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# BRAKING IO

## POD 5

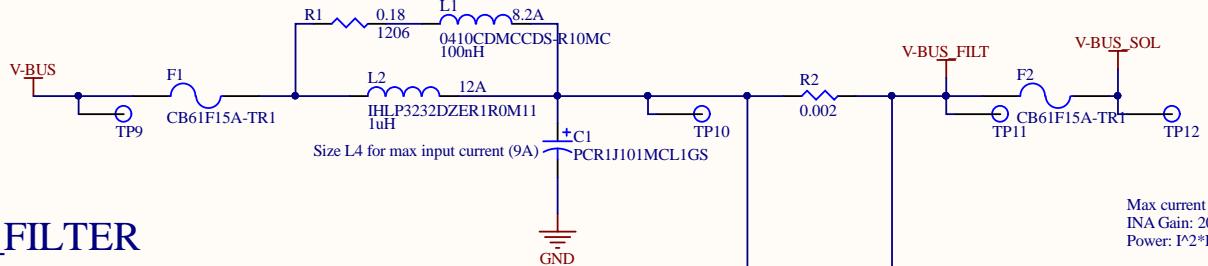
### REV 1

Title <b>Braking IO PCB</b>		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706	
Engineer:	Revision:		

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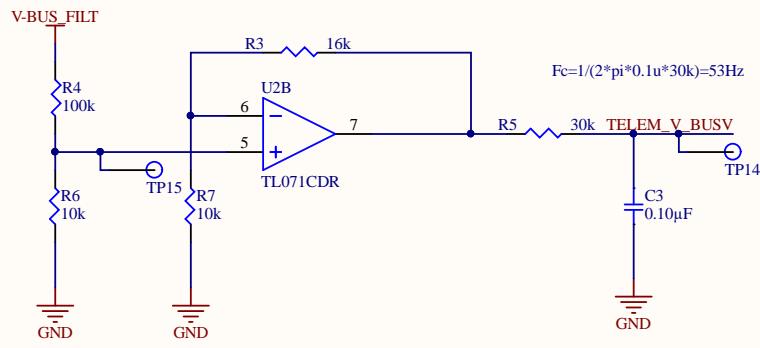
should change upstream fuse to be higher current rating than downstream.



## BUS\_FILTER

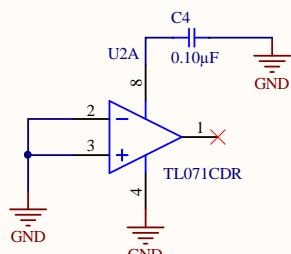
Filter design reference: <http://www.ti.com/lit/an/snva538/snva538.pdf>  
<http://ecee.colorado.edu/~rwe/papers/APEC99.pdf>

Max current draw:  $9A \rightarrow 9A \cdot 0.01\Omega = 0.09V$   
 INA Gain:  $200V/V \rightarrow 4.0V$  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 TELEM

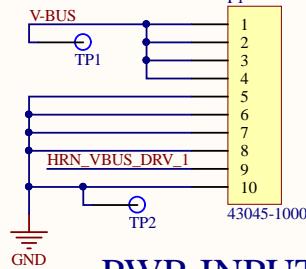
Max current draw:  $9A \rightarrow 9A \cdot 0.002\Omega = 0.018V$   
 INA Gain:  $200V/V \rightarrow 3.6V$  at Max current  
 Power:  $I^2 \cdot R = 4A \cdot 0.01 = 0.04W$

Title <b>Bus Filter</b>		Badgerloop Electrical
Engineer:	Revision:	133 Engineering Research Building
Date: 10/1/2019	Time: 11:45:31 PM	1500 Engineering Drive
File: bus_filter.SchDoc		Madison, WI 53706

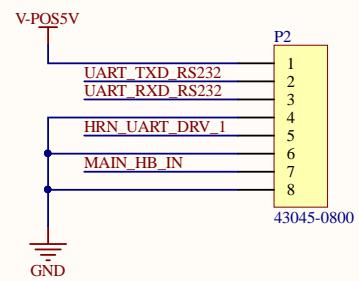
**BADGER**  
**LOOP**

1 2 3 4

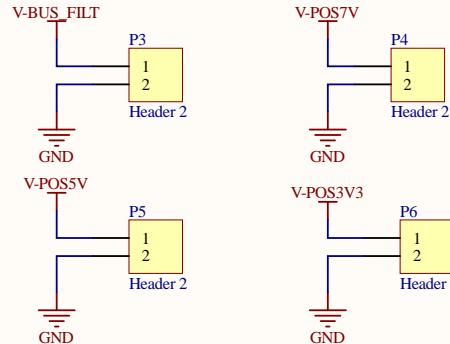
A



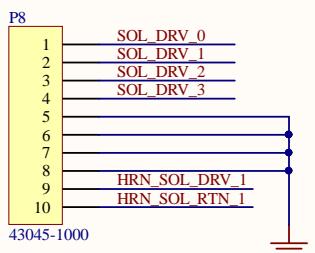
PWR INPUT



UART

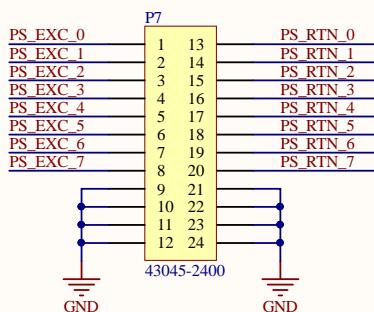
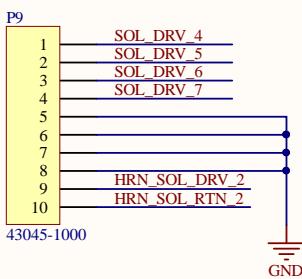


