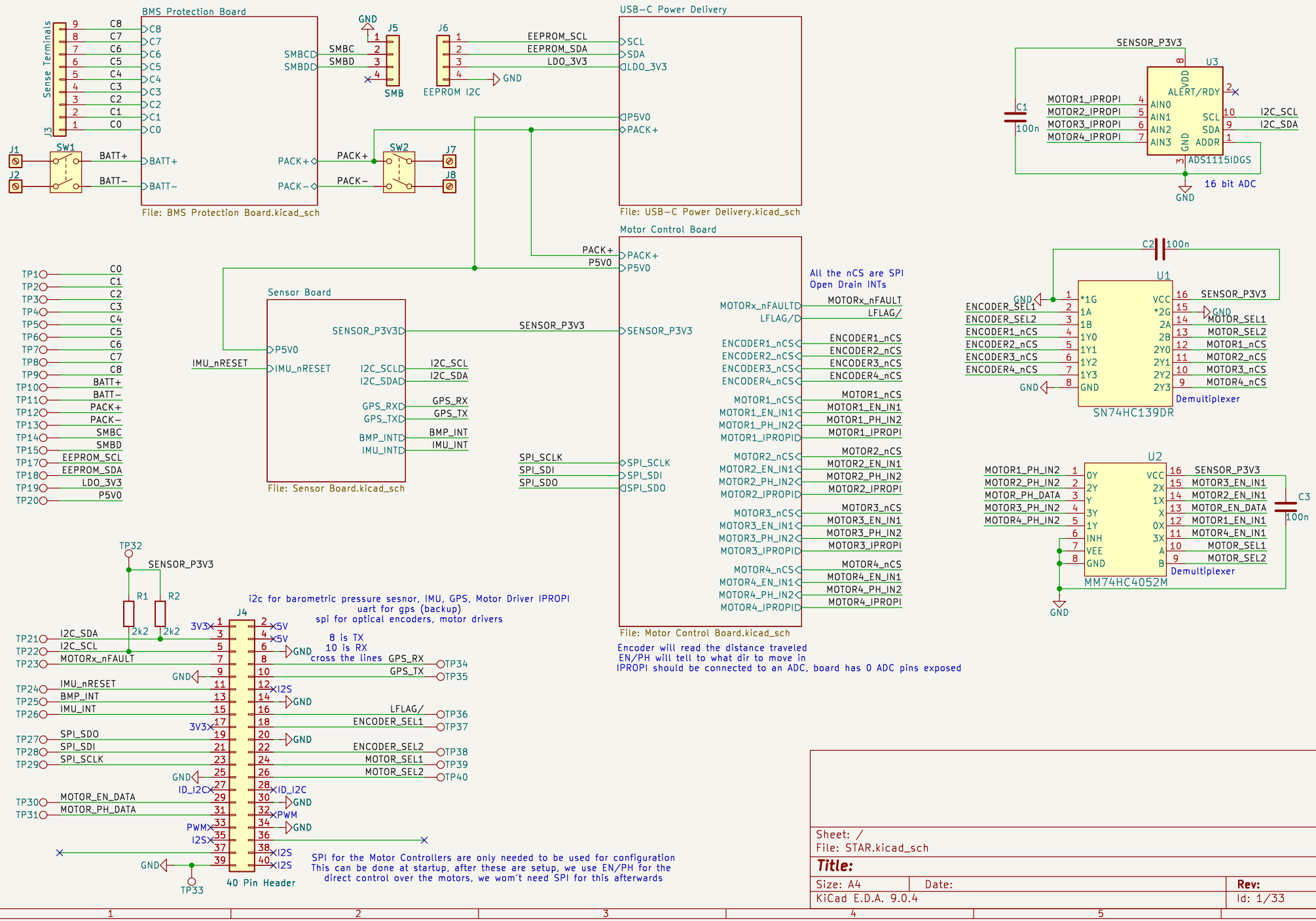
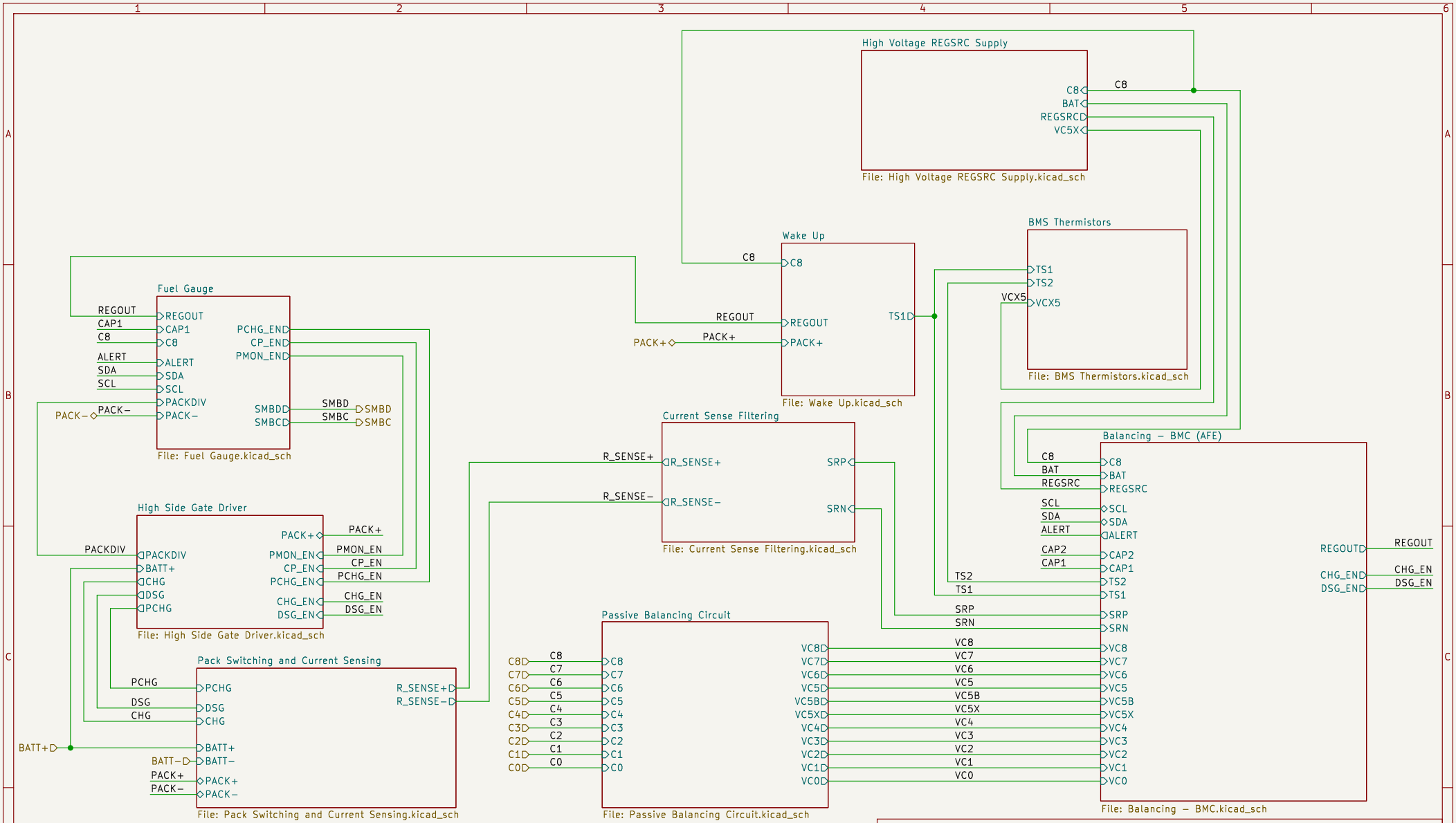

