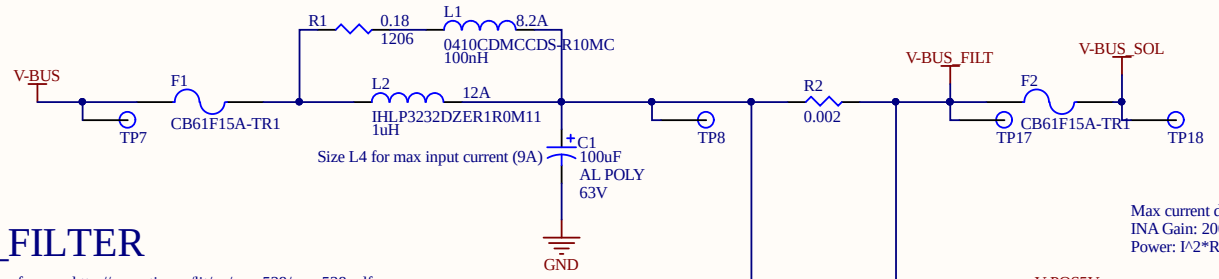
BRAKING IO

POD 5

REV 1

Title	***Braking IO PCB***	Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer:	Revision:	
Date: 9/13/2019 Time: 6:40:58 PM	Sheet of	
File: braking_io.SchDoc		

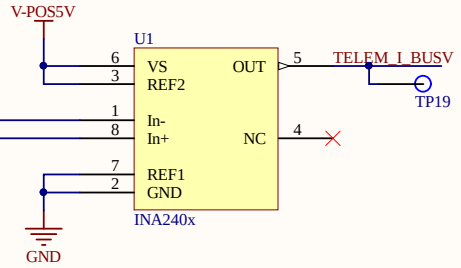
should change upstream fuse to be higher current rating than downstream.



BUS_FILTER

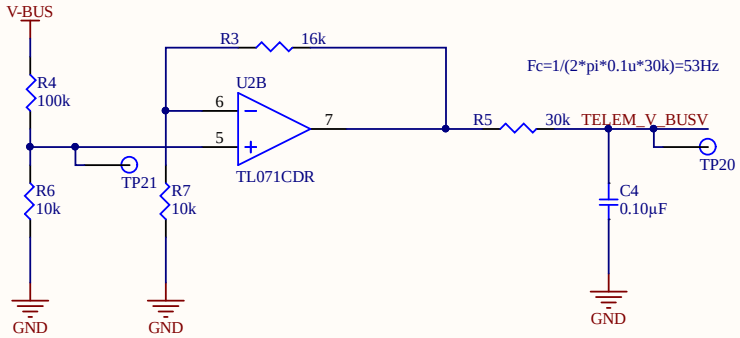
Filter design reference: http://www.ti.com/lit/an/snva538/snva538.pdf
http://ecee.colorado.edu/~rwe/papers/APEC99.pdf

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



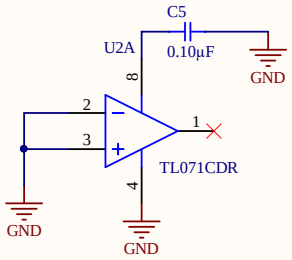
CURRENT TELEM

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

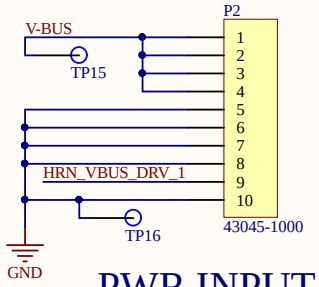


GAIN: 1.6V/V
MIN BUS VOLTAGE: 20V -> 1.82V
MIN BUS VOLTAGE: 28V -> 2.54V

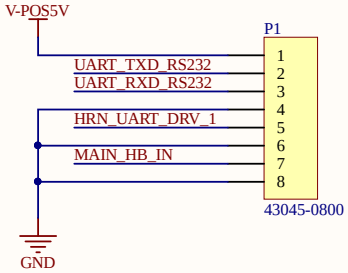
VOLTAGE TELEMETRY



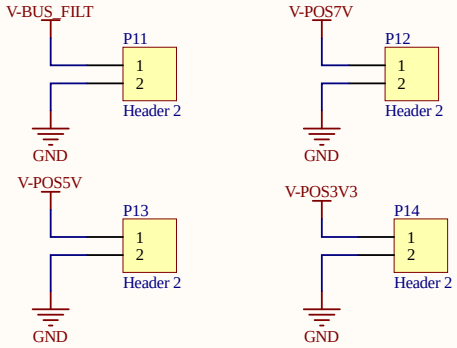
Title **Bus Filter**		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer:	Revision:	
Date: 9/13/2019 Time: 6:40:58 PM	Sheet of	
File: bus_filter.SchDoc		



