IO Connectors

THERMO1 DP
THERMO1 DN
THERMO2 DP
THERMO2 DN
THERMO3 DP
THERMO3 DN

RS_DP
RS_DN

PRESSURE1 Sense
PRESSURE2 Sense
PRESSURE3 Sense

SBVALVE_1_COM
SBVALVE_1_T2
SBVALVE_1_T3

SBVALVE_2_COM
SBVALVE_2_T2
SBVALVE_2_T3

SERVOPWR
SERVOGND

VBAT
GNDBAT

PWM HV

SOL_VALVE_1 PWR
SOL_VALVE_1 OUT
SOL_VALVE_2 PWR
SOL_VALVE_2 OUT
SOL_VALVE_3 PWR
SOL_VALVE_3 OUT

STVALVE_1_GND
STVALVE_1_OPEN
STVALVE_1_CLOSED

STVALVE_2_GND
STVALVE_2_OPEN
STVALVE_2_CLOSED

QuickDisco N2O PWR
QuickDisco N2O OUT
QuickDisco N2 PWR
QuickDisco N2 OUT

CAM IN
CAM OUT

File: IO Connectors.kicad_sch

Sensor Unit

THERMO1 DP
THERMO1 DN
THERMO2 DP
THERMO2 DN
THERMO3 DP
THERMO3 DN

RS_DP
RS_DN

PRESSURE1 Sense
PRESSURE2 Sense
PRESSURE3 Sense

SBVALVE_1_COM
SBVALVE_1_T2
SBVALVE_1_T3

SBVALVE_2_COM
SBVALVE_2_T2
SBVALVE_2_T3

SOL_VALVE_1 FAULT
SOL_VALVE_2 FAULT
SOL_VALVE_3 FAULT
DAC_OUT3
DAC_OUT2
DAC_OUT1
VBAT DN
VBAT DP

File: Sensor Unit.kicad_sch

CS THERMO1 SPI
CS THERMO2 SPI
CS THERMO3 SPI
SCK SPI
MISO SPI
MOSI SPI

WRITE_RS
READ_RS
ENABLE_RS

1DRDY THERMO
2DRDY THERMO
3DRDY THERMO

SDA I2C
SCL I2C
RESET ADC

Temp_Sense
FAULT ADC

CS THERMO1 SPI
CS THERMO2 SPI
CS THERMO3 SPI
SCK SPI
MISO SPI
MOSI SPI

WRITE_RS
READ_RS
ENABLE_RS

1DRDY THERMO
2DRDY THERMO
3DRDY THERMO

PCB Temperature Sense

RP2040 Standard

GP9/SPI1 CS
GP13/SPI1 CS
GP29/SPI1 CS
GP8/SPI1 MISO
GP10/SPI1 SCK
GP11/SPI1 MOSI

GP4/UART1 TX
GP5/UART1 RX
GP6/UART1 CTS

GPIO7
GPIO12
GPIO17

GP14/I2C1 SDA
GP15/I2C1 SCL
GPIO16

GP26_ADC0
GP27_ADC1

Red Status
Green Status
Buzzer

GPIO0
GPIO1
GPIO2

File: RP2040 Standard Design.kicad_sch

Power Unit

VBAT DP
VBAT DN

SERVOPWR
SERVOGND

VBAT
GNDBAT

File: Power Unit.kicad_sch

Actuation Unit

SOL_VALVE_3 DUTY
SOL_VALVE_2 DUTY
SOL_VALVE_1 DUTY
SOL_VALVE_1 FAULT
SOL_VALVE_2 FAULT
SOL_VALVE_3 FAULT

PWM HV

SOL_VALVE_1 PWR
SOL_VALVE_1 OUT
SOL_VALVE_2 PWR
SOL_VALVE_2 OUT
SOL_VALVE_3 PWR
SOL_VALVE_3 OUT

STVALVE_1_GND
STVALVE_1_OPEN
STVALVE_1_CLOSED

STVALVE_2_GND
STVALVE_2_OPEN
STVALVE_2_CLOSED

QuickDisco N2O PWR
QuickDisco N2O OUT
QuickDisco N2 PWR
QuickDisco N2 OUT

CAM IN
CAM OUT

PWM LV

SOL_VALVE_1
SOL_VALVE_2
SOL_VALVE_3

QuickDisco N2O
QuickDisco N2

STVALVE_1
STVALVE_2

CAM EN

GP3/PWM1 B

GPIO18
GPIO19
GPIO20
GPIO21
GPIO22
GPIO23
GPIO24
GPIO25
GPIO28

File: Actuation Unit.kicad_sch

LEDs Drivers

POWER

+3.3V   +5VA   +5V   +8.4V   +12V

