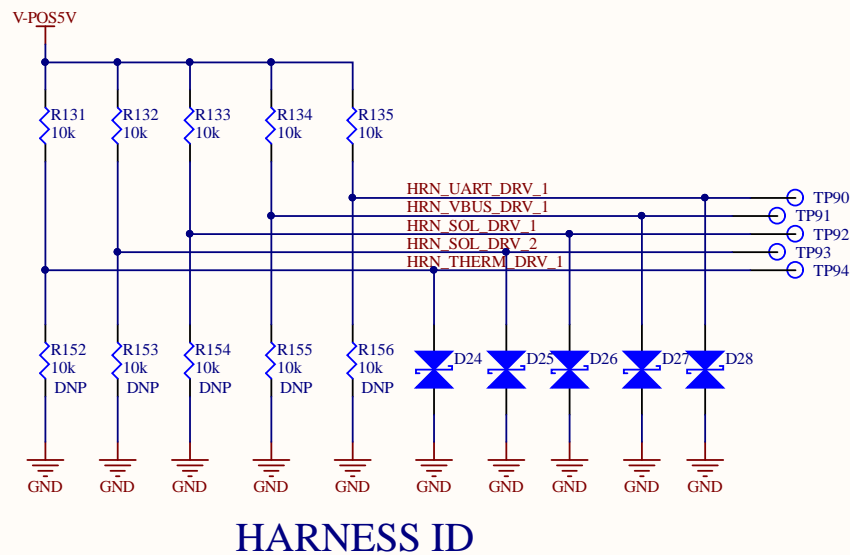
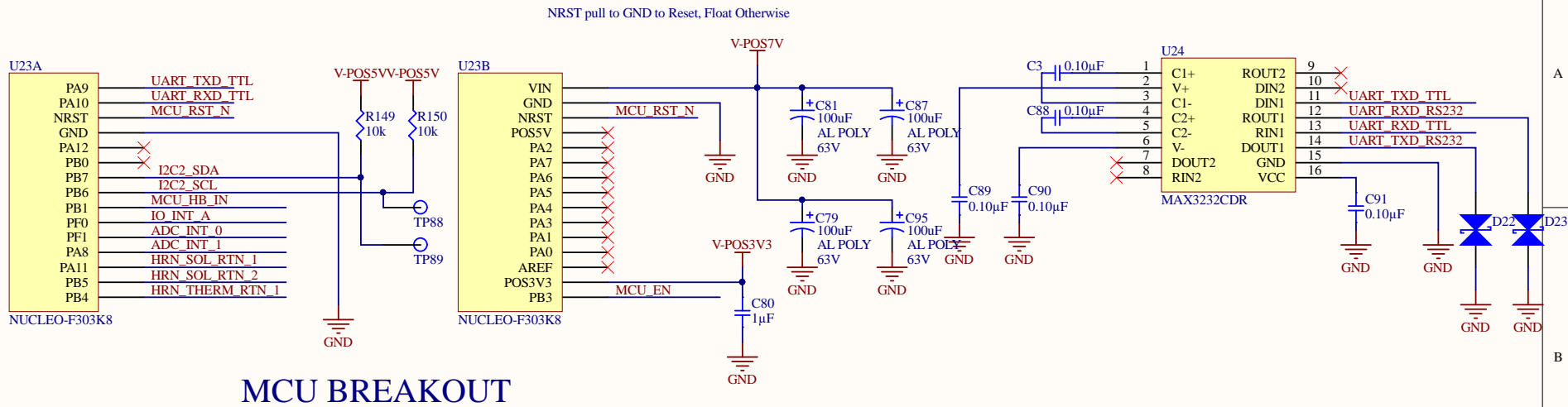


Place on corners of board

Avoid routing under screw head

Title Connectors		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706	
Engineer:	Revision:	Sheet of	
Date: 9/14/2019	Time: 11:10:59 PM		
File: connectors.SchDoc			





Title Microcontroller		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706	
Engineer:		Revision:	
Date: 9/14/2019	Time: 11:11:00 PM	Sheet	of
File: mcu.SchDoc		BADGER LOOP	

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A

V-POS24V
┆

B


B

C

C

D

D

Title Power 24V		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706		
Engineer:		Revision:		
Date: 9/14/2019	Time: 11:11:00 PM	Sheet	of	
File: power_24V.SchDoc				

