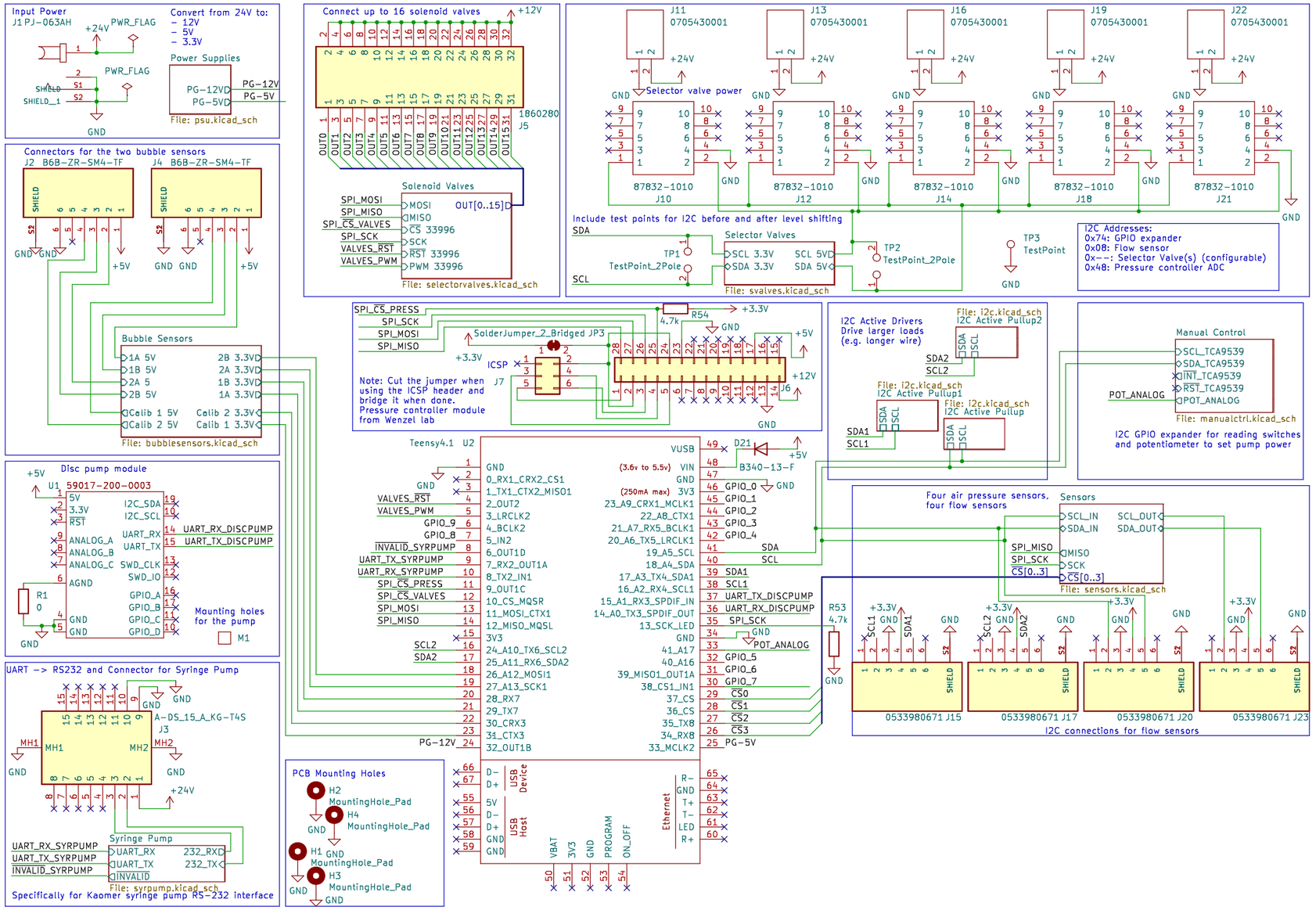