CR1 Yellow   CR2 Yellow   CR3 Yellow   CR4 Yellow   CR5 Yellow

R1 62   R2 150   R3 150   R4 320   R5 500

GND   AGND   GND   GND   GND

STATUS

+5V

U1
VLMKG3400-GS08
3 C_Green   C_RED 1
2 A_Green   A_Red 4

+5V

R6 10k   R7 100

IC1
NSVT30010MXV6T1G
E2   E1
B2   B1
C1   C2

R8 100   R9 10k

Green Status   Red Status

+5V

R11 1k

LS1
PKMCS0909E4000-R1

Buzzer   R10 1k

U2
BC846BLT1G

GND
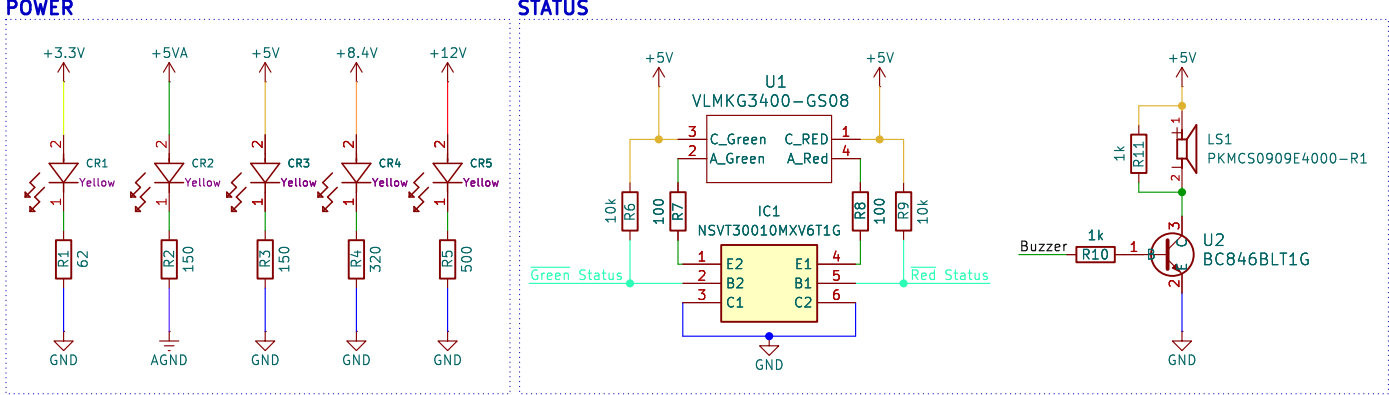
Guilherme Coelho
Miguel Amorim
Porto Space Team
Sheet: /
File: HYDRA.kicad_sch
Title: Hydraulic Regulation & Actuation system
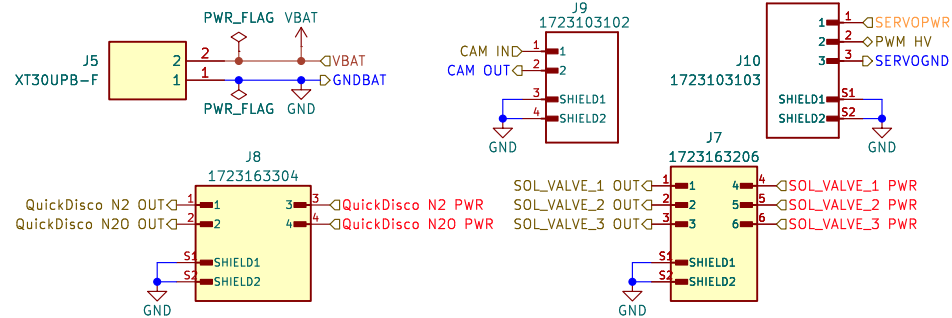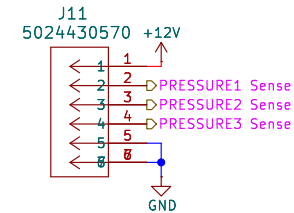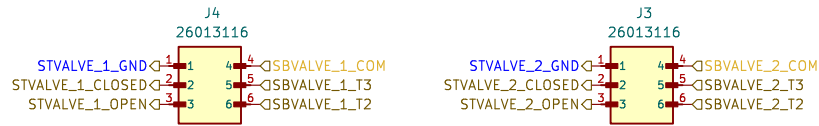Size: User   Date: 2025-09-01   Rev:
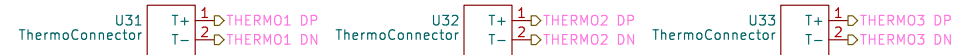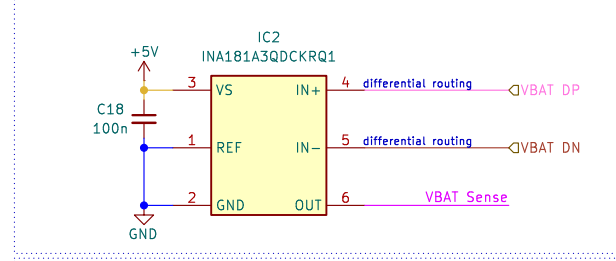KiCad E.D.A. 9.0.3   Id: 1/6

JZ-500 2x1.5mm² 16AWG

PWR_FLAG VBAT

J5
XT30UPB-F
2
1
VBAT
GNDBAT

PWR_FLAG GND

J9
1723103102
CAM IN 1
CAM OUT 2
3 SHIELD1
4 SHIELD2
GND

J10
1723103103
1 SERVOPWR
2 PWM HV
3 SERVOGND
SHIELD1 S1
SHIELD2 S2
GND

J8
1723163304
QuickDisco N2 OUT 1 3 QuickDisco N2 PWR
QuickDisco N2O OUT 2 4 QuickDisco N2O PWR
S1
S2 SHIELD1
SHIELD2
GND

J7
1723163206
SOL_VALVE_1 OUT 1 4 SOL_VALVE_1 PWR
SOL_VALVE_2 OUT 2 5 SOL_VALVE_2 PWR
SOL_VALVE_3 OUT 3 6 SOL_VALVE_3 PWR
S1
S2 SHIELD1
SHIELD2
GND

Igus Chainflex M12x1 4x0.34m² 22AWG

J11
5024430570 +12V
1
2 PRESSURE1 Sense
3 PRESSURE2 Sense
4 PRESSURE3 Sense
5
6
GND

TRONIC-CY (LiY-CY) 3x0.5mm² 20AWG

J4
26013116
STVALVE_1_GND 1 4 SBVALVE_1_COM
STVALVE_1_CLOSED 2 5 SBVALVE_1_T3
STVALVE_1_OPEN 3 6 SBVALVE_1_T2

J3
26013116
STVALVE_2_GND 1 4 SBVALVE_2_COM
STVALVE_2_CLOSED 2 5 SBVALVE_2_T3
STVALVE_2_OPEN 3 6 SBVALVE_2_T2

Igus Chainflex CFTHERMO 2x0.23mm² 24AWG

U31
ThermoConnector
T+ 1 THERMO1 DP
T- 2 THERMO1 DN

U32
ThermoConnector
T+ 1 THERMO2 DP
T- 2 THERMO2 DN

U33
ThermoConnector
T+ 1 THERMO3 DP
T- 2 THERMO3 DN

CAN-BUS 1x2x0.22m² 24AWG

J6
5024430270
1 RS_DP
2 RS_DN
MP1
MP2 3
4
AGND

H1
MountingHole

H2
MountingHole

H3
MountingHole_Pad
AGND

H4
MountingHole
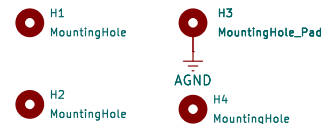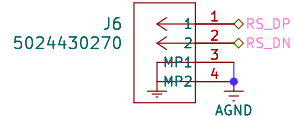
Guilherme Coelho
Miguel Amorim
Porto Space Team
Sheet: /IO Connectors/
File: IO Connectors.kicad_sch

Title: Hydraulic Regulation & Actuation system
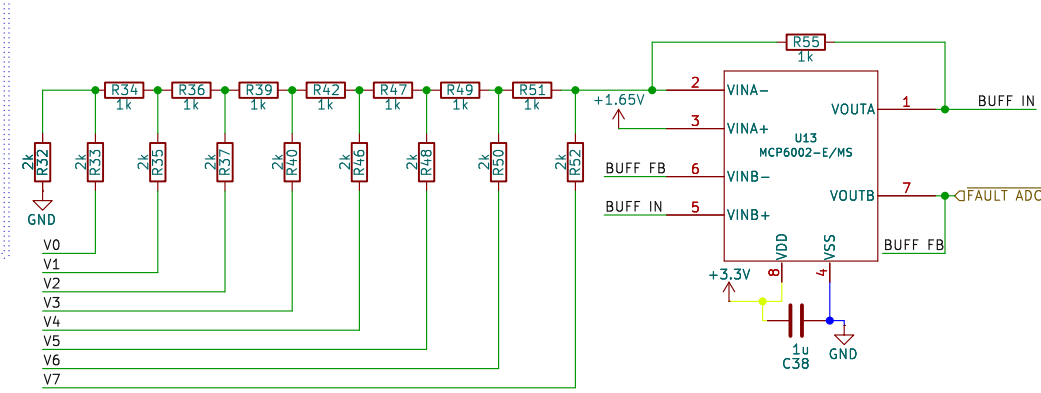
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KiCad E.D.A. 9.0.3