1

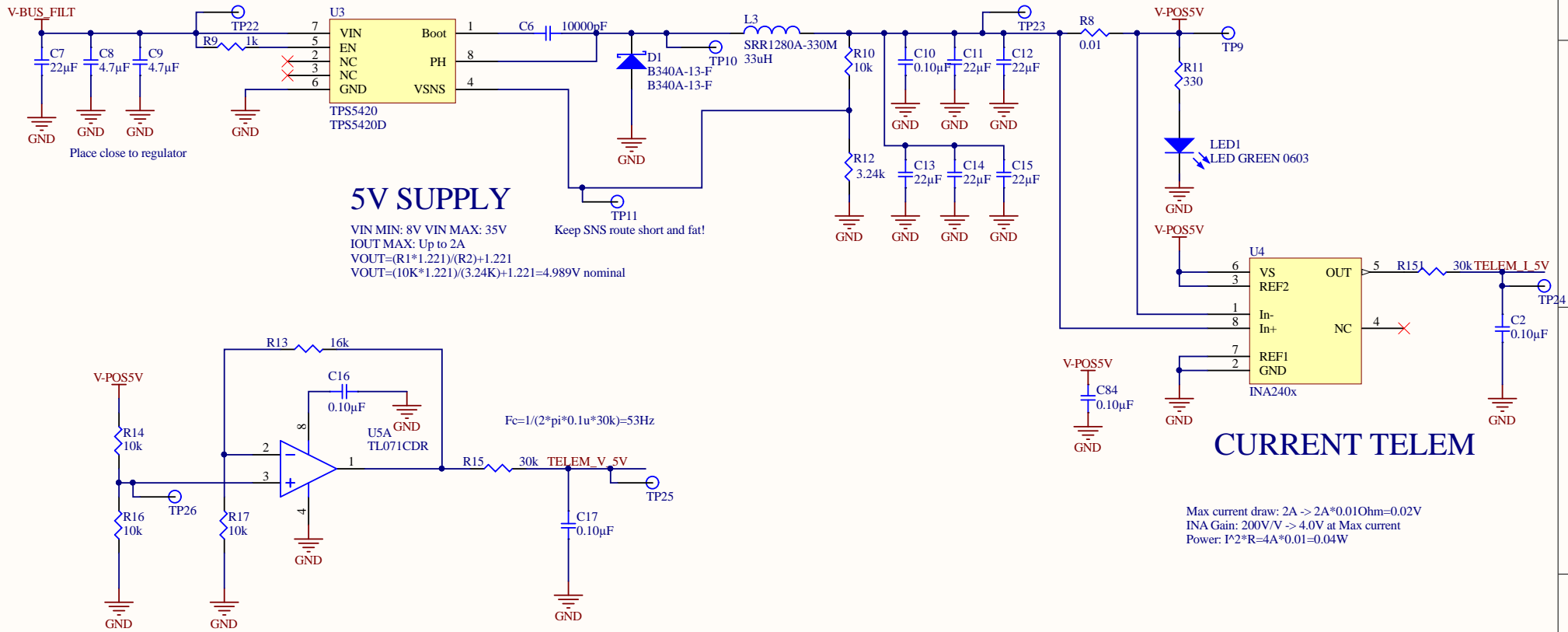
2

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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



5V SUPPLY

VIN MIN: 8V VIN MAX: 35V
IOUT MAX: Up to 2A
 $V_{OUT} = (R1 \cdot 1.221) / (R2) + 1.221$
 $V_{OUT} = (10K \cdot 1.221) / (3.24K) + 1.221 = 4.989V$ nominal

Keep SNS route short and fat!

CURRENT TELEM

Max current draw: $2A \rightarrow 2A \cdot 0.010\Omega = 0.02V$
INA Gain: $200V/V \rightarrow 4.0V$ at Max current
Power: $I^2 \cdot R = 4A \cdot 0.01 = 0.04W$

