

A

A

B

B

C

C

D

D

# BRAKING IO

## POD 5

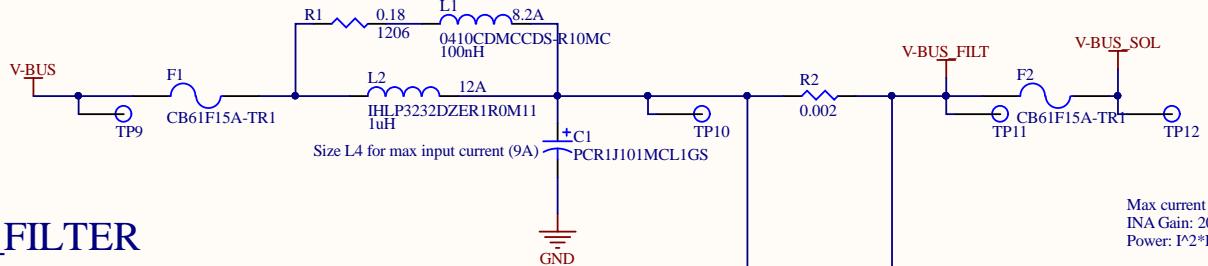
### REV 1

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

A

A

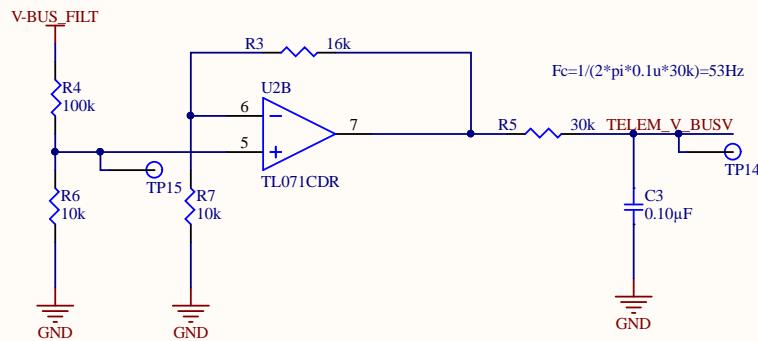
should change upstream fuse to be higher current rating than downstream.



## BUS\_FILTER

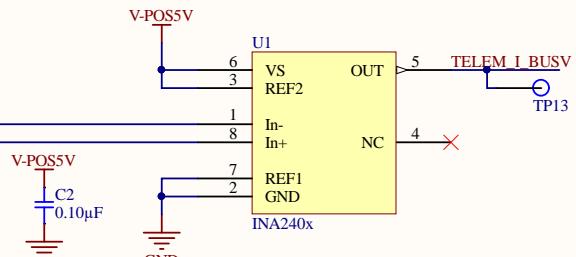
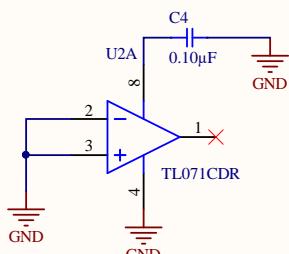
Filter design reference: <http://www.ti.com/lit/an/snva538/snva538.pdf>  
<http://ecee.colorado.edu/~rwe/papers/APEC99.pdf>

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  
 MAX 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: 10/11/2019	Time: 11:11:06 AM	1500 Engineering Drive
File: bus_filter.SchDoc		Madison, WI 53706

**BADGER**  
**LOOP**

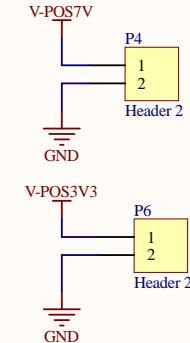
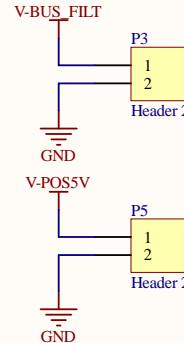
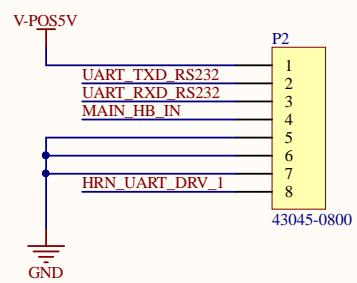
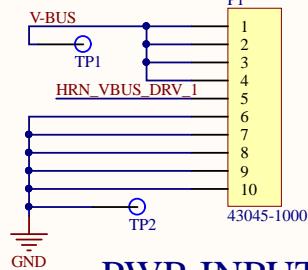
1

2

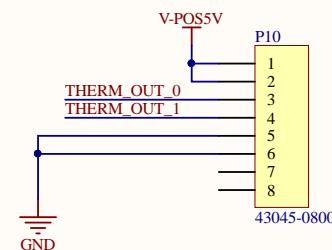
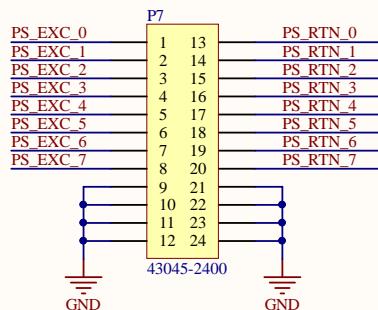
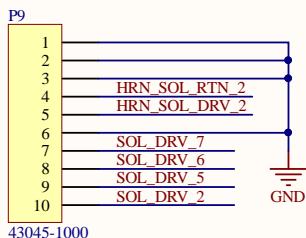
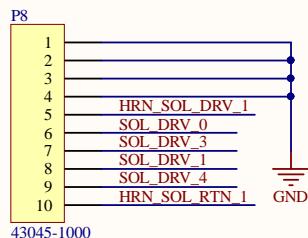
3

