

Pressurization Board Series 1

Sheet: Microcontroller



File: Microcontroller.sch

Sheet: ADCs



File: ADC.sch

Sheet: Power



File: Power.sch

Sheet: Connectors



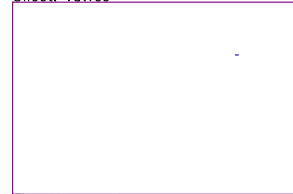
File: Connectors.sch

Sheet: Motors



File: Motors.sch

Sheet: Valves



File: Valves.sch

Sheet: Pressure Transducers



File: PressureTransducers.sch

Sheet: Thermocouples



File: Thermocouples.sch

Sheet: Comms



File: Comms.sch

Sheet: Memory



File: Memory.sch

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Sheet: /

File: pressurization_series1.sch

Title: Pressurization Board Series 1

Size: A4

Date: 2020-08-17

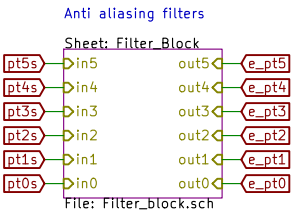
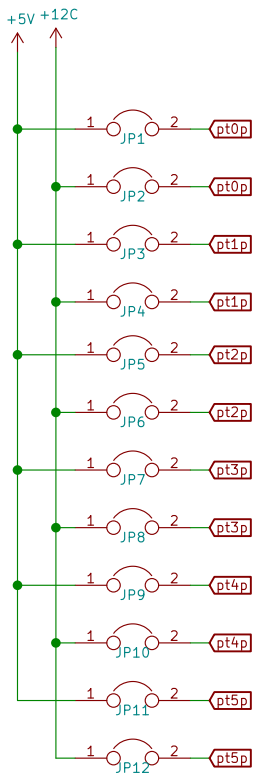
Rev: Rev A

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Id: 1/25

Pressure Transducers

Pts can be powered be either 5v or 12v



Note: Cutoff frequency of filter should be half the sampling frequency minus some margin.
Need to sample at twice the measured frequency (Nyquist).
ADCs sampled at 200HZ in the past,
so 80-90 HZ cutoff would be good.

FILTER RC SELECTION:
for 5v pressure transducers
R1 = 3kohm
R2 = 5.6kohm
C = 1uF

This filter yeilds:
 $F_c = 81.47 \text{ Hz}$
Gain = 0.65 (FSO adc input = 3.26V)

see this sheet for calculations:
<https://docs.google.com/spreadsheets/d/15WcBS81j1mEnTeu4w-lgx77W5PSOB0aJVBm6bfbJjco/edit#gid=0>

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Sheet: /Pressure Transducers/
File: PressureTransducers.sch

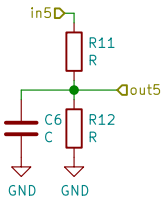
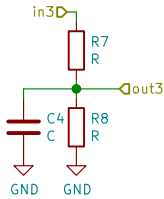
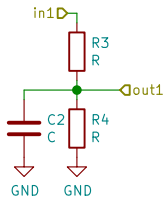
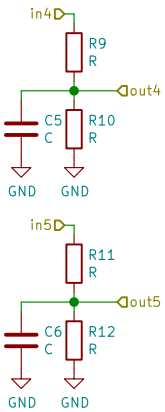
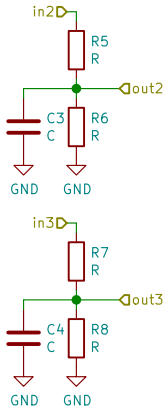
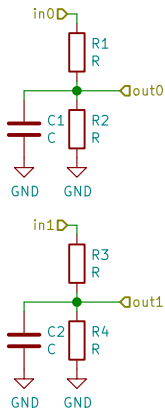
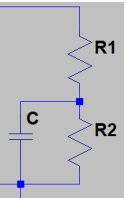
Title: Pressurization Board Series 1

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Pressure Transducers Filter Block

$$G_{DC} = \frac{1}{1 + \frac{R_1}{R_2}}$$

$$\omega_c = \frac{2(1 + \frac{R_1}{R_2}) - 1 - \frac{R_1}{R_2}}{R_1 C}$$



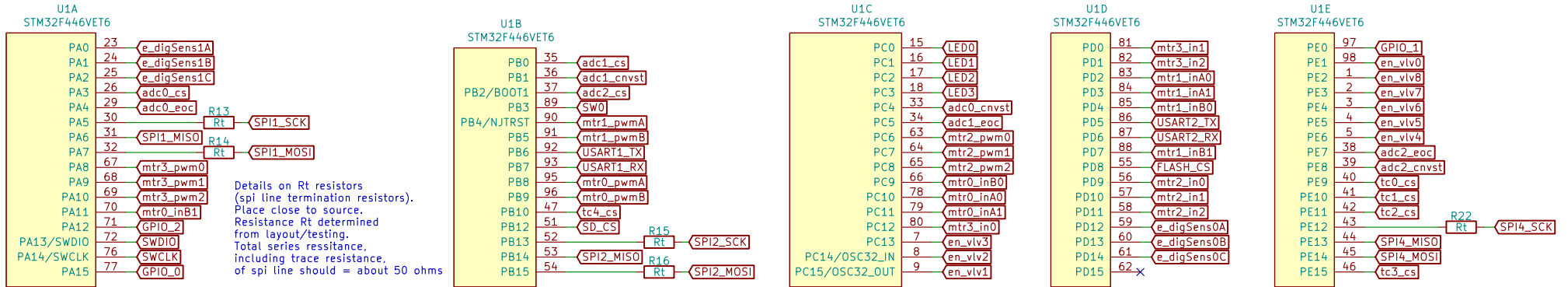
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Sheet: /Pressure Transducers/Filter_Block/
File: Filter_block.sch

Title: Pressurization Board Series 1

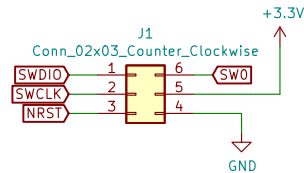
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Microcontroller

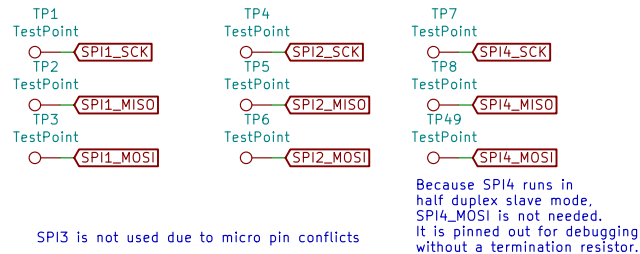
Broken into blocks for readability



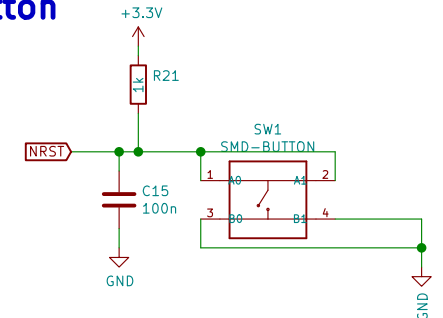
Programming Header J Link



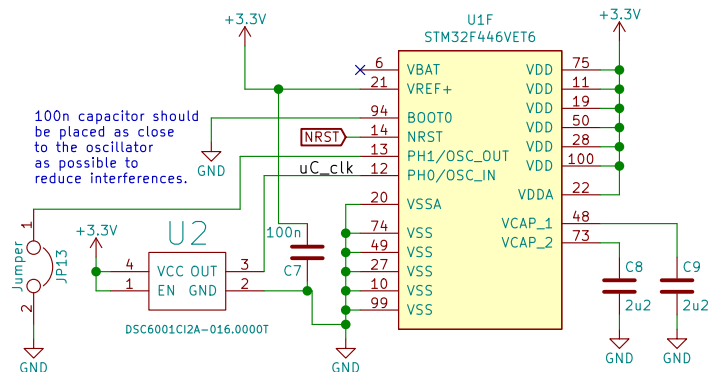
SPI Test Points



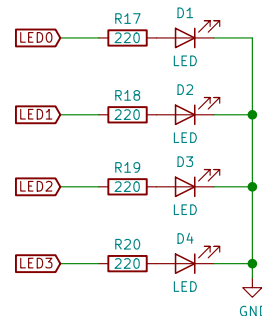
Reset Button



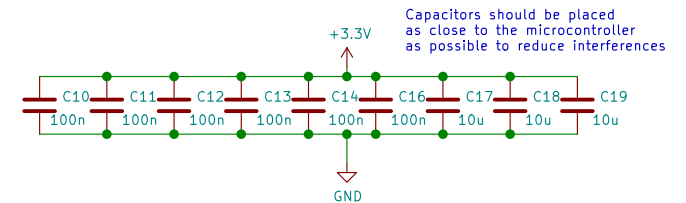
Oscillator & Micro Power



Micro LEDs



Capacitors



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Sheet: /Microcontroller/
File: Microcontroller.sch