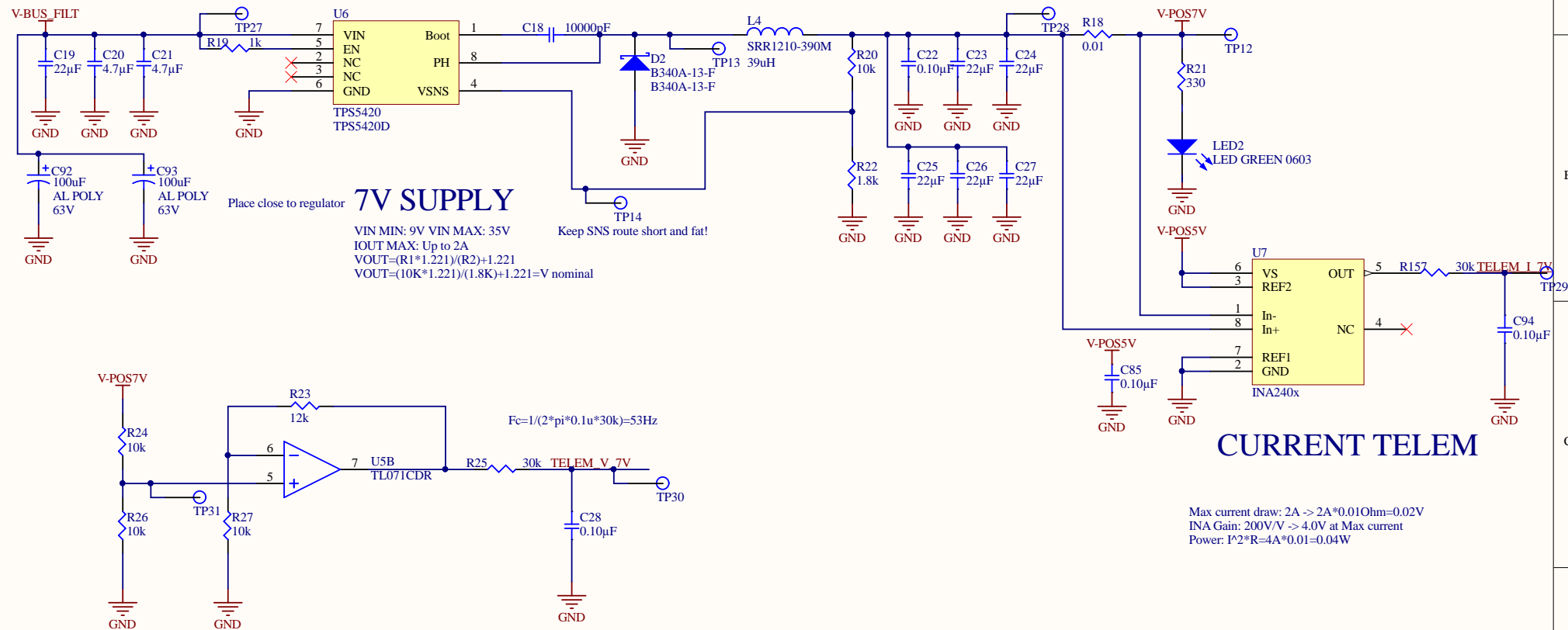
VOLTAGE TELEMETRY

GAIN: 1.6 \rightarrow MAX ADC VOLTAGE 4.0V

Title Power 5V		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706	
Engineer:	Revision:	BADGER LOOP	
Date: 9/14/2019	Time: 11:11:00 PM		
File: power_5V.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



GAIN: 1.2 -> MAX ADC VOLTAGE 4.20V

VOLTAGE TELEMETRY

Title 7V SUPPLY		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706	
Engineer:	Revision:	BADGER LOOP	
Date: 9/14/2019	Time: 11:11:00 PM		
File: power_7V.SchDoc	Sheet of		