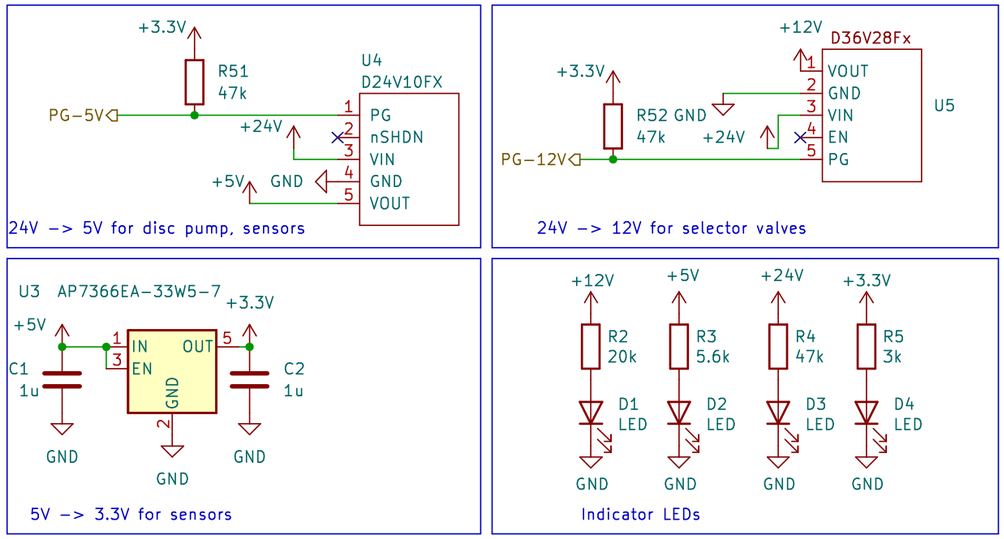