BMS Protection Board
Sense Terminals
J3
C8
C7
C6
C5
C4
C3
C2
C1
C0
J1
J2
SW1
BATT+
BATT−
SMBC
SMBD
GND
J5
SMB
J6
EEPROM I2C
EEPROM_SCL
EEPROM_SDA
LDO_3V3
PACK+
PACK−
SW2
J7
J8
File: BMS Protection Board.kicad_sch
USB−C Power Delivery
SCL
SDA
LDO_3V3
P5V0
PACK+
File: USB−C Power Delivery.kicad_sch
SENSOR_P3V3
U3
ALERT/RDY
VDD
GND
ADDR
MOTOR1_IPROPI
MOTOR2_IPROPI
MOTOR3_IPROPI
MOTOR4_IPROPI
AIN0
AIN1
AIN2
AIN3
SCL
SDA
I2C_SCL
I2C_SDA
C1
100n
ADS1115IDGS
16 bit ADC
TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
TP9
TP10
TP11
TP12
TP13
TP14
TP15
TP17
TP18
TP19
TP20
Sensor Board
IMU_nRESET
SENSOR_P3V3
I2C_SCL
I2C_SDA
GPS_RX
GPS_TX
BMP_INT
IMU_INT
File: Sensor Board.kicad_sch
Motor Control Board
SPI_SCLK
SPI_SDI
SPI_SDO
All the nCS are SPI
Open Drain INTs
MOTORx_nFAULT
LFLAG/
ENCODER1_nCS
ENCODER2_nCS
ENCODER3_nCS
ENCODER4_nCS
MOTOR1_nCS
MOTOR1_EN_IN1
MOTOR1_PH_IN2
MOTOR1_IPROPI
MOTOR2_nCS
MOTOR2_EN_IN1
MOTOR2_PH_IN2
MOTOR2_IPROPI
MOTOR3_nCS
MOTOR3_EN_IN1
MOTOR3_PH_IN2
MOTOR3_IPROPI
MOTOR4_nCS
MOTOR4_EN_IN1
MOTOR4_PH_IN2
MOTOR4_IPROPI
File: Motor Control Board.kicad_sch
Encoder will read the distance traveled
EN/PH will tell to what dir to move in
IPROPI should be connected to an ADC, board has 0 ADC pins exposed
C2
100n
U1
SN74HC139DR
Demultiplexer
ENCODER_SEL1
ENCODER_SEL2
MOTOR_SEL1
MOTOR_SEL2
U2
MM74HC4052M
MOTOR1_PH_IN2
MOTOR2_PH_IN2
MOTOR_PH_DATA
MOTOR3_PH_IN2
MOTOR4_PH_IN2
MOTOR3_EN_IN1
MOTOR2_EN_IN1
MOTOR_EN_DATA
MOTOR1_EN_IN1
MOTOR4_EN_IN1
C3
TP32
R1
R2
2k2
J4
40 Pin Header
i2c for barometric pressure sesnor, IMU, GPS, Motor Driver IPROPI
uart for gps (backup)
spi for optical encoders, motor drivers
8 is TX
10 is RX
cross the lines GPS_RX
GPS_TX
I2S
LFLAG/
ENCODER_SEL1
ENCODER_SEL2
MOTOR_SEL1
MOTOR_SEL2
ID_I2C
PWM
MOTOR_EN_DATA
MOTOR_PH_DATA
TP33
SPI for the Motor Controllers are only needed to be used for configuration
This can be done at startup, after these are setup, we use EN/PH for the
direct control over the motors, we wom't need SPI for this afterwards
Sheet: /
File: STAR.kicad_sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. 9.0.4
Id: 1/33



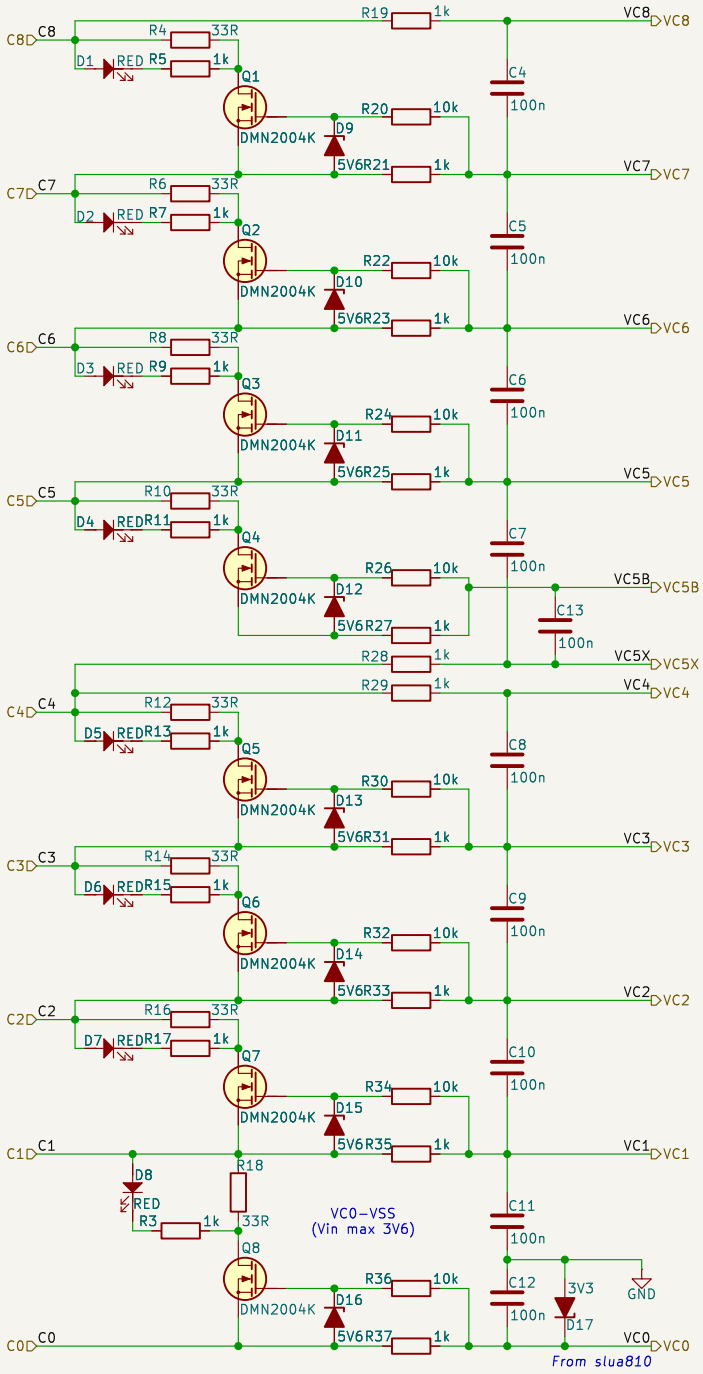

**BMS Protection Board for 8S Battery Pack**
**In/Out: min voltage: 25.6V, nominal voltage: 29.6V, max voltage: 33.6V**
**Output: 50A continuous discharge current**
**Min Each Cell set to 3.2V, Max Each Cell set to 4.2V**

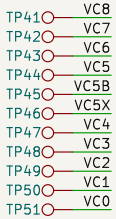
Sheet: /BMS Protection Board/
File: BMS Protection Board.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 2/33 |

# Passive Balancing Circuit

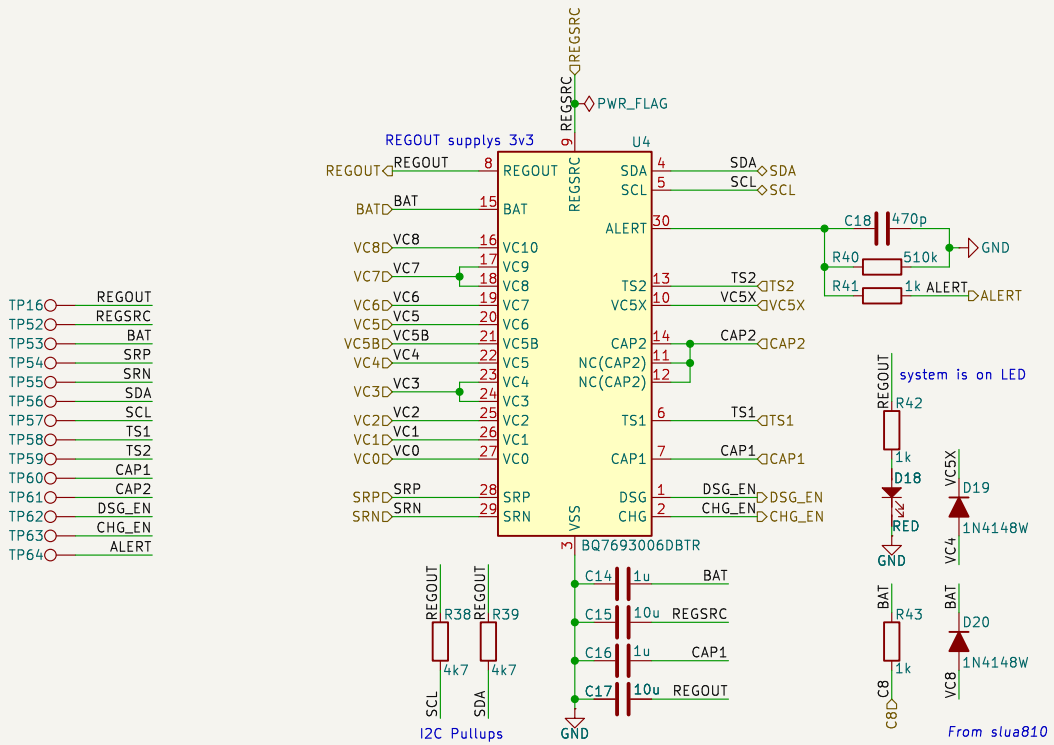



Sheet: /BMS Protection Board/Passive Balancing Circuit/
File: Passive Balancing Circuit.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 3/33 |