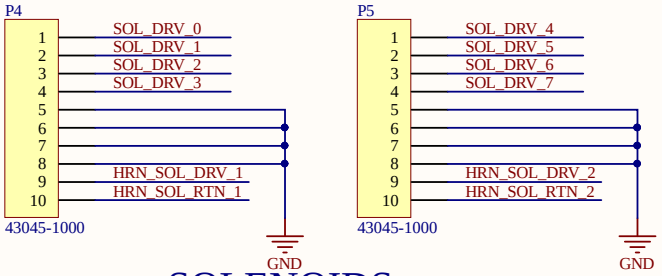
PWR INPUT



UART

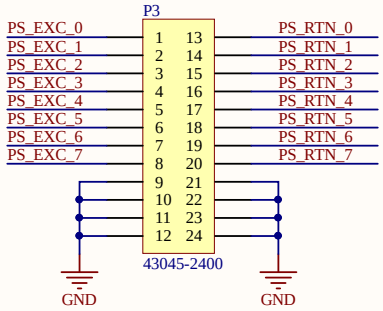


DEBUG

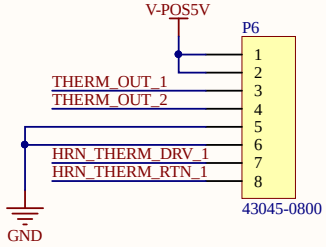


SOLENOIDS

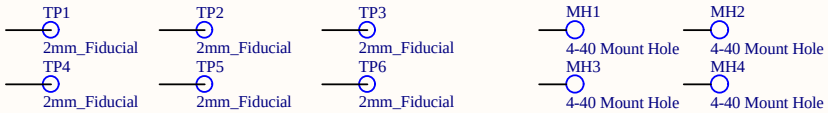
Split into 2 connectors as only 4 solenoids are likely to be used