Input Power
J1 PJ-063AH
+24V
PWR_FLAG
PWR_FLAG
SHIELD
SHIELD_1
S1
S2
GND
Convert from 24V to:
- 12V
- 5V
- 3.3V
Power Supplies
PG-12V
PG-5V
PG-12V
PG-5V
File: psu.kicad_sch
Connectors for the two bubble sensors
J2 B6B-ZR-SM4-TF
J4 B6B-ZR-SM4-TF
SHIELD
GND
+5V
Bubble Sensors
1A 5V
1B 5V
2A 5
2B 5V
2B 3.3V
2A 3.3V
1B 3.3V
1A 3.3V
Calib 1 5V
Calib 2 5V
Calib 2 3.3V
Calib 1 3.3V
File: bubblesensors.kicad_sch
Connect up to 16 solenoid valves
+12V
1860280
J5
OUT0
OUT1
OUT2
OUT3
OUT4
OUT5
OUT6
OUT7
OUT8
OUT9
OUT10
OUT11
OUT12
OUT13
OUT14
OUT15
Solenoid Valves
SPI_MOSI
SPI_MISO
SPI_CS_VALVES
SPI_SCK
VALVES_RST
VALVES_PWM
MOSI
MISO
CS 33996
SCK
RST 33996
PWM 33996
OUT[0..15]
File: selectorvalves.kicad_sch
J11
0705430001
J13
0705430001
J16
0705430001
J19
0705430001
J22
0705430001
+24V
GND
Selector valve power
87832-1010
J10
J12
J14
J18
J21
Include test points for I2C before and after level shifting
SDA
SCL
TP1
TestPoint_2Pole
TP2
TestPoint_2Pole
TP3
TestPoint
Selector Valves
SCL 3.3V
SDA 3.3V
SCL 5V
SDA 5V
File: svalves.kicad_sch
I2C Addresses:
0x74: GPIO expander
0x08: Flow sensor
0x--: Selector Valve(s) (configurable)
0x48: Pressure controller ADC
SPI_CS_PRESS
SPI_SCK
SPI_MOSI
SPI_MISO
SolderJumper_2_Bridged JP3
ICSP
J7
J6
R54
4.7k
+3.3V
+5V
+12V
GND
Note: Cut the jumper when using the ICSP header and bridge it when done.
Pressure controller module from Wenzel lab
I2C Active Drivers
Drive larger loads (e.g. longer wire)
File: i2c.kicad_sch
I2C Active Pullup2
SDA2
SCL2
File: i2c.kicad_sch
I2C Active Pullup1
SDA1
SCL1
File: i2c.kicad_sch
I2C Active Pullup
Manual Control
SCL_TCA9539
SDA_TCA9539
INT_TCA9539
RST_TCA9539
POT_ANALOG
File: manualctrl.kicad_sch
I2C GPIO expander for reading switches and potentiometer to set pump power
Teensy4.1 U2
VUSB
(3.6v to 5.5v) VIN
(250mA max) 3V3
D21
B340-13-F
GPIO_0
GPIO_1
GPIO_2
GPIO_3
GPIO_4
SDA
SCL
SDA1
SCL1
UART_TX_DISCPUMP
UART_RX_DISCPUMP
SPI_SCK
POT_ANALOG
GPIO_5
GPIO_6
GPIO_7
CS0
CS1
CS2
CS3
VALVES_RST
VALVES_PWM
GPIO_9
GPIO_8
INVALID_SYRPUMP
UART_TX_SYRPUMP
UART_RX_SYRPUMP
SPI_CS_PRESS
SPI_CS_VALVES
SPI_MOSI
SPI_MISO
SCL2
SDA2
PG-12V
PG-5V
USB Device
USB Host
Ethernet
VBAT
3V3
PROGRAM
ON_OFF
Four air pressure sensors, four flow sensors
Sensors
SCL_IN
SDA_IN
SCL_OUT
SDA_OUT
SPI_MISO
SPI_SCK
CS[0..3]
File: sensors.kicad_sch
R53
4.7k
0533980671 J15
0533980671 J17
0533980671 J20
0533980671 J23
I2C connections for flow sensors
Connection to daughter board
I2C 0 – I2C 2 (6 wires)
3.3V
5V
12V
24V
SPI (3 wires)
GPIO (10 wires)
These connectors are optional
J9
522712079
GPIO_9
GPIO_8
GPIO_7
GPIO_6
GPIO_5
GPIO_4
GPIO_3
GPIO_2
GPIO_1
GPIO_0
SPI_MOSI
SPI_MISO
SPI_SCK
SCL2
SDA2
SCL1
SDA1
SDA
SCL
GND
J8
705430039
+3.3V +5V +12V
+24V
Connections for powering the daughter board
GND
Disc pump module
U1 59017-200-0003
5V
3.3V
RST
ANALOG_A
ANALOG_B
ANALOG_C
AGND
I2C_SDA
I2C_SCL
UART_RX
UART_TX
SWD_CLK
SWD_IO
GPIO_A
GPIO_B
GPIO_C
GPIO_D
R1
0
Mounting holes for the pump
M1
UART –> RS232 and Connector for Syringe Pump
A-DS_15_A_KG-T4S
J3
MH1
MH2
+24V
Syringe Pump
UART_RX_SYRPUMP
UART_TX_SYRPUMP
INVALID_SYRPUMP
UART_RX
UART_TX
INVALID
232_RX
232_TX
File: syrpump.kicad_sch
Specifically for Kaomer syringe pump RS-232 interface
PCB Mounting Holes
H1 MountingHole_Pad
H2 MountingHole_Pad
H3 MountingHole_Pad
H4 MountingHole_Pad


