

A

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D

D

BRAKING IO

POD 5

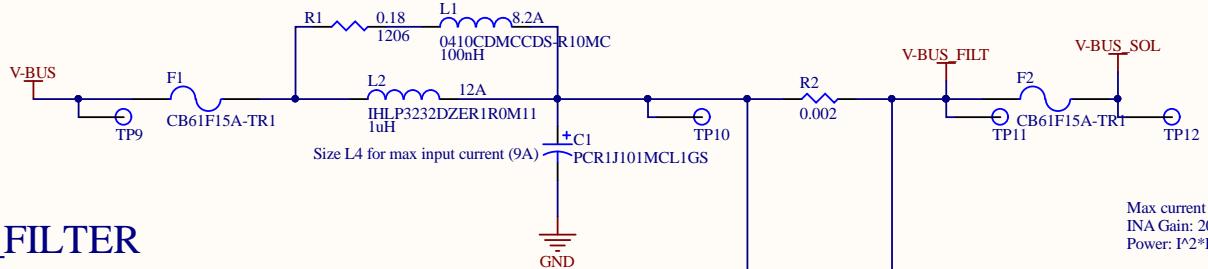
REV 1

Title Braking IO PCB		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706	
Engineer:	Revision:		
Date: 9/28/2019	Time: 8:20:26 PM	Sheet of	
File: braking_io.SchDoc			

A

A

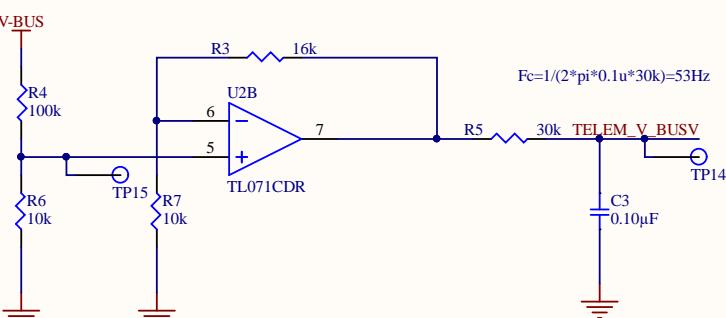
should change upstream fuse to be higher current rating than downstream.



BUS_FILTER

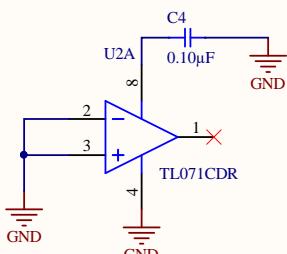
Filter design reference: <http://www.ti.com/lit/an/snva538/snva538.pdf>
<http://ecee.colorado.edu/~rwe/papers/APEC99.pdf>

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

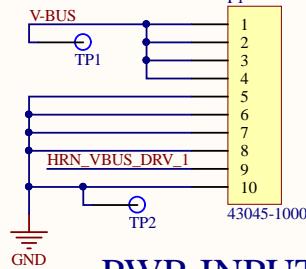
Max current draw: $9A \rightarrow 9A \cdot 0.002\Omega = 0.018V$
 INA Gain: $200V/V \rightarrow 3.6V$ at Max current
 Power: $I^2 \cdot R = 4A \cdot 0.01 = 0.04W$

Title Bus Filter		Badgerloop Electrical
Engineer:	Revision:	133 Engineering Research Building
Date: 9/28/2019	Time: 8:20:26 PM	1500 Engineering Drive
File: bus_filter.SchDoc		Madison, WI 53706

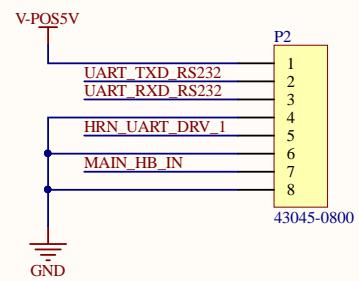
BADGER
LOOP

1 2 3 4

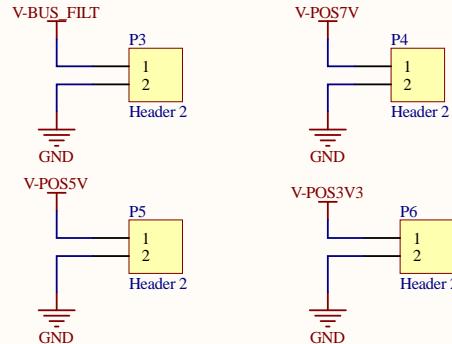
A



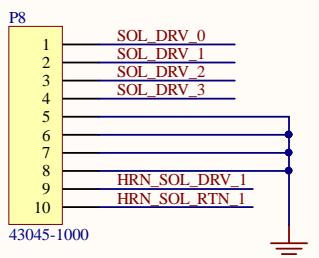
PWR INPUT



UART

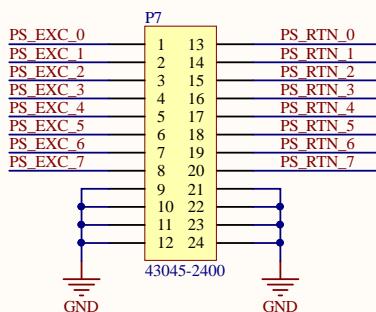
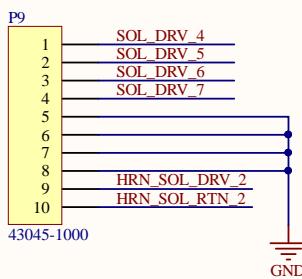