4

A

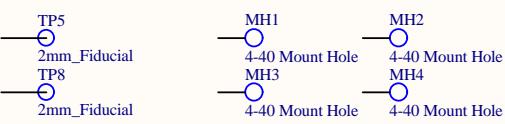
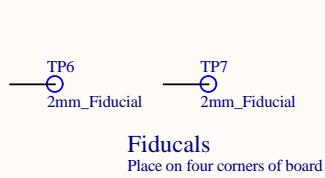


B



C

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



#### Title *Connectors*

Engineer:	Revision:
Date: 10/11/2019	Time: 11:11:06 AM
File: connectors.SchDoc	Sheet of

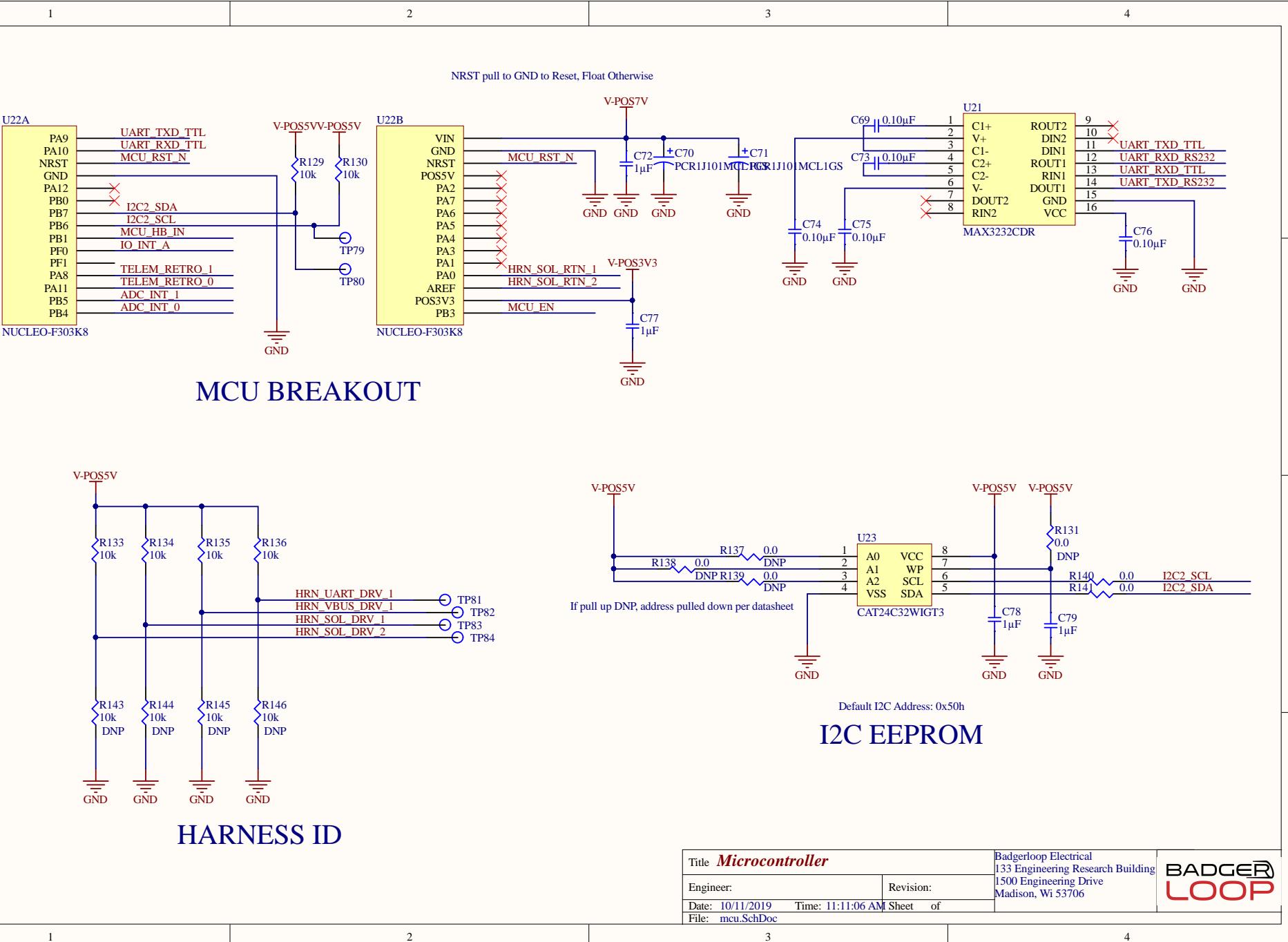
**BADGER**  
**LOOP**

1

2

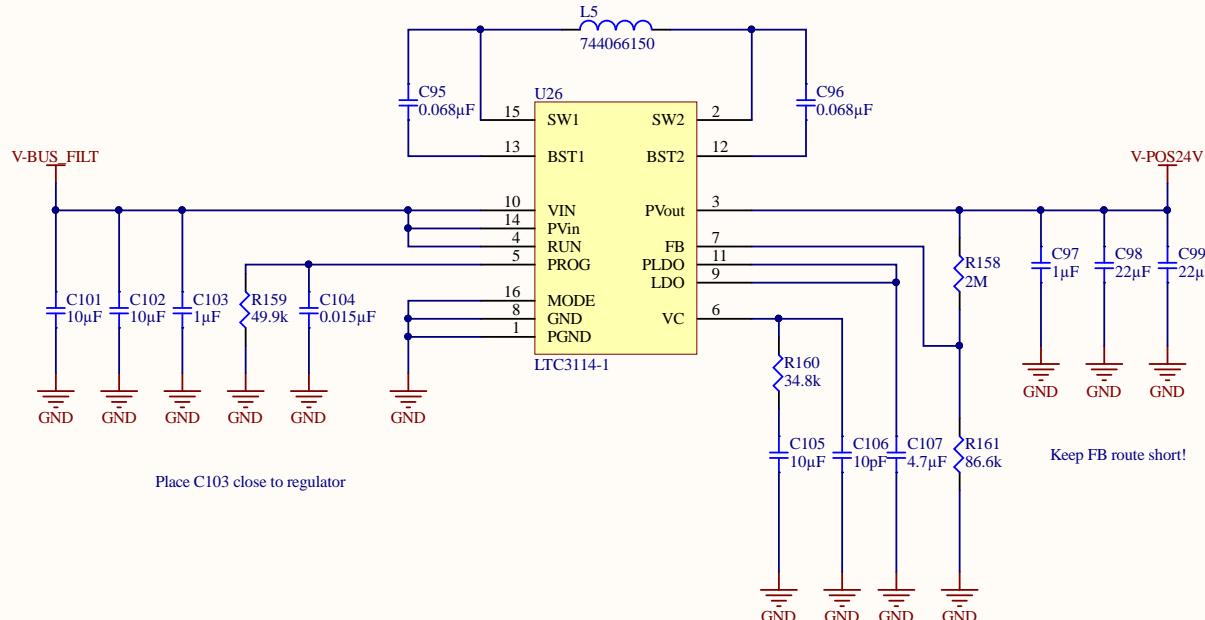
3

4



A

A



C

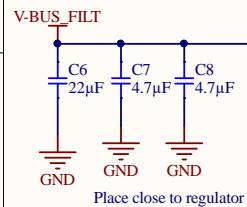
C

Title <b>Power 24V</b>		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer:	Revision:	
Date: 10/11/2019	Time: 11:11:06 AM	Sheet of
File: power_24V.SchDoc		<b>BADGER</b> <b>LOOP</b>