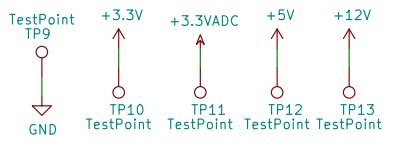
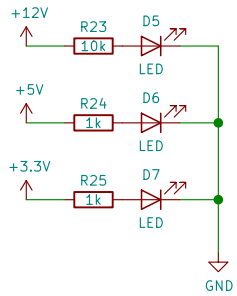
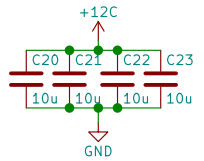
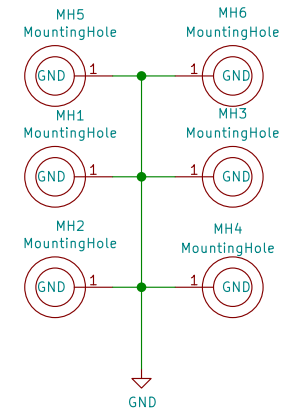
Title: Pressurization Board Series 1

Size: A4
KiCad E.D.A. kicad (5.1.5-0-10_14)

Date: 2020-08-17

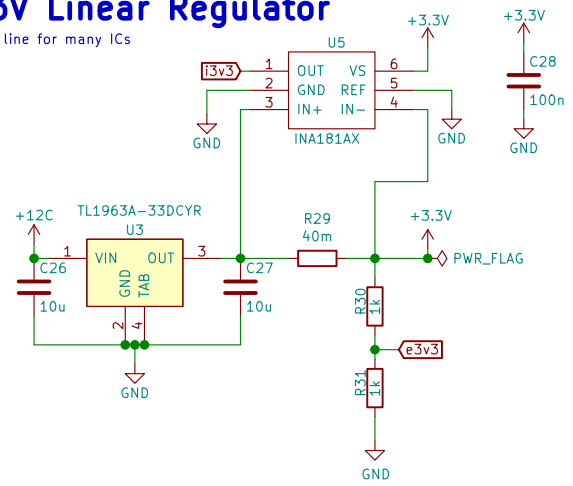
Rev: Rev A
Id: 4/25

Misc

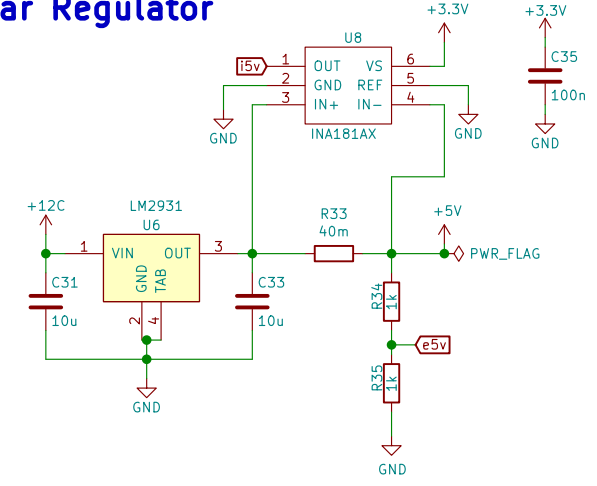


3.3V Linear Regulator

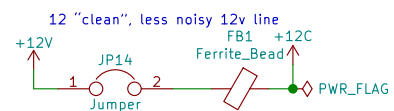
+3.3V line for many ICs



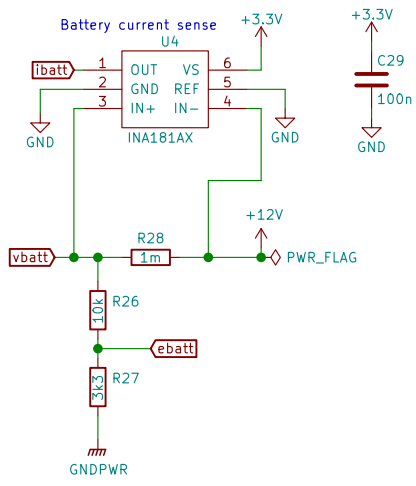
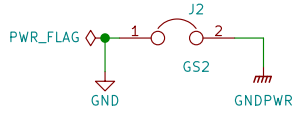
5V Linear Regulator



12V, 12C, GND, GNDPWR

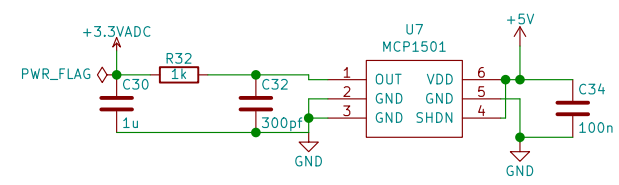


Gndpwr is noisy ground that connects to high current devices (vlvs, mtrs)



3v3 Reference

Precise 3.3v line used for adcs



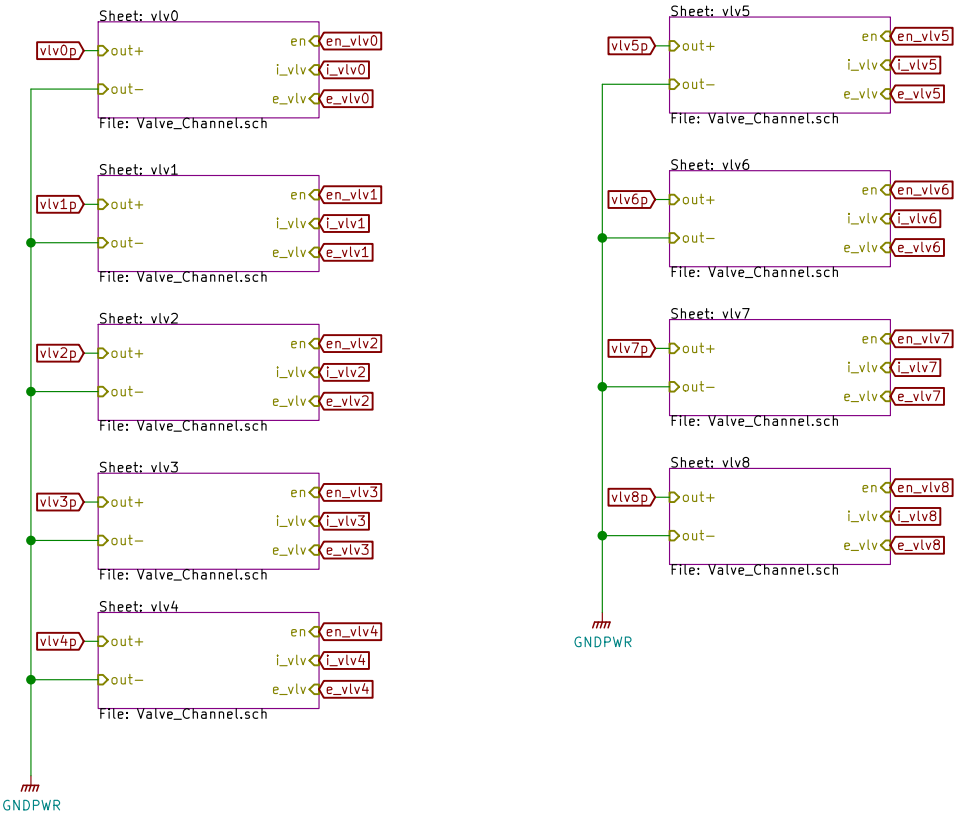
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Sheet: /Power/
File: Power.sch

Title: Pressurization Board Series 1

Size: A4 Date: 2020-08-17 Rev: Rev A
KiCad E.D.A. kicad (5.1.5-0-10_14) Id: 5/25

Valves



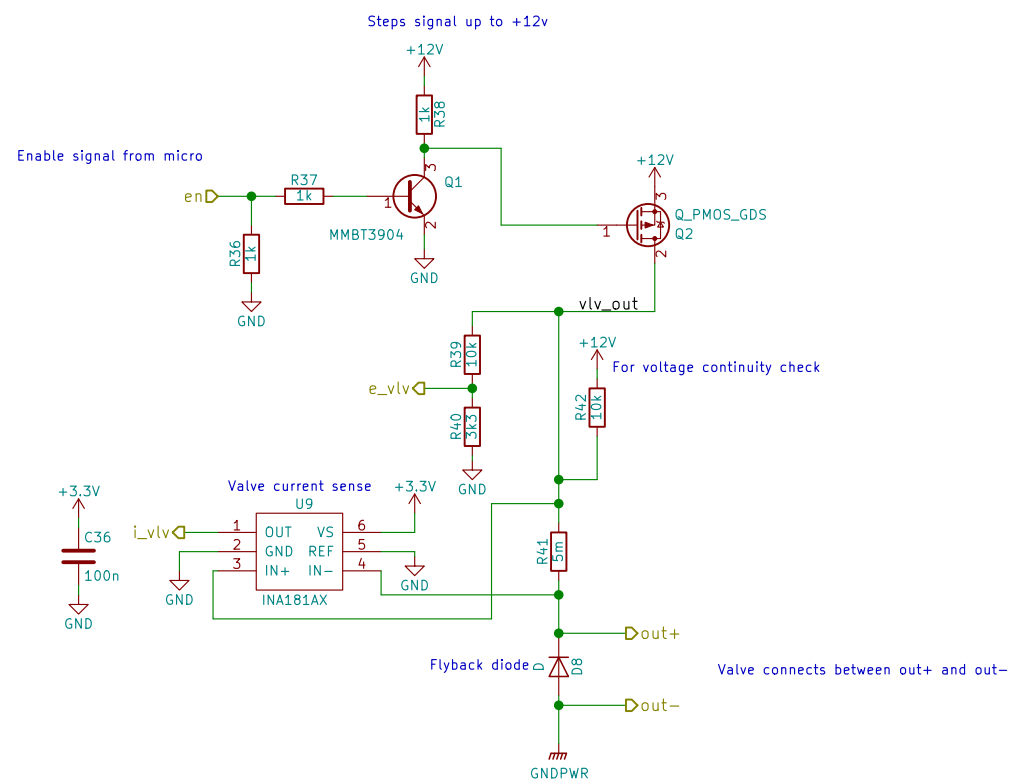
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Sheet: /Valves/
File: Valves.sch