DEBUG

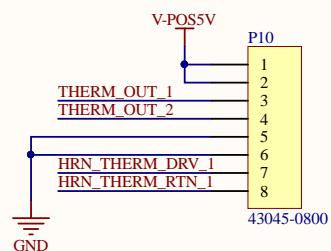


SOLENOIDS

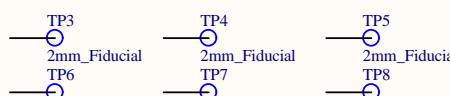
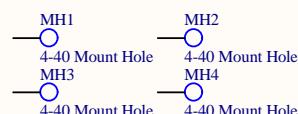
Split into 2 connectors as only 4 solenoids are likely to be used



PRESSURE SENSORS



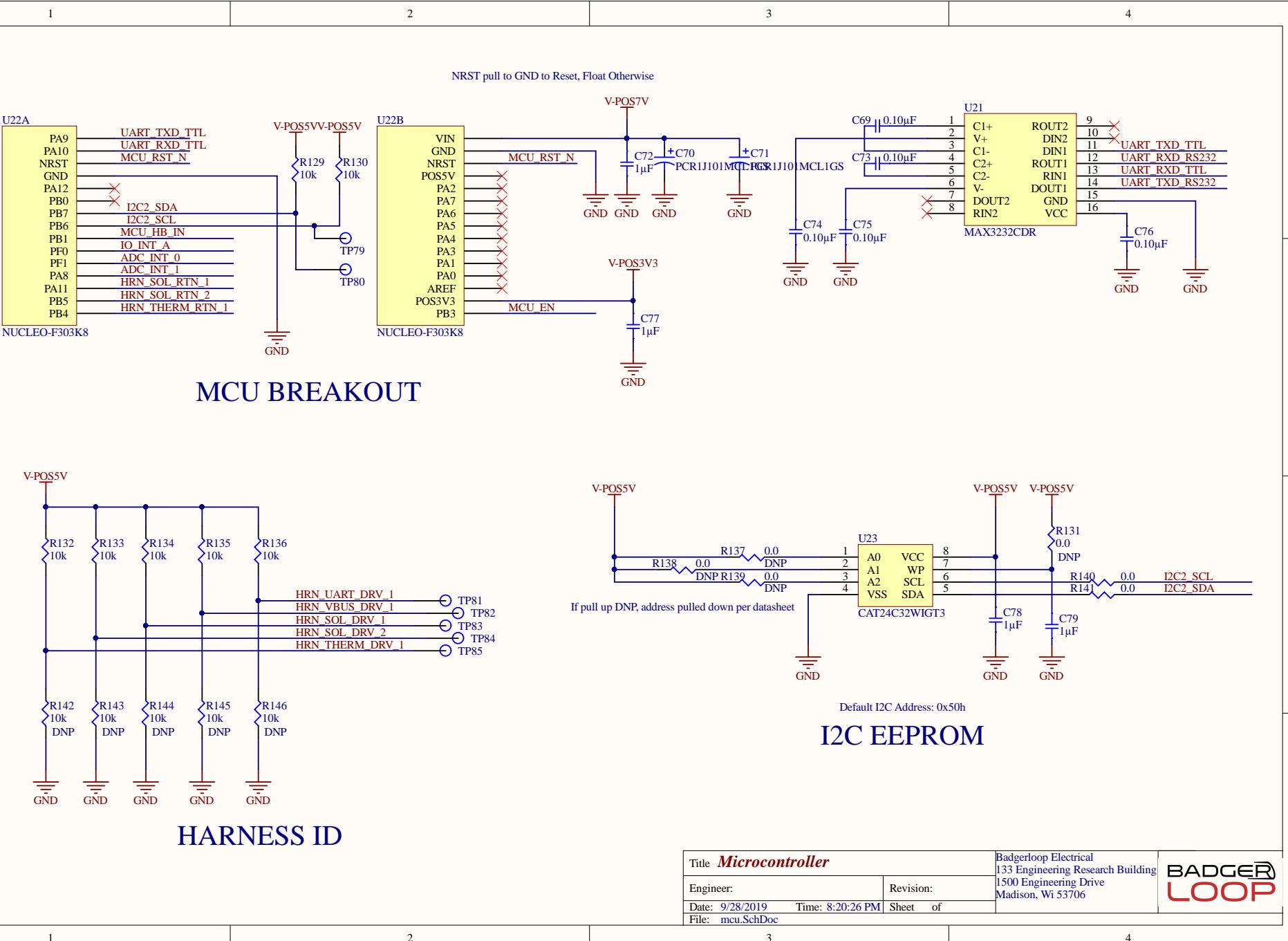
THERMISTORS

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

Title <i>Connectors</i>		Badgerloop Electrical
Engineer:	Revision:	133 Engineering Research Building
Date: 9/28/2019	Time: 8:20:26 PM	1500 Engineering Drive
File: connectors.SchDoc		Madison, Wi 53706