# Balancing & BMC (AFE)

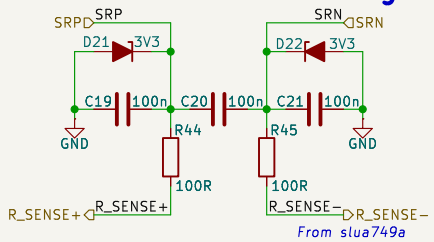
| | |
|---|---|
| TP16 | REGOUT |
| TP52 | REGSRC |
| TP53 | BAT |
| TP54 | SRP |
| TP55 | SRN |
| TP56 | SDA |
| TP57 | SCL |
| TP58 | TS1 |
| TP59 | TS2 |
| TP60 | CAP1 |
| TP61 | CAP2 |
| TP62 | DSG_EN |
| TP63 | CHG_EN |
| TP64 | ALERT |

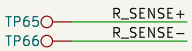
Sheet: /BMS Protection Board/Balancing – BMC (AFE)/
File: Balancing – BMC.kicad_sch

**Title:**

| | | |
|---|---|---|
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 4/33 |

# Current Sense Filtering

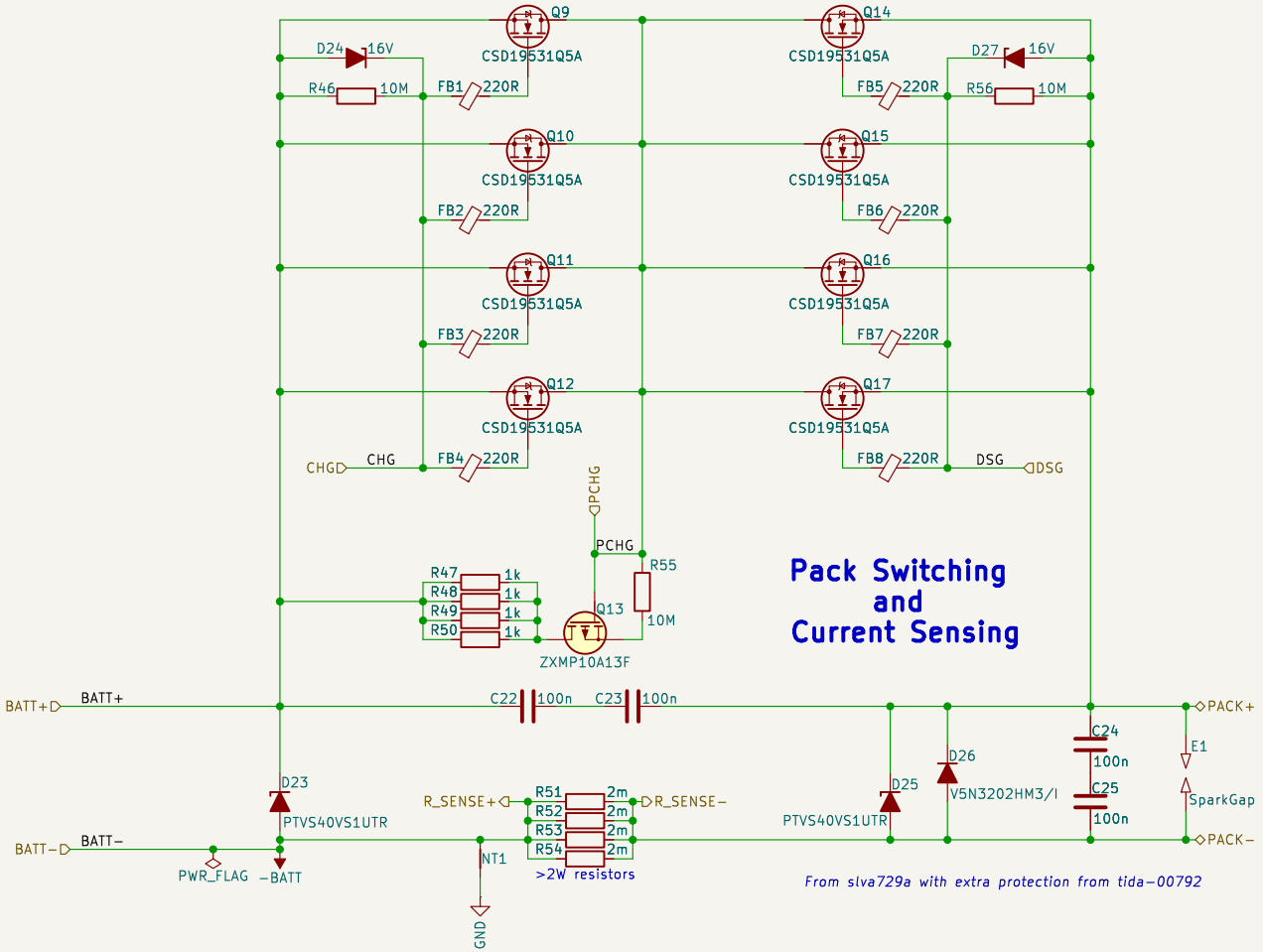


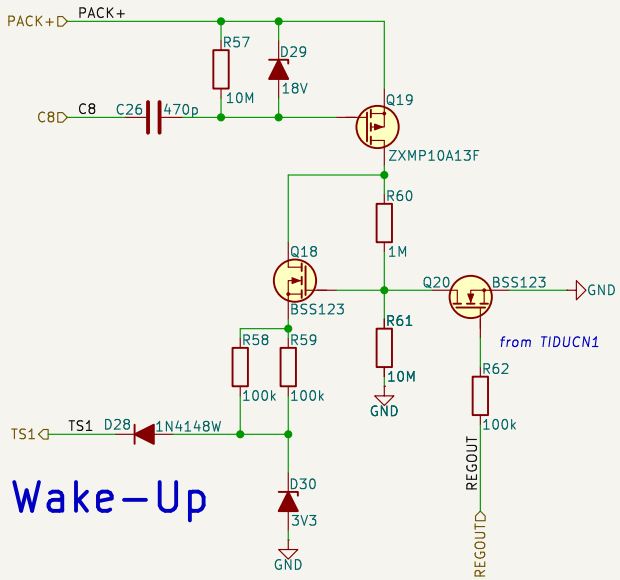

Sheet: /BMS Protection Board/Current Sense Filtering/
File: Current Sense Filtering.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 5/33 |

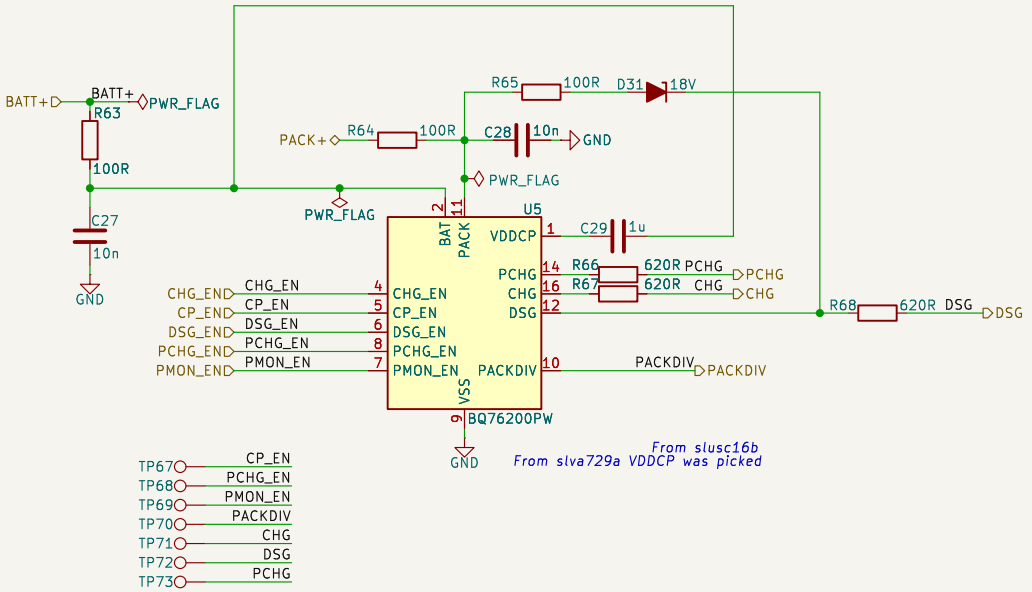



| | | |
|---|---|---|
| Sheet: /BMS Protection Board/Pack Switching and Current Sensing/ | | |
| File: Pack Switching and Current Sensing.kicad_sch | | |
| **Title:** | | |
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 6/33 |




| | | |
|---|---|---|
| Sheet: /BMS Protection Board/Wake Up/ | | |
| File: Wake Up.kicad_sch | | |
| **Title:** | | |
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 7/33 |