+3.3V
R51
47k
PG–5V
U4
D24V10FX
PG
nSHDN
VIN
GND
VOUT
+24V
+5V
GND
24V –> 5V for disc pump, sensors

+12V
D36V28Fx
VOUT
GND
VIN
EN
PG
U5
+3.3V
R52
47k
GND
+24V
PG–12V
24V –> 12V for selector valves

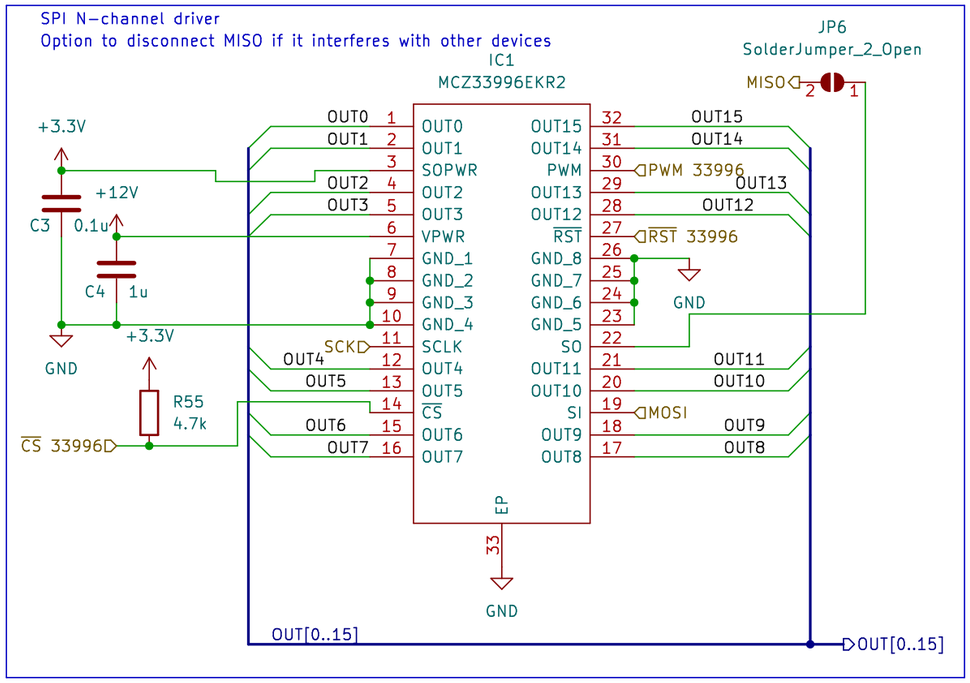
U3 AP7366EA–33W5–7
+5V
+3.3V
IN
OUT
EN
GND
C1
1u
C2
1u
GND
GND
GND
5V –> 3.3V for sensors

+12V
+5V
+24V
+3.3V
R2
20k
R3
5.6k
R4
47k
R5
3k
D1
LED
D2
LED
D3
LED
D4
LED
GND
GND
GND
GND
Indicator LEDs

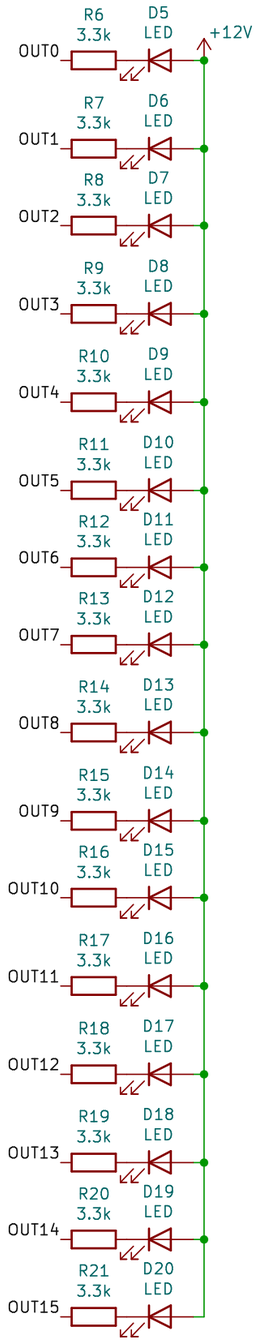
SPI N-channel driver
Option to disconnect MISO if it interferes with other devices