DEBUG

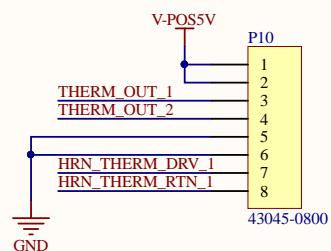


SOLENOIDS

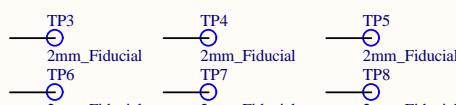
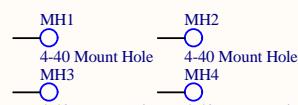
Split into 2 connectors as only 4 solenoids are likely to be used



PRESSURE SENSORS



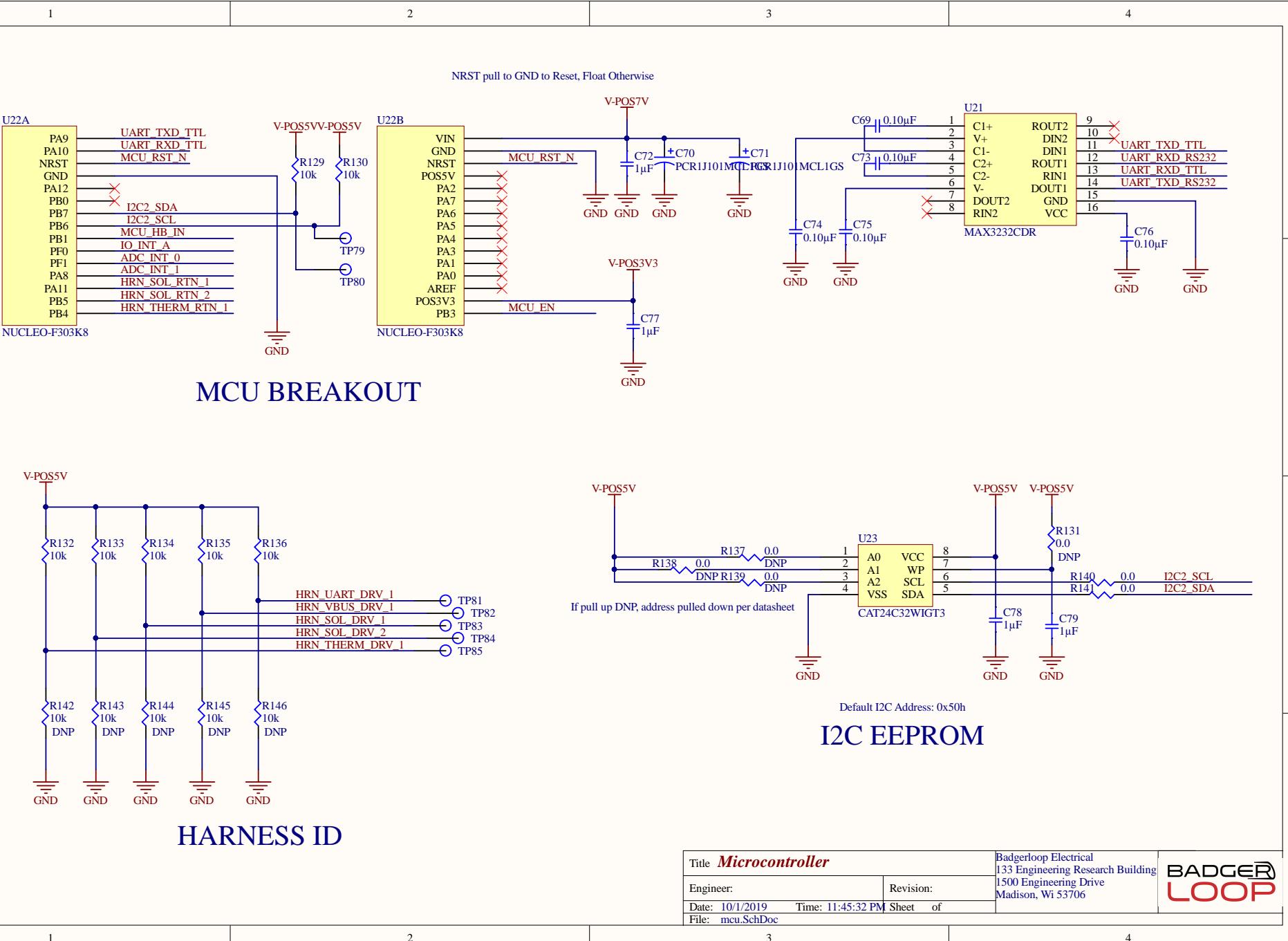
THERMISTORS

Fiducials  
Place on four corners of boardMount Holes  
Avoid routing under screw head