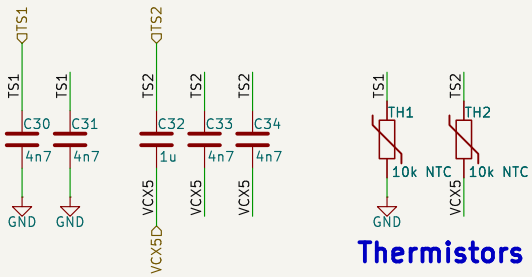
# High-Side Gate Driver




Sheet: /BMS Protection Board/High Side Gate Driver/
File: High Side Gate Driver.kicad_sch

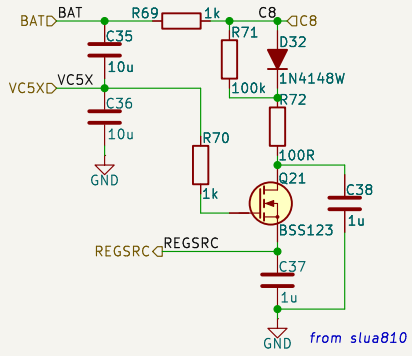
**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 8/33 |



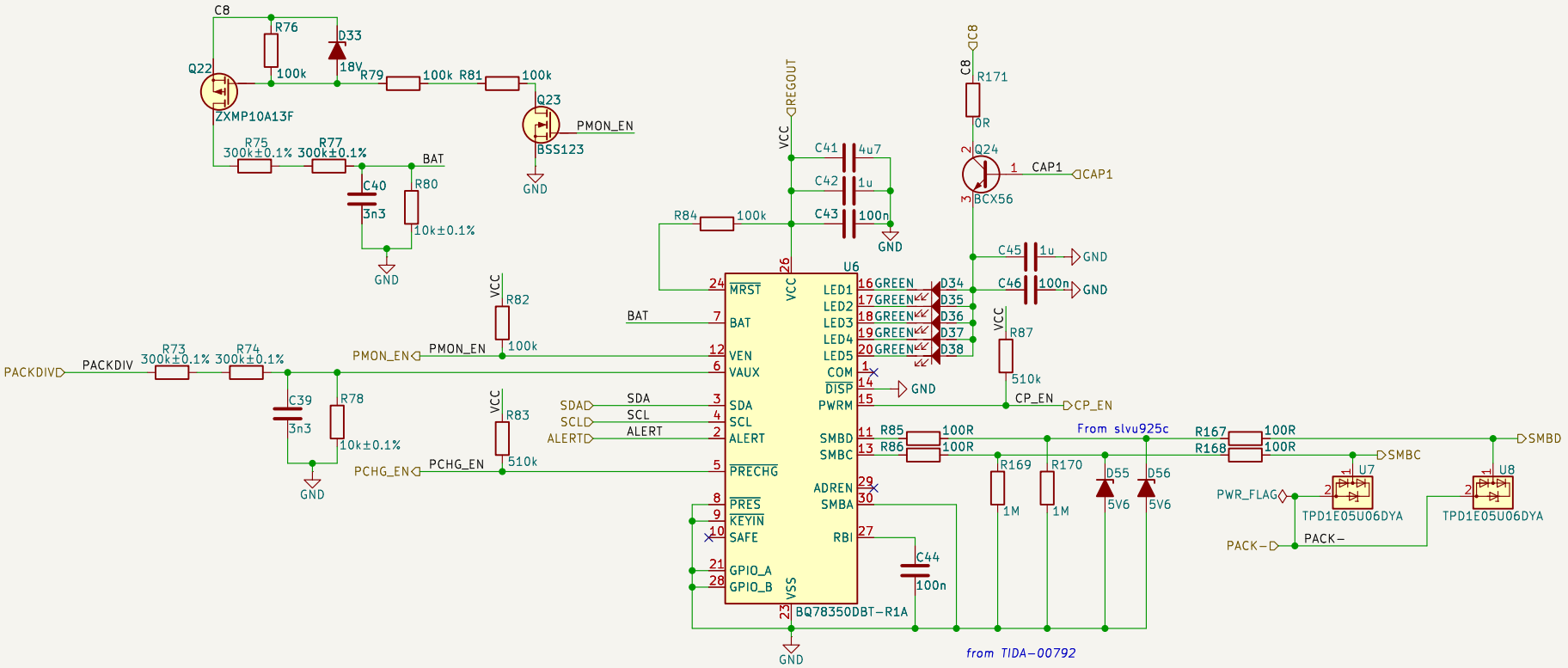

| | | |
|---|---|---|
| Sheet: /BMS Protection Board/BMS Thermistors/ | | |
| File: BMS Thermistors.kicad_sch | | |
| **Title:** | | |
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 9/33 |

## High Voltage REGSRC Supply

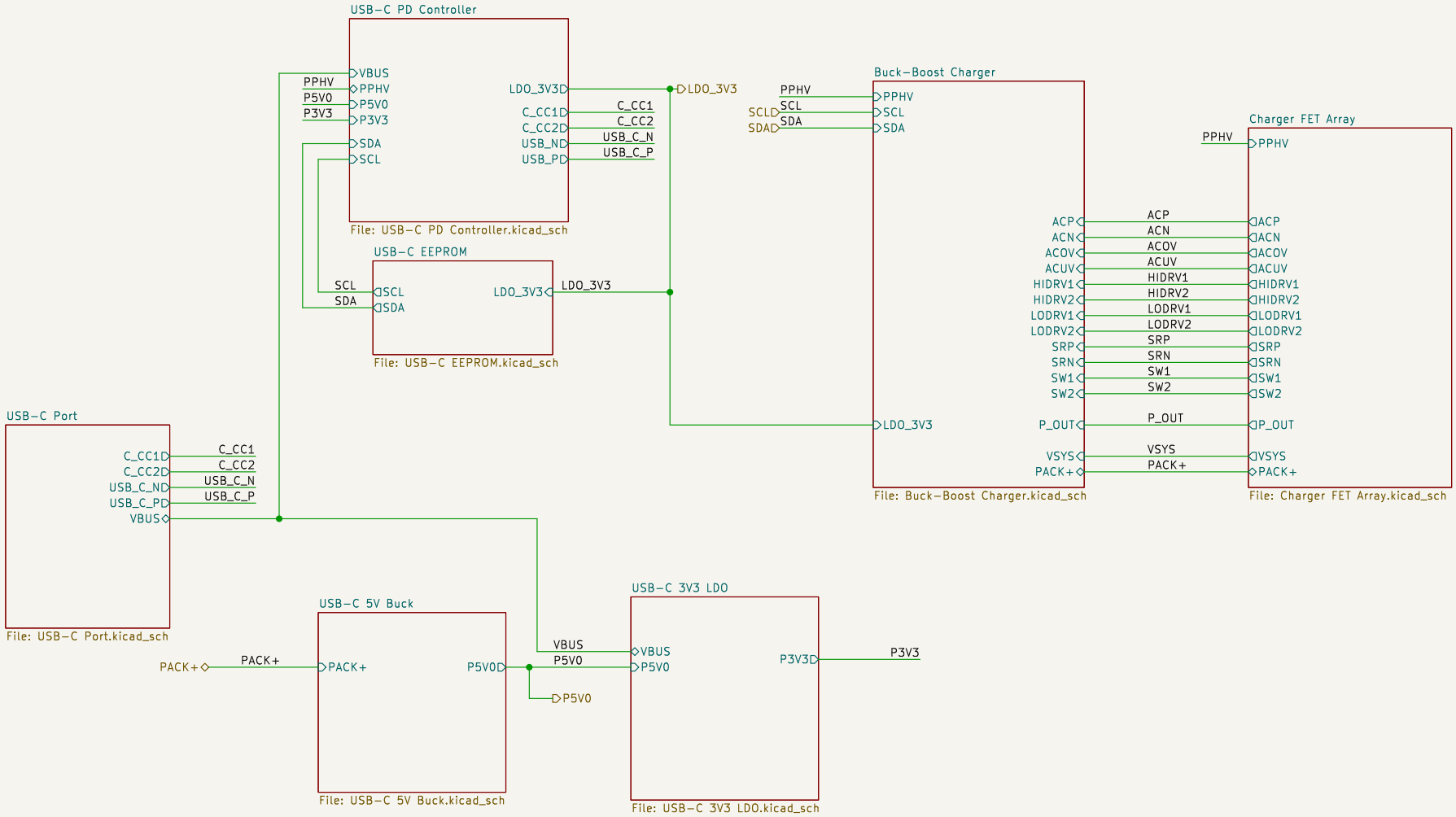



| | | |
|---|---|---|
| Sheet: /BMS Protection Board/High Voltage REGSRC Supply/ | | |
| File: High Voltage REGSRC Supply.kicad_sch | | |
| **Title:** | | |
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 10/33 |