1

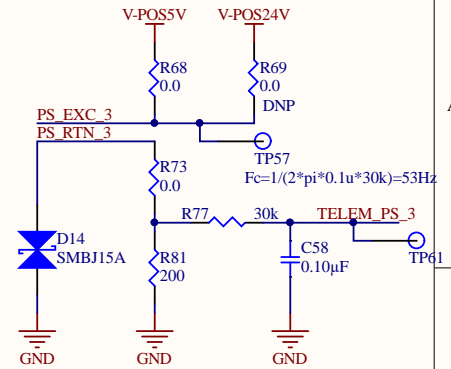
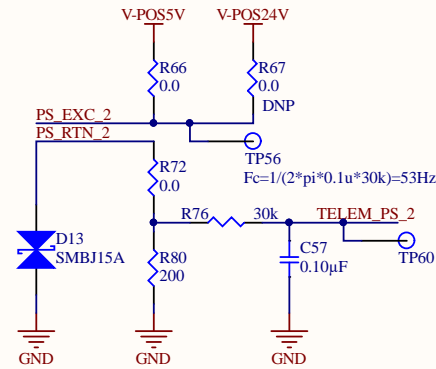
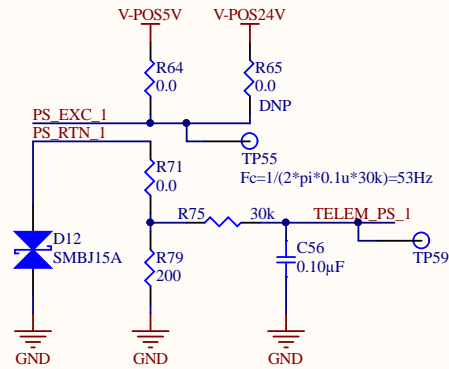
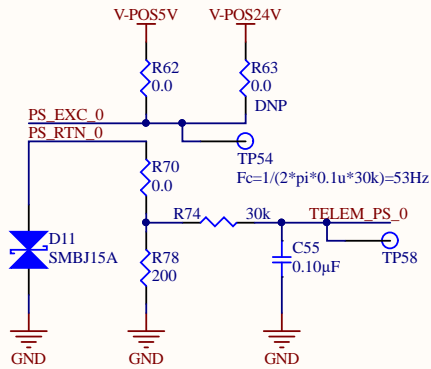
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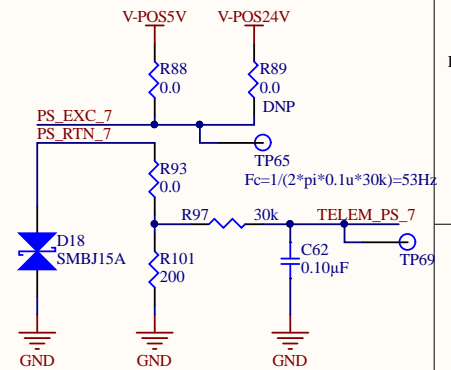
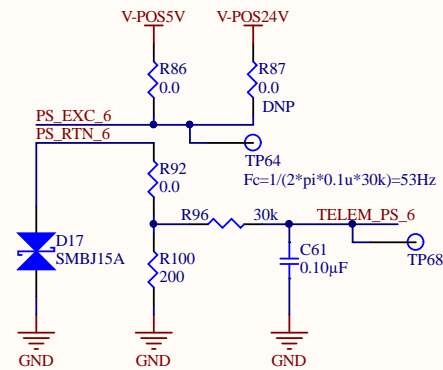
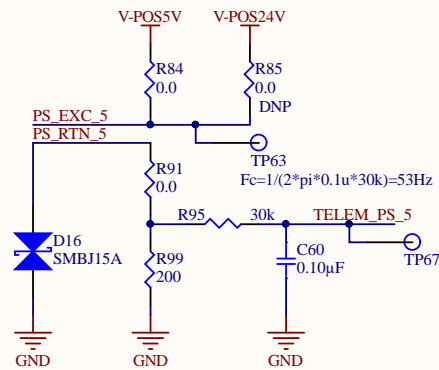
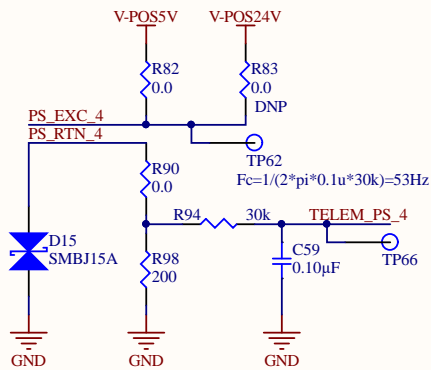
A

A



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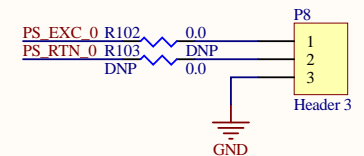