Title <b>Connectors</b>		Badgerloop Electrical
Engineer:	Revision:	133 Engineering Research Building
Date: 10/1/2019	Time: 11:45:31 PM	1500 Engineering Drive
File: connectors.SchDoc		Madison, Wi 53706

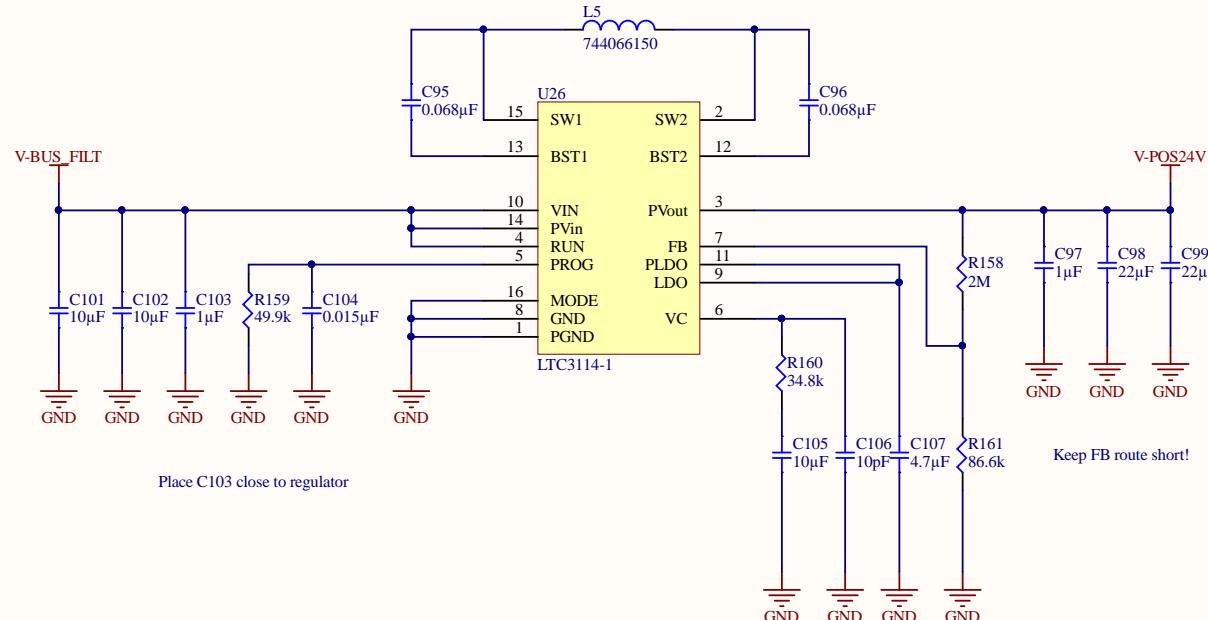
**BADGER**  
**LOOP**

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Title **Power 24V**

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

**BADGER**  
**LOOP**

Engineer:	Revision:
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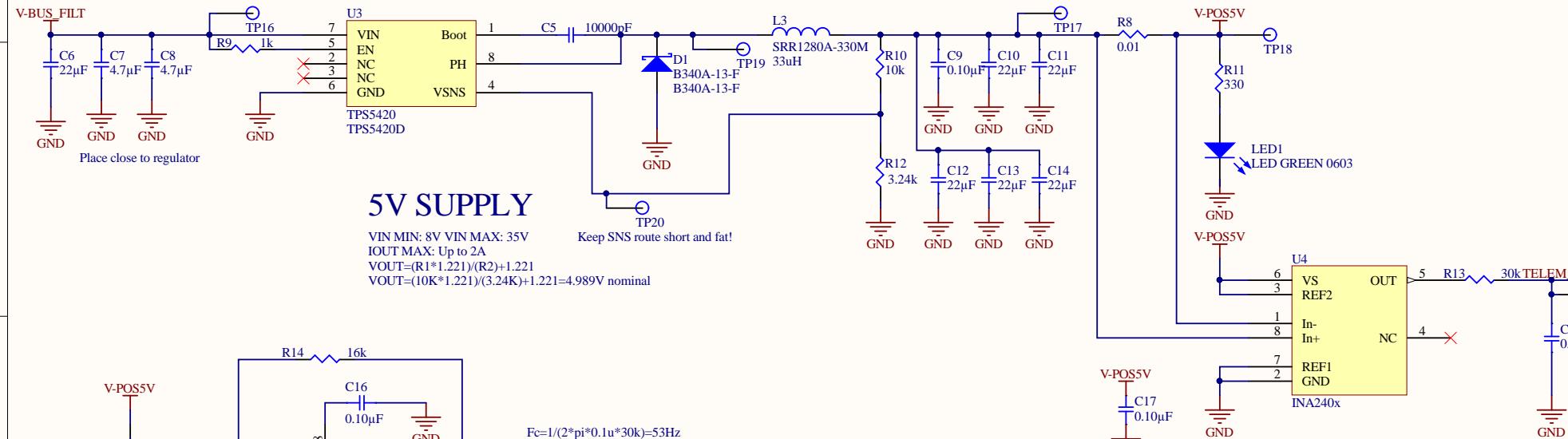
Date: 10/1/2019	Time: 11:45:32 PM	Sheet of
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File: power_24V.SchDoc
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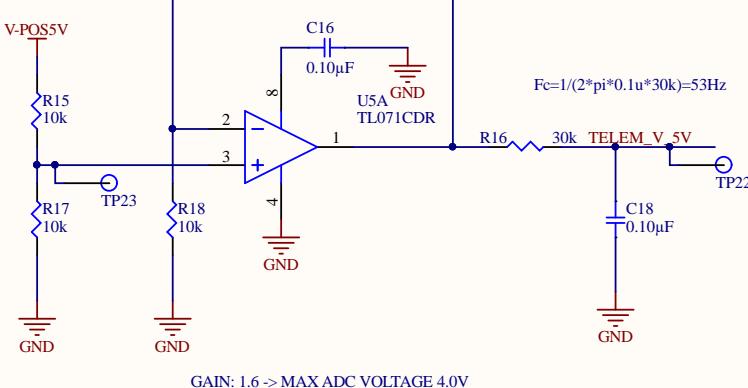
Notes:  
Follow layout reference design  
Place bypass caps close to regulator  
Keep hot loops as short as possible  
Possible to replace ceramic bulk cap with a tantalum.