# Fuel Gauge




| | | |
|---|---|---|
| Sheet: /BMS Protection Board/Fuel Gauge/ | | |
| File: Fuel Gauge.kicad_sch | | |
| **Title:** | | |
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 11/33 |




***Design is based off of PMP41062***

## The Correct Flashing Process
Here is the correct workflow:

Generate Your Configuration: Use the TPS2575x Application Customization Tool from Texas Instruments to create the binary file (.bin) that contains all your desired settings.

Program the EEPROM Separately: Connect the CAT24C512 EEPROM to your dedicated flasher or an Arduino. Do this before connecting it to the TPS25751.

Connect power (VCC), ground (GND), SDA, and SCL.

Use the flasher's software to write the .bin file you generated onto the EEPROM.

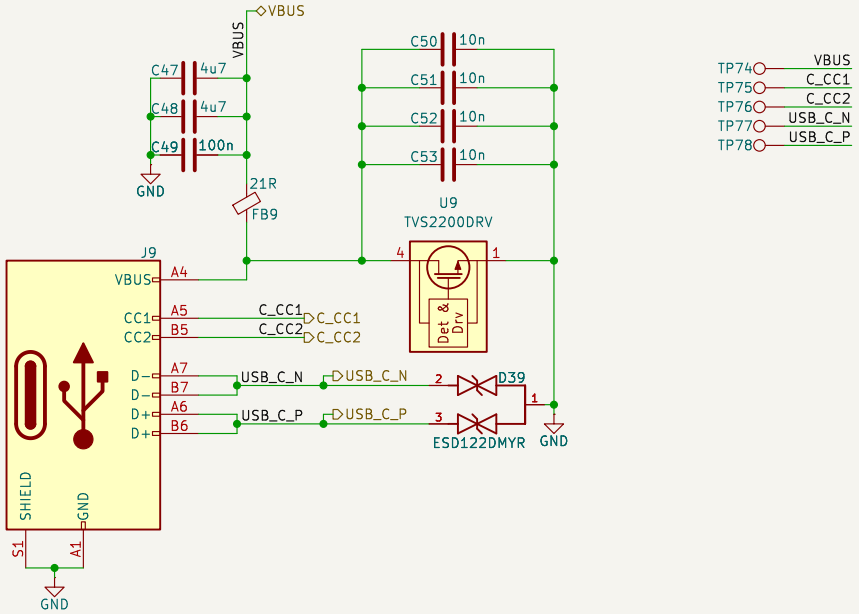
Assemble the Final Circuit: Once the EEPROM is successfully flashed, connect it to the I2Cc (the controller port) of the TPS25751.

Now, when you power on your circuit, the TPS25751 will use its I2Cc port to automatically read the settings you loaded onto the EEPROM and will configure itself correctly.

Sheet: /USB-C Power Delivery/
File: USB-C Power Delivery.kicad_sch

**Title:**

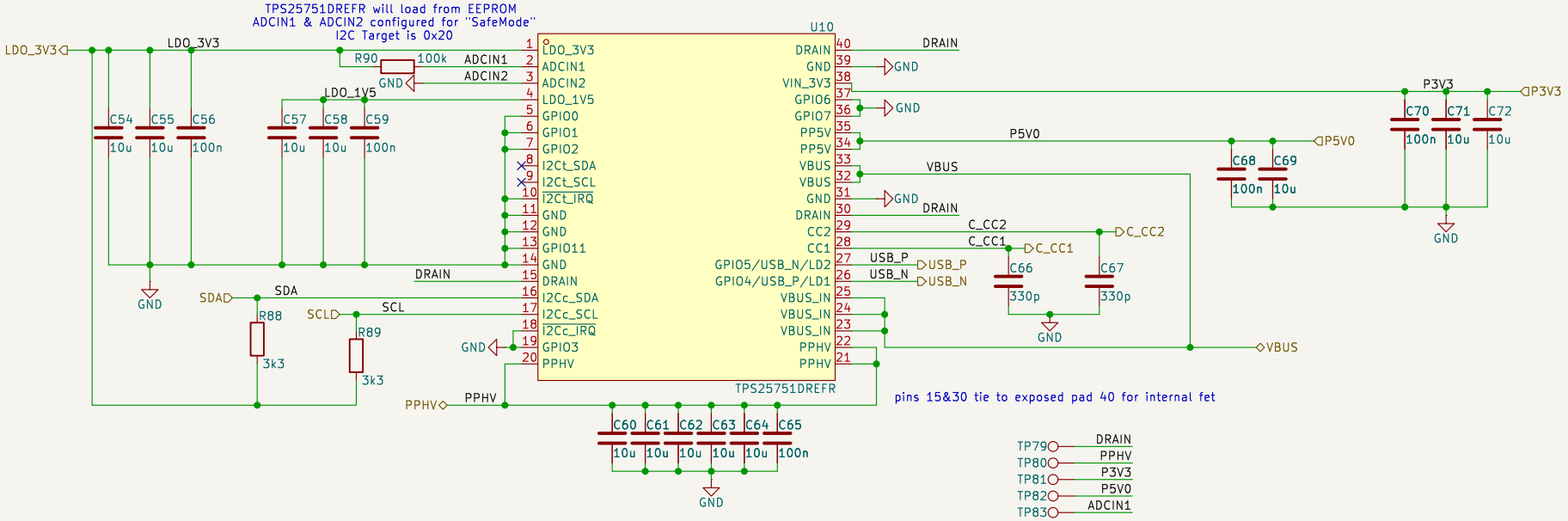
| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 12/33 |




Sheet: /USB-C Power Delivery/USB-C Port/
File: USB-C Port.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 13/33 |



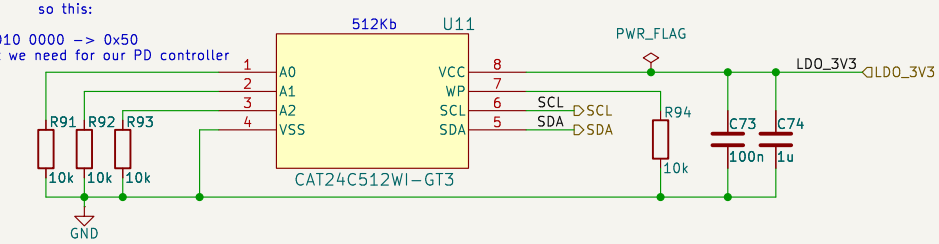

| | | |
|---|---|---|
| Sheet: /USB-C Power Delivery/USB-C PD Controller/ | | |
| File: USB-C PD Controller.kicad_sch | | |
| **Title:** | | |
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 14/33 |

1010 ????
GND=0

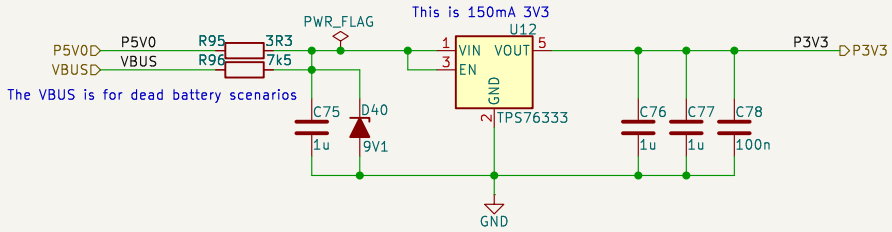
so this:

1010 0000 -> 0x50
which is what we need for our PD controller

Flash this with the bin taken from TI's website. Use I2C to USB adapter.
Flash this when the system is off (not powered), only flash/power this.