C

C

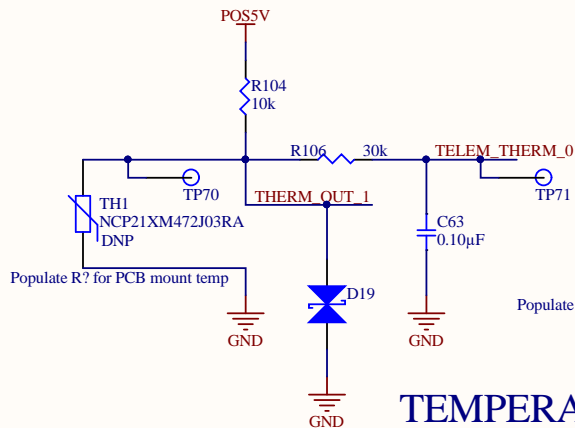
PRESSURE SENSORS

Populate Bottom resistor for current output
 Current Min Output: 4mA*200=800mV
 Current Max Output: 20mA*200=4.0V
 Voltage Min Output: 0.5V
 Voltage Max Output: 4.5V

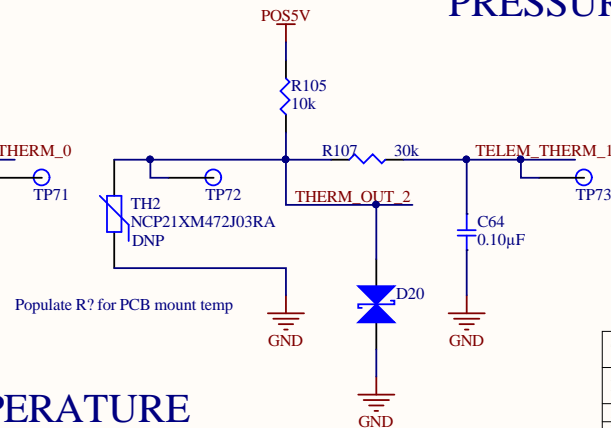


D

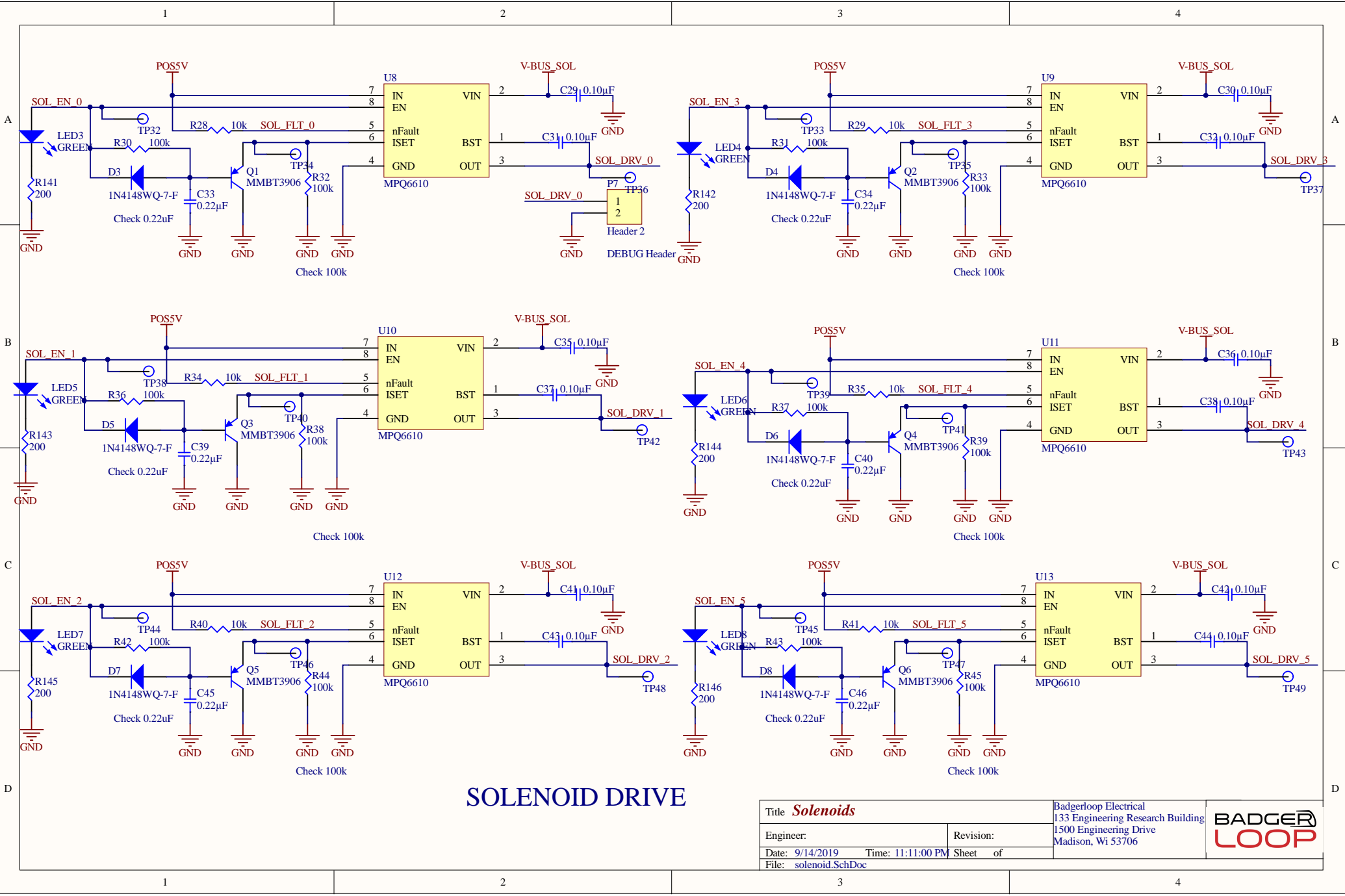
D



TEMPERATURE



Title Pressure Sensors		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706	