A

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)

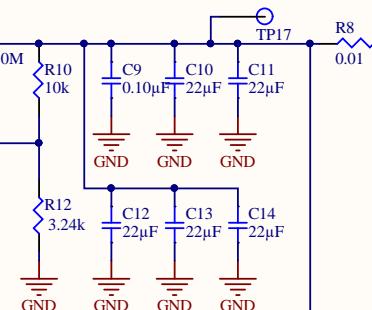


Place close to regulator

## 5V SUPPLY

VIN MIN: 8V VIN MAX: 35V  
IOUT MAX: Up to 2A  
VOUT=(R1\*1.221)(R2)+1.221  
VOUT=(10K\*1.221)/(3.24K)+1.221=4.989V nominal

Keep SNS route short and fat!

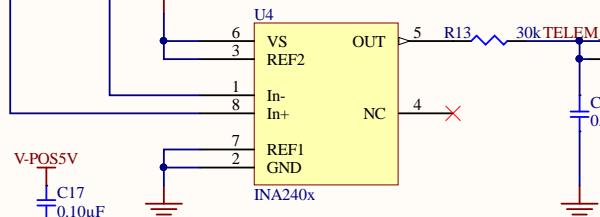


Replace with Tantalum?

Place close to regulator

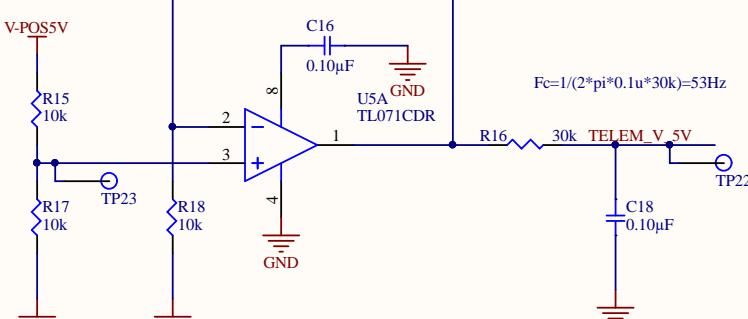
See [https://github.com/badgerloop-software/hardware/tree/master/braking\\_io/design](https://github.com/badgerloop-software/hardware/tree/master/braking_io/design)