Rev:
Id: 6/6

This page is a KiCad electronic schematic diagram and is essentially a full-page technical illustration.
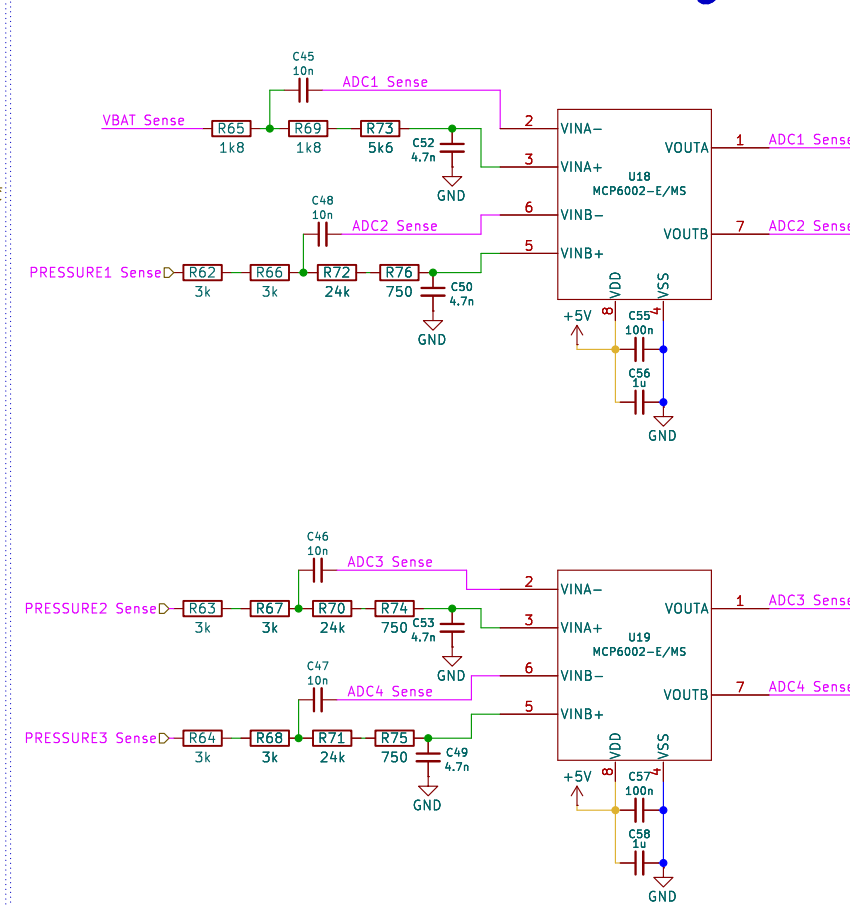

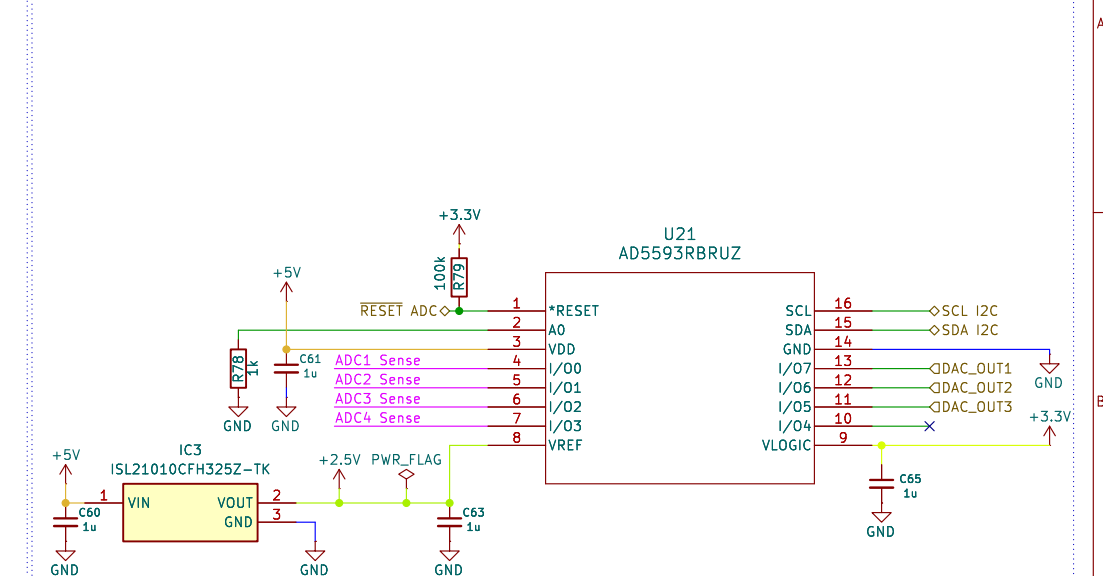# Current Sensor

FAULTS AQUISITION ADC
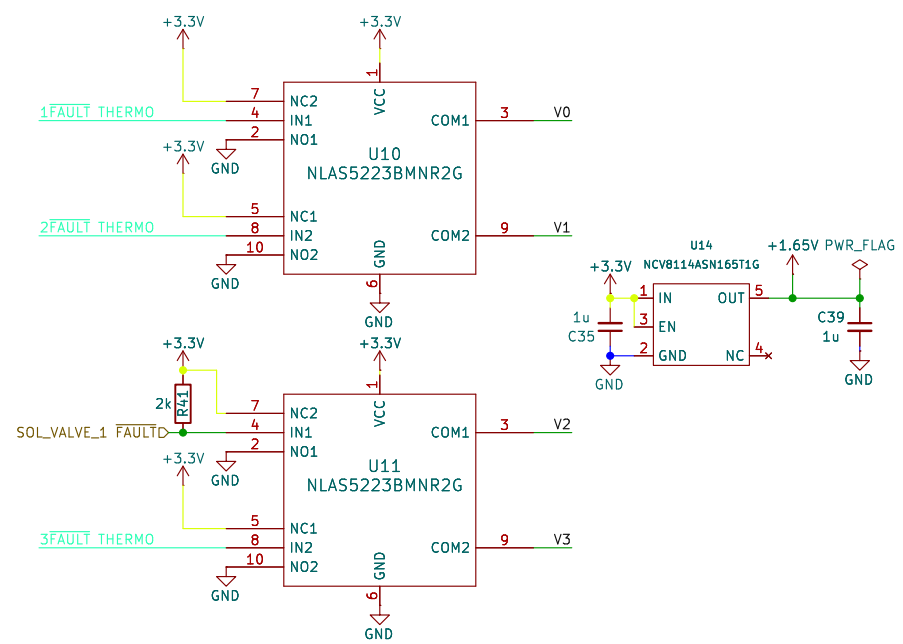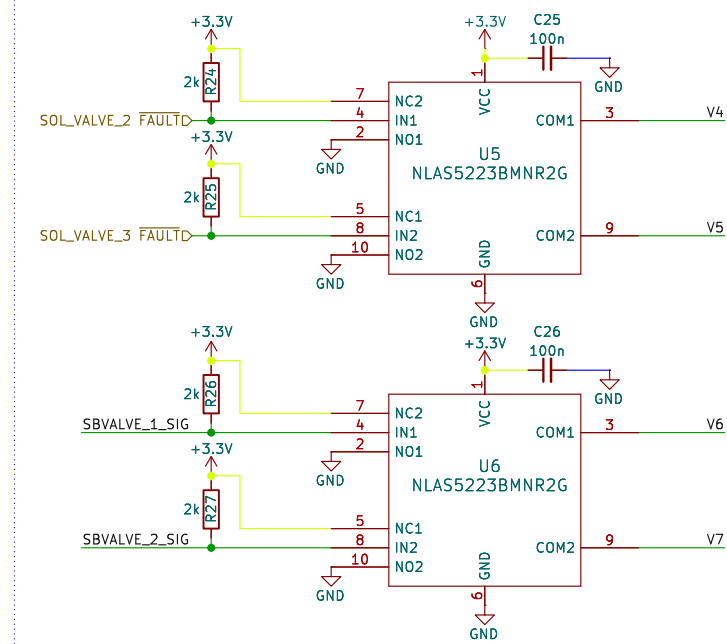
2nd Order Low Pass Active
Bessel Filter – Anti Aliasing