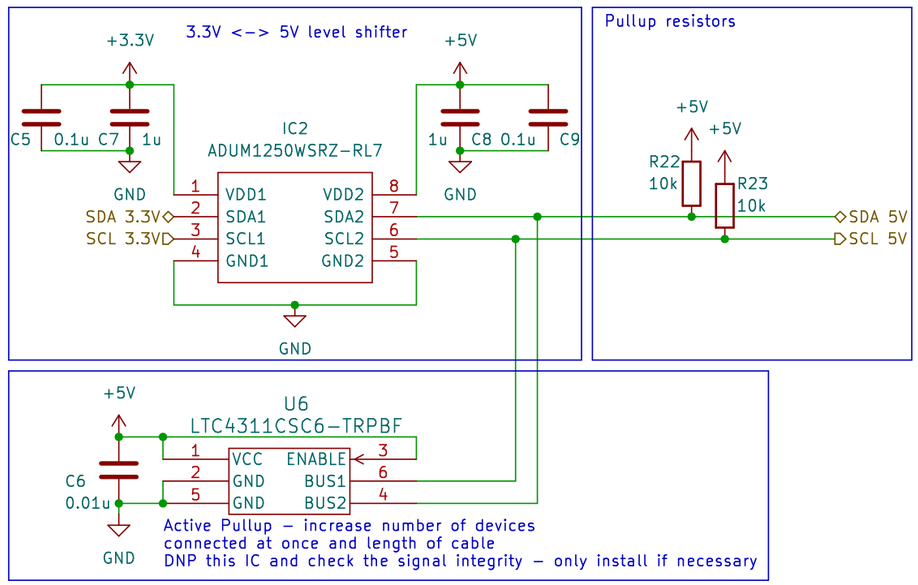
IC1
MCZ33996EKR2

JP6
SolderJumper_2_Open



Indicator LEDs
1 for each valve (16 total)




3.3V <-> 5V level shifter
+3.3V
+5V
C5
0.1u
C7
1u
GND
IC2
ADUM1250WSRZ-RL7
1u
C8
0.1u
C9
GND
1
VDD1
2
SDA1
SDA 3.3V
3
SCL1
SCL 3.3V
4
GND1
VDD2
8
SDA2
7
SCL2
6
GND2
5
GND
Pullup resistors
+5V
+5V
R22
10k
R23
10k
SDA 5V
SCL 5V
+5V
U6
LTC4311CSC6-TRPBF
C6
0.01u
1
VCC
2
GND
5
GND
ENABLE
3
BUS1
6
BUS2
4
GND
Active Pullup – increase number of devices
connected at once and length of cable
DNP this IC and check the signal integrity – only install if necessary

14 input devices – 12 DIP switches, 1 switch, 1 button

S1
210-6MS
12 DIP switches
Control up to 12 valves independently

S4
210-6MS

+3.3V

SW11 SW0
SW10 SW1
SW9 SW2
SW8 SW3
SW7 SW4
SW6 SW5

R24 10k
R25 10k
R26 10k
R27 10k
R28 10k
R29 10k
R36 10k
R35 10k
R34 10k
R33 10k
R32 10k
R31 10k

GND

SW1
D6C90F1LFS

SW12
R30 10k
"Set Valves" momentary pushbutton

SW13
S2
450301014042
Enable/Disable Manual Control

SW14
S3
450301014042

Pressure/Vacuum selector (sets valves 1/4 to either be both on or both off)

+3.3V

MH2
MH1
CW
WIPER
CCW
POT_ANALOG
PTV09A-4020U-B103
VR1
Potentiometer for manual pump control

GPIO expander
Connect to 12 DIP switches, 1 switch, 1 button over I2C (all inputs)