LED1 LED GREEN 0603



## CURRENT TELEMETRY

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



GAIN: 1.6 -> MAX ADC VOLTAGE 4.0V

## VOLTAGE TELEMETRY

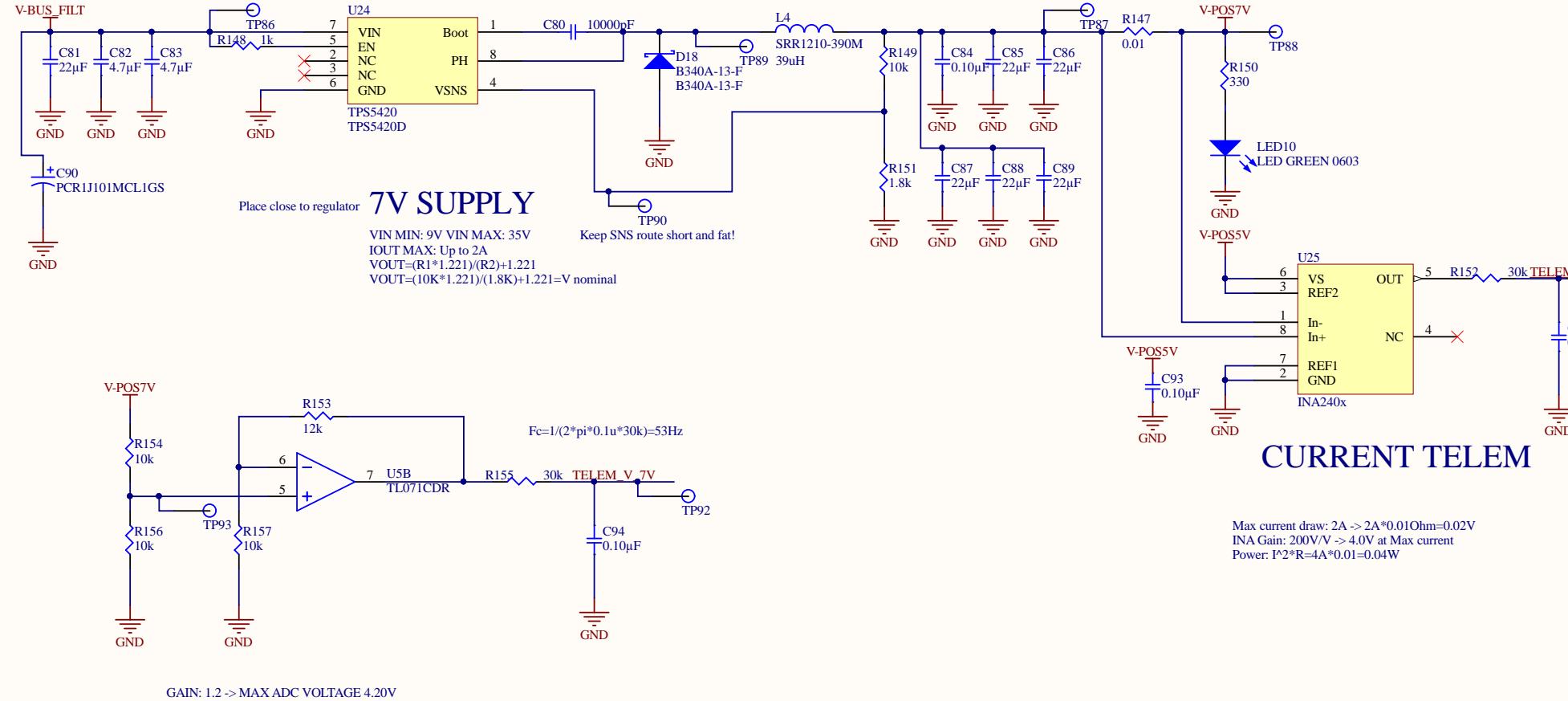
Title	Badgerloop Electrical	
Engineer:	Revision:	
Date: 10/11/2019	Time: 11:11:06 AM	Sheet of
File: power_5V.SchDoc		