Title: Pressurization Board Series 1

Size: A4	Date: 2020-08-17	Rev: Rev A
KiCad E.D.A. kicad (5.1.5-0-10_14)		Id: 6/25

Valve Channel



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Sheet: /Valves/vlv0/
File: Valve_Channel.sch

Title: Pressurization Board Series 1

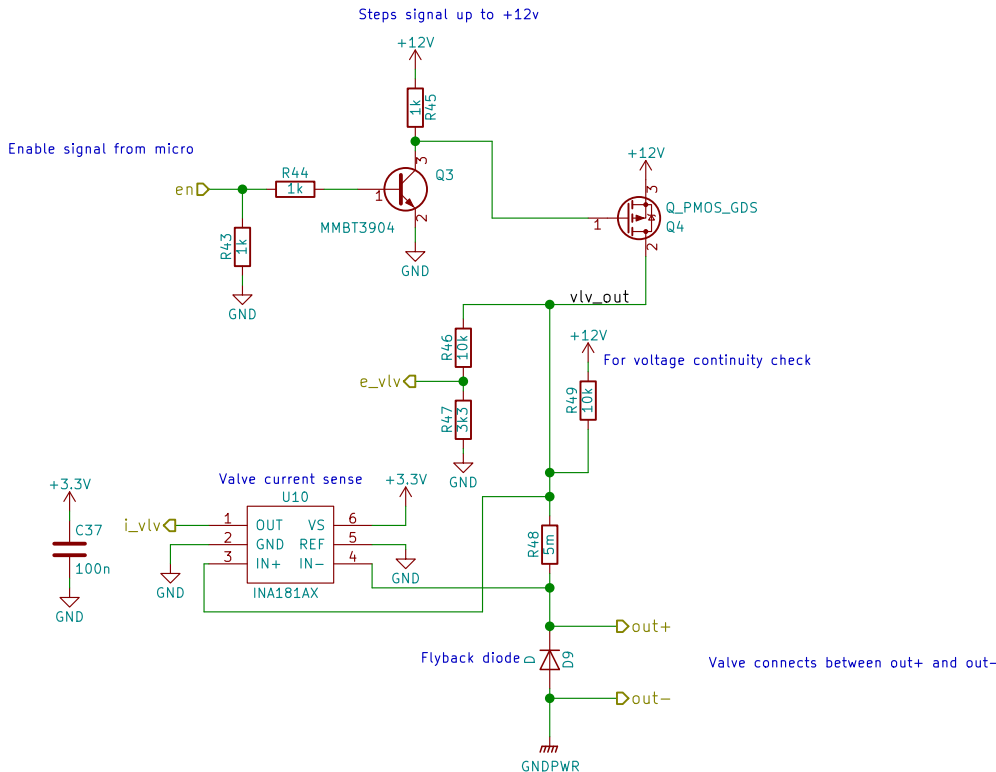
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KiCad E.D.A.	kicad (5.1.5-0-10_14)

Rev: Rev A

Id: 7/25

Valve Channel



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Sheet: /Valves/vlv1/
File: Valve_Channel.sch

Title: Pressurization Board Series 1

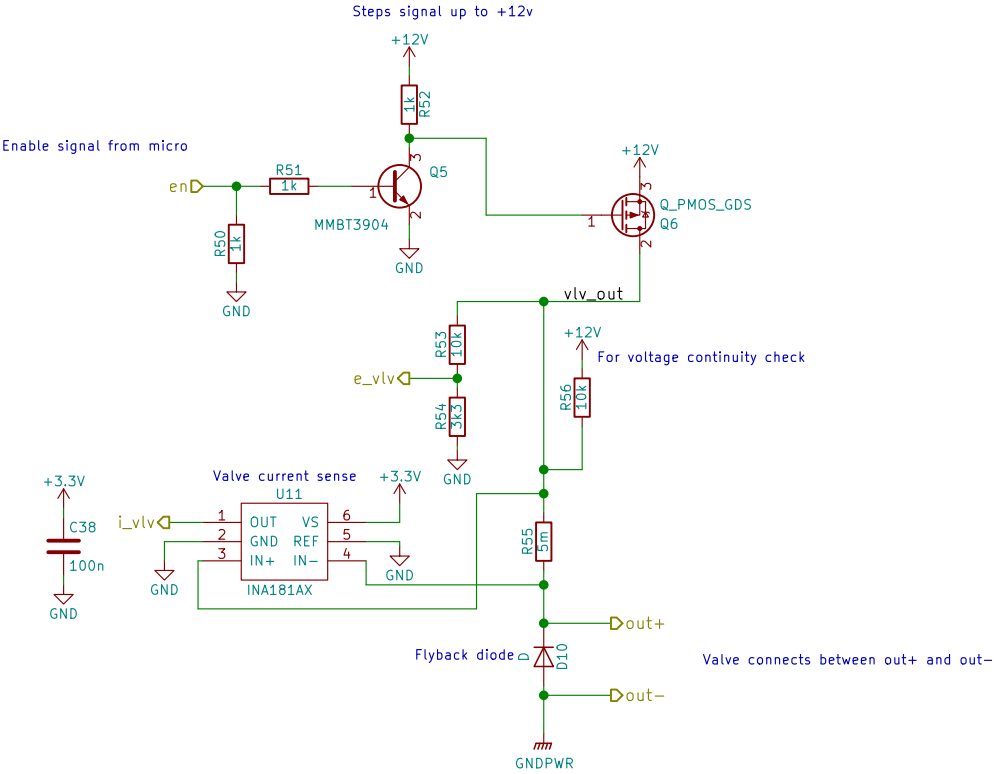
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Rev: Rev A

Id: 8/25

Valve Channel



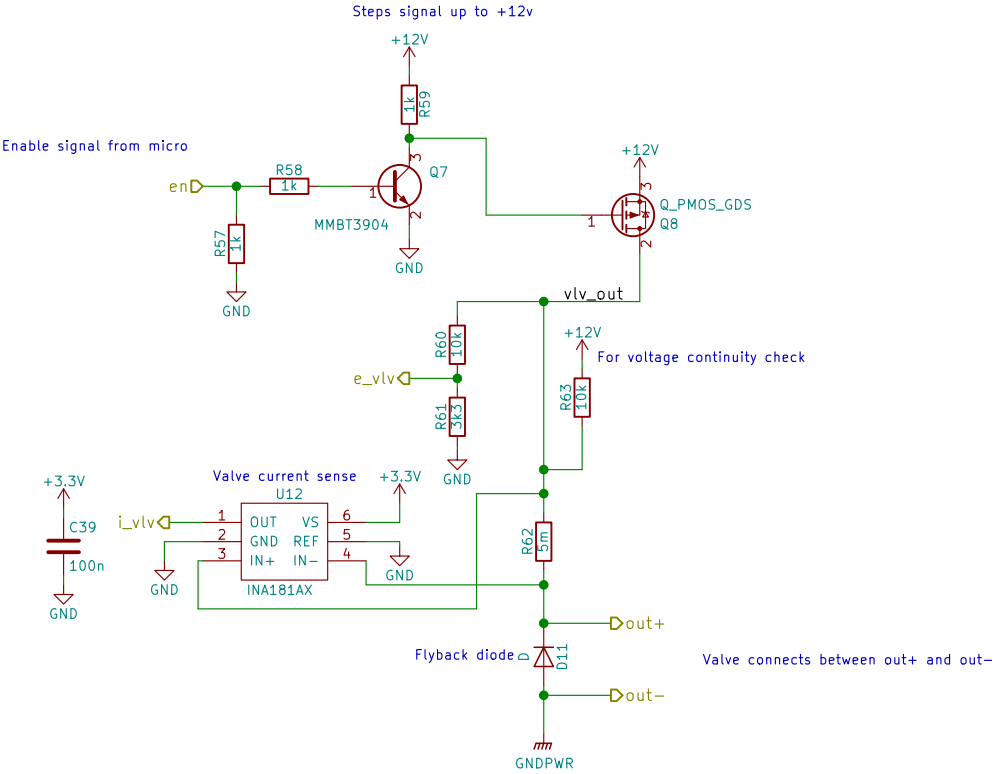
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Sheet: /Valves/vlv2/
File: Valve_Channel.sch

Title: Pressurization Board Series 1

Size: A4	Date: 2020-08-17	Rev: Rev A
KiCad E.D.A. kicad (5.1.5-0-10_14)		Id: 9/25