JP1
SolderJumper_3_Bridged12
R38 10k
R37 10k
INT_TCA9539
RST_TCA9539

U7
TCA9539PWR

*INT
A1
*RESET
P00
P01
P02
P03
P04
P05
P06
P07
VCC
SDA
SCL
A0
P17
P16
P15
P14
P13
P12
P11
P10

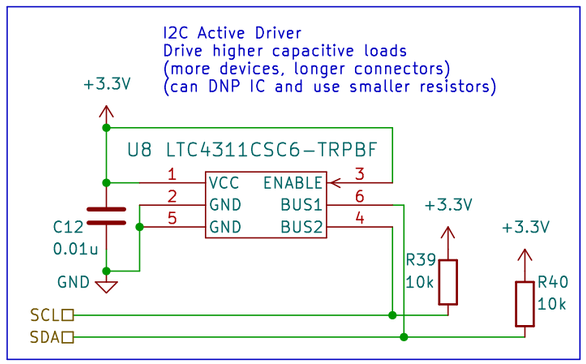
C10 0.1u
C11 1u

SDA_TCA9539
SCL_TCA9539

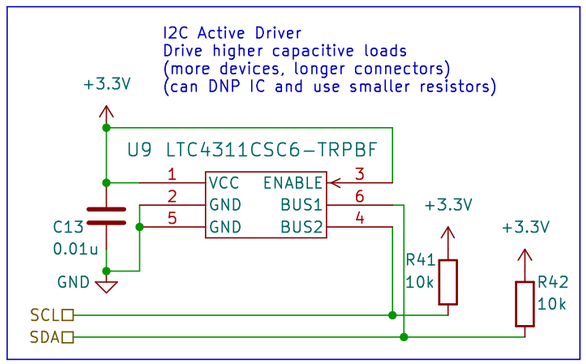
JP2
SolderJumper_3_Bridged12

Use solder jumpers to set the address
Default = 0x74

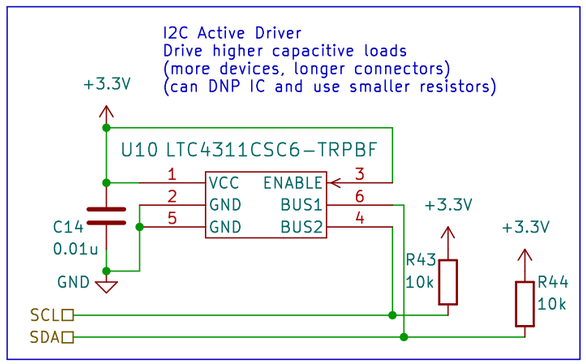
DNP – test signal integrity without the active pullups and populate them if necessary

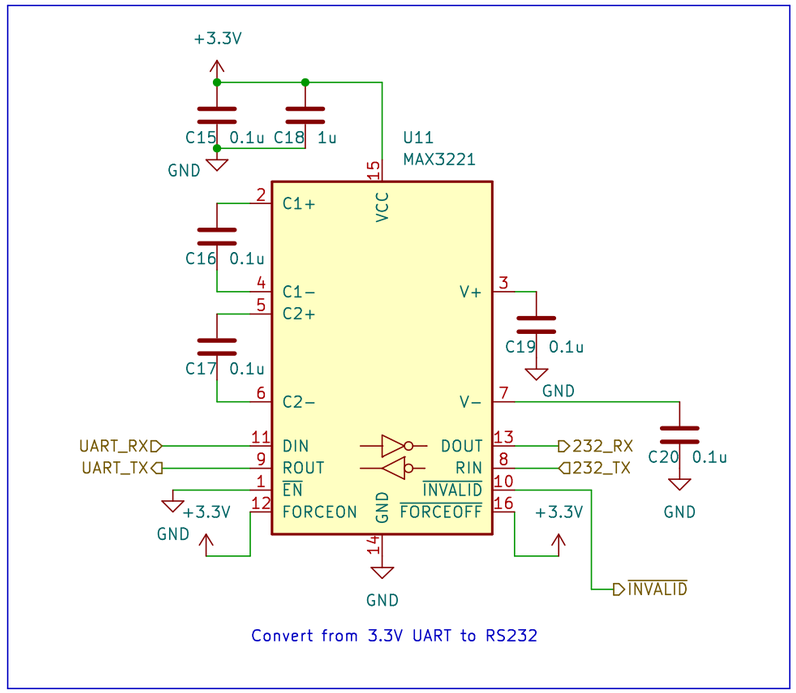


DNP – test signal integrity without the active pullups and populate them if necessary

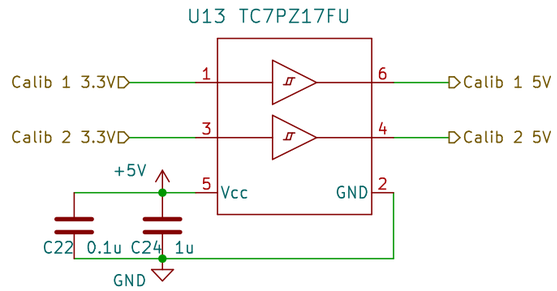


DNP – test signal integrity without the active pullups and populate them if necessary