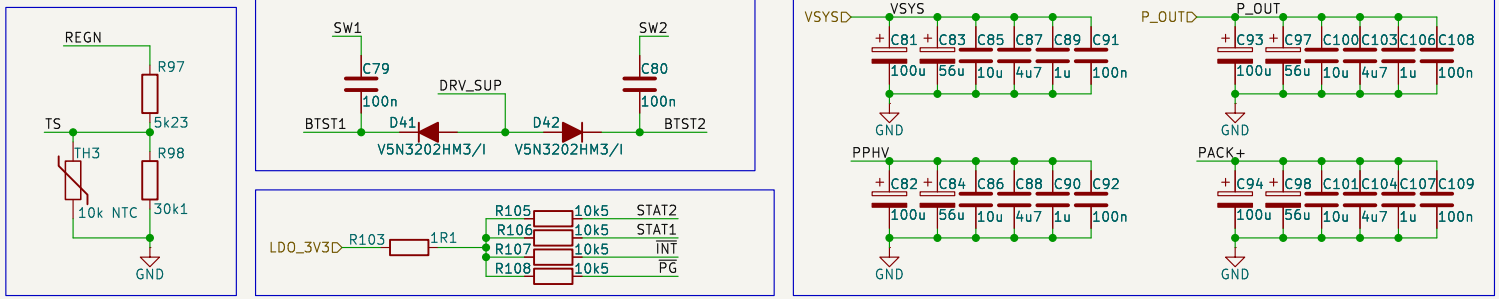

| | | |
|---|---|---|
| Sheet: /USB-C Power Delivery/USB-C EEPROM/ | | |
| File: USB-C EEPROM.kicad_sch | | |
| **Title:** | | |
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 15/33 |




Sheet: /USB-C Power Delivery/USB-C 3V3 LDO/
File: USB-C 3V3 LDO.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 16/33 |




these should be precision resistors

Target Voltage = 8 cells * 4.2 V/cell = 33.6 V
Rtop = 249kΩ (from datasheet's recommendation)
Rbot = Btop * (Vfb / (Vbat_reg − Vfb)) + Rfbg
Vfb: 1.536V from datasheet
Rfbg: 33Ω from datasheet
Rbot = 11.96kΩ

"PIN32 is for reverse mode voltage regulation"

U13 BQ25756RRVR

PACK+ R100 249k±0.1% R101 11k96±0.1%

R99 11k36±0.1%

R102 2k49±0.1%

R104 100k±0.1%

R109 0R

C95 4u7 C99 1u C102 1u C105 100n

C96 4u7

Set to 300kHz

For my application:
8S4P setup, each cell is ~2200mAh
4 * 2200mAh = 8.8Ah

Setting charging at 0.5*C
Ichg = 8.8Ah * 0.5 = 4.4A
R = 50Akω / 4.4A = 11.36kΩ

Since this is 100W, 20V/5A,
a safe upper will be set for 8A

using 5mΩ sense resistor:
R = 20Akω / 8A = 2.5kΩ

TP84 VSYS
TP85 P_OUT
TP86 ACP
TP87 ACN
TP88 SRP
TP89 SRN
TP90 FB
TP91 FBG
TP92 TS
TP93 ICHG
TP94 ILIM_HIZ
TP95 ACUV
TP96 ACOV
TP97 FSW_SYNC
TP98 CE
TP99 BTST1
TP100 BTST2
TP101 DRV_SUP
TP102 HIDRV1
TP103 SW1
TP104 LODRV1
TP105 HIDRV2
TP106 SW2
TP107 LODRV2
TP108 REGN
TP109 INT
TP110 STAT1
TP111 STAT2
TP112 SCL
TP113 SDA
TP114 PG

Sheet: /USB-C Power Delivery/Buck-Boost Charger/
File: Buck-Boost Charger.kicad_sch

**Title:**

Size: A4 | Date: | **Rev:**
KiCad E.D.A. 9.0.4 | Id: 17/33

Switching Frequency = 400kHz
Vin = 25.6V -> 33.6V (29.6V nominal)
Vout = 5V
Iout = 5A
Ripple = 1% * 5V = 50 mV

* From Datasheet: Delta_I_L should be between 30% and 50%:
* If we do 40%, 40% * 5A = 2A
Lo = Vout / (Delta_I_L * F_sw) * (1 - Vout / Vin_nom) = 5 / (2 * 400k) * (1 - 5 / 29.6) = 5.19uH -> 5.6uH

* "The inductor's saturation current rating must be higher than the maximum peak current."
Deltaa_I_L = Vout / (L_o * F_sw) * (1 - Vout / Vin_MAX) = 5 / (5.6u * 400k) * (1 - 5 / 33.6) = 1.89A
* Verify with the peak current
I_LO(PK) = I_o + Delta_I_L / 2 = 5 + 1.89 / 2 = 5.945
*** The inductor selected must have a saturation current rating above 6A

A 20% Saftey margin: 5.95 * 1.2 = 7.14A
The switching frequency is programmed by a single resistor from the RT pin to AGND.
R_RT[kΩ] = ((10^6 / F_sw{kHz}) - 59) / 41 = ((10^6 / 400) - 59) / 41 = 59.54kΩ = 59k

(pin 6)
* From datasheet:
* Vrefl = 1V
* I_IMON_OFFSET = 25uA
* gm_IMON = 2uA/mV
R_IMON = V_refl / ((R_CS * G_mIMON * I_CC) + I_IMON_OFFSET) = 1 / ((8m * 2u * 5) + 25u) = 9.53kΩ

F_C = F_sw / 10 = 400k / 10 = 40k
C_IMON = 1 / (2 * pi * R_IMON * F_C) = 1 / (2 * pi * 9.54k * 40k) = 417pF = 470pF

Current Sense Resistor:
* From Datasheet V_CS-TH = 60mV
Rs = V_CS-TH / (1.2 * I_LO(PK)) = 60m / (1.2 * 5.95) = 8.4mΩ -> 8mΩ is a standard resistor

* Ripple Cout
Cout >= Delta_I_L / (8 * F_sw * Delta_Vout) = 1.9 / (8 * 400k * 50m) = 11.87uF = 11.9uF
* Transient Cout, assuming an acceptable voltage overshoot of 3% (150 mV)
Cout >= (L_o * (Delta_I_Load)^2) / ((Vout + Delta_V_overshoot)^2 - (Vout)^2) = (5.6u * 5^2) / ((5 + 0.15)^2 - 5^2) = 92uF = 100uF

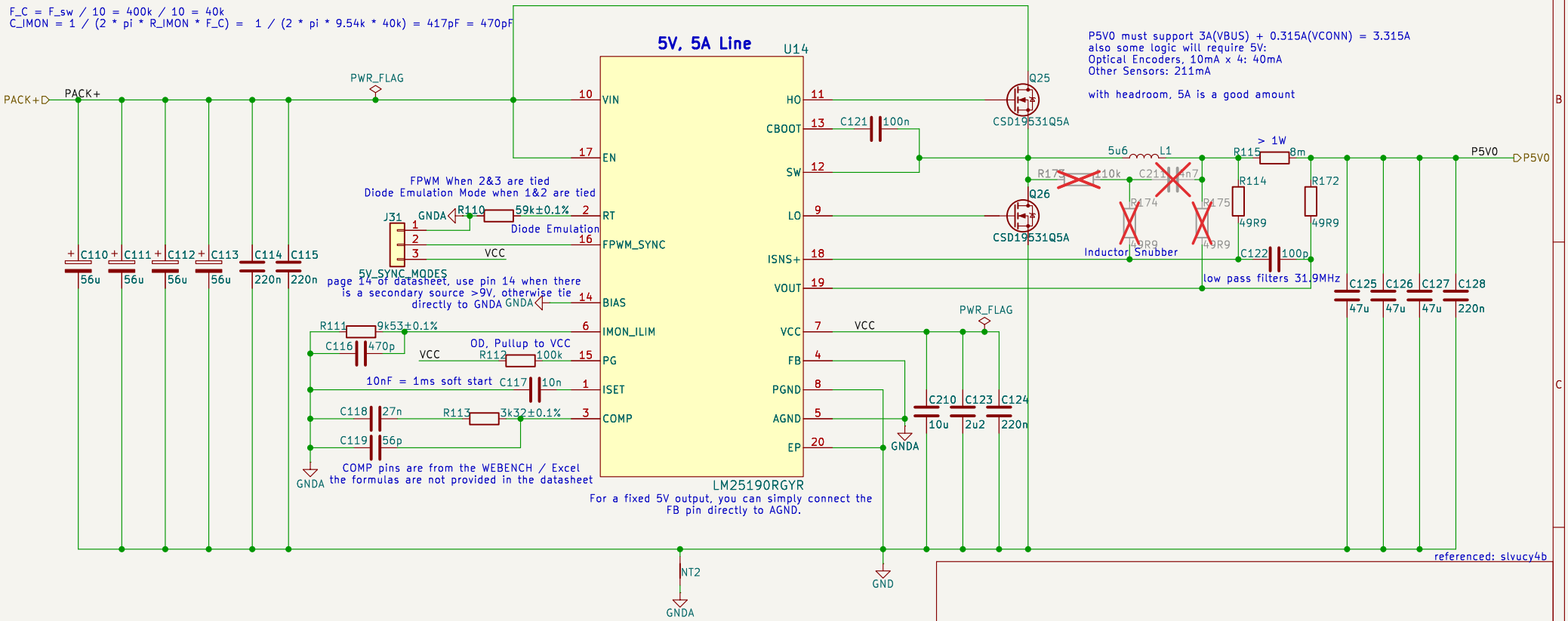
I_CO(RMS) = Delta_I_L / 12^(1/2) = 0.55A
*** The Capacitor Bank must be rated for > 0.55A for its ripple current