ADC & DAC

Current Sense Channel: Fc = 5kHz
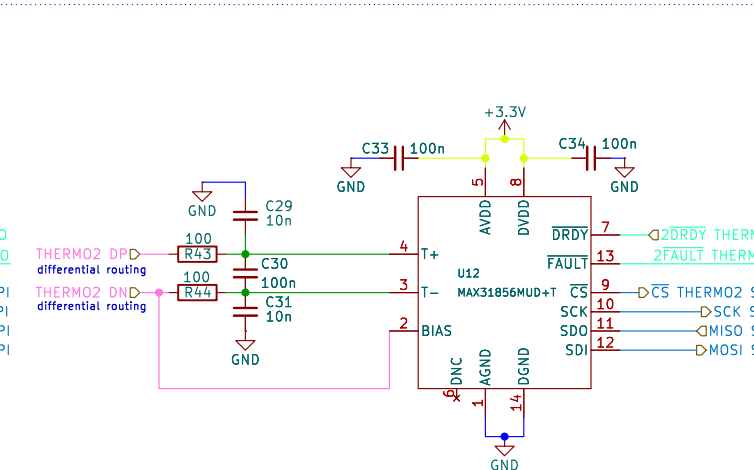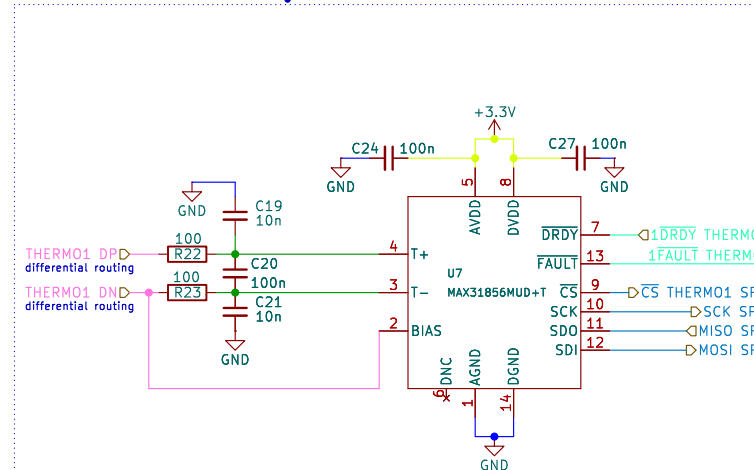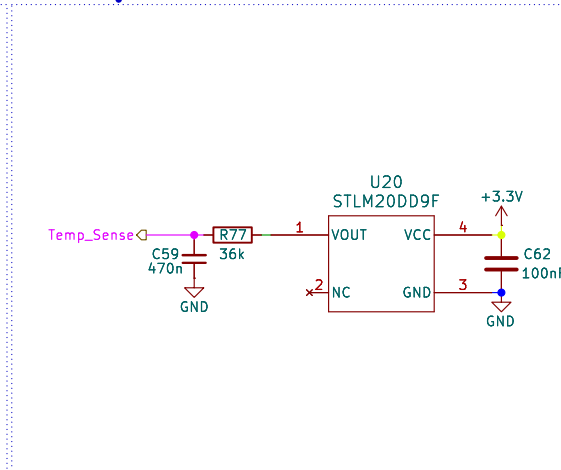Pressure Sense Channels: Fc = 1.5kHz
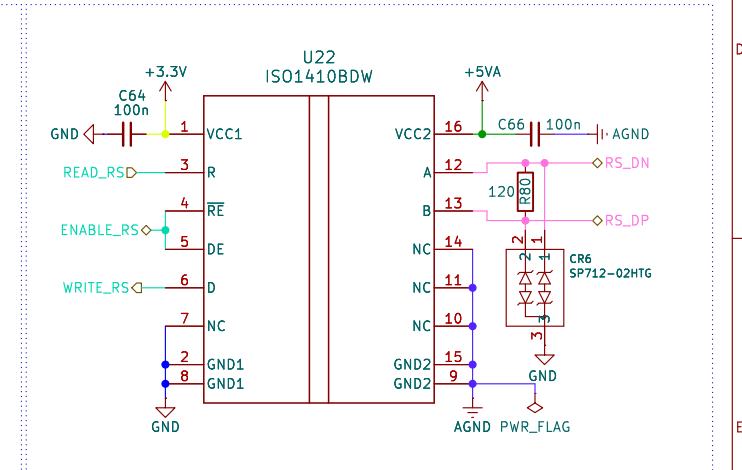
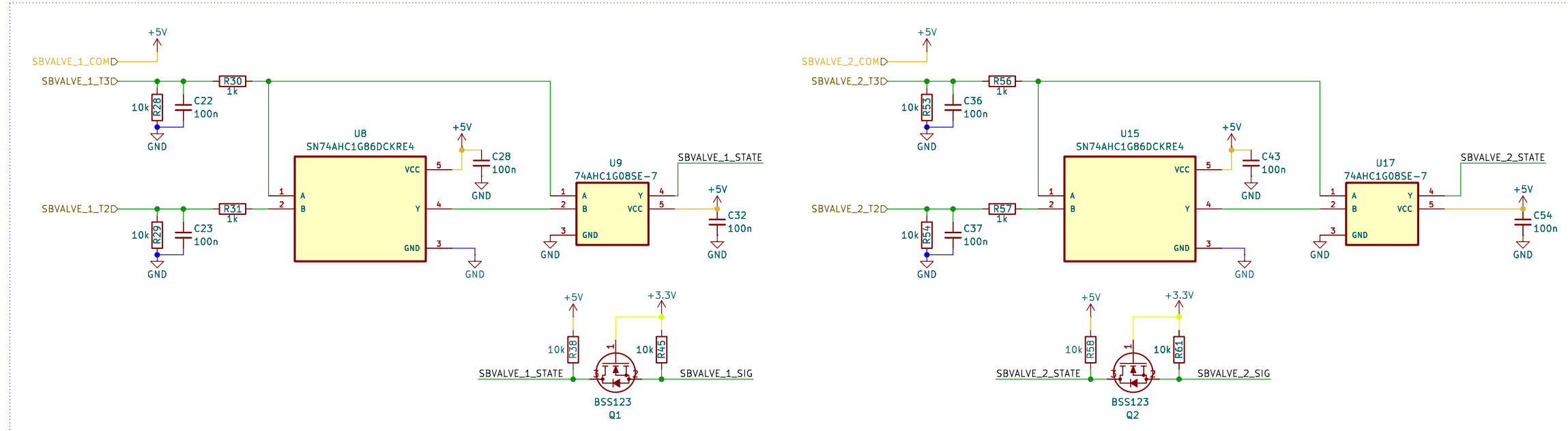8 Channel 12Bit ADC/DAC
ADDR I2C: 'h11