Valve Channel



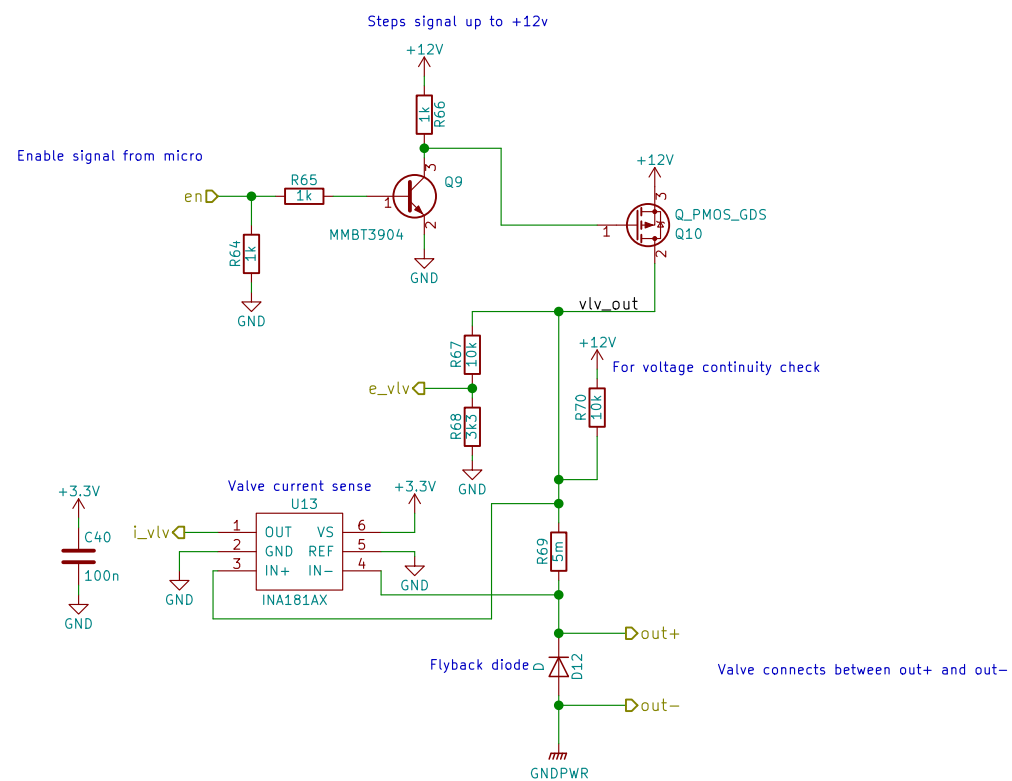
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Title: Pressurization Board Series 1

Size: A4	Date: 2020-08-17	Rev: Rev A
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Valve Channel



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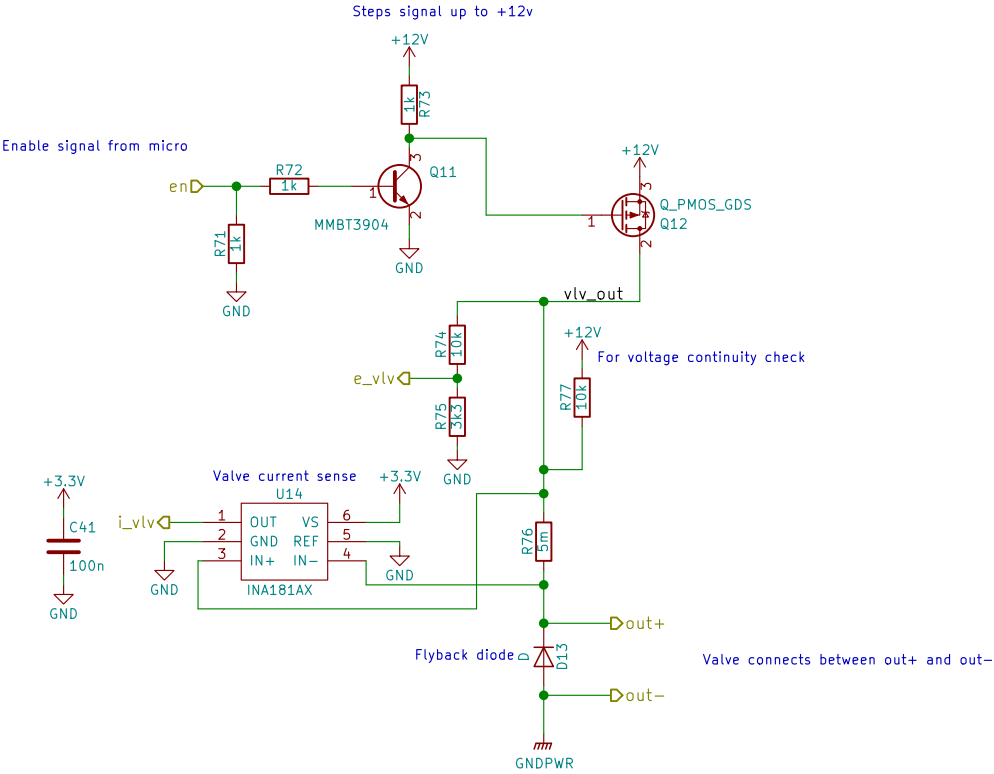
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Rev: Rev A
Id: 11/25

Valve Channel



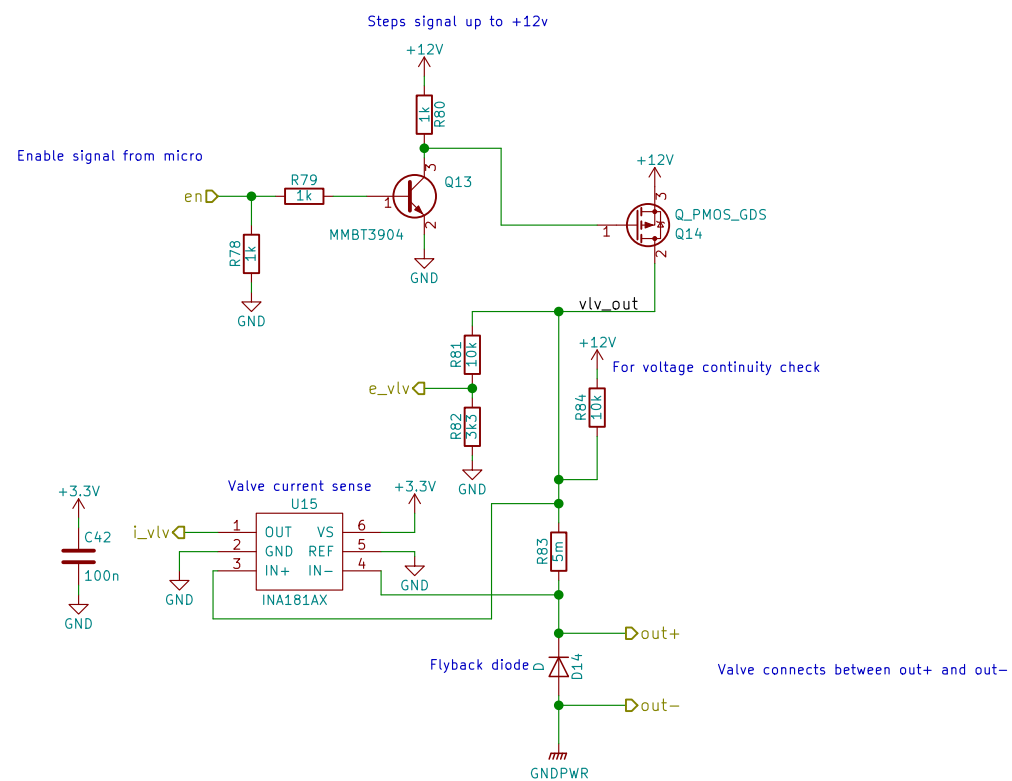
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Title: Pressurization Board Series 1

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Valve Channel



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Title: Pressurization Board Series 1