Engineer:		Revision:	
Date: 9/14/2019	Time: 11:11:00 PM	Sheet	of
File: pressure.SchDoc		BADGER LOOP	



SOLENOID DRIVE

Title <i>Solenoids</i>		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706	
Engineer:		Revision:	
Date: 9/14/2019	Time: 11:11:00 PM	Sheet	of
File: solenoid.SchDoc			

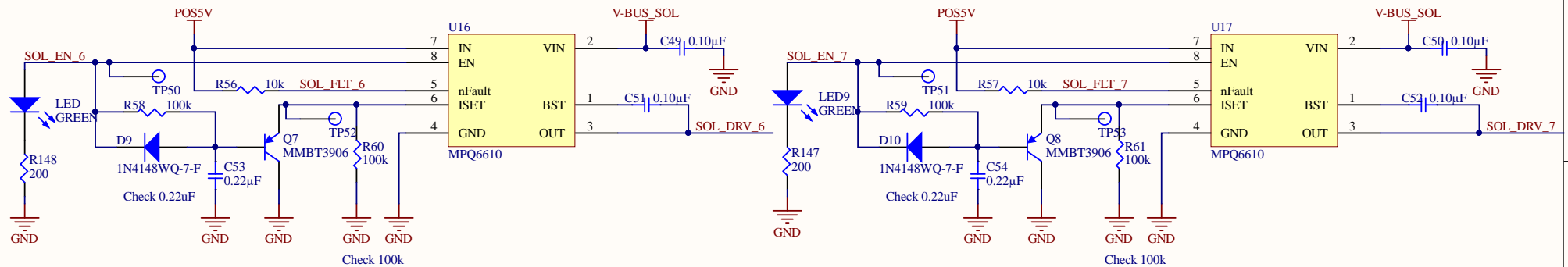
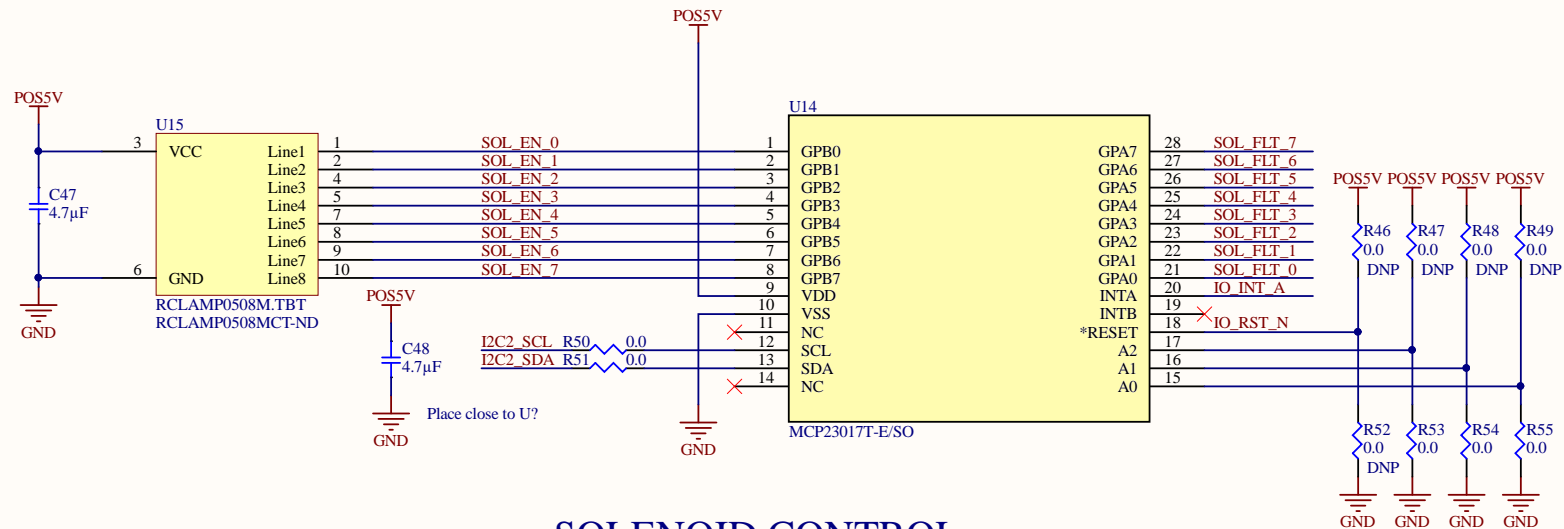