Thermocouples
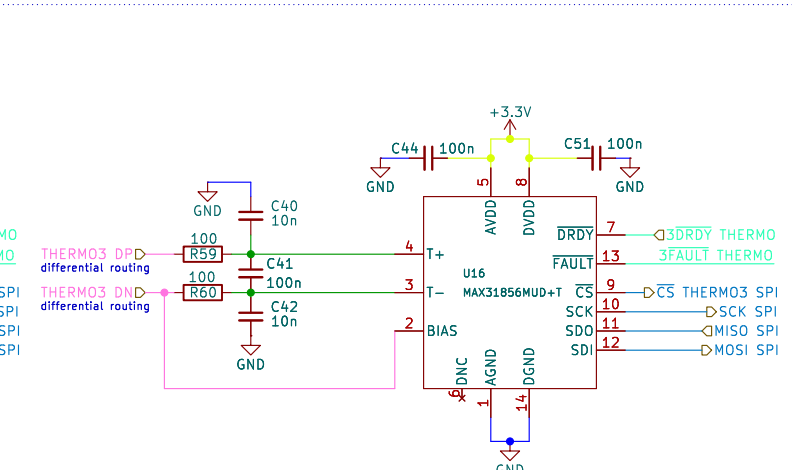
Temperature Sensor

RS-485 Transceiver

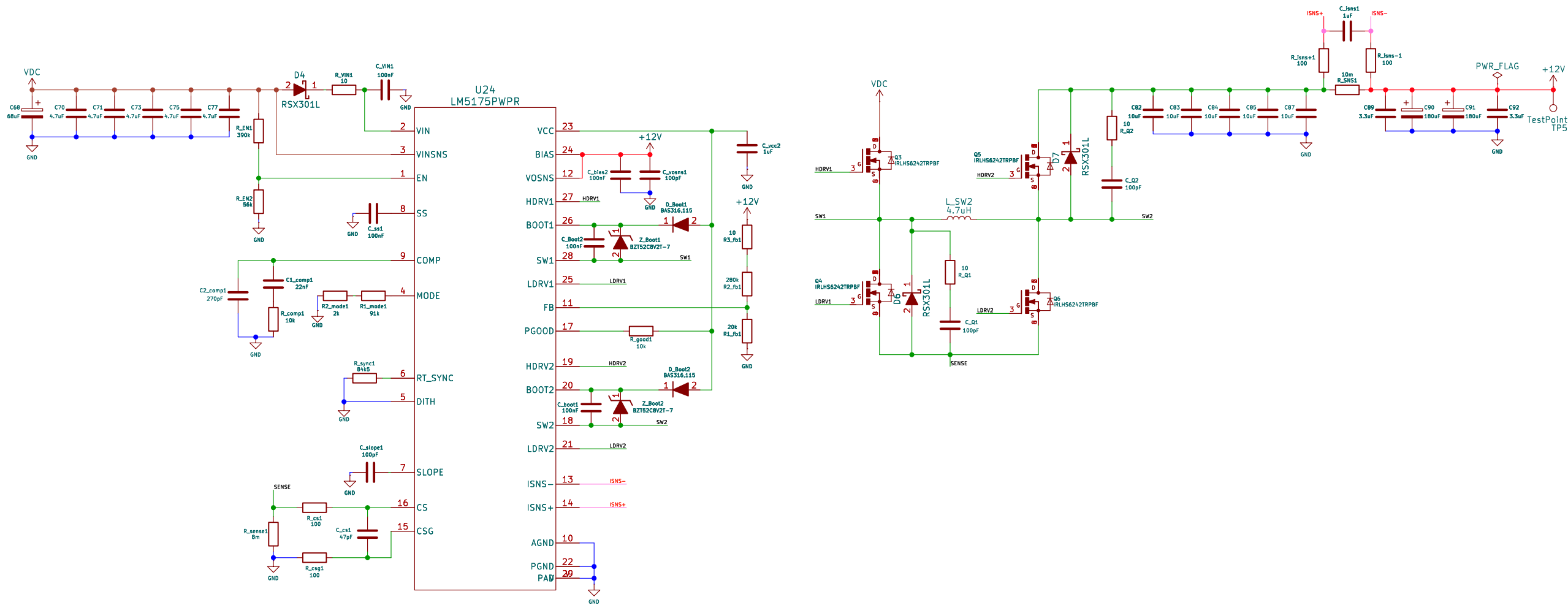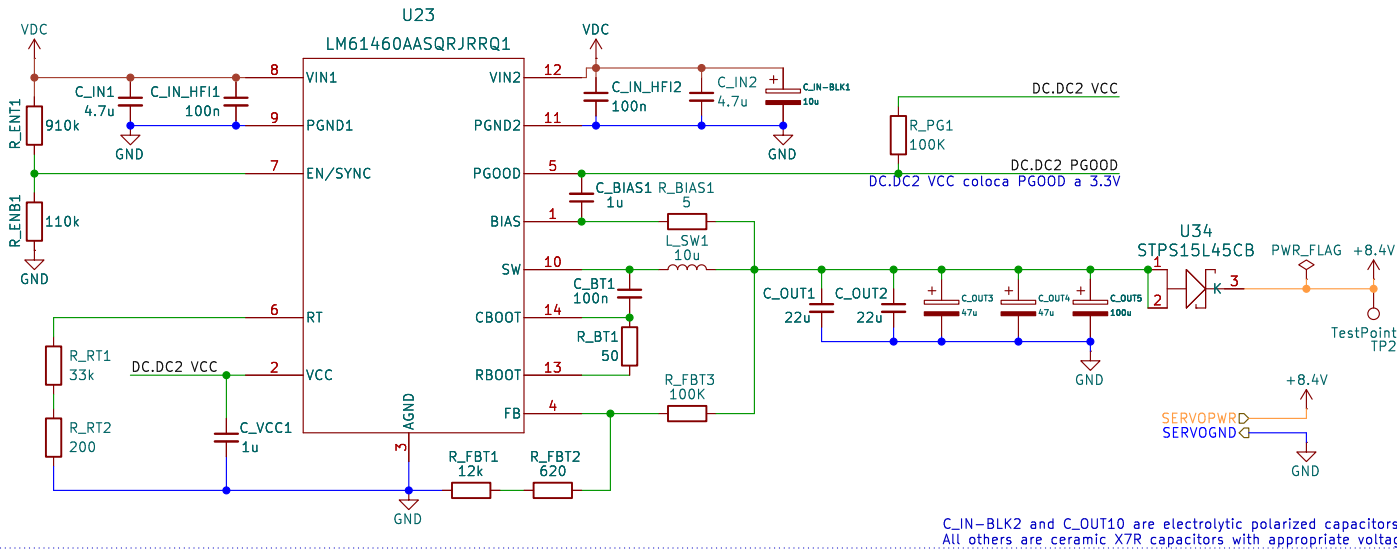# SBVALVES ACTUATOR POSITION

Buck–Boost DC–DC 10–36V to 12V Converter

VDC: 12.8V nominal, 14.6V charged

U24 LM5175PWPR

Pins: VIN, VINSNS, EN, SS, COMP, MODE, RT_SYNC, DITH, SLOPE, CS, CSG, VCC, BIAS, VOSNS, HDRV1, BOOT1, SW1, LDRV1, FB, PGOOD, HDRV2, BOOT2, SW2, LDRV2, ISNS-, ISNS+, AGND, PGND, PAD

D4 RSX301L, R_VIN1 10, C_VIN1 100pF
C68 68uF, C70 4.7uF, C71 4.7uF, C73 4.7uF, C75 4.7uF, C77 4.7uF
R_EN1 390k, R_EN2 56k
C_ss1 100nF
C2_comp1 270pF, C1_comp1 22nF, R2_mode1 2k, R1_mode1 91k, R_comp1 10k
R_sync1 845
C_slope1 100pF
R_cs1 100, R_sense1 8m, C_cs1 47pF, R_csg1 100

C_bias2 100nF, C_osns1 100pF, C_vcc2 1uF
D_Boot1 BAS316.115, C_Boot2 100nF, Z_Boot1 BZT52C8V2T-7
10 R1_fb1, 280n R2_fb1, 20n R1_fb1
R_good1 10k, D_Boot2 BAS316.115, C_Boot1 100nF, Z_Boot2 BZT52C8V2T-7