Cin:
Dmax = Vout / Vin(MIN) = 5 / 25.6 = 195m
I_CIN(RMS) = SQRT(D * ((1 - D) * (I_out)^2 + (Delta_I_L)^2 / 12) = SQRT(195m * ((1 - 195m) * 5^2 + 1.9^2 / 12) = 1.99 A(RMS)
Delta_V_Supply = 1% * 25.6V = 0.256 = 0.25V
C_in >= (I_out * D * (1 - D)) / (F_sw * Delta_V_Supply) = (5 * 195m * (1 - 195m)) / (400k * 0.25) = 7.85uF

Soft Start:
* From datasheet: I_ISET (internal) is 10uA
* Delta_V = 1V (voltage ramp from 0 to 1)
I = Delta_Q / Delta_T , C = Delta_Q / Delta_V , Delta_T = (C * Delta_V) / I
T_SSCC = (C_ISET * Delta_V) / I_ISET = (10n * 1) / 10u = 1ms

P5V0 must support 3A(VBUS) + 0.315A(VCONN) = 3.315A
also some logic will require 5V:
Optical Encoders, 10mA x 4: 40mA
Other Sensors: 211mA

with headroom, 5A is a good amount

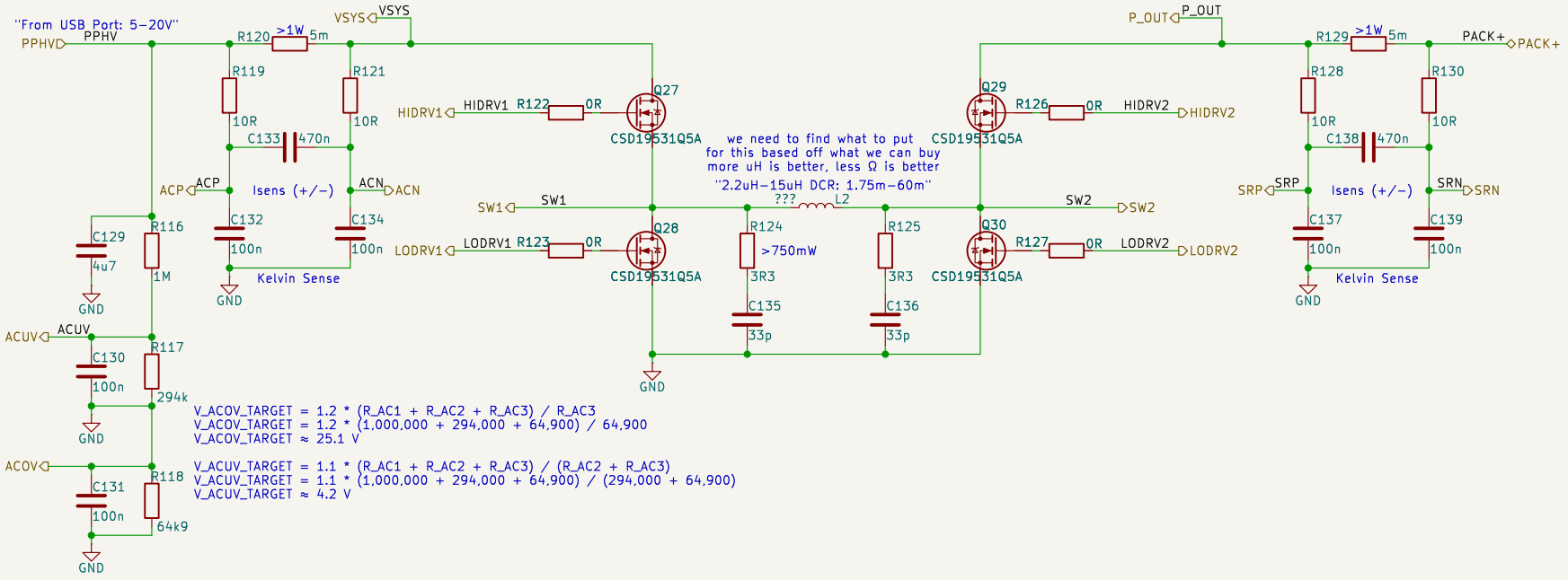



referenced: slvucy4b

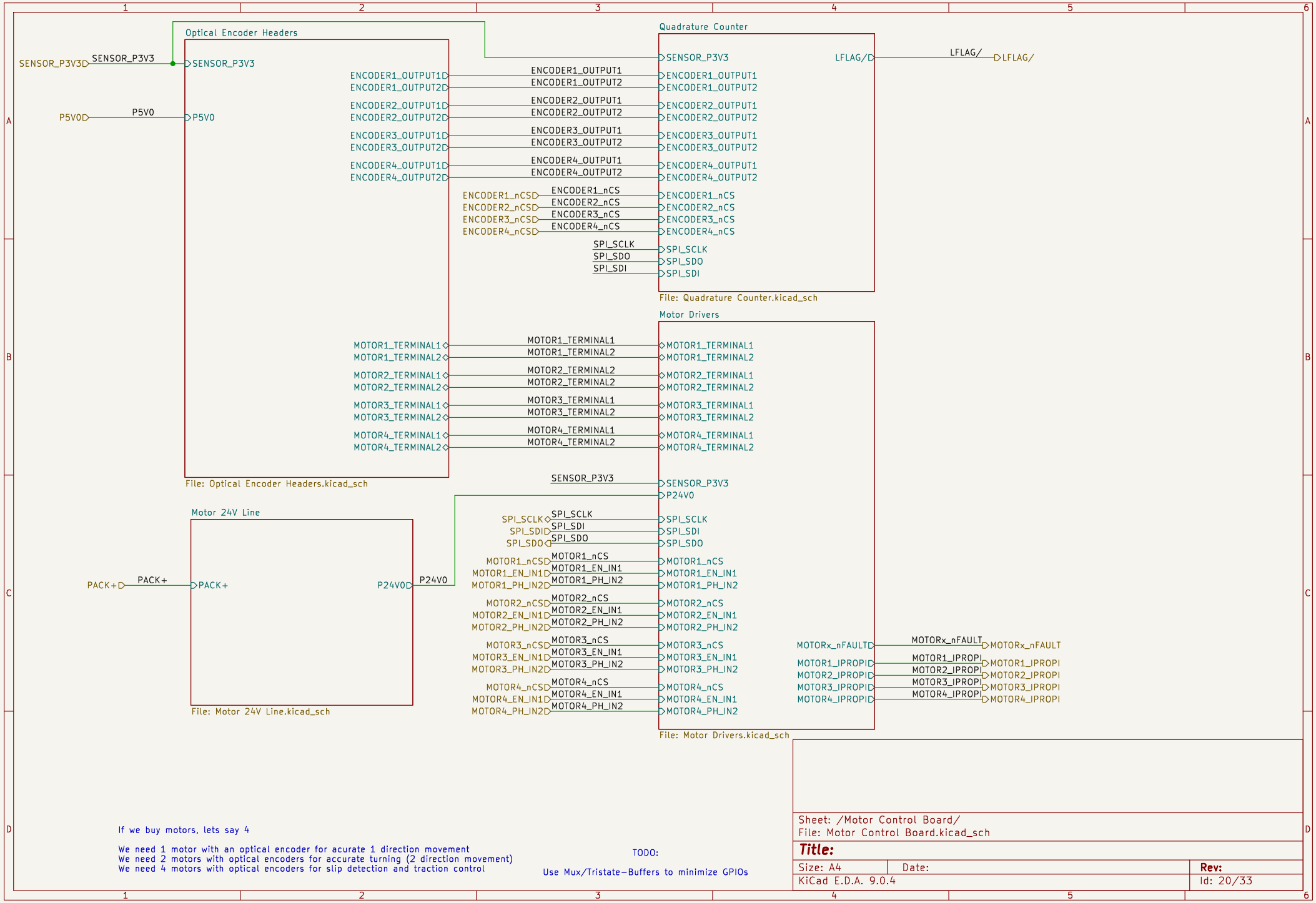
Sheet: /USB-C Power Delivery/USB-C 5V Buck/
File: USB-C 5V Buck.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 18/33 |




| | | |
|---|---|---|
| Sheet: /USB-C Power Delivery/Charger FET Array/ | | |
| File: Charger FET Array.kicad_sch | | |
| **Title:** | | |
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 19/33 |