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Note: Connect LEDs to Solenoid line externally for easy identification

Title **Solenoid Control**

Engineer:

Date: 9/14/2019

File: solenoid_drv.SchDoc

Revision:

Time: 11:11:01 PM

Sheet of

Badgerloop Electrical
133 Engineering Research Building
1500 Engineering Drive
Madison, WI 53706

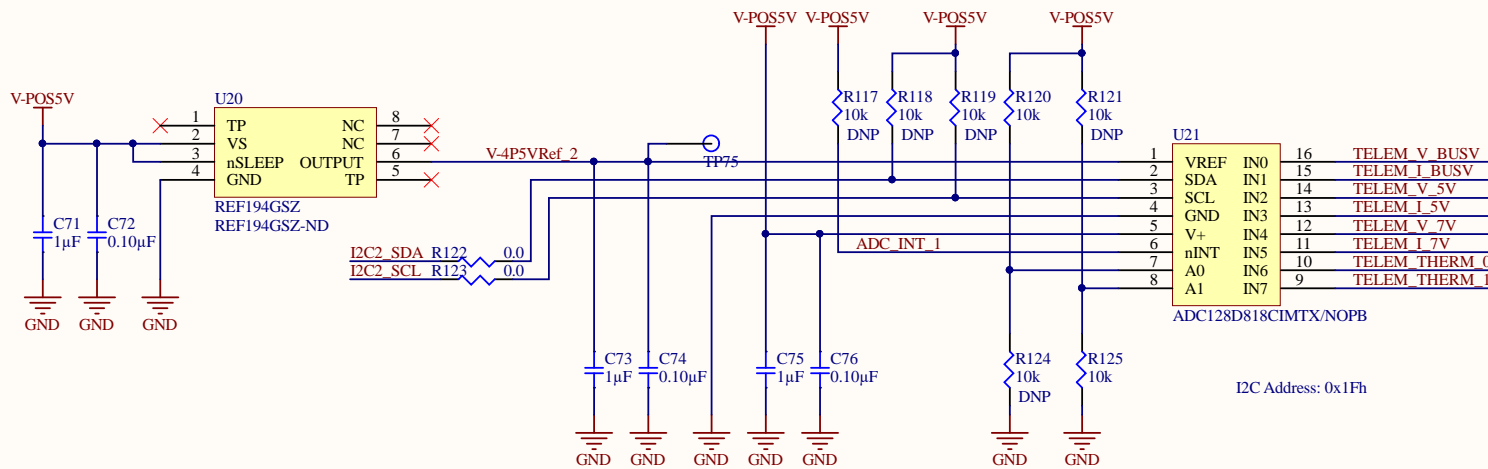
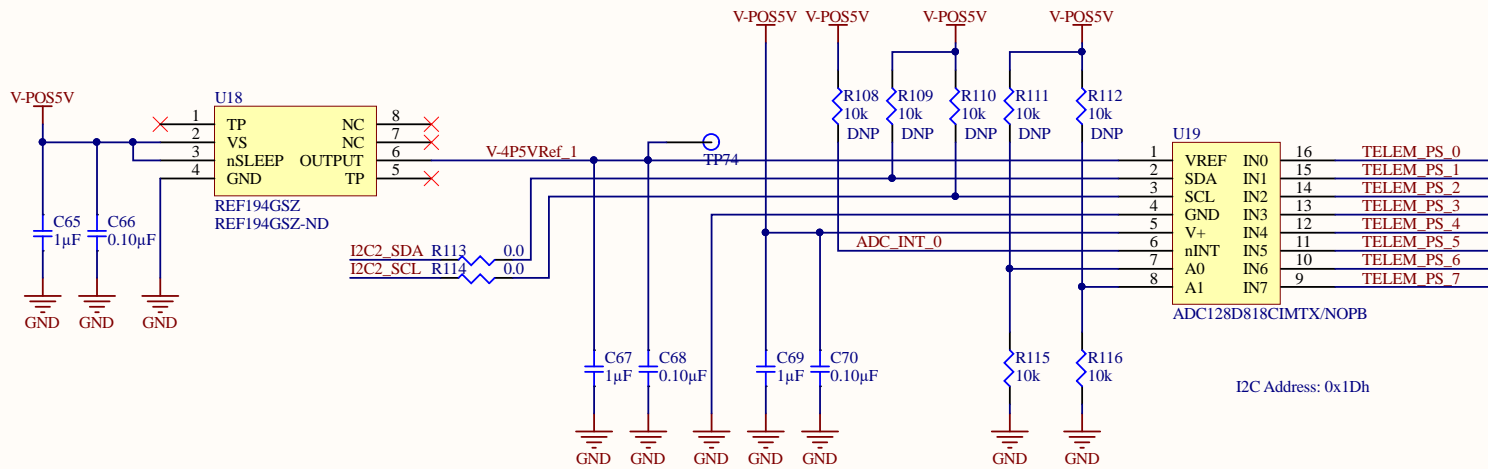
BADGER
LOOP