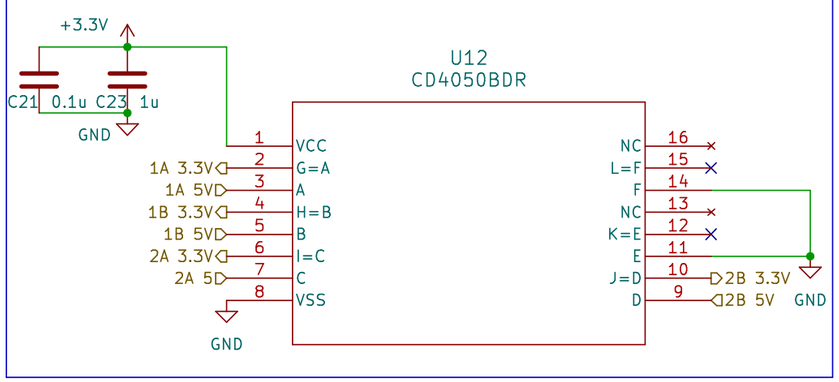


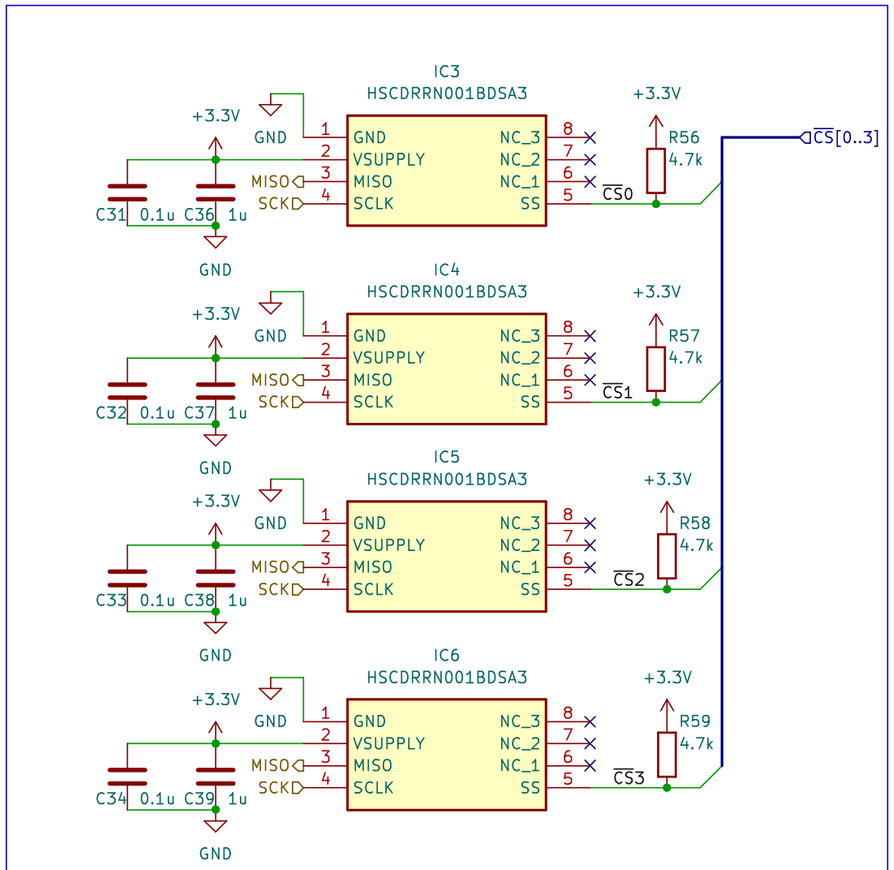

+3.3V
C15 0.1u
C18 1u
GND
U11
MAX3221
15
VCC
2
C1+
C16 0.1u
4
C1−
5
C2+
C17 0.1u
6
C2−
3
V+
C19 0.1u
GND
7
V−
C20 0.1u
GND
UART_RX
UART_TX
11
DIN
9
ROUT
1
EN
12
FORCEON
DOUT
RIN
INVALID
FORCEOFF
13
8
10
16
232_RX
232_TX
+3.3V
GND
GND
14
GND
+3.3V
INVALID
Convert from 3.3V UART to RS232