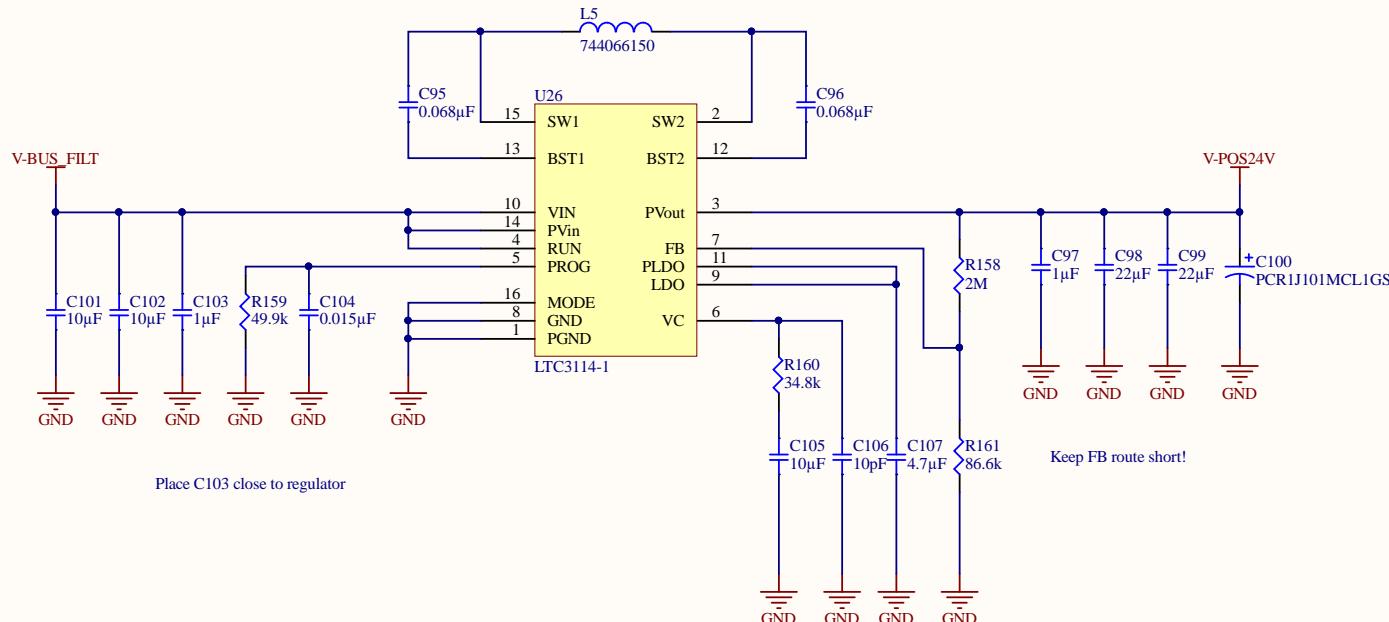
BADGER
LOOP

1 2 3 4



A

A



Place C103 close to regulator

Keep FB route short!

C

C

Title **Power 24V**

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

Engineer:	Revision:
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Date: 9/28/2019	Time: 8:20:27 PM
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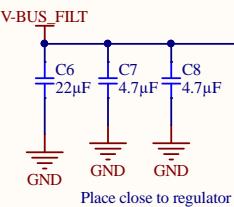
File: power_24V.SchDoc

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.

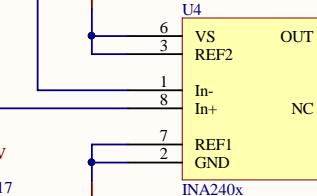
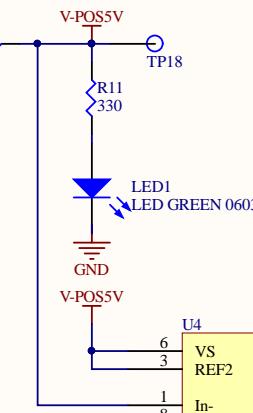
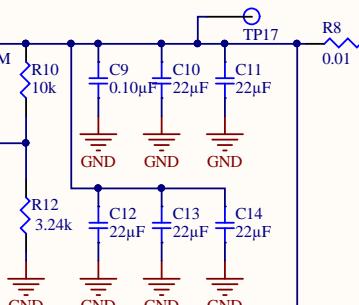
Replace with Tantalum?
Place close to regulator
[See https://github.com/badgerloop-software/hardware/tree/master/braking_io/design](https://github.com/badgerloop-software/hardware/tree/master/braking_io/design)