PRESSURE SENSORS



THERMISTORS



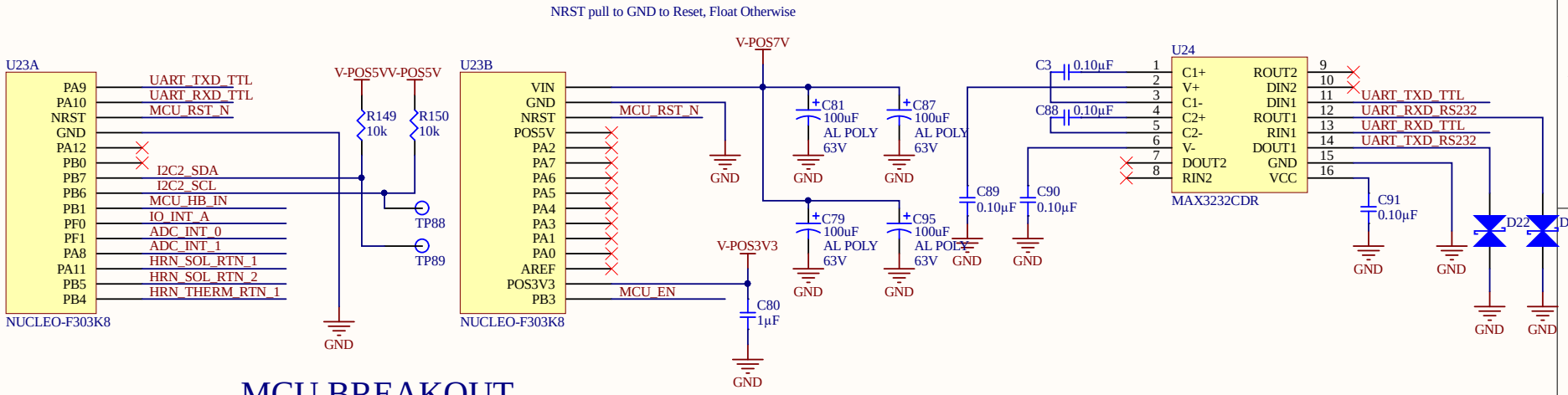
Fiducals

Place on corners of board

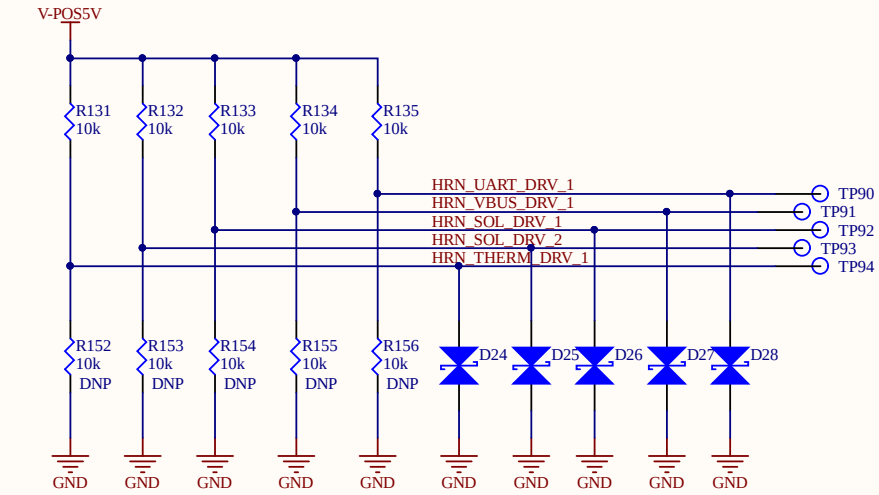
Mount Holes

Avoid routing under screw head

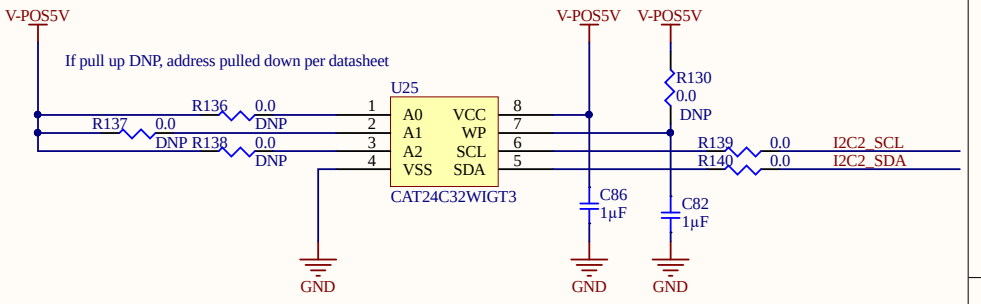
Title **Connectors**		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer:	Revision:	
Date: 9/13/2019 Time: 6:40:58 PM	Sheet of	
File: connectors.SchDoc		



MCU BREAKOUT



HARNESS ID

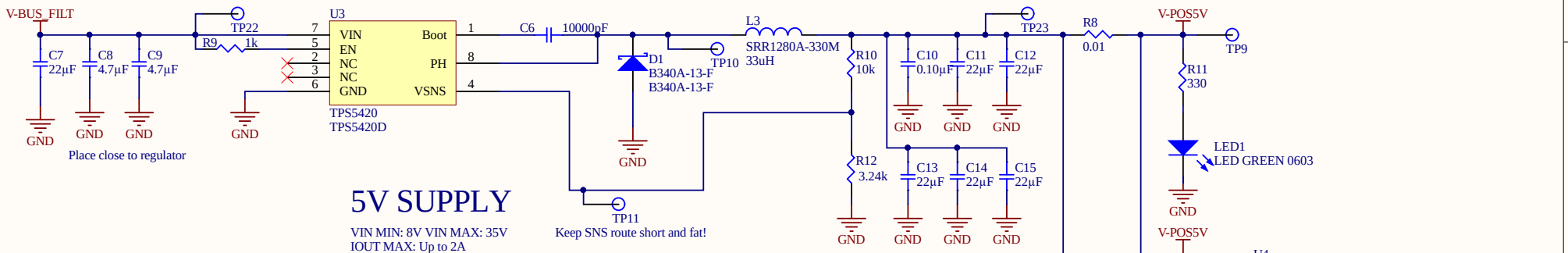


I2C EEPROM

Title	***Microcontroller***	Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer:	Revision:	
Date: 9/13/2019 Time: 6:40:58 PM	Sheet of	
File: mcu.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.

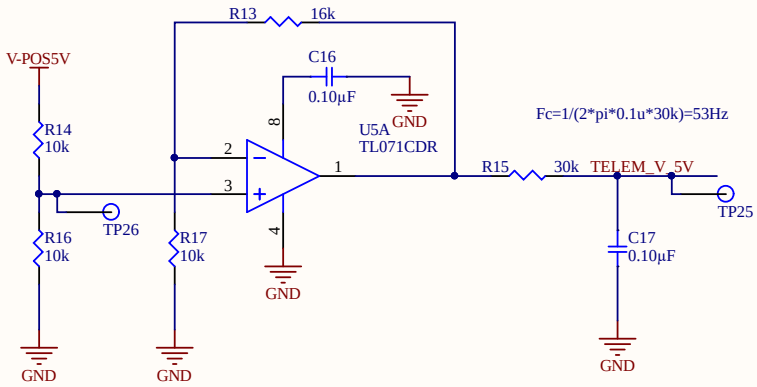
Replace with Tantalum?
Place close to regulator
See https://github.com/badgerloop-software/hardware/tree/master/braking_io/design



5V SUPPLY

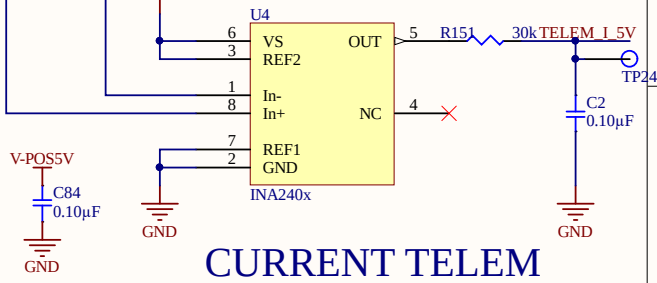
VIN MIN: 8V VIN MAX: 35V
IOUT MAX: Up to 2A
VOUT=(R1*1.221)/(R2)+1.221
VOUT=(10K*1.221)/(3.24K)+1.221=4.989V nominal

Keep SNS route short and fat!