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



## CURRENT TELEMETRY

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



## VOLTAGE TELEMETRY

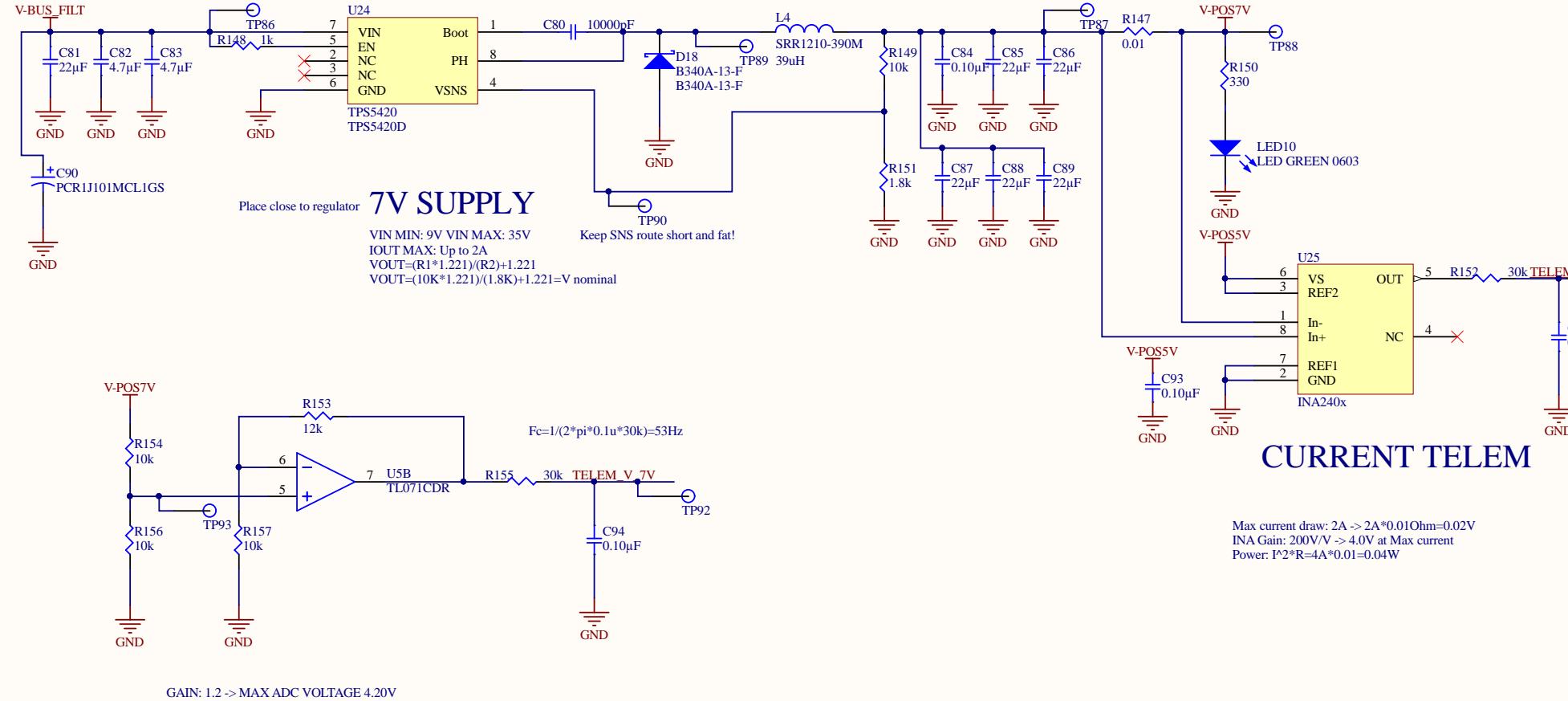
Title	Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706	
Engineer:	Revision:	
Date: 10/1/2019	Time: 11:45:32 PM	Sheet of
File: power_5V.SchDoc		

**BADGER**  
**LOOP**

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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](https://github.com/badgerloop-software/hardware/tree/master/braking_io/design)