5V SUPPLY

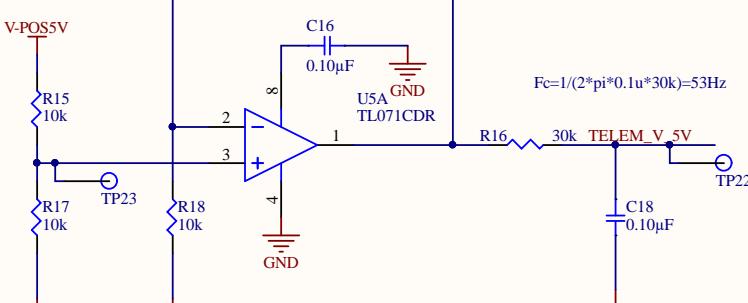
VIN MIN: 8V VIN MAX: 35V
IOUT MAX: Up to 2A
 $V_{OUT} = (R_1 * 1.221) / (R_2 + 1.221)$
 $V_{OUT} = (10K * 1.221) / (3.24K + 1.221) = 4.989V$ nominal

Keep SNS route short and fat!



CURRENT TELEMETRY

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



VOLTAGE TELEMETRY

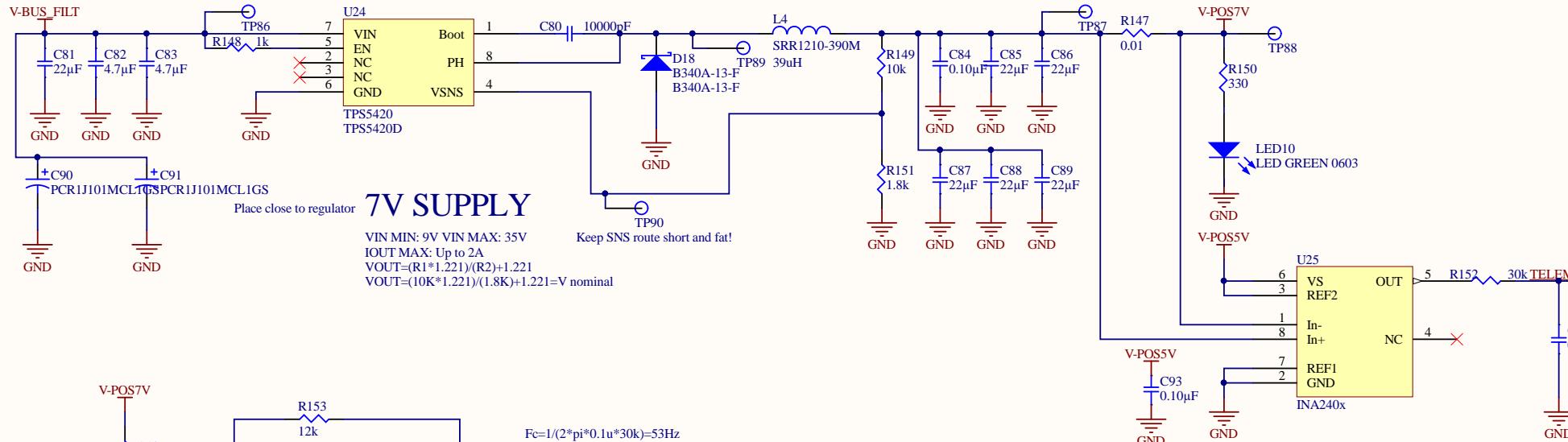
Title	Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706	
Engineer:	Revision:	
Date: 9/28/2019	Time: 8:20:27 PM	Sheet of
File: power_5V.SchDoc		

**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.



GAIN: 1.2 -> MAX ADC VOLTAGE 4.20V

VOLTAGE TELEMETRY

Title 7V SUPPLY		Badgerloop Electrical
Engineer:		133 Engineering Research Building
Date: 9/28/2019 Time: 8:20:27 PM		1500 Engineering Drive
File: power_7V.SchDoc		Madison, WI 53706

**BADGER
LOOP**

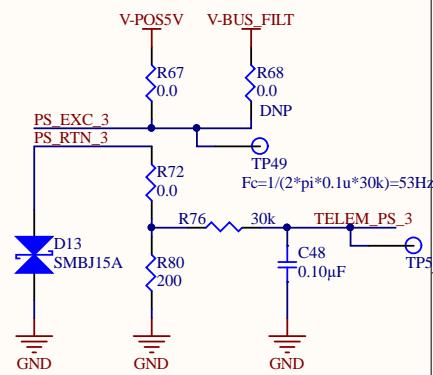
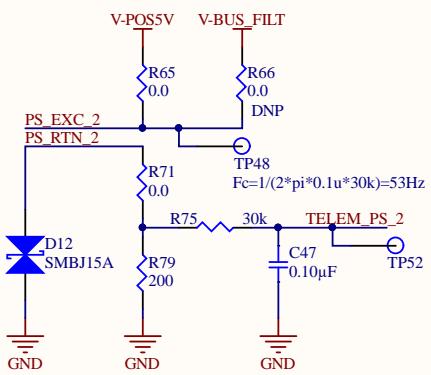
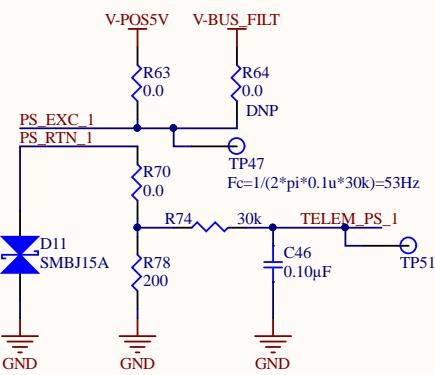
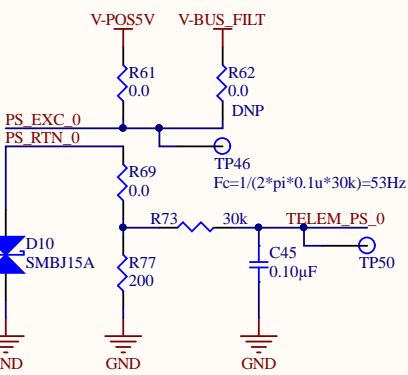
1