GAIN: 1.6 -> MAX ADC VOLTAGE 4.0V

VOLTAGE TELEMETRY



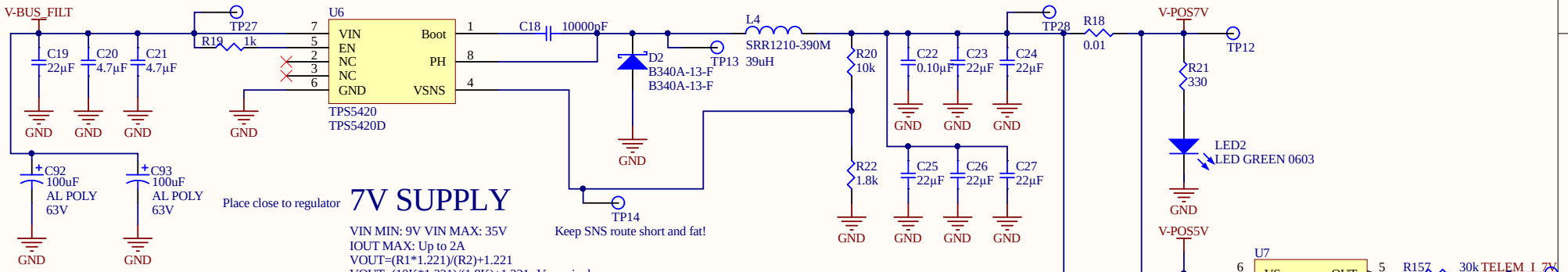
CURRENT TELEM

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

Title		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer:	Revision:	
Date: 9/13/2019 Time: 6:40:58 PM	Sheet of	
File: power_5V.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



Place close to regulator

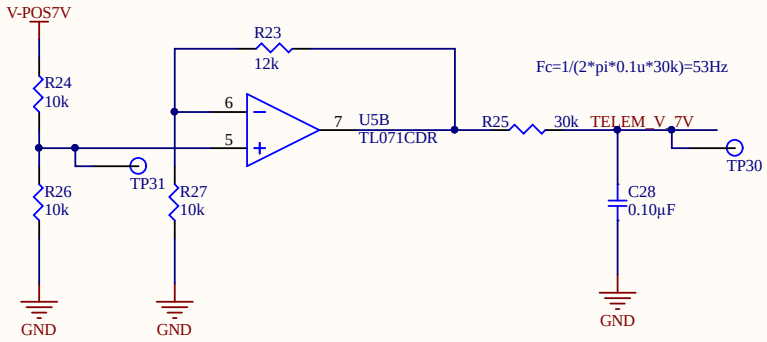
7V SUPPLY

VIN MIN: 9V VIN MAX: 35V
IOUT MAX: Up to 2A
VOUT=(R1*1.221)/(R2)+1.221
VOUT=(10K*1.221)/(1.8K)+1.221=V nominal

Keep SNS route short and fat!

CURRENT TELEM

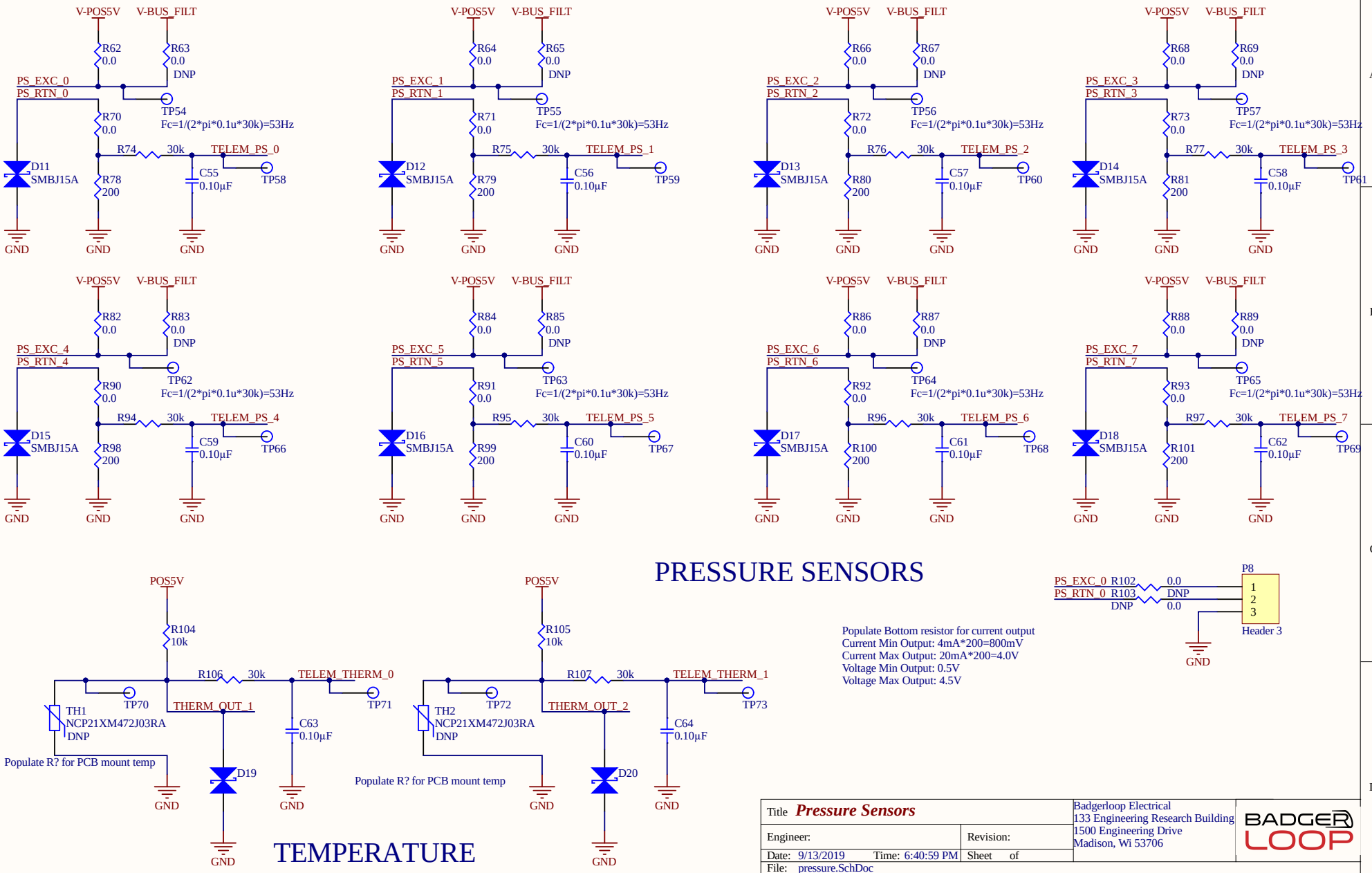
Max current draw: 2A -> 2A*0.01Ohm=0.02V
INA Gain: 200V/V -> 4.0V at Max current
Power: I^2*R=4A*0.01=0.04W