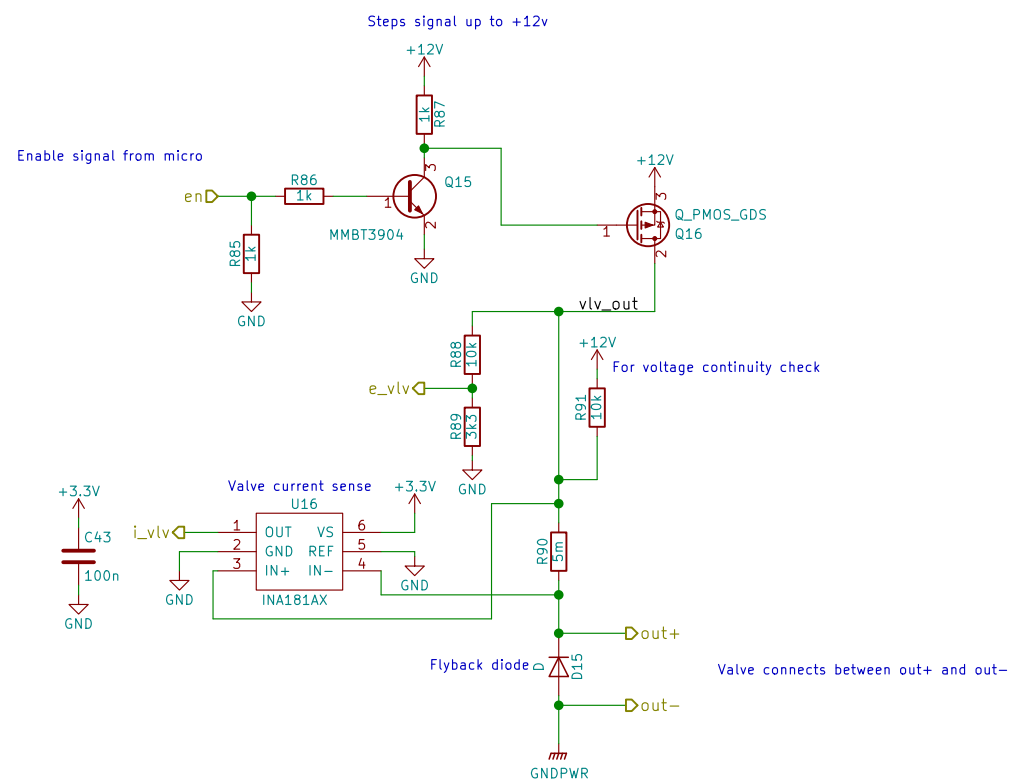
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Rev: Rev A

KiCad E.D.A.	kiCad (5.1.5-0-10_14)
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Id: 13/25

Valve Channel



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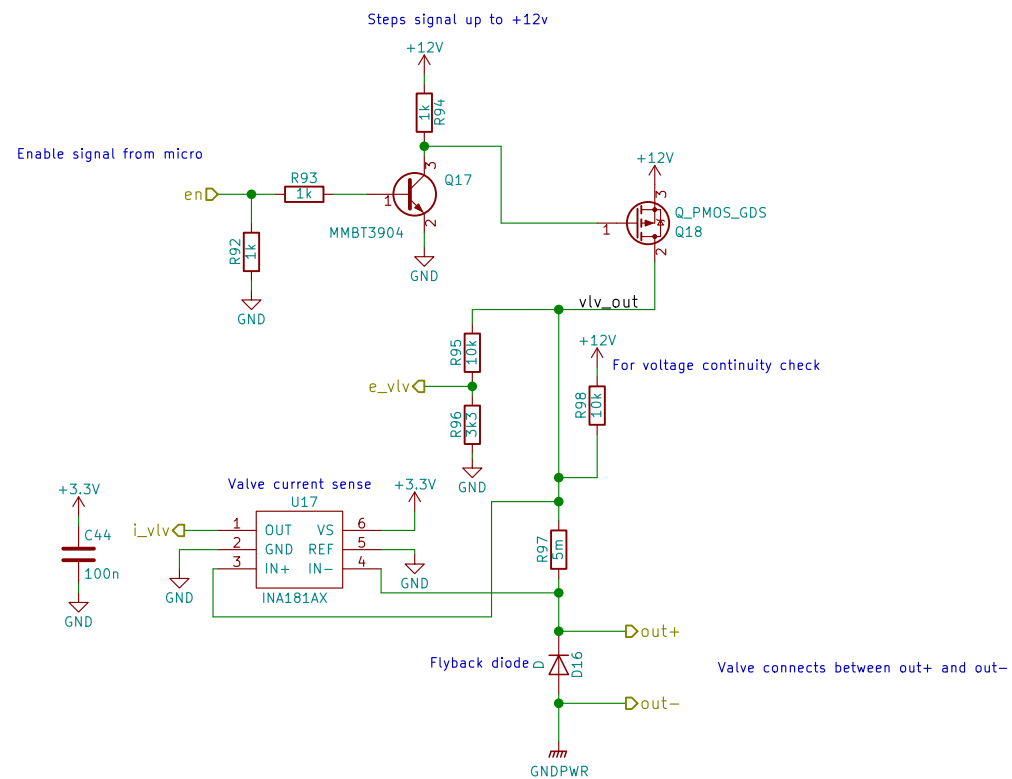
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Title: Pressurization Board Series 1

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Rev: Rev A
Id: 14/25

Valve Channel



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Sheet: /Valves/vlv8/
File: Valve_Channel.sch

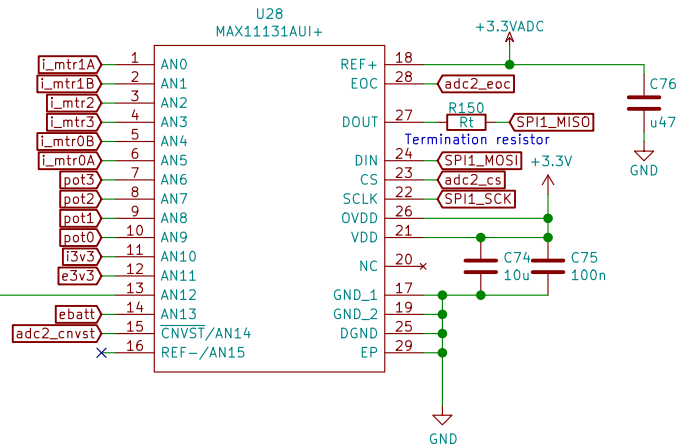
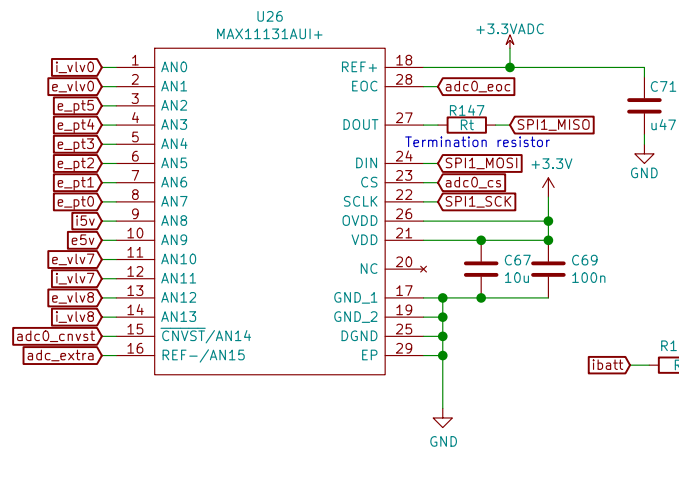
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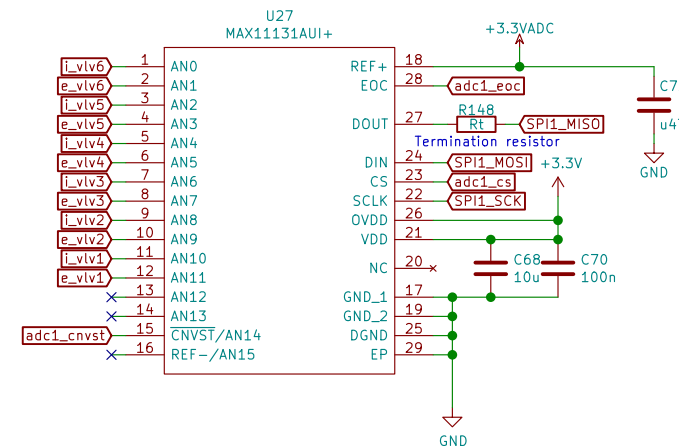
Rev: Rev A
Id: 15/25

Analog to Digital Converters

ADC Test Points



- adc0_cs TP33 TestPoint
- adc1_cs TP34 TestPoint
- adc2_cs TP35 TestPoint
- adc0_eoc TP36 TestPoint
- adc1_eoc TP37 TestPoint
- adc2_eoc TP38 TestPoint
- adc0_cnvst TP39 TestPoint
- adc1_cnvst TP40 TestPoint
- adc2_cnvst TP41 TestPoint



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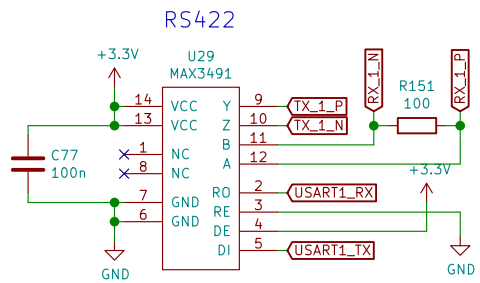
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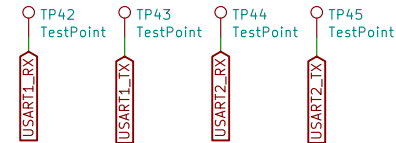
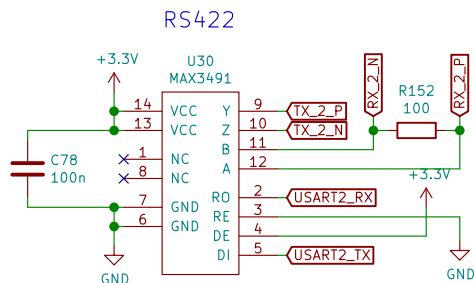
Size: A4	Date: 2020-08-17	Rev: Rev A
KiCad E.D.A. kicad (5.1.5-0-10_14)		Id: 16/25

Communications

Two separate RS422 lines for communications between the micro and computer or another board. RS422 ICs communicate with the micro via USART.