ISNS+ ISNS-, C_isns1 1uF, R_isns+1 100, R_isns-1 100, 10m R_SNS1
PWR_FLAG +12V
C82 10uF, C83 10uF, C84 10uF, C85 10uF, C87 10uF, C89 3.3uF, C90 180uF, C91 180uF, C92 3.3uF
TestPoint TP5

Q3 IRLHS6242TRPBF, Q5 IRLHS6242TRPBF, D7 RSX301L, C_Q2 100pF
L_SW2 4.7uH
Q4 IRLHS6242TRPBF, Q6 IRLHS6242TRPBF, D6 RSX301L, C_Q1 100pF
10 R_Q1
HDRV1, HDRV2, LDRV1, LDRV2, SW1, SW2, SENSE

Buck DC–DC >15V to 8.4V Converter

VDC: 12.8V nominal, 14.6V charged

Vout is set to 8.9V to compensate Diode drops.
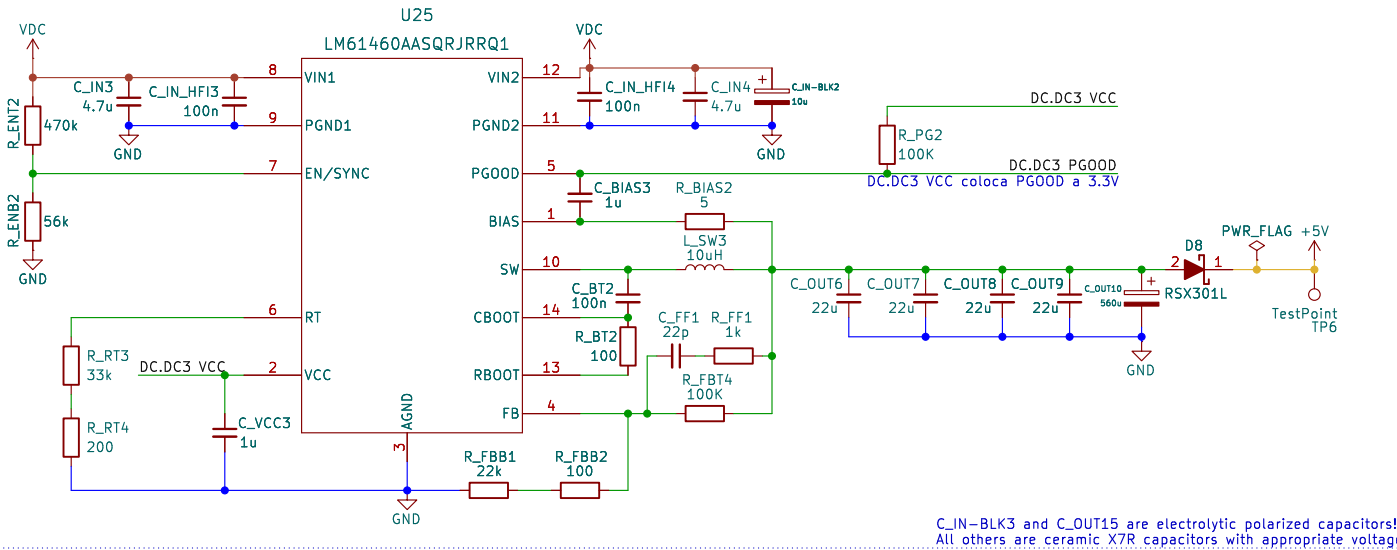The Schottky diode has a 425mV forward voltage drop.

U23 LM61460AASQRJRRQ1
Pins: VIN1, VIN2, PGND1, PGND2, EN/SYNC, PGOOD, BIAS, SW, CBOOT, RBOOT, FB, RT, VCC, AGND

R_ENT1 910k, R_ENB1 110k
C_IN1 4.7u, C_IN_HFI1 100n, C_IN_HFI2 100n, C_IN2 4.7u, C_IN-BLK1 10u
R_RT1 33k, R_RT2 200, C_VCC1 1u
C_BIAS1 1u, R_BIAS1 5, L_SW1 10u
C_BT1 100n, R_BT1 50, R_FBT3 100K
R_PG1 100K
DC.DC2 VCC, DC.DC2 PGOOD
DC.DC2 VCC coloca PGOOD a 3.3V
C_OUT1 22u, C_OUT2 22u, C_OUT3 47u, C_OUT4 47u, C_OUT5 100u
U34 STPS15L45CB, PWR_FLAG +8.4V, TestPoint TP2
R_FBT1 12k, R_FBT2 620
SERVOPWR SERVOGND, +8.4V

C_IN-BLK2 and C_OUT10 are electrolytic polarized capacitors!
All others are ceramic X7R capacitors with appropriate voltage ratings.

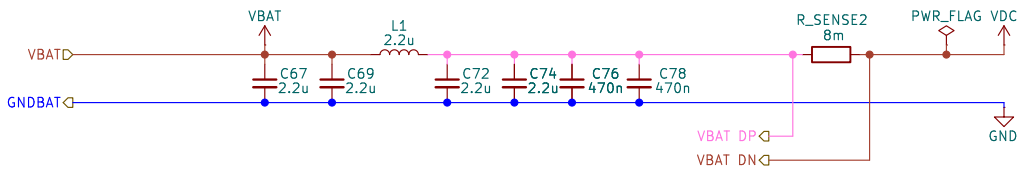# Buck DC–DC >15V to 5V Converter

VDC: 12.8V nominal, 14.6V charged

Vout is set to 5.5V to compensate Diode drops
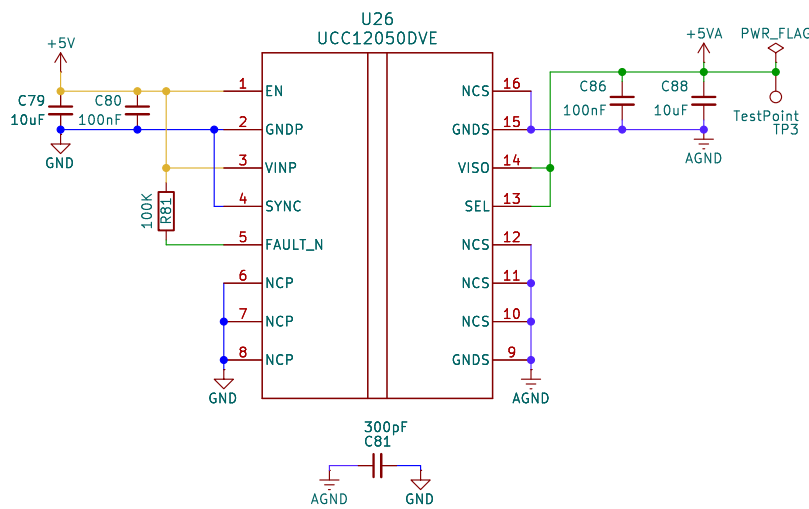The Schottky diode has a 420mV forward voltage drop.