Title **7V SUPPLY**

Engineer:

Revision:

Date: 10/1/2019

Time: 11:45:32 PM

Sheet of

File: power\_7V.SchDoc

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

**BADGER**  
**LOOP**

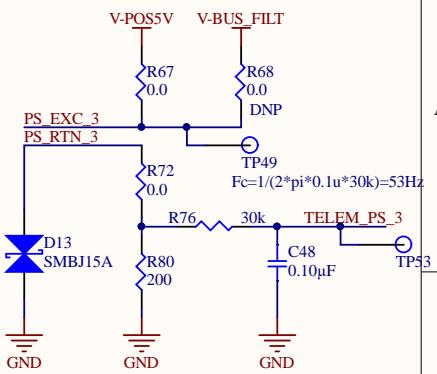
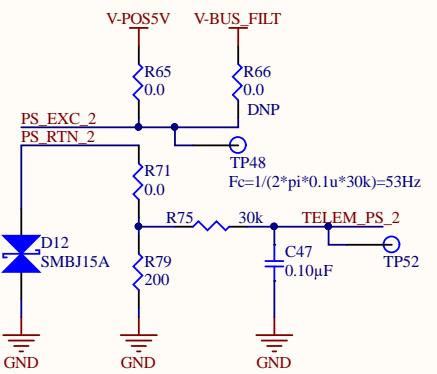
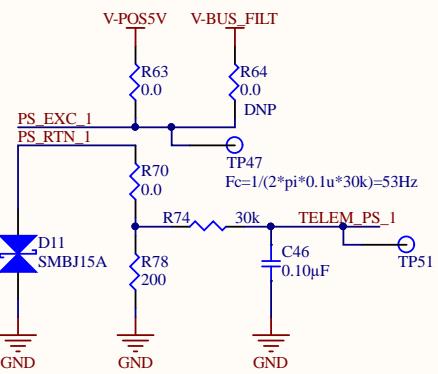
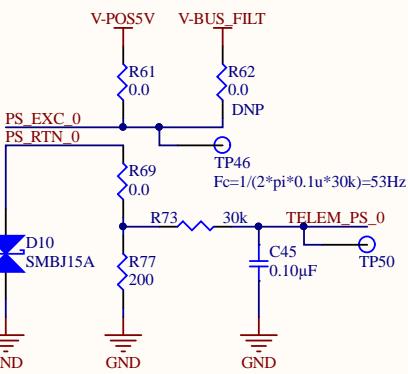
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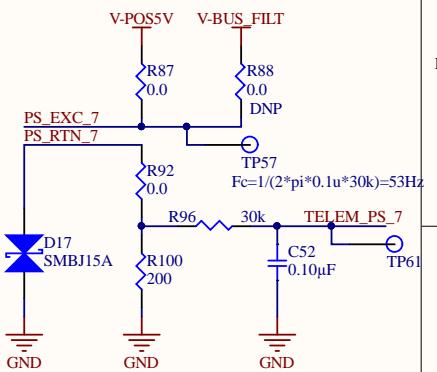
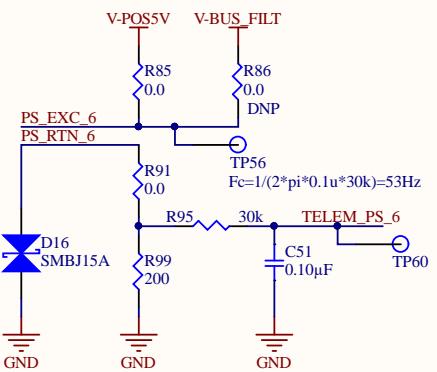
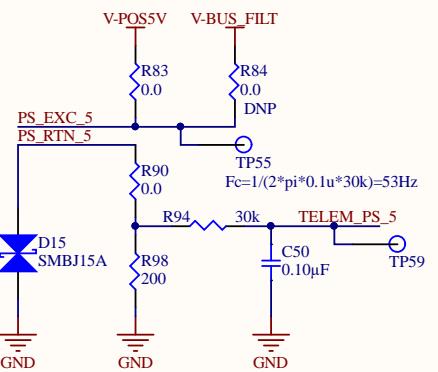
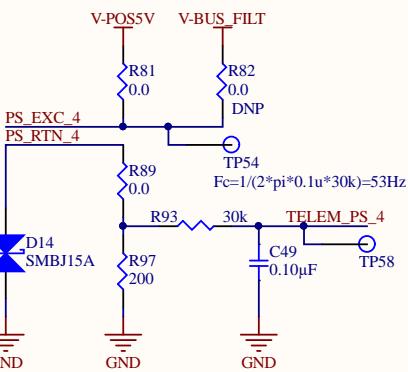
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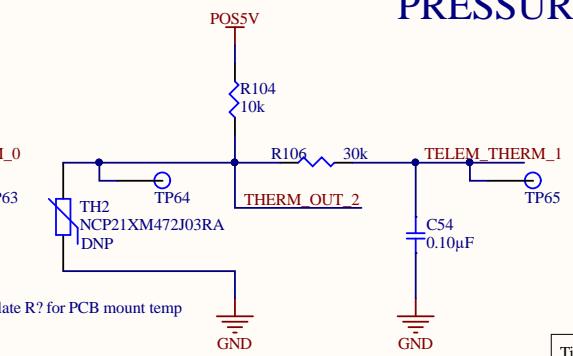
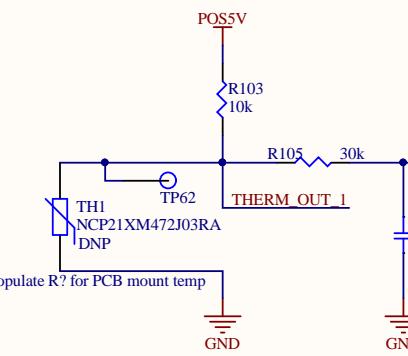
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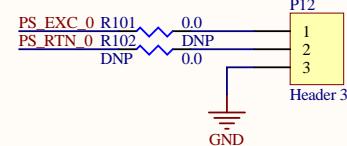
C