Note: On EC3 max3491csd was used
Should use max3491esd, better temp rating
(both are soic-14 package)



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Sheet: /Comms/
File: Comms.sch

Title: Pressurization Board Series 1

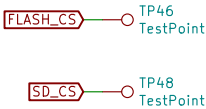
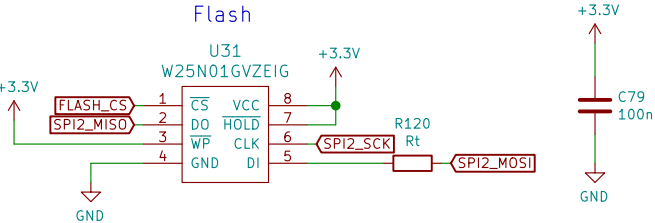
Size: A4 Date: 2020-08-17

KiCad E.D.A. kicad (5.1.5-0-10_14)

Rev: Rev A

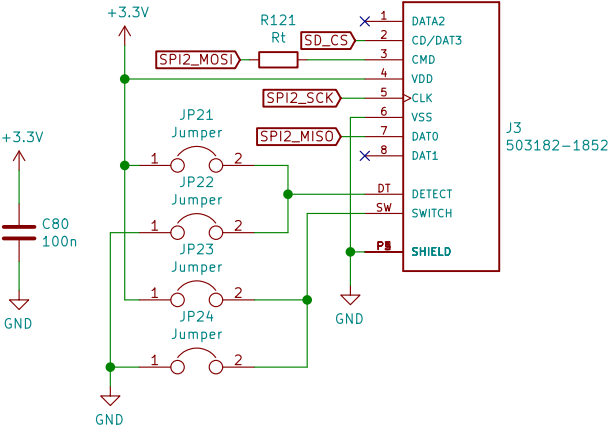
Id: 17/25

Memmory



No EEPROM

SD Card



SD card pin mappings used above are standard with SPI communications for most SD card readers

Jumpers are for pins that need to be tested for what state high/low corresponds to

WP- Write Protect cannot be left floating, connection to gnd allows write
COMMON- If there's a card, CD will be connected to COM, otherwise they are disconnected
CD- Card detected pin
SHIELD- connected to socket, usually tied to ground

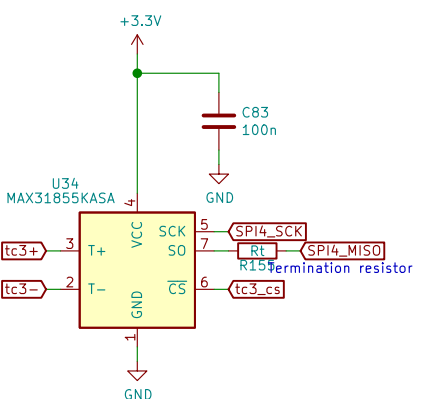
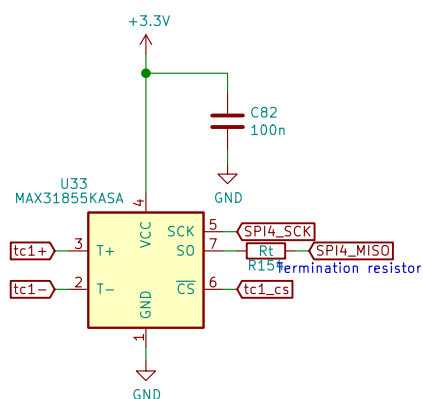
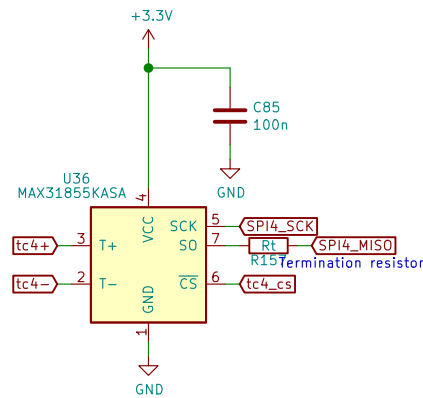
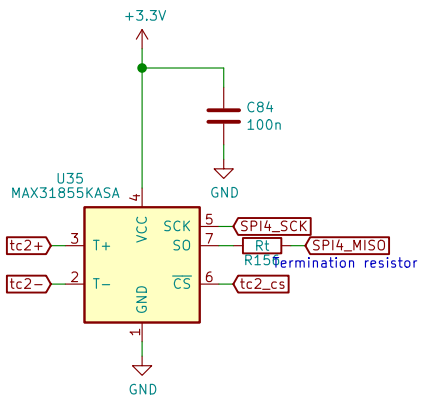
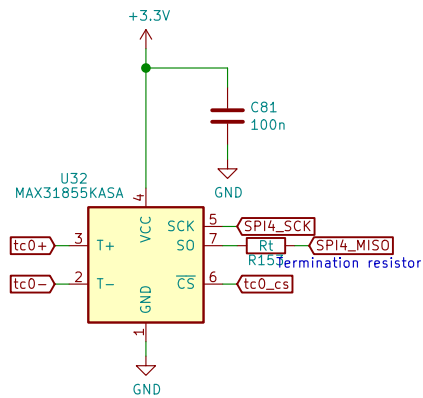
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Sheet: /Memory/
File: Memory.sch

Title: Pressurization Board Series 1

Size: A4	Date: 2020-08-17	Rev: Rev A
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Thermocouples



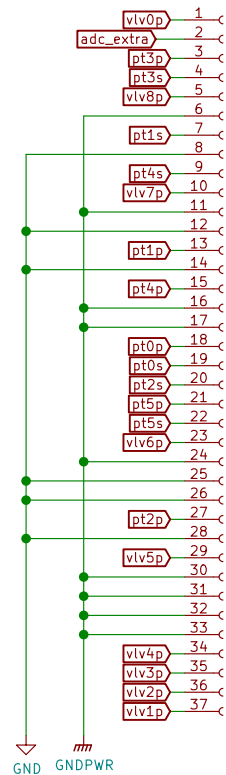
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Sheet: /Thermocouples/
File: Thermocouples.sch

Title: Pressurization Board Series 1

Size: A4	Date: 2020-08-17	Rev: Rev A
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Valve & Pressure Transducer Connector



J4
2-208224-1 or similar
Mates to 206305-1 or similar
Board connector pinout
MATCHES harness connector pinout

Valve & Pressure Transducer
Connector Diagram Legend:
P: Power
G: Ground
S: Signal
+: One side of motor/valve
-: Other side of motor/valve
Red: Valves
Blue: Pressure Transducers

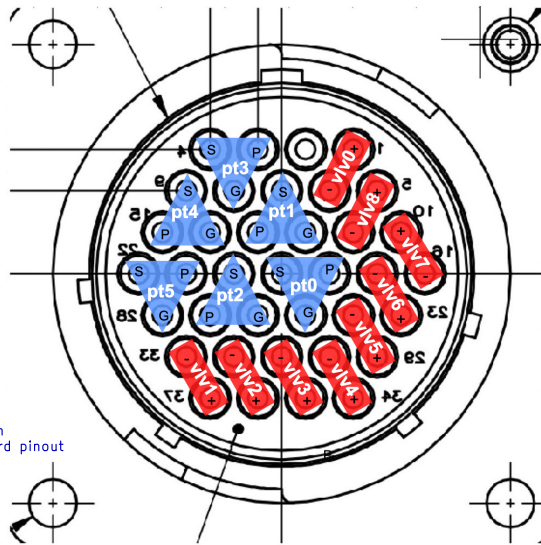
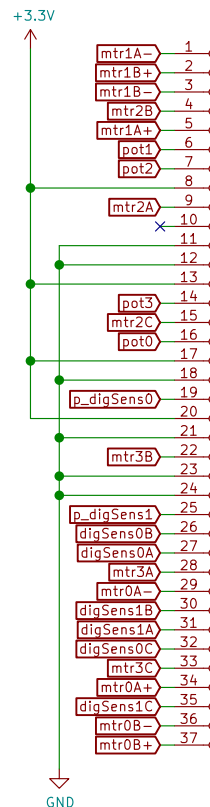


Diagram is for both
connector and board pinout

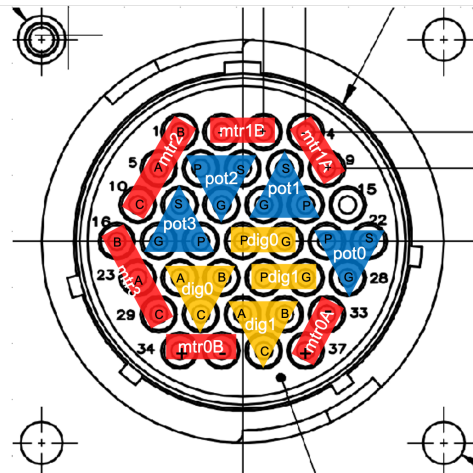
Motor Connector



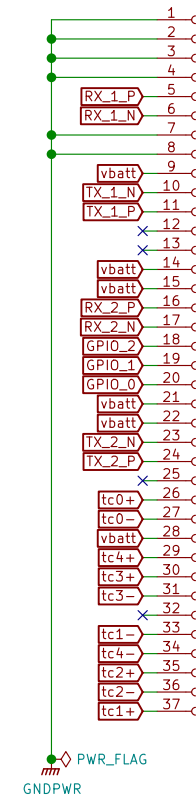
J5
1-206934-4 or similar
Mates to 206150-1 or similar
Board connector pinout MIRRORS
harness connector pinout
about the vertical axis
(numerically)