2

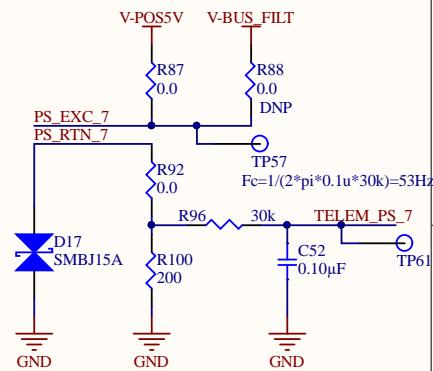
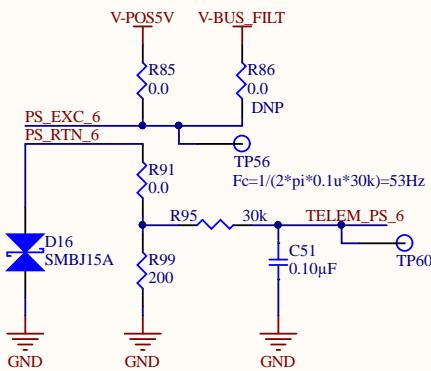
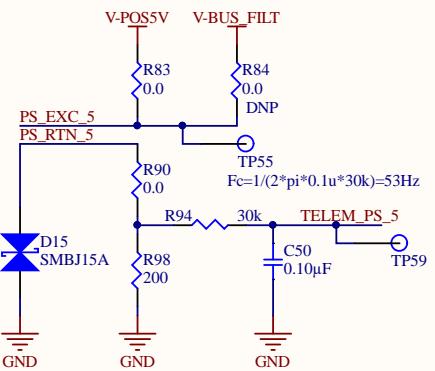
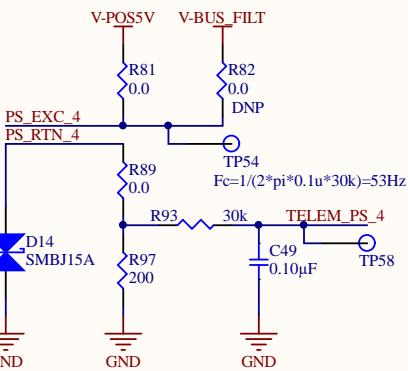
3

4

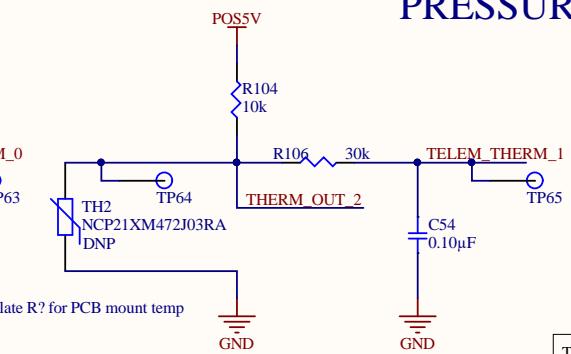
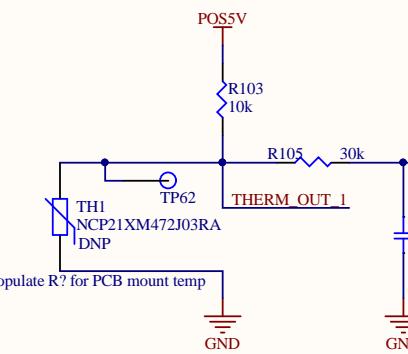
A



B



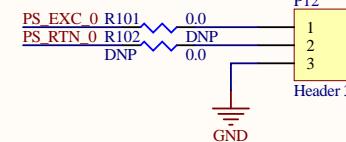
C



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**

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133 Engineering Research Building
1500 Engineering Drive
Madison, WI 53706

BADGER
LOOP

Engineer:

Revision:

Date: 9/28/2019 Time: 8:20:27 PM

Sheet of

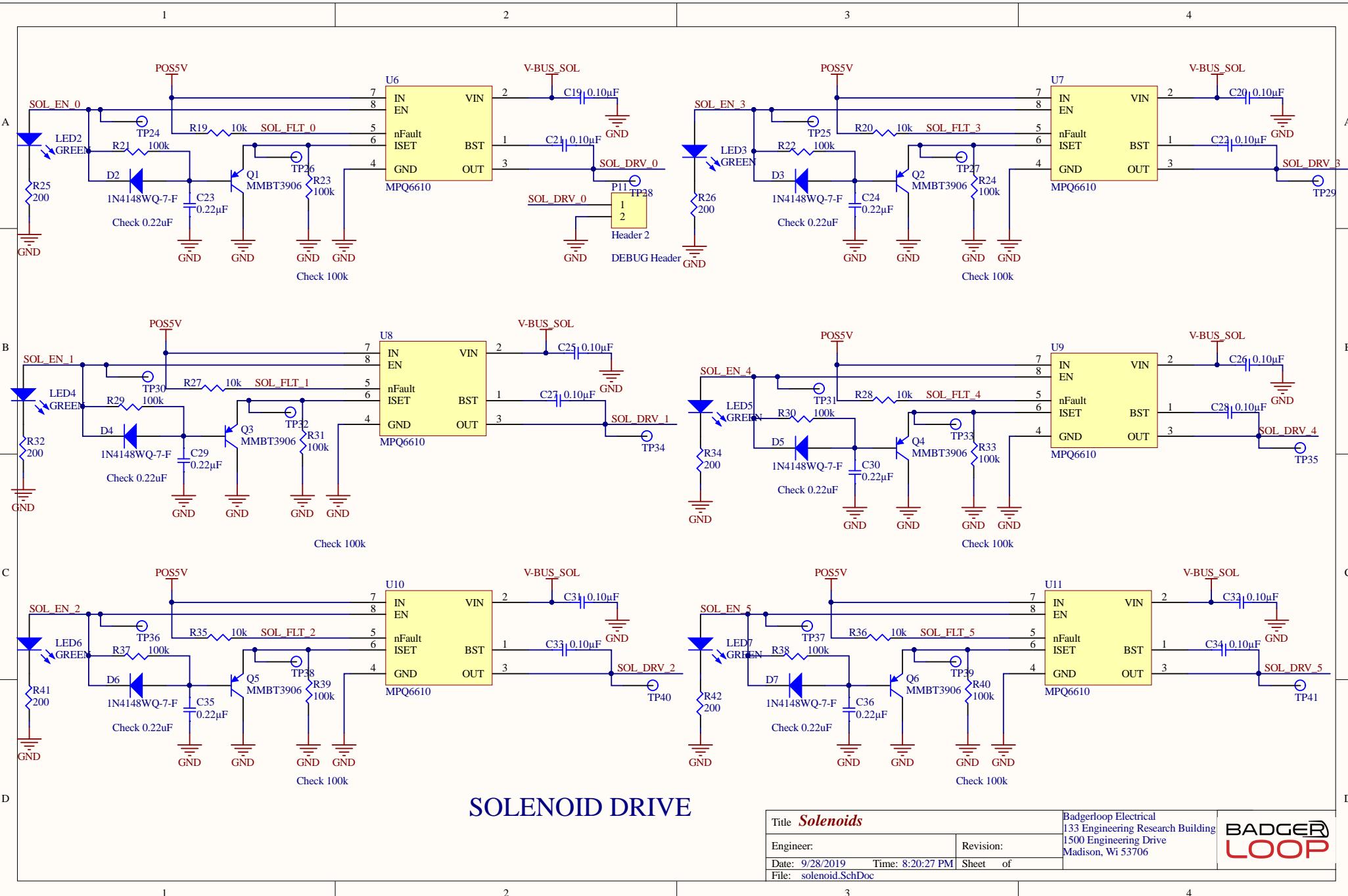
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1

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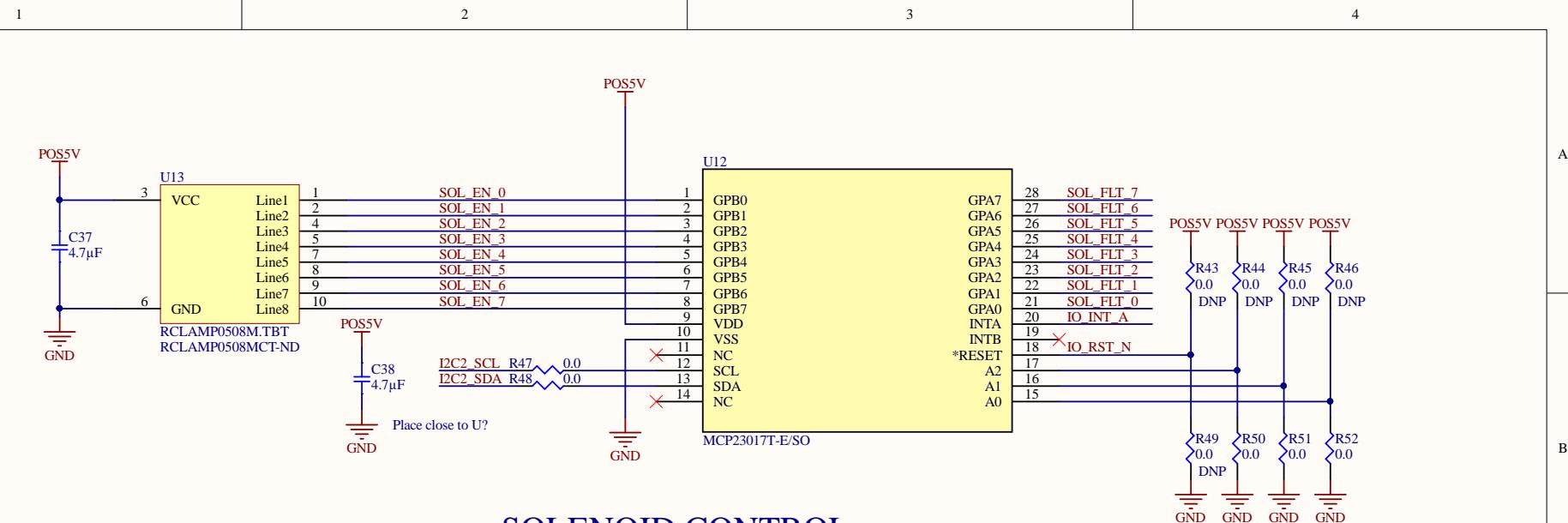
3