## TEMPERATURE

## 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



Title **Pressure Sensors**

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

**BADGER**  
**LOOP**

Engineer:

Revision:

Date: 10/1/2019 Time: 11:45:33 PM Sheet of

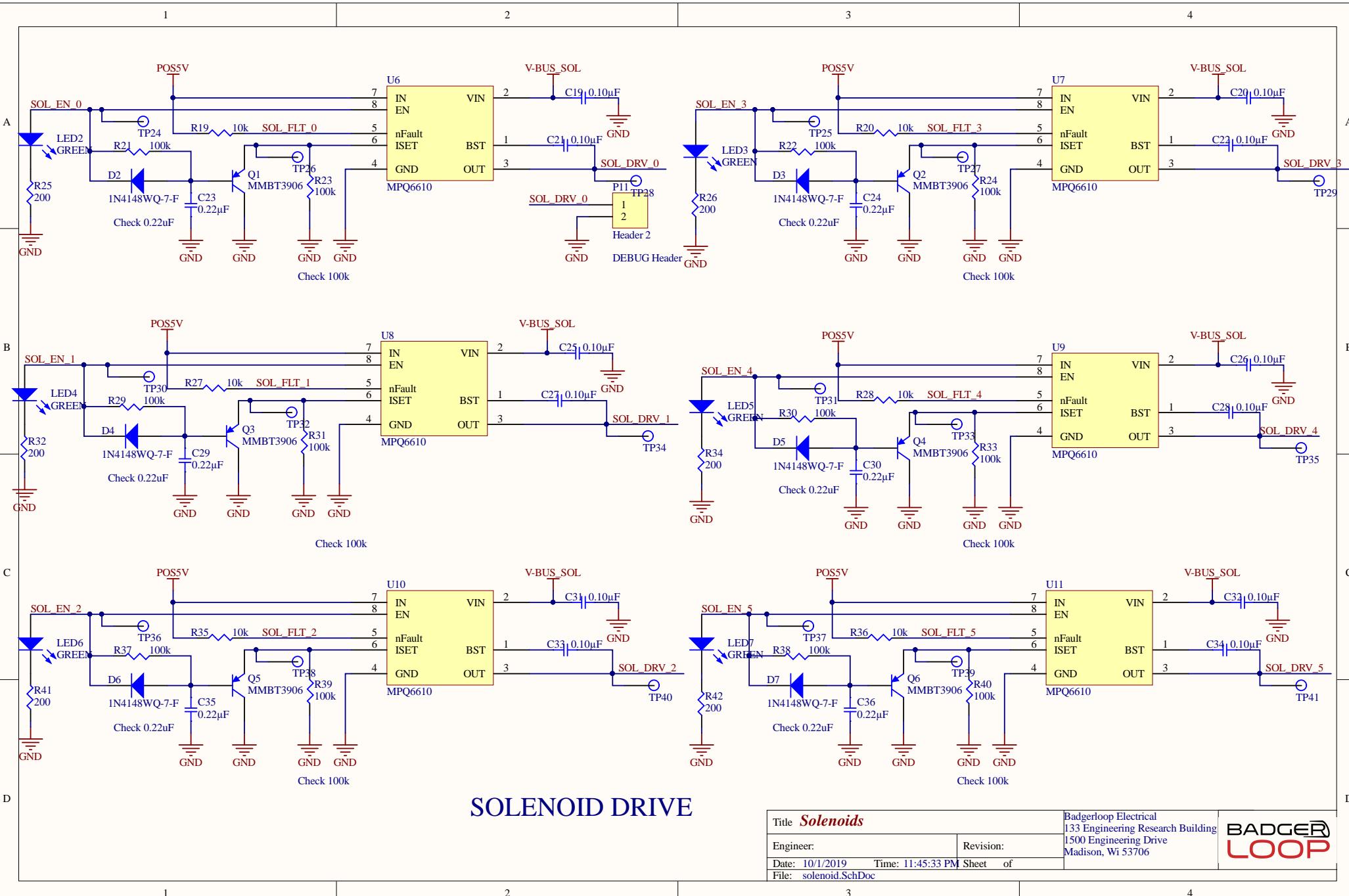
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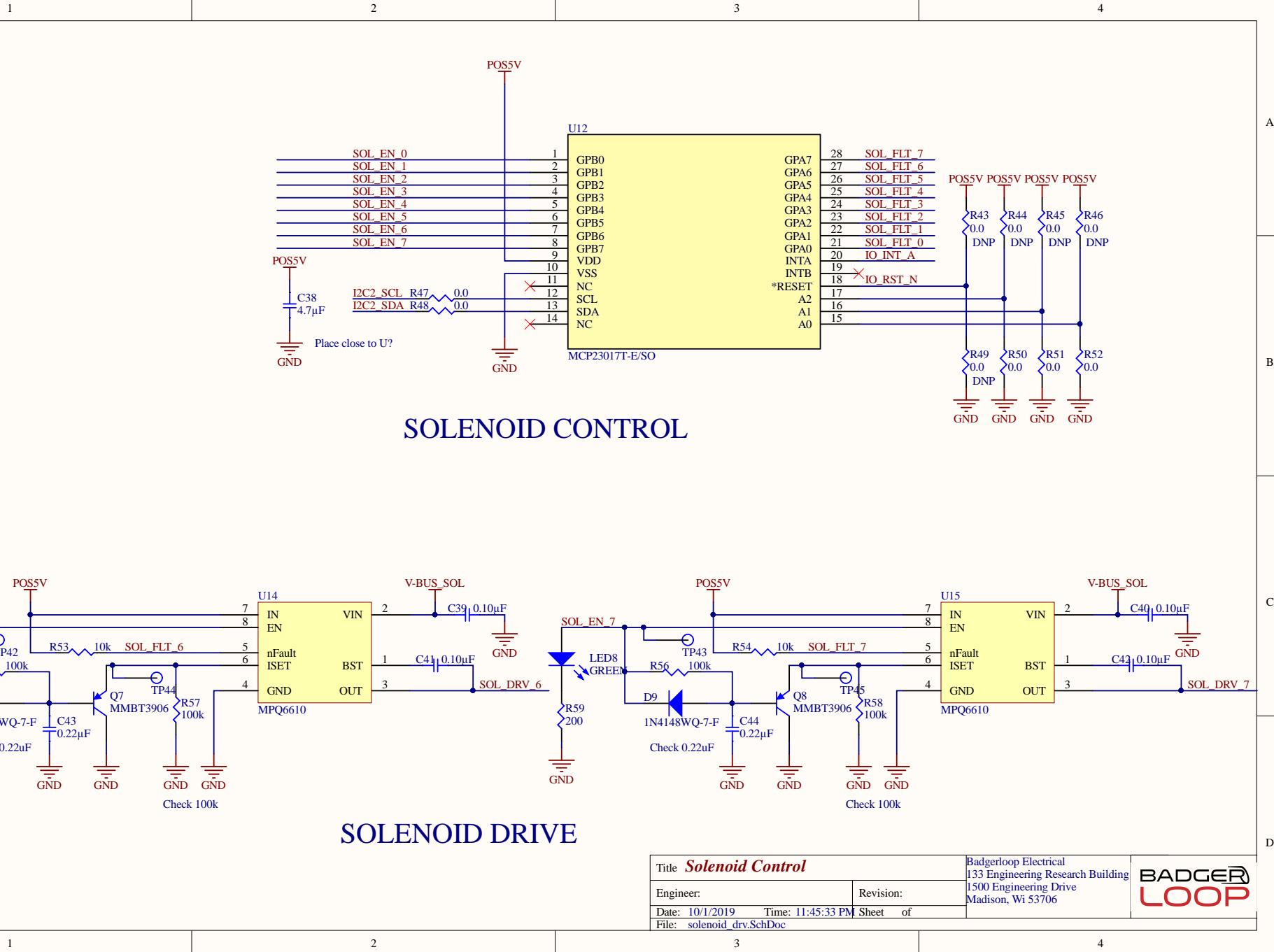
3