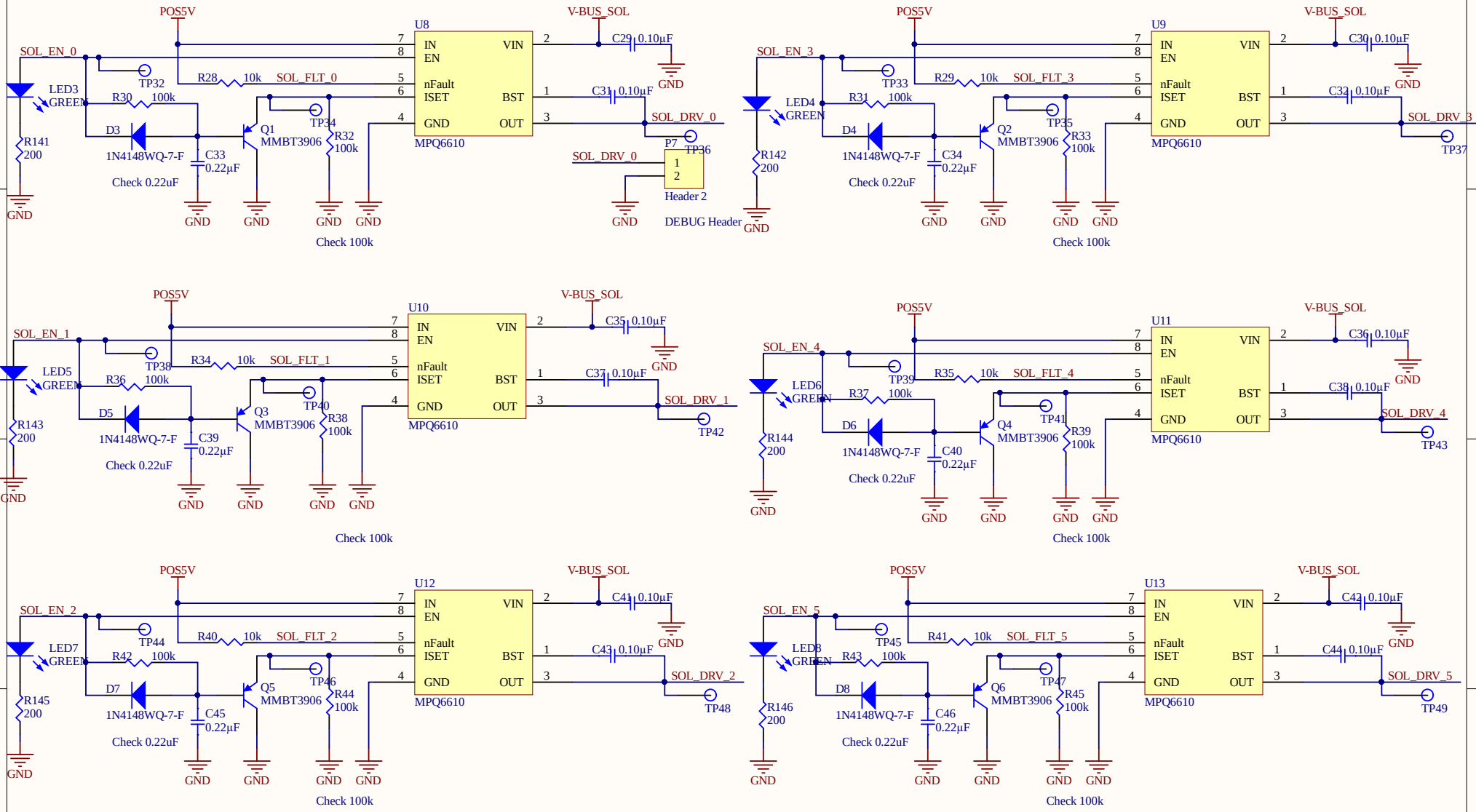


GAIN: 1.2 -> MAX ADC VOLTAGE 4.20V

VOLTAGE TELEMETRY

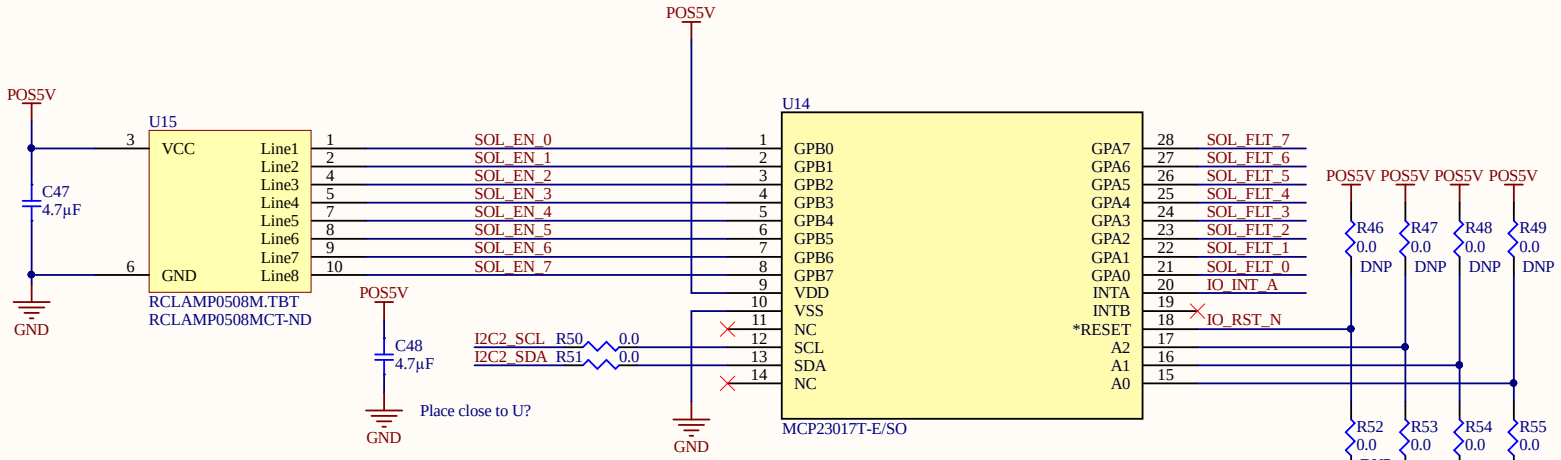
Title *7V SUPPLY*		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer:	Revision:	
Date: 9/13/2019 Time: 6:40:59 PM	Sheet of	
File: power_7V.SchDoc		


PRESSURE SENSORS
V-POS5V
V-BUS_FILT
R62 0.0
R63 0.0 DNP
PS_EXC_0
PS_RTN_0
TP54
Fc=1/(2*pi*0.1u*30k)=53Hz
R70 0.0
R74 30k
TELEM_PS_0
D11 SMBJ15A
R78 200
C55 0.10µF
TP58
GND
R64 0.0
R65 0.0 DNP
PS_EXC_1
PS_RTN_1
TP55
R71 0.0
R75 30k
TELEM_PS_1
D12 SMBJ15A
R79 200
C56 0.10µF
TP59
R66 0.0
R67 0.0 DNP
PS_EXC_2
PS_RTN_2
TP56
R72 0.0
R76 30k
TELEM_PS_2
D13 SMBJ15A
R80 200
C57 0.10µF
TP60
R68 0.0
R69 0.0 DNP
PS_EXC_3
PS_RTN_3
TP57
R73 0.0
R77 30k
TELEM_PS_3
D14 SMBJ15A
R81 200
C58 0.10µF
TP61
R82 0.0
R83 0.0 DNP
PS_EXC_4
PS_RTN_4
TP62
R90 0.0
R94 30k
TELEM_PS_4
D15 SMBJ15A
R98 200
C59 0.10µF
TP66
R84 0.0