**BADGER**  
**LOOP**

A

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: 10/11/2019

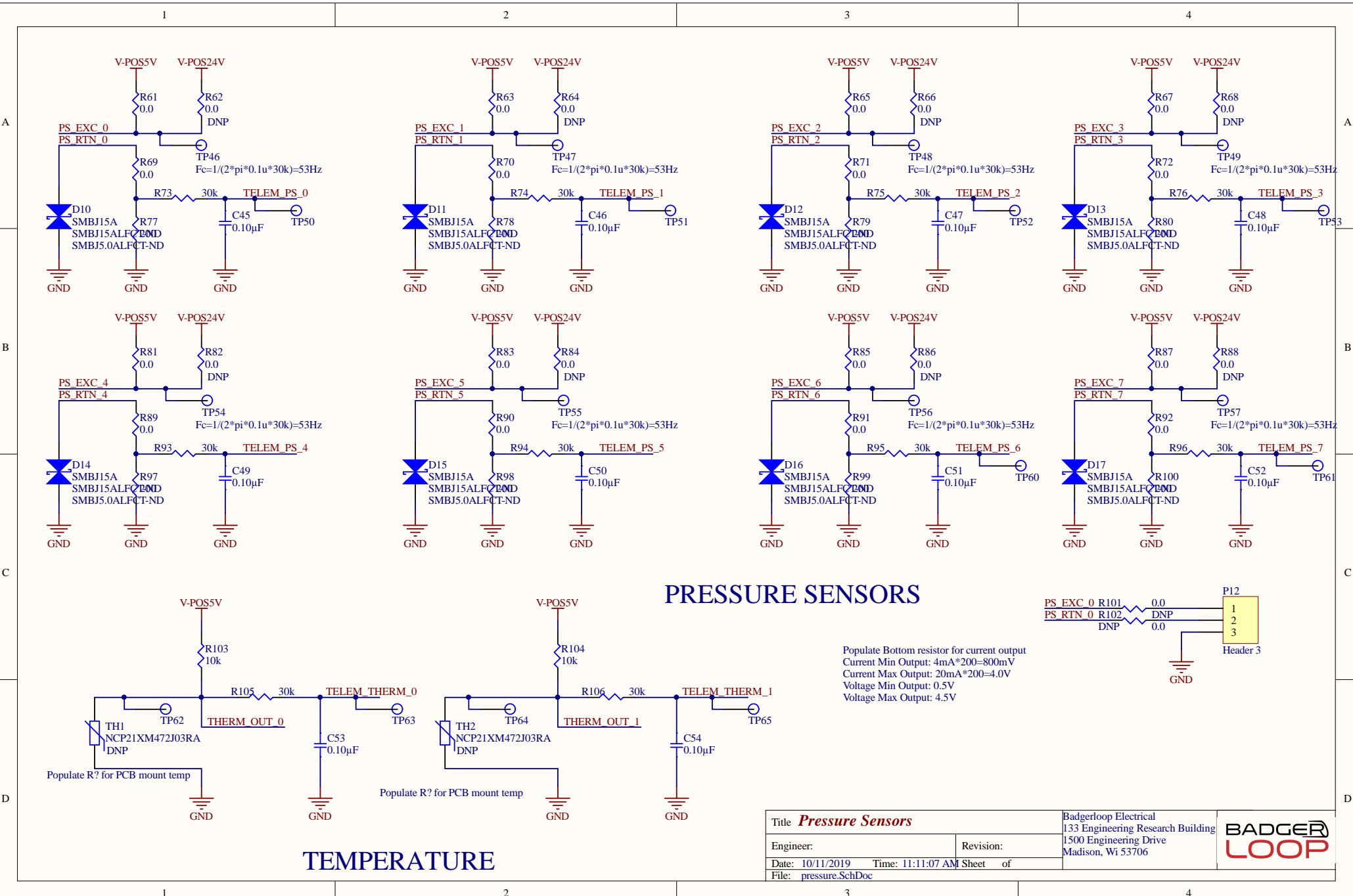
Time: 11:11:06 AM

Sheet of

File: power\_7V.SchDoc

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

**BADGER**  
**LOOP**



A

A

B

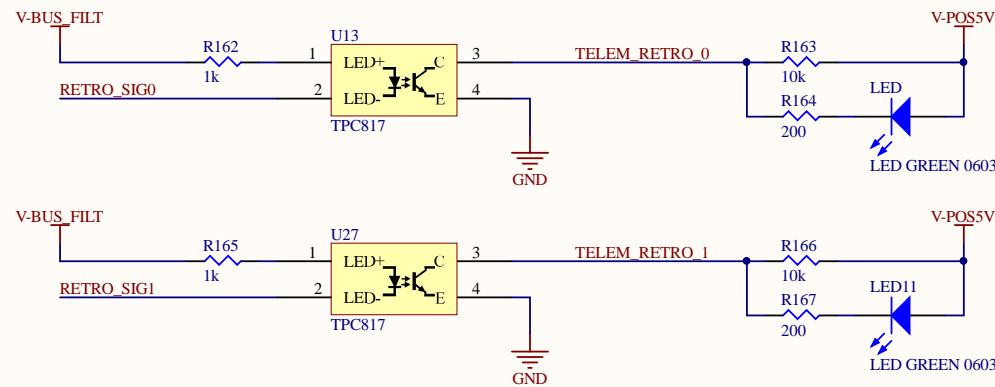
B

C

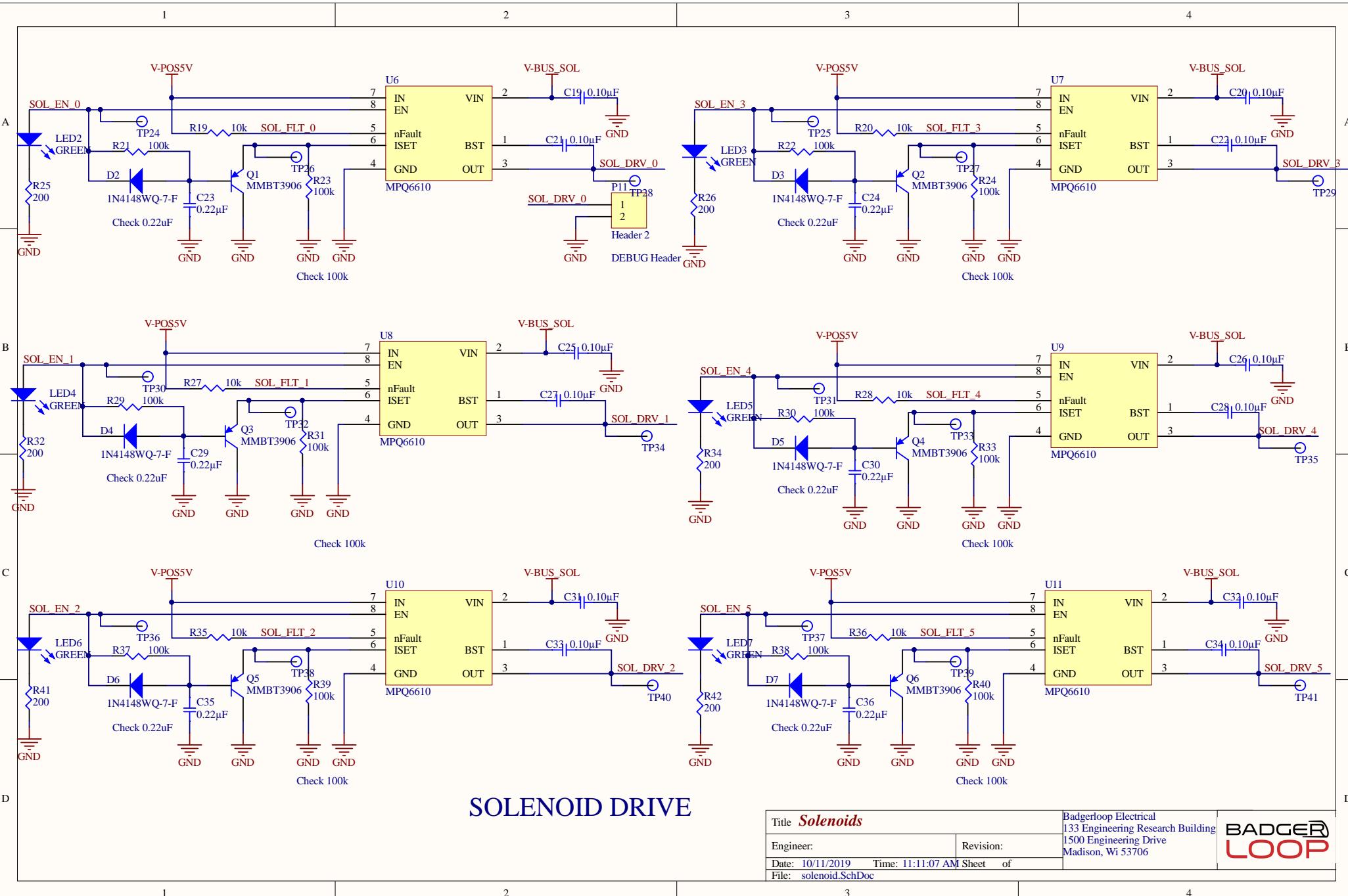
C

D

D



Title <i>Retro</i>		Badgerloop Electrical
		133 Engineering Research Building
Engineer:		Revision:
Date: 10/11/2019	Time: 11:11:07 AM	Sheet of
File: retro.SchDoc		