4



Title <b>Solenoids</b>		Badgerloop Electrical
Engineer:	Revision:	133 Engineering Research Building
Date: 10/1/2019	Time: 11:45:33 PM	1500 Engineering Drive
File: solenoid.SchDoc		Madison, WI 53706

**BADGER  
LOOP**



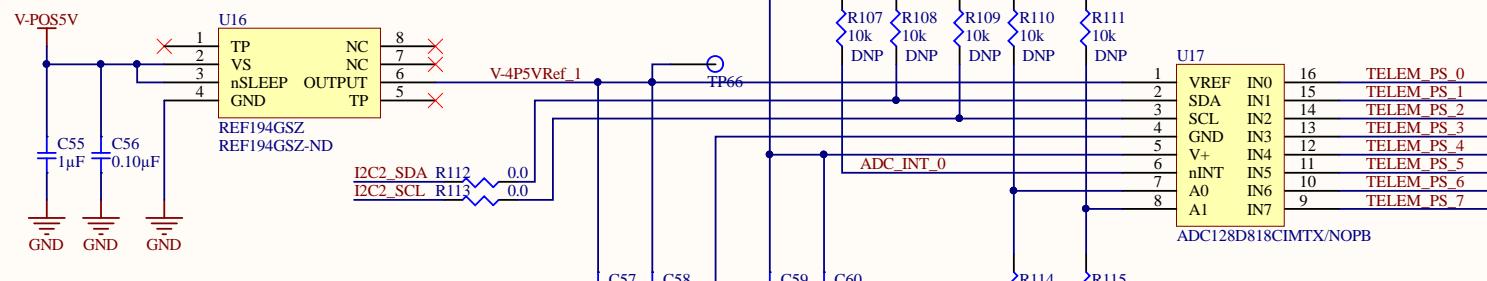
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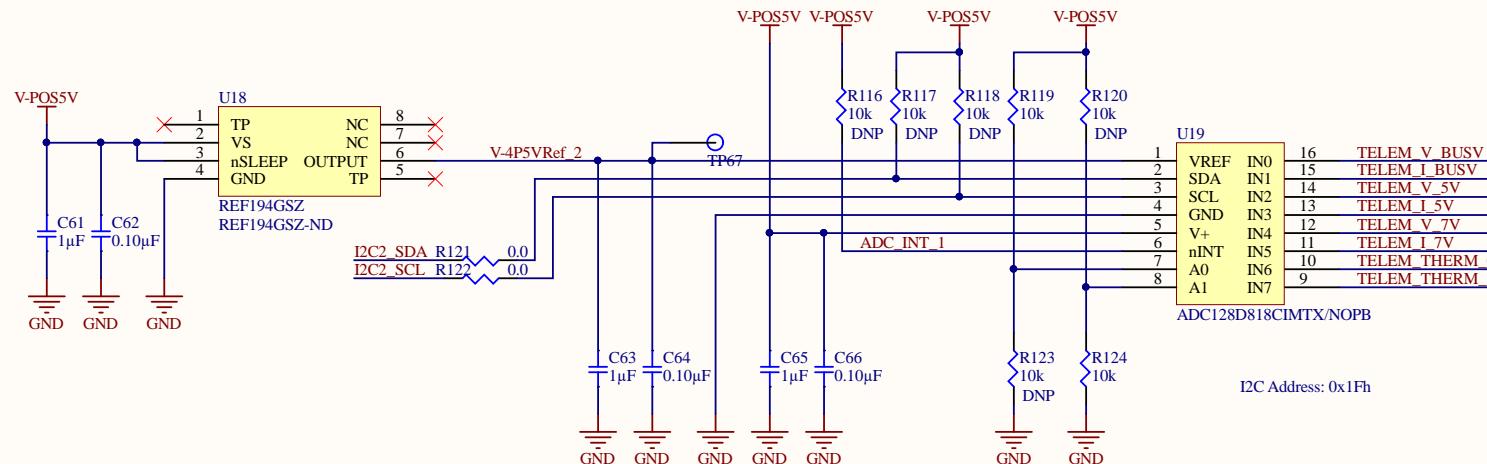
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## PRESSURE



## RAIL AND TEMPERATURE

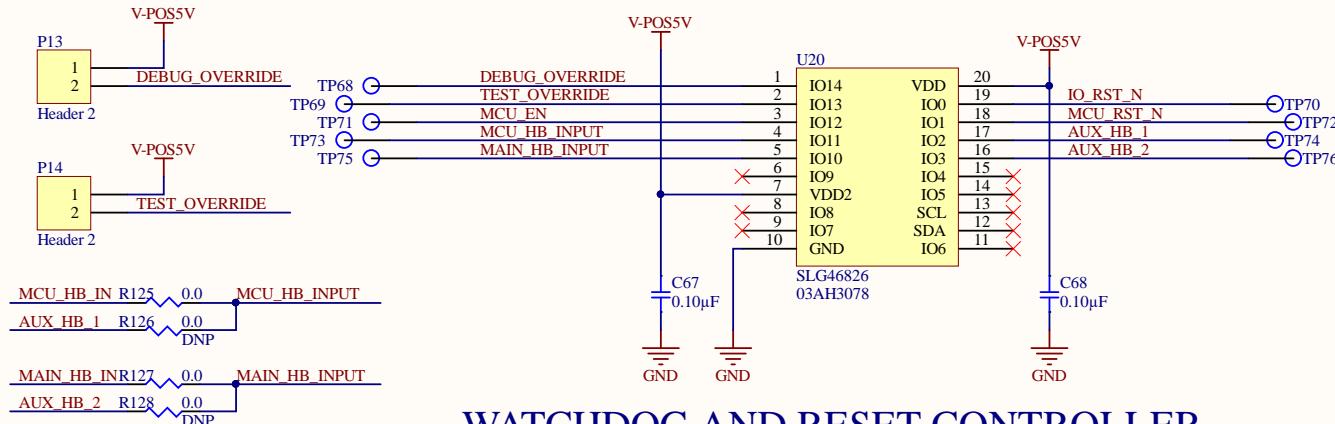
Title <b>ADC</b>		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706
Engineer:		Revision:
Date: 10/1/2019 Time: 11:45:34 PM		Sheet of
File: <a href="#">telemetry_adc.SchDoc</a>		

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**BADGER**  
**LOOP**

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## 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 <b>Watchdog</b>		Badgerloop Electrical
Engineer:		133 Engineering Research Building
Revision:		1500 Engineering Drive
Date: 10/1/2019 Time: 11:45:34 PM Sheet of 1		Madison, WI 53706
File: <a href="#">watchdog.SchDoc</a>		<b>BADGER</b> <b>LOOP</b>