R85 0.0 DNP
PS_EXC_5
PS_RTN_5
TP63
R91 0.0
R95 30k
TELEM_PS_5
D16 SMBJ15A
R99 200
C60 0.10µF
TP67
R86 0.0
R87 0.0 DNP
PS_EXC_6
PS_RTN_6
TP64
R92 0.0
R96 30k
TELEM_PS_6
D17 SMBJ15A
R100 200
C61 0.10µF
TP68
R88 0.0
R89 0.0 DNP
PS_EXC_7
PS_RTN_7
TP65
R93 0.0
R97 30k
TELEM_PS_7
D18 SMBJ15A
R101 200
C62 0.10µF
TP69
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
PS_EXC_0 R102 0.0
PS_RTN_0 R103 DNP
DNP 0.0
P8
1
2
3
Header 3
TEMPERATURE
POS5V
R104 10k
R106 30k
TELEM_THERM_0
TP70
TP71
THERM_OUT_1
TH1 NCP21XM472J03RA DNP
C63 0.10µF
Populate R? for PCB mount temp
D19
R105 10k
R107 30k
TELEM_THERM_1
TP72
TP73
THERM_OUT_2
TH2 NCP21XM472J03RA DNP
C64 0.10µF
Populate R? for PCB mount temp
D20
Title Pressure Sensors
Engineer:
Revision:
Date: 9/13/2019 Time: 6:40:59 PM
Sheet of
File: pressure.SchDoc
Badgerloop Electrical
133 Engineering Research Building
1500 Engineering Drive
Madison, Wi 53706
BADGER LOOP