Title: <b>Solenoids</b>	Badgerloop Electrical
Engineer:	Revision:
Date: 10/11/2019	Time: 11:11:07 AM
File: solenoid.SchDoc	Sheet of 4

**BADGER  
LOOP**

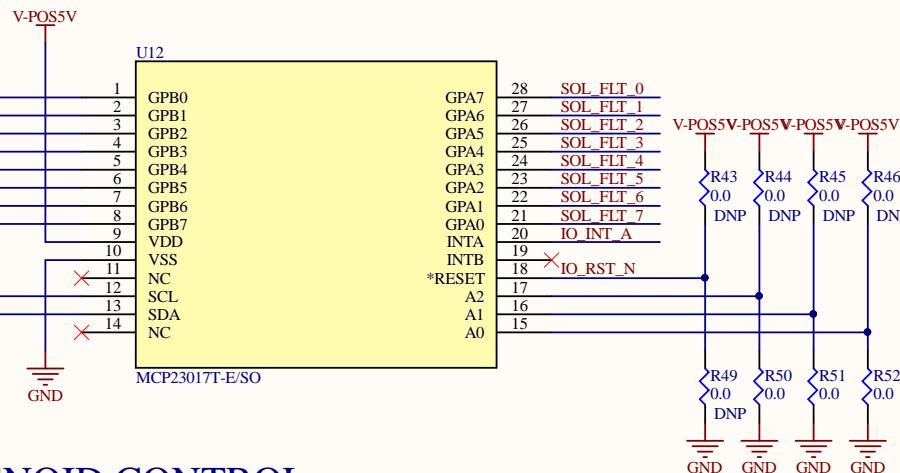
1

2

3

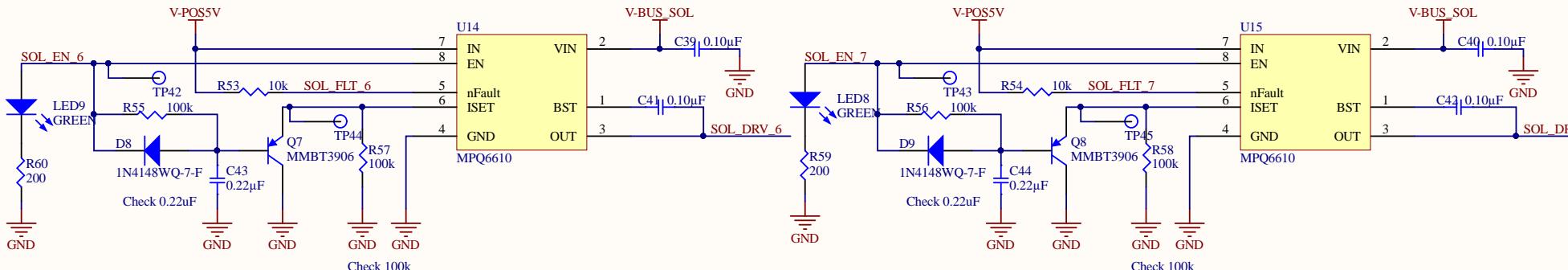
4

A



## SOLENOID CONTROL

C



## SOLENOID DRIVE

Title **Solenoid Control**

Engineer:

Revision:

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

Date: 10/11/2019 Time: 11:11:07 AM Sheet of

File: solenoid\_drv.SchDoc



1

2

3

4

A

B

C

D

1

2

3

4

A

B

C

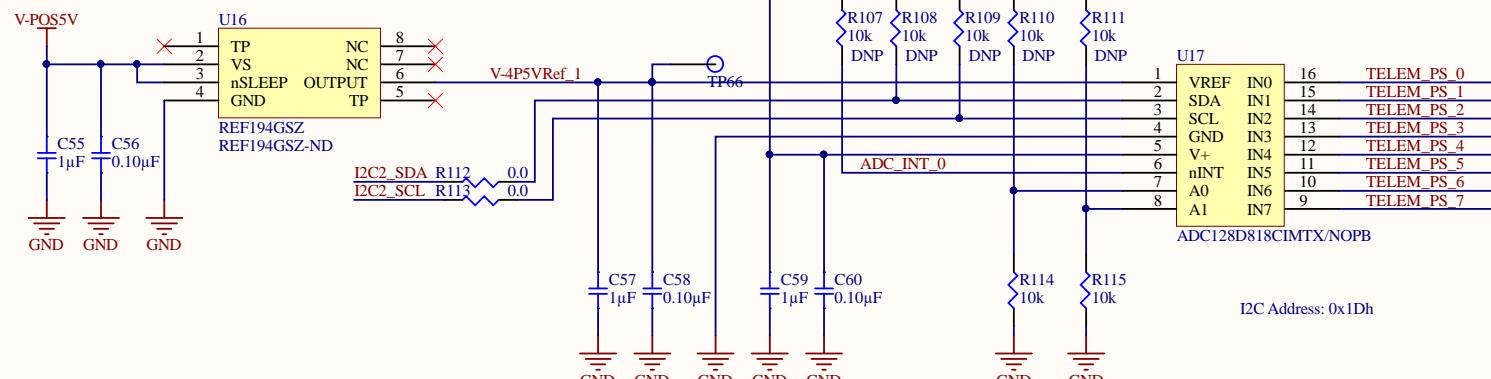
D

A

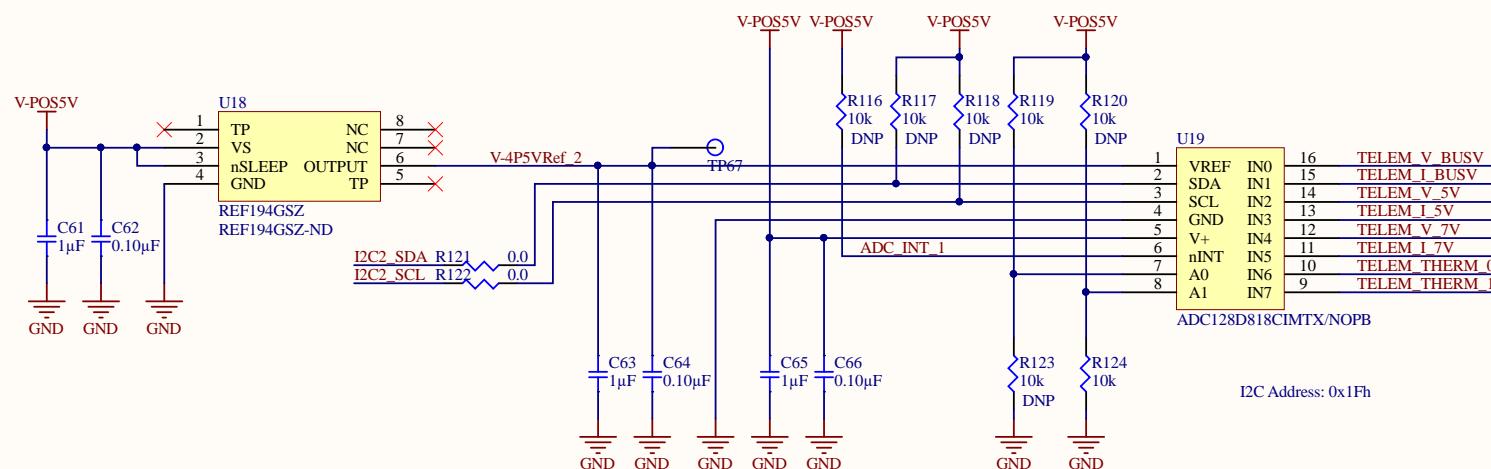
B

C

D



## PRESSURE



## RAIL AND TEMPERATURE

Title <b>ADC</b>		Badgerloop Electrical
Engineer:	Revision:	133 Engineering Research Building
Date: 10/11/2019	Time: 11:11:07 AM	1500 Engineering Drive
File: telemetry_adc.SchDoc		Madison, WI 53706