4

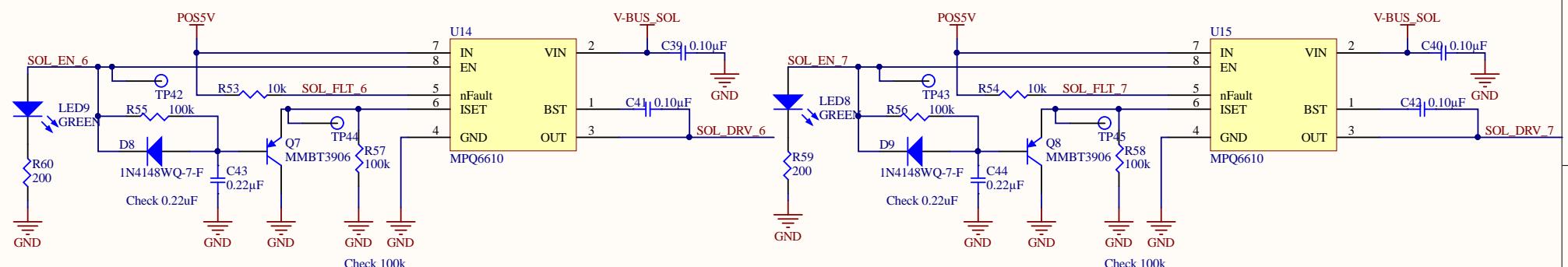


Title: Solenoids	Badgerloop Electrical
Engineer:	Revision:
Date: 9/28/2019	Time: 8:20:27 PM
File: solenoid.SchDoc	Sheet of

**BADGER
LOOP**



SOLENOID CONTROL



SOLENOID DRIVE

Title Solenoid Control		Badgerloop Electrical
Engineer:	Revision:	133 Engineering Research Building
Date: 9/28/2019	Time: 8:20:27 PM	1500 Engineering Drive
File: solenoid_drv.SchDoc		Madison, WI 53706

**BADGER
LOOP**

1 2 3 4

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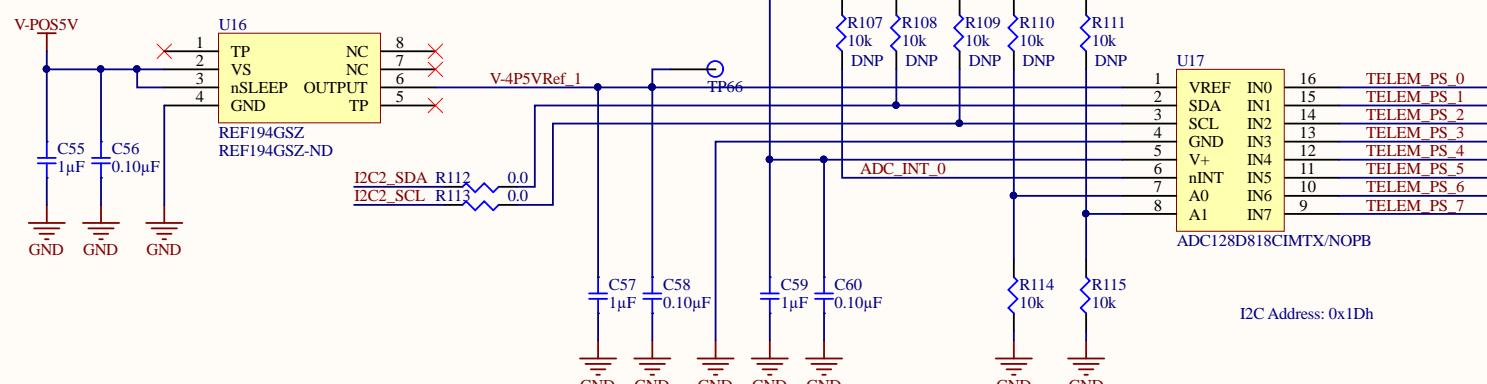
D