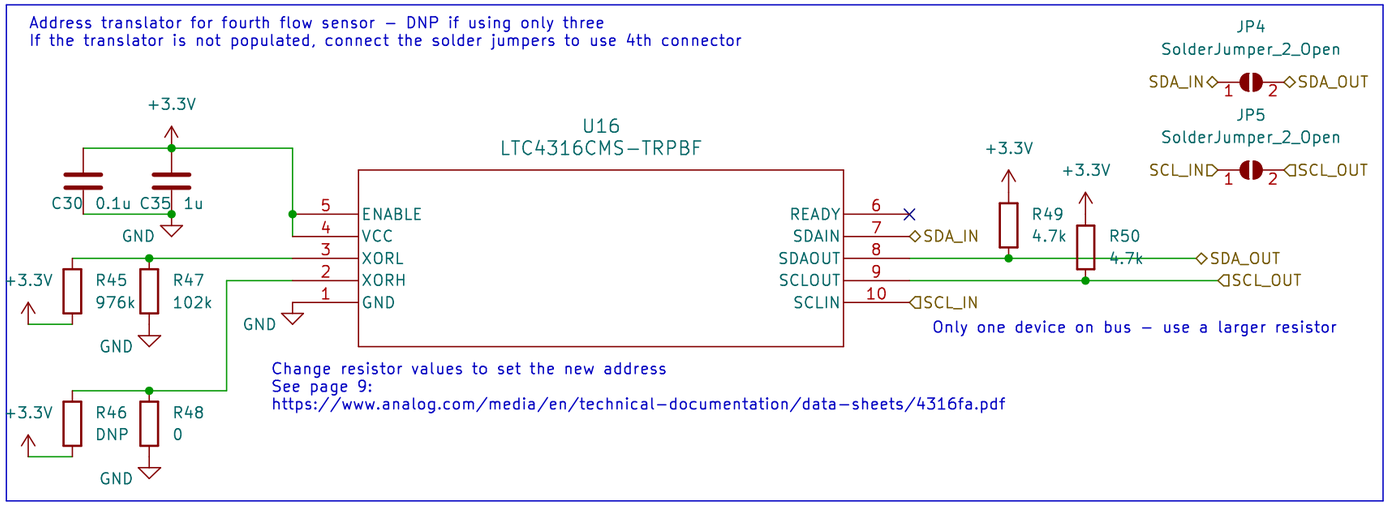
Level shift the calibration signal from 3.3V to 5V



Level shift the bubble detection signal from 5V to 3.3V




IC3
HSCDRRN001BDSA3
+3.3V
GND
MISO
SCK
C31 0.1u
C36 1u
R56 4.7k
CS0
IC4
HSCDRRN001BDSA3
C32 0.1u
C37 1u
R57 4.7k
CS1
IC5
HSCDRRN001BDSA3
C33 0.1u
C38 1u
R58 4.7k
CS2
IC6
HSCDRRN001BDSA3
C34 0.1u
C39 1u
R59 4.7k
CS3
GND VSUPPLY MISO SCLK NC_3 NC_2 NC_1 SS
CS[0..3]
Pressure sensors connect over SPI and have unique chip select pins


Address translator for fourth flow sensor – DNP if using only three
If the translator is not populated, connect the solder jumpers to use 4th connector
U16
LTC4316CMS-TRPBF
ENABLE VCC XORL XORH GND
READY SDAIN SDAOUT SCLOUT SCLIN
C30 0.1u
C35 1u
R45 976k
R47 102k
R46 DNP
R48 0
R49 4.7k
R50 4.7k
SDA_IN
SCL_IN
SDA_OUT
SCL_OUT
JP4
SolderJumper_2_Open
JP5
SolderJumper_2_Open
Only one device on bus – use a larger resistor
Change resistor values to set the new address
See page 9:
https://www.analog.com/media/en/technical-documentation/data-sheets/4316fa.pdf