U25 LM61460AASQRJRRQ1
Pins: VIN1, VIN2, PGND1, PGND2, EN/SYNC, PGOOD, BIAS, SW, CBOOT, RBOOT, FB, RT, VCC, AGND

R_ENT2 470k, R_ENB2 56k
C_IN3 4.7u, C_IN_HFI3 100n, C_IN_HFI4 100n, C_IN4 4.7u, C_IN-BLK2 10u
R_RT3 33k, R_RT4 200, C_VCC3 1u
C_BIAS3 1u, R_BIAS2 5, L_SW3 10uH
C_BT2 100n, C_FF1 22p, R_FF1 1k, R_BT2 100, R_FBT4 100K
R_PG2 100K
DC.DC3 VCC, DC.DC3 PGOOD
DC.DC3 VCC coloca PGOOD a 3.3V
C_OUT6 22u, C_OUT7 22u, C_OUT8 22u, C_OUT9 22u, C_OUT15 560u
D8 RSX301L, PWR_FLAG +5V, TestPoint TP6
R_FBB1 22k, R_FBB2 100

C_IN-BLK3 and C_OUT15 are electrolytic polarized capacitors!
All others are ceramic X7R capacitors with appropriate voltage ratings.

EMI Filter

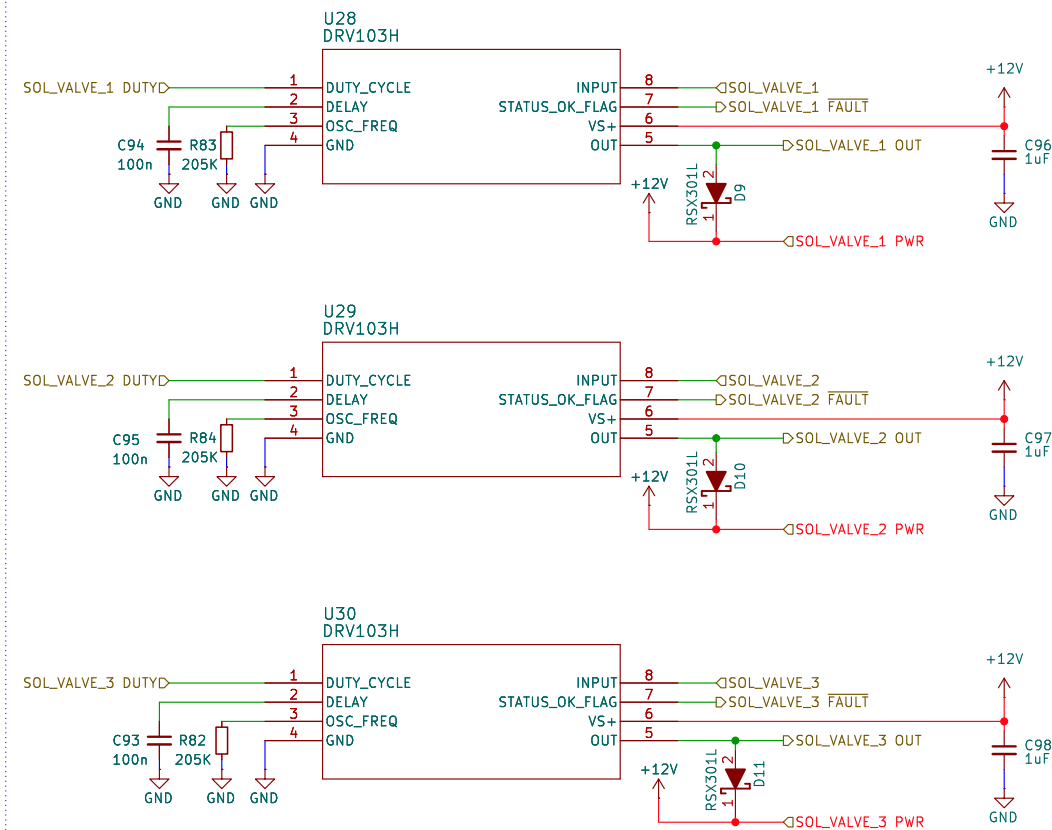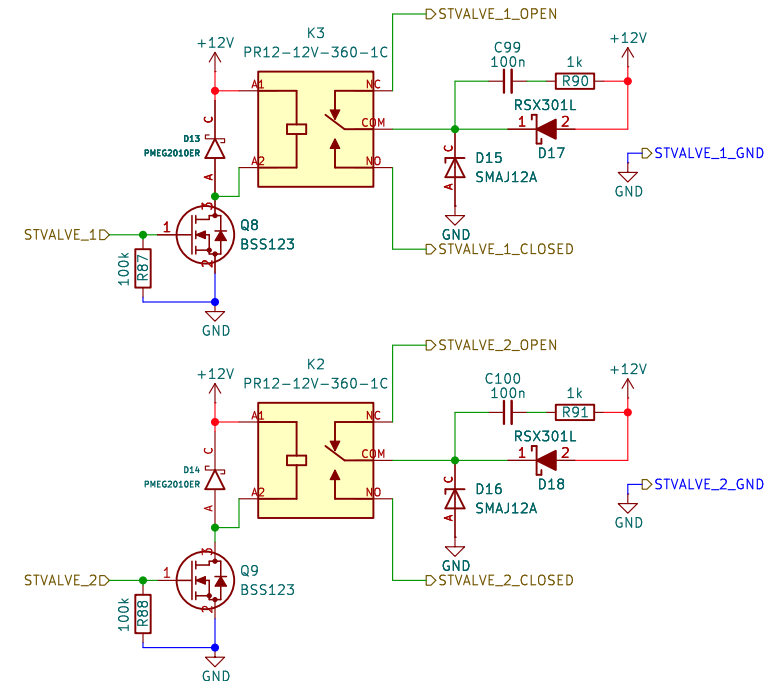VBAT, VBATD, GNDBAT
L1 2.2u
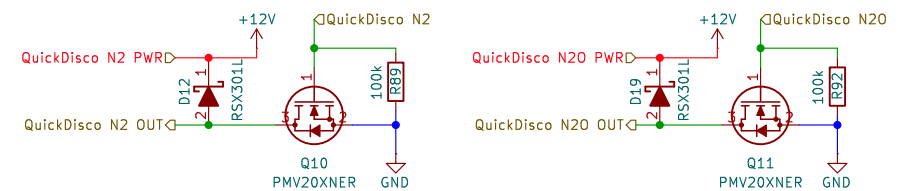C67 2.2u, C69 2.2u, C72 2.2u, C74 2.2u, C76 470n, C78 470n
R_SENSE2 8m, PWR_FLAG VDC
VBAT_DP, VBAT_DN, GND

Galvanically Isolated Buck Converter

U26 UCC12050DVE
Pins: EN, GNDP, VINP, SYNC, FAULT_N, NCP, NCP, NCP, NCS, GNDS, VISO, SEL, NCS, NCS, GNDS

+5V, C79 10uF, C80 100nF
100k R280
+5VA PWR_FLAG
C86 100nF, C88 10uF, TestPoint TP3
CB1 300pF
AGND, GND

Controlled Solenoid Valve Drivers

U28 DRV103H

SOL_VALVE_1 DUTYC — 1 DUTY_CYCLE | INPUT 8 — SOL_VALVE_1
2 DELAY | STATUS_OK_FLAG 7 — SOL_VALVE_1 FAULT
3 OSC_FREQ | VS+ 6 — +12V
4 GND | OUT 5 — SOL_VALVE_1 OUT

C94 100n | R83 205K | GND GND GND
C96 1uF | GND
+12V | RSX301L D9 | SOL_VALVE_1 PWR

U29 DRV103H

SOL_VALVE_2 DUTYC — 1 DUTY_CYCLE | INPUT 8 — SOL_VALVE_2
2 DELAY | STATUS_OK_FLAG 7 — SOL_VALVE_2 FAULT
3 OSC_FREQ | VS+ 6 — +12V
4 GND | OUT 5 — SOL_VALVE_2 OUT