A

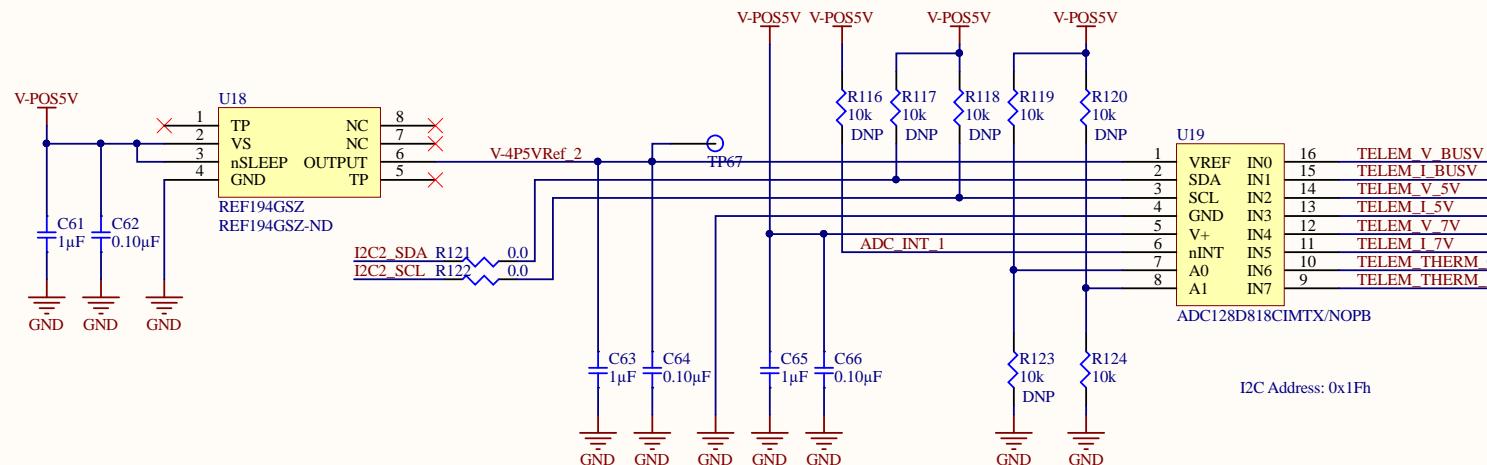
B

C

D



PRESSURE



RAIL AND TEMPERATURE

Title ADC		Badgerloop Electrical
Engineer:	Revision:	133 Engineering Research Building
Date: 9/28/2019	Time: 8:20:28 PM	1500 Engineering Drive
File: telemetry_adc.SchDoc		Madison, WI 53706

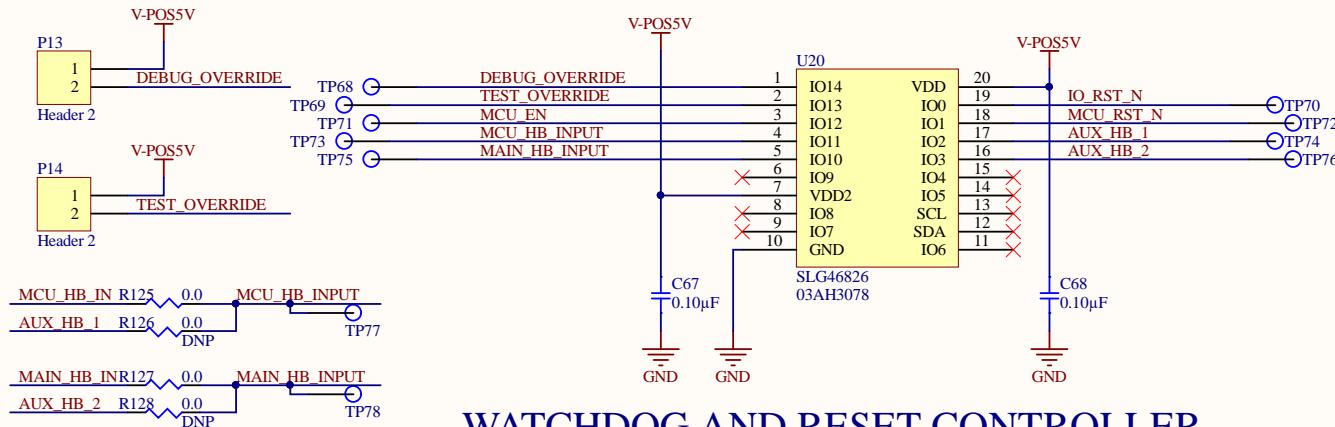
1 2 3 4

1 2 3 4

BADGER
LOOP

A

A



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 Watchdog		Badgerloop Electrical
Engineer:		133 Engineering Research Building
Date: 9/28/2019 Time: 8:20:28 PM		1500 Engineering Drive
File: watchdog.SchDoc		Madison, WI 53706