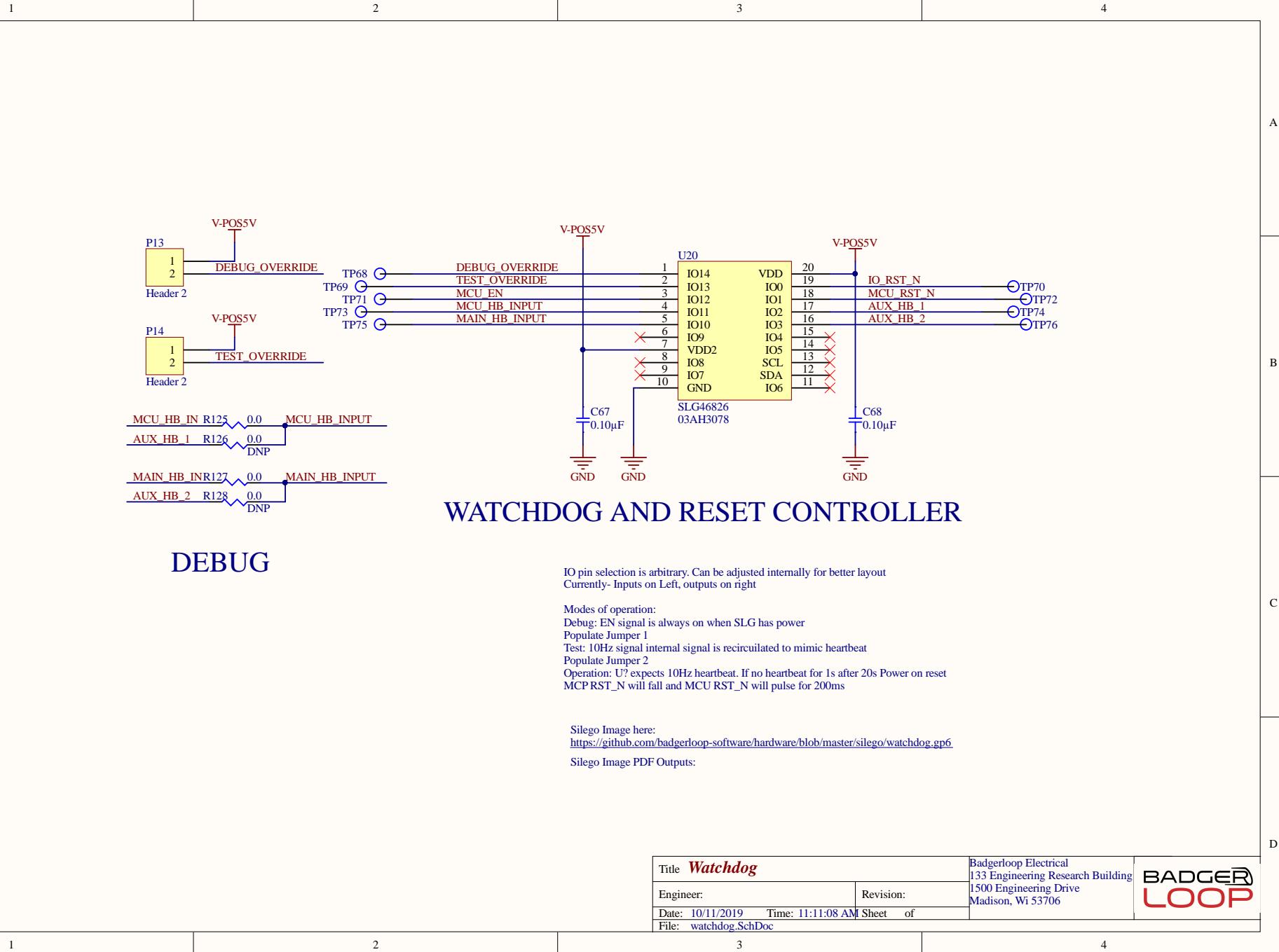
**BADGER**  
**LOOP**

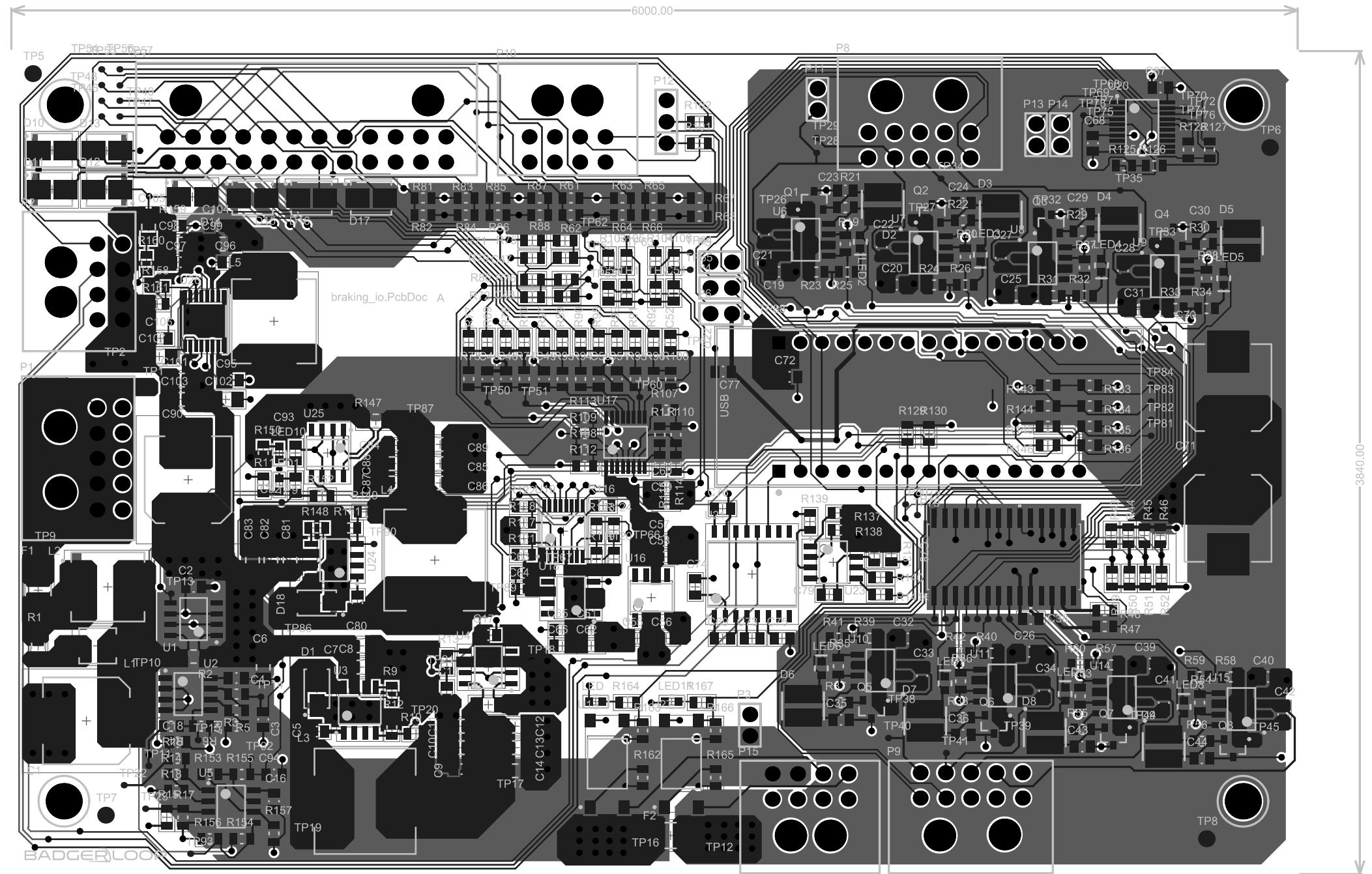
1

2

3

4





Comment	Description	Des
PCR1J101MCL1GS	CAP ALUM POLY 100	C1,
0.10µF	CAP CER 0.1UF 10V	C2,
10000pF	CAP CER 10000PF 25	C5,
22µF	CAP CER 22UF 25V	C6,
4.7µF	CAP CER 4.7UF 50V	C7,
0.22µF	CAP CER 0.22UF 10V	C23,
4.7µF	CAP CER 4.7UF 6.3V	C38,
1µF	CAP CER 1UF 50V X	C55,
0.068µF	CAP CER 0.068UF 50	C95,
10µF	CAP CER 10UF 50V X	C10,
1µF	CAP CER 1UF 50V X	C10,
0.015µF	CAP CER 0.015UF 25	C10,
10pF	CAP CER 10PF 100V	C10,
B340A-13-F	DIODE SCHOTTKY 4	D1,
1N4148WQ-7-F	Diodes - General Pur	D2,
SMBJ15A	TVS DIODE 15V 24.4	D10,
CB61F15A-TR1		F1,
0410CDMCCDS-R10MC		L1
IHLP3232DZER1R0M	Fixed Inductors 1uH	L2
SRR1280A-330M	Inductor Power Shie	L3
SRR1210-390M	FIXED IND 39UH 4.2	L4
744066150	FIXED IND 15UH 3.2	L5
GREEN		LED
LED GREEN 0402		LED