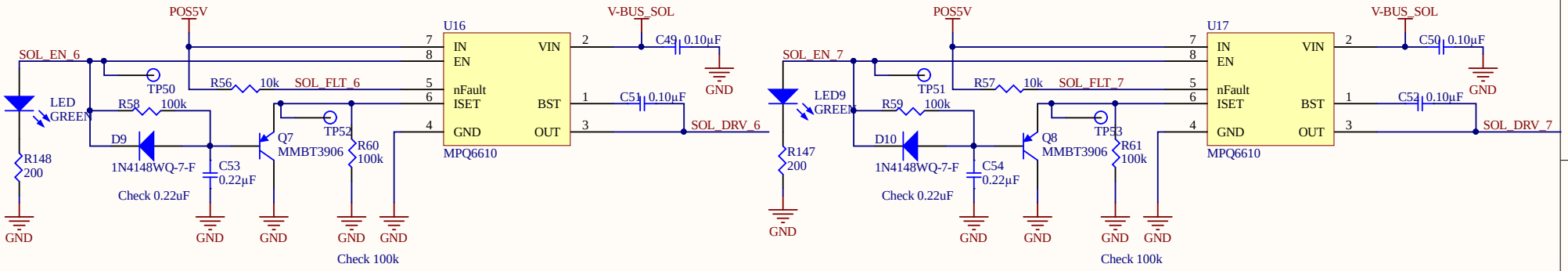


SOLENOID DRIVE

Title	***Solenoids***	Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer:	Revision:	
Date: 9/13/2019 Time: 6:40:59 PM	Sheet of	
File: solenoid.SchDoc		