1

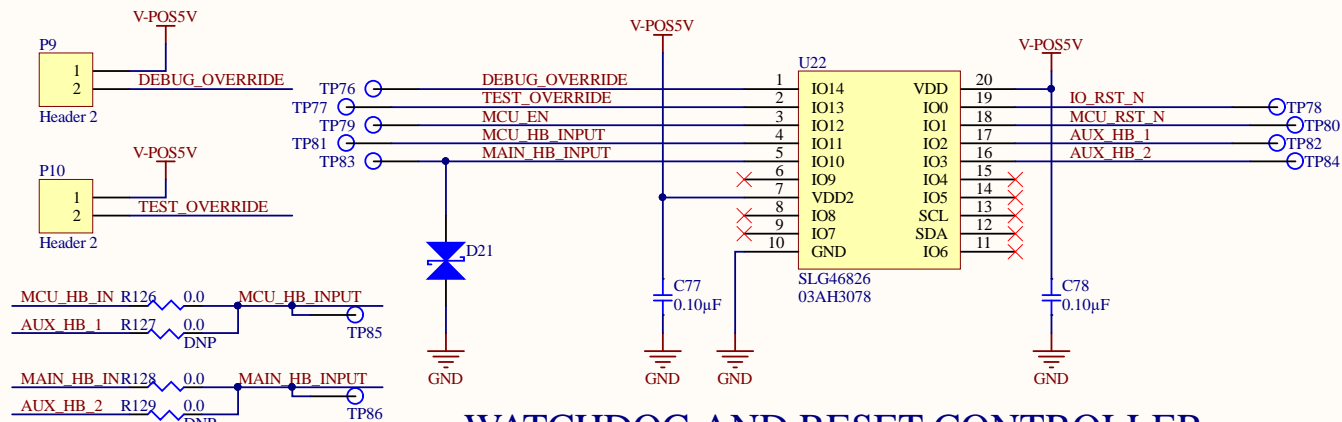
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Title ADC		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706	
Engineer:	Revision:	BADGER LOOP	
Date: 9/14/2019	Time: 11:11:01 PM		
File: telemetry_adc.SchDoc	Sheet of		



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: 9/14/2019	Time: 11:11:01 PM	Sheet	of		
File: watchdog.SchDoc					