Motor Connector Diagram Legend:
P: Power
G: Ground
S: Signal
A, B, C: Digital sensor (encoder or hall)
output signals
+: One side of motor/valve
-: Other side of motor/valve
Red: Motors
Blue: Potentiometers
Yellow: Digital sensor

Diagram is for connector pinout only!
Board pinout is mirrored
See pinout above for board



Power & Comms & Thermocouple Connector



J6
2-208224-1 or similar
Mates to 206305-1 or similar
Board connector pinout MATCHES harness connector pinout

Power, Comms & Thermocouples
Connector Diagram Legend:
P: Power
G: Ground
R+: RS422 receive (positive differential)
R-: RS422 receive (negative differential)
T+: RS422 transmit (positive differential)
T-: RS422 transmit (negative differential)
+: One side of tc
-: Other side of tc
Red: Battery
Blue: Comms
Green: Thermocouples

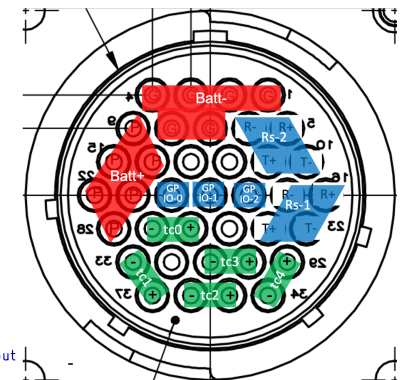


Diagram is for both
connector and board pinout

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Sheet: /Connectors/
File: Connectors.sch

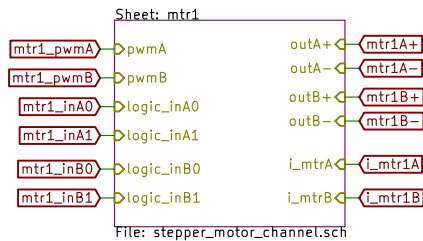
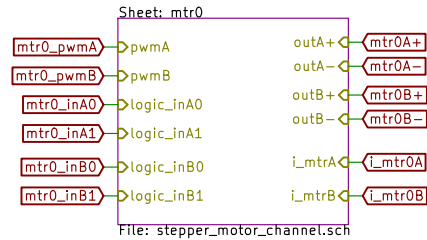
Title: Pressurization Board Series 1

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Date: 2020-08-17
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Rev: Rev A
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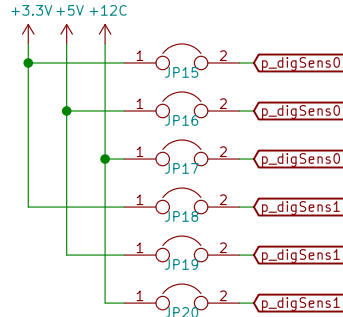
Bipolar Stepper Motors

Can also support brushed dc motors
15A max per phase
A & B refer to the two phases of a bipolar stepper motor

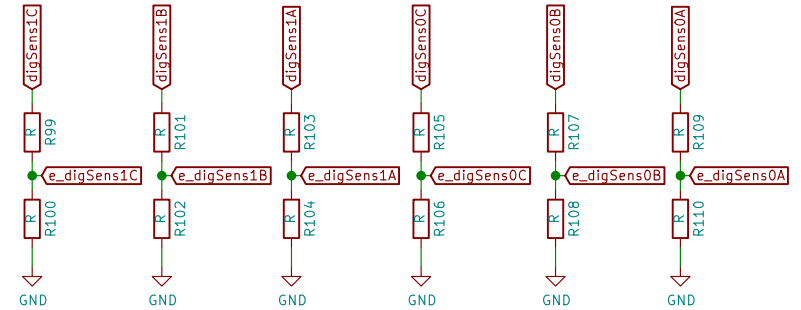


Digital Sensors: Encoders or Hall Effect Sensors

Encoders have two output voltages, hall effect sensors have three output voltages



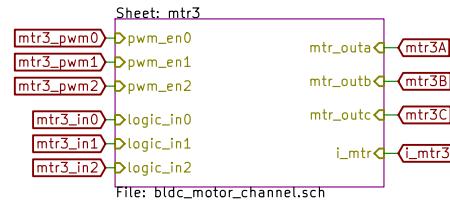
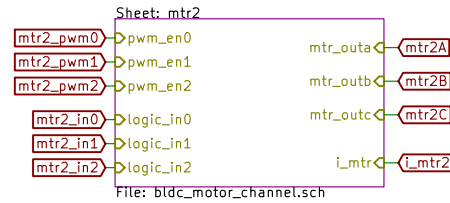
Encoder/Hall could possibly be powered by 3.3v, 5v, or 12v
These lines can also be used to power hall effect sensors.



Voltage divider to step down the sensor voltage to <3.3V for the micro, if it is >3.3V.
If it is <3.3V, a 0 ohm resistor can be used on the top and the bottom one must be left open.

Brushless DC Motors (3 phase)

Channels 2,3 are for brushless dc motors



Potentiometers

For any motor (and valves)

Two potentiometers are for measuring the two motor positions.
Two extra potentiometers are for measuring the position of the two needle valves turned by the motors.

Potentiometer signal goes straight from connector to ADC.
Potentiometers are not filtered because the center frequency of the filter changes with potentiometer position.

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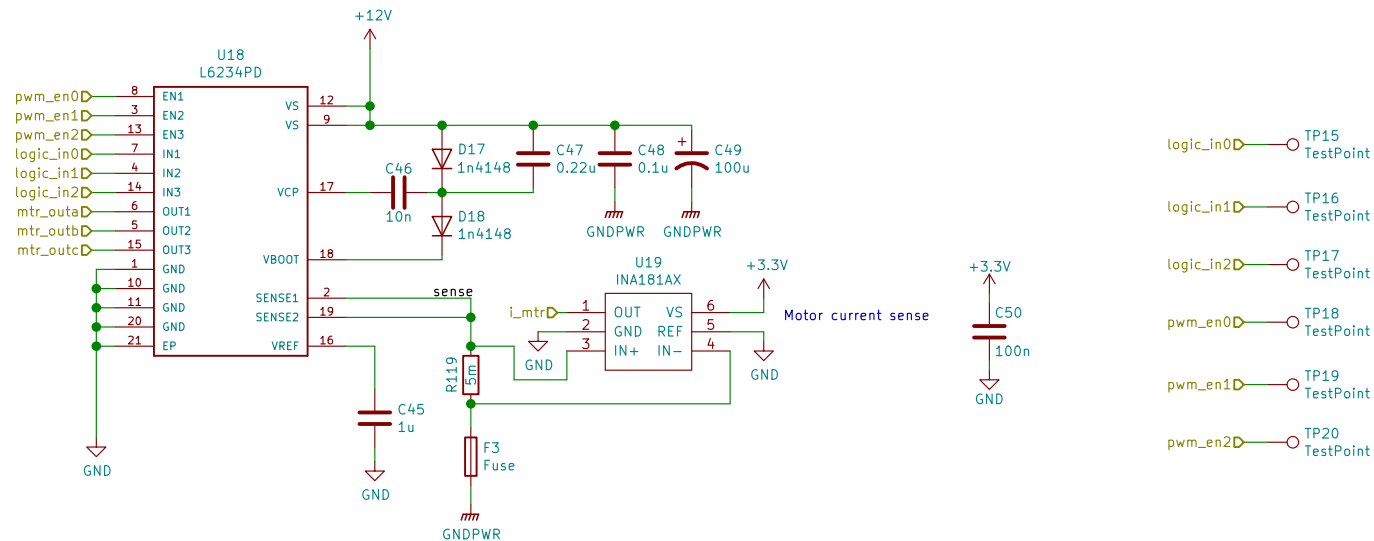
Sheet: /Motors/
File: Motors.sch

Title: Pressurization Board Series 1

Size: A4
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Rev: Rev A
Id: 21/25

Brushless Motor Channel



Brushless DC motor is driven by a triple half H bridge IC (L6234).
5A max pulsed current.
INx pins toggle whether the high side or low side mosfets of a half bridge are on.
A logic HIGH switches the high side mosfet on, a logic LOW switches the low side mosfet on.
ENx pins enable/disable individual half bridges.
A logic HIGH enables the channel and a logic LOW disables the channel by switching power off.
OUTX should be fed as inputs into 3 phase motor.