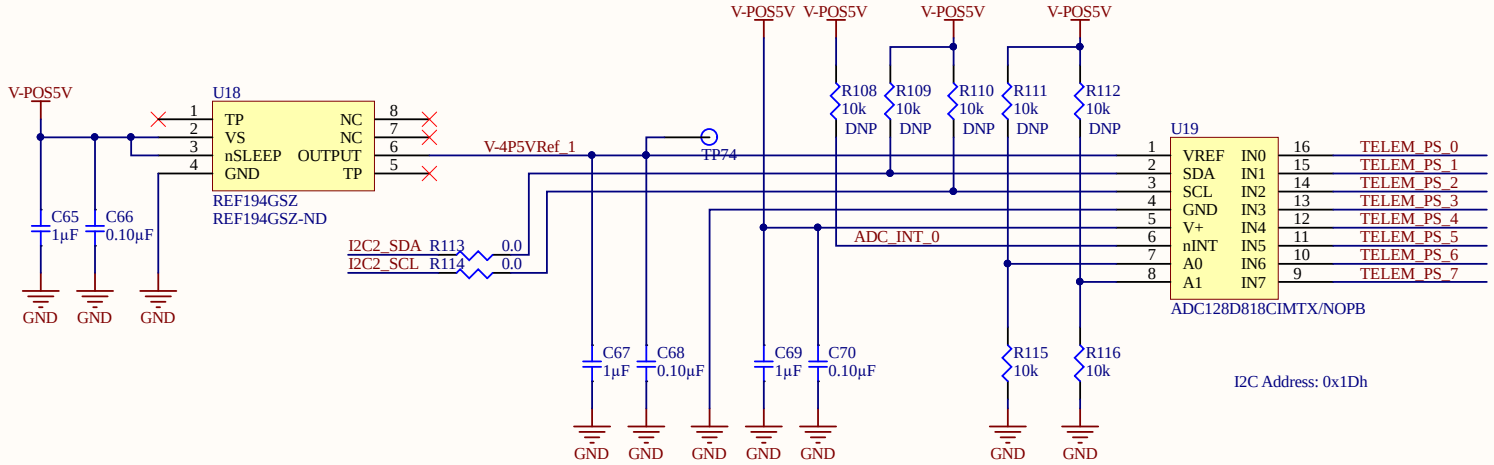
SOLENOID CONTROL



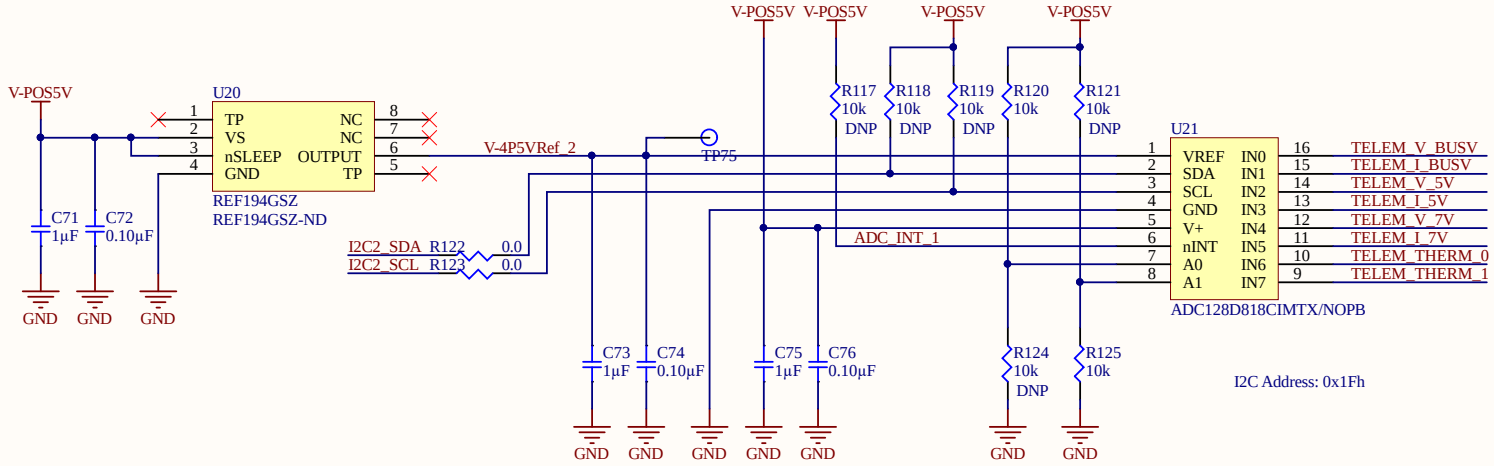
SOLENOID DRIVE

Note: Connect LEDs to Solenoid line externally for easy identification

Title	***Solenoid Control***	Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer:	Revision:	
Date: 9/13/2019 Time: 6:41:00 PM	Sheet of	
File: solenoid_drv.SchDoc		

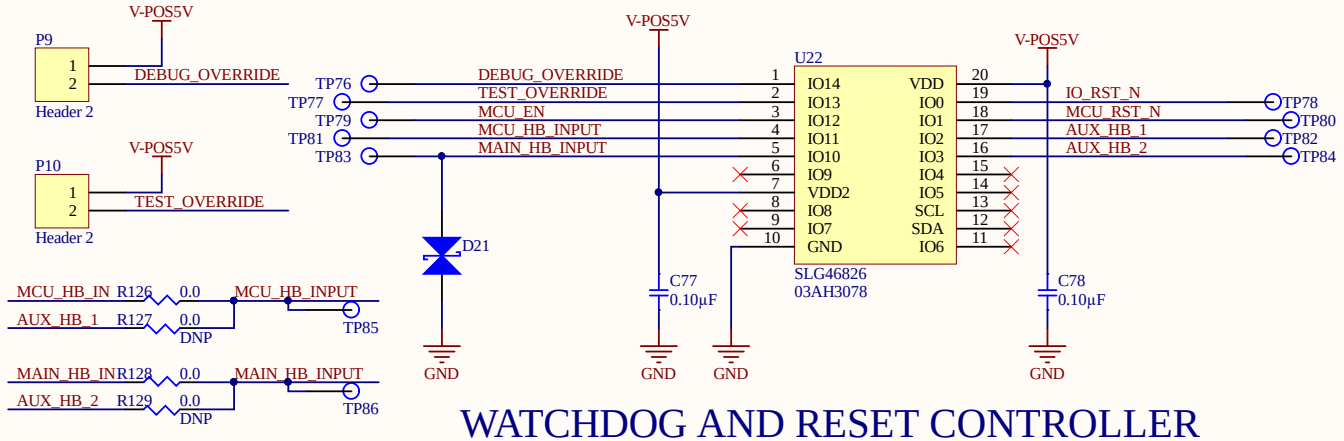


PRESSURE



RAIL AND TEMPERATURE

Title *ADC*		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer:	Revision:	
Date: 9/13/2019 Time: 6:41:00 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 recircuilated 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 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer:	Revision:	
Date: 9/13/2019 Time: 6:41:00 PM	Sheet of	
File: watchdog.SchDoc		