C95 100n | R84 205K | GND GND GND
C97 1uF | GND
+12V | RSX301L D10 | SOL_VALVE_2 PWR

U30 DRV103H

SOL_VALVE_3 DUTYC — 1 DUTY_CYCLE | INPUT 8 — SOL_VALVE_3
2 DELAY | STATUS_OK_FLAG 7 — SOL_VALVE_3 FAULT
3 OSC_FREQ | VS+ 6 — +12V
4 GND | OUT 5 — SOL_VALVE_3 OUT

C93 100n | R82 205K | GND GND GND
C98 1uF | GND
+12V | RSX301L D11 | SOL_VALVE_3 PWR

Steel Ball Valve Actuators
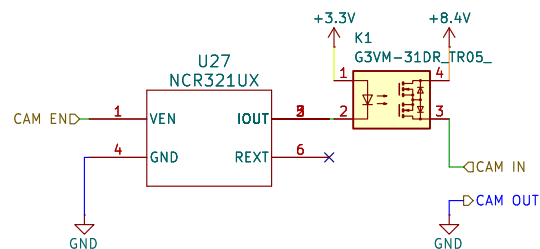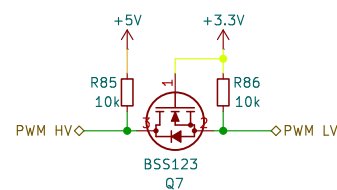
+12V | K3 PR12-12V-360-1C | STVALVE_1_OPEN
C99 100n | R90 1k | +12V
D13 PMEG2010ER | RSX301L D17 | STVALVE_1_GND
GND
STVALVE_1 — R87 100k | Q8 BSS123 | D15 SMAJ12A | D17
GND | STVALVE_1_CLOSED
GND

+12V | K2 PR12-12V-360-1C | STVALVE_2_OPEN
C100 100n | R91 1k | +12V
D14 PMEG2010ER | RSX301L D18 | STVALVE_2_GND
GND
STVALVE_2 — R88 100k | Q9 BSS123 | D16 SMAJ12A | D18
GND | STVALVE_2_CLOSED
GND

Solenoid Valve Drivers

QuickDisco N2 PWR — +12V | QuickDisco N2
D12 RSX301L | R89 100k
QuickDisco N2 OUT — Q10 PMV20XNER | GND

QuickDisco N20 PWR — +12V | QuickDisco N20
D19 RSX301L | R92 100k
QuickDisco N20 OUT — Q11 PMV20XNER | GND

Camera Driver

U27 NCR321UX

+3.3V | +8.4V
K1 G3VM-31DR_TR05_
CAM EN — 1 VEN | IOUT 3 — 2 | 3 — CAM IN
4 GND | REXT 6 — ×
GND | GND CAM OUT

ServoMotor Signal

+5V | +3.3V
R85 10k | R86 10k
PWM HV — Q7 BSS123 — PWM LV

RP2040

JP1
Jumper_2_Open

+3.3V

GND
RST

+3.3V

R12 1k
R17 1k

1uF
C1

100nF 100nF
C2 C4
GND

C3
1uF
GND

+3.3V
100nF for each DVDD, IOVDD, USB_VDD, ADC_AVDD!

C5 C7 C8 C9 C10 C11 C12 C14
100nF 100nF 100nF 100nF 100nF 100nF 100nF 100nF
GND

C6
1uF
GND

1uF as close as possible to VREG_OUT!

1uF as close as possible to VREG_IN!

26 RUN

VREG_VOUT 45
DVDD 23
IOVDD 1
USB_VDD 48
ADC_AVDD 43
VREG_IN 44

GPIO0 2 GPIO0
GPIO1 3 GPIO1
GPIO2 4 GPIO2
GPIO3 5 GP3/PWM1 B
GPIO4 6 GP4/UART1 TX
GPIO5 7 GP5/UART1 RX
GPIO6 8 GP6/UART1 CTS
GPIO7 9 GPIO7
GPIO8 11 GP8/SPI1 MISO
GPIO9 12 GP9/SPI1 CS
GPIO10 13 GP10/SPI1 SCK
GPIO11 14 GP11/SPI1 MOSI
GPIO12 15 GPIO12
GPIO13 16 GP13/SPI1 CS
GPIO14 17 GP14/I2C1 SDA
GPIO15 18 GP15/I2C1 SCL
GPIO16 27 GPIO16
GPIO17 28 GPIO17
GPIO18 29 GPIO18
GPIO19 30 GPIO19
GPIO20 31 GPIO20
GPIO21 32 GPIO21
GPIO22 34 GPIO22
GPIO23 35 GPIO23
GPIO24 36 GPIO24
GPIO25 37 GPIO25

USB_DP 27 USB_D+ 47 USB_DP
USB_DN   USB_D- 46 USB_DM
R13
R14 27

MCU CS SPI 56 QSPI_SS

MCU SD0 SPI 53 QSPI_SD0
MCU SD1 SPI 55 QSPI_SD1
MCU SD2 SPI 54 QSPI_SD2
MCU SD3 SPI 51 QSPI_SD3
MCU SCLK SPI 52 QSPI_SCLK

MCU1
RP2040

Crystal 20 XIN

21 XOUT

CLK SWD 100 R15 24 SWCLK
SWD 100 R16 25 SWD

19 TESTEN

GND 57

GPIO26_ADC0 38 GP26_ADC0
GPIO27_ADC1 39 GP27_ADC1
GPIO28_ADC2 40 GPIO28
GPIO29_ADC3 41 GP29/SPI1 CS

GND

SWD Connector
J1
1 1 CLK SWD 2
2 2 GND
3 3 SWD 3
EP 5

D1
ESD122DMYR
GND

Powered Crystal

+3.3V

R18 10k

XTAL1
ASE-12.000MHZ-LC-T

1 TRI-STATE(STBY) VDD 4
2 GND/CASE OUTPUT 3

+3.3V
1uF
C13
GND

Crystal

GND

16MB Flash Memory

JP2
Jumper_2_Open
USB_BOOT

GND

R21 1k

U3
W25Q128JVSIQ TR

MCU CS SPI 1 /CS
MCU SD1 SPI 2 DO(IO1)
MCU SD2 SPI 3 /WP(IO2)
4 GND

VCC 8
/HOLD_/RESET 7 MCU SD3 SPI
CLK 6 MCU SCLK SPI
DI(IO0) 5 MCU SD0 SPI

+3.3V
C17
100nF
GND

GND

5V-3V3 LDO

GND +3.3V PWR_FLAG
U4
ST1L05APU33R

+5V

4.7uF
C16

1 NC
2 V0
3 V1

GND 7
GND 6
NC 5
NC 4

GND

USB-C

+5V
C15
100n
GND

D3
PMEG2010ER
C A

VBUS

J2
DX07S016JA1R1500

12 VBUS

5k1 R19
5k1 R20
GND

3 CC1
9 CC2

SBU2 4
SHIELD SB 11
SBU1 10

USB_DN
USB_DP

8 D-
5 D-
7 D+
6 D+

D2
SP3004-04XTG
1 IO1 VCC 5
3 IO2
4 IO3
6 IO4 GND 2

VBUS

12 GND

GND

GND

Guilherme Coelho
Miguel Amorim
Porto Space Team
Sheet: /RP2040 Standard/
File: RP2040 Standard Design.kicad_sch

Title: Hydraulic Regulation & Actuation system

Size: A4   Date:
KiCad E.D.A. 9.0.3

Rev:
Id: 2/6