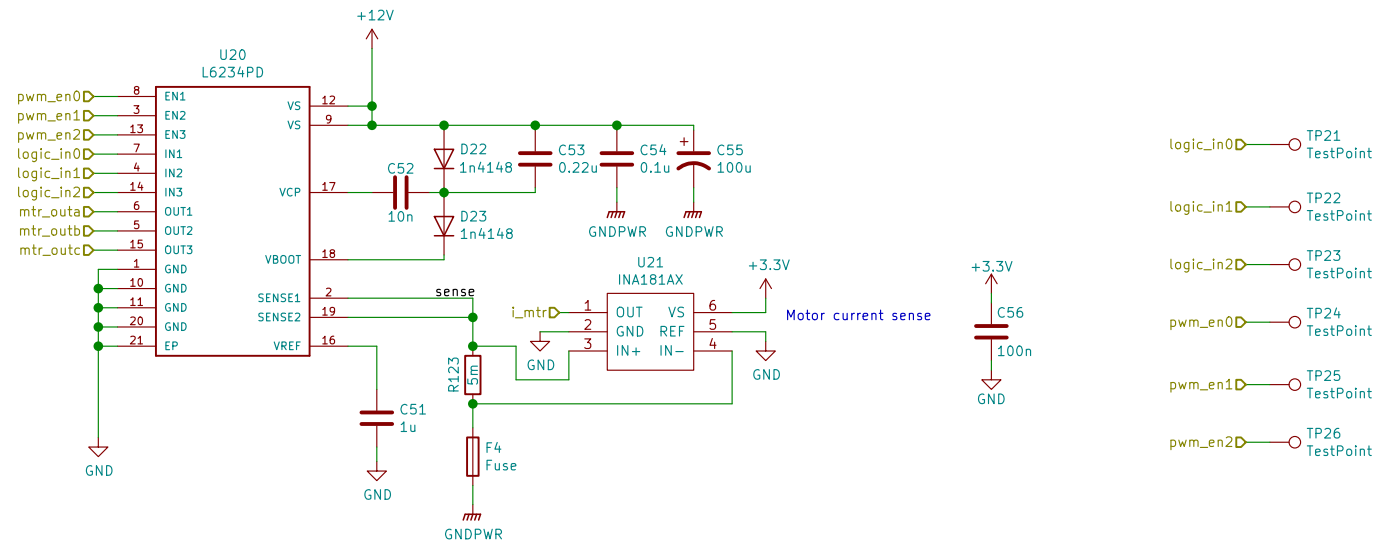
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Sheet: /Motors/mtr2/
File: bldc_motor_channel.sch

Title: Pressurization Board Series 1

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Brushless Motor Channel



Brushless DC motor is driven by a triple half H bridge IC (L6234).
 5A max pulsed current.
 INx pins toggle whether the high side or low side mosfets of a half bridge are on.
 A logic HIGH switches the high side mosfet on, a logic LOW switches the low side mosfet on.
 ENx pins enable/disable individual half bridges.
 A logic HIGH enables the channel and a logic LOW disables the channel by switching power off.
 OUTx should be fed as inputs into 3 phase motor.

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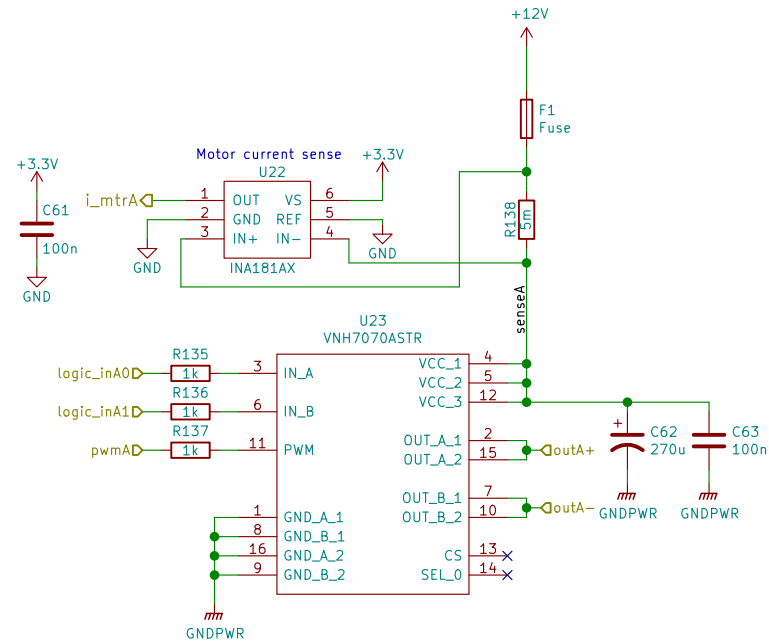
Sheet: /Motors/mtr3/
File: bldc_motor_channel.sch

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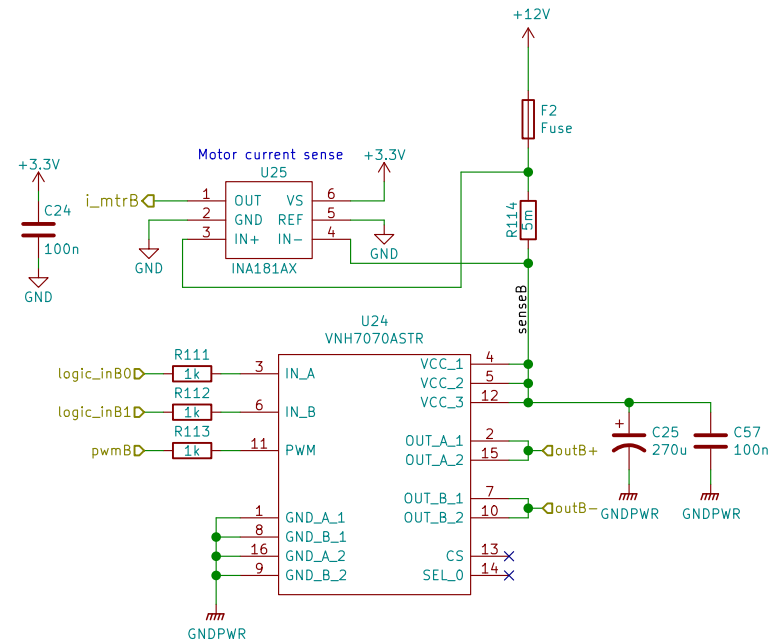
Bipolar Stepper Motor Channel

Phase A

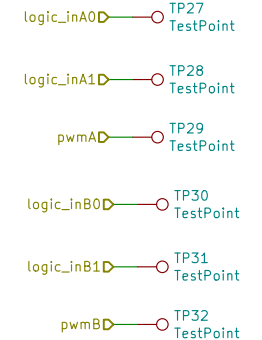


Stepper motor driven by two full Hbridge ICs (VN7070ASTR)
 15A max current.
 PWM input applies to both half bridges.
 Inx inputs control which mosfets are on
 See table 11 of datasheet for details, ignore CS and SEL0.
 CS and SEL0 pins are intentionally not used
 Current sensing is instead done externally.
 High side current sensing is easier for layout.

Phase B



Test Points



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Sheet: /Motors/mtr0/
 File: stepper_motor_channel.sch

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Size: A4	Date: 2020-08-17	Rev: Rev A
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Phase A

Stepper motor driven by two full Hbridge ICs (VN7070ASTR)
15A max current.
PWM input applies to both half bridges.
Inx inputs control which mosfets are on
See table 11 of datasheet for details, ignore CS and SEL0.
CS and SEL0 pins are intentionally not used
Current sensing is instead done externally.
High side current sensing is easier for layout.

Phase B

The diagram illustrates the Phase B circuit for a stepper motor driver. It features a motor current sense circuit and a stepper motor driver circuit.

Motor current sense circuit (U40): The INA181AX (U40) is configured as a current sense amplifier. Its non-inverting input (IN+) is connected to the motor's senseB terminal through a 5mΩ sense resistor (R126). The inverting input (IN-) is connected to ground. The output (OUT) is connected to a +3.3V supply through a 100nF capacitor (C64). The VS pin is connected to +3.3V, and the REF pin is connected to ground. The GND pin is also connected to ground.

Stepper motor driver circuit (U39): The VN7070ASTR (U39) is configured as a stepper motor driver. Its IN_A pin is connected to logic_inB0 through a 1kΩ resistor (R122). Its IN_B pin is connected to logic_inB1 through a 1kΩ resistor (R124). Its PWM pin is connected to pwmB through a 1kΩ resistor (R125). The VCC_1, VCC_2, and VCC_3 pins are connected to a +12V supply through a fuse (F6). The OUT_A_1 pin is connected to OutB+ through a 270uF capacitor (C65). The OUT_B_1 pin is connected to OutB- through a 100nF capacitor (C66). The GND_A_1, GND_B_1, GND_A_2, and GND_B_2 pins are connected to GNDPWR. The CS pin is connected to GNDPWR, and the SEL_0 pin is connected to GNDPWR.

Test Points

Signal	Test Point
logic_inA0	TP47 TestPoint
logic_inA1	TP50 TestPoint
pwmA	TP51 TestPoint
logic_inB0	TP52 TestPoint
logic_inB1	TP53 TestPoint
pwmB	TP54 TestPoint

Stepper motor driven by two full Hbridge ICs (VNH7070ASTR)
15A max current.
PWM input applies to both half bridges.
Inx inputs control which mosfets are on
See table 11 of datasheet for details, ignore CS and SEL0.
CS and SEL0 pins are intentionally not used
Current sensing is instead done externally.
High side current sensing is easier for layout.

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Sheet: /Motors/mtr1/
File: stepper_motor_channel.sch

Title: Pressurization Board Series 1

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