Optical Encoder Headers
SENSOR_P3V3
P5V0
ENCODER1_OUTPUT1
ENCODER1_OUTPUT2
ENCODER2_OUTPUT1
ENCODER2_OUTPUT2
ENCODER3_OUTPUT1
ENCODER3_OUTPUT2
ENCODER4_OUTPUT1
ENCODER4_OUTPUT2
ENCODER1_nCS
ENCODER2_nCS
ENCODER3_nCS
ENCODER4_nCS
SPI_SCLK
SPI_SDO
SPI_SDI
MOTOR1_TERMINAL1
MOTOR1_TERMINAL2
MOTOR2_TERMINAL1
MOTOR2_TERMINAL2
MOTOR3_TERMINAL1
MOTOR3_TERMINAL2
MOTOR4_TERMINAL1
MOTOR4_TERMINAL2
File: Optical Encoder Headers.kicad_sch
Quadrature Counter
LFLAG/
File: Quadrature Counter.kicad_sch
Motor Drivers
P24V0
MOTOR1_nCS
MOTOR1_EN_IN1
MOTOR1_PH_IN2
MOTOR2_nCS
MOTOR2_EN_IN1
MOTOR2_PH_IN2
MOTOR3_nCS
MOTOR3_EN_IN1
MOTOR3_PH_IN2
MOTOR4_nCS
MOTOR4_EN_IN1
MOTOR4_PH_IN2
MOTORx_nFAULT
MOTOR1_IPROPI
MOTOR2_IPROPI
MOTOR3_IPROPI
MOTOR4_IPROPI
File: Motor Drivers.kicad_sch
Motor 24V Line
PACK+
File: Motor 24V Line.kicad_sch
If we buy motors, lets say 4
We need 1 motor with an optical encoder for acurate 1 direction movement
We need 2 motors with optical encoders for accurate turning (2 direction movement)
We need 4 motors with optical encoders for slip detection and traction control
TODO:
Use Mux/Tristate-Buffers to minimize GPIOs
Sheet: /Motor Control Board/
File: Motor Control Board.kicad_sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. 9.0.4
Id: 20/33

Switching Frequency = 400kHz
Vin = 25.6V -> 33.6V (29.6V nominal)
Vout = 24V
Iout = 20A
Ripple = 1% * 24V = 240 mV

* From Datasheet: Delta_I_L should be between 30% and 50%:
* If we do 30%, 30% * 20A = 6A
Lo = Vout / (Delta_I_L * F_sw) * (1 - Vout / Vin_nom) = 24 / (6 * 400k) * (1 - 24 / 29.6) = 1.9uH -> 2.2uH

* "The inductor's saturation current rating must be higher than the maximum peak current."
Delta_I_L = Vout / (L_o * F_sw) * (1 - Vout / Vin_MAX) = 24 / (2.2u * 400k) * (1 - 24 / 33.6) = 7.8A
* Verify with the peak current
I_LO(PK) = I_o + Delta_I_L / 2 = 20 + 7.8 / 2 = 23.9A
*** The inductor selected must have a saturation current rating above 24A

A 20% Saftey margin: 23.9 * 1.2 = 28.7A

The switching frequency is programmed by a single resistor from the RT pin to AGND.
R_RT[kΩ] = ((10^6 / F_sw[kHz]) - 59) / 41 = ((10^6 / 400) - 59) / 41 = 59.54kΩ -> 59kΩ

(pin 6)
* From datasheet:
* Vrefl = 1V
* I_IMON_OFFSET = 25uA
* gm_IMON = 2uA/mV
R_IMON = V_refl / ((R_CS * G_mIMON * I_CC) + I_IMON_OFFSET) = 1 / ((2m * 2u * 20) + 25u) = 9.26kΩ -> 9.31kΩ (standard E96)

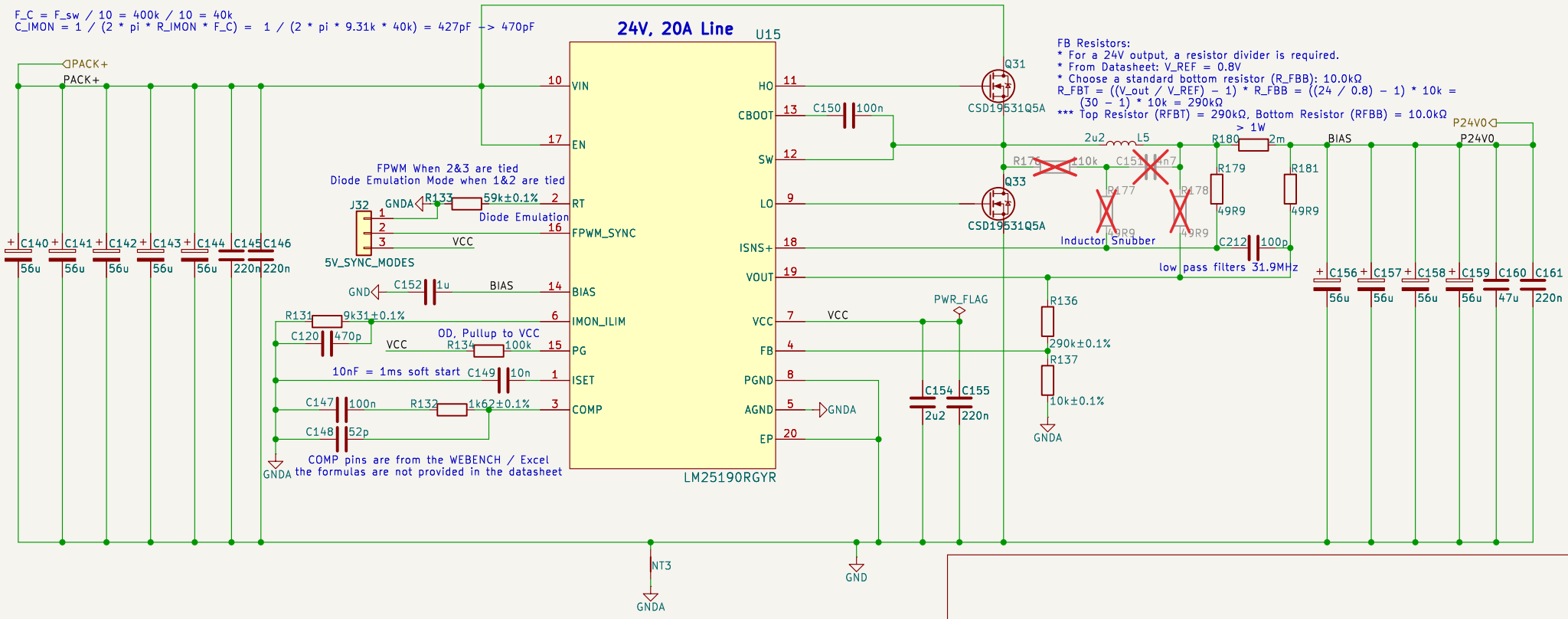
F_C = F_sw / 10 = 400k / 10 = 40k
C_IMON = 1 / (2 * pi * R_IMON * F_C) = 1 / (2 * pi * 9.31k * 40k) = 427pF -> 470pF

Current Sense Resistor:
* From Datasheet V_CS-TH = 60mV
Rs = V_CS-TH / I_PEAKCL = 60m / 28.7A = 2.09mΩ -> 2.0mΩ is a standard resistor

* Cout
Transient response will dominate capacitor selection for a high-current design.
A practical choice for a 20A output would be at least 220uF effective capacitance. -> 220uF
* I_CO(RMS) = Delta_I_L / 12^(1/2) = 7.8 / 3.46 = 2.25A(RMS)
*** The Capacitor Bank must be rated for > 2.25A for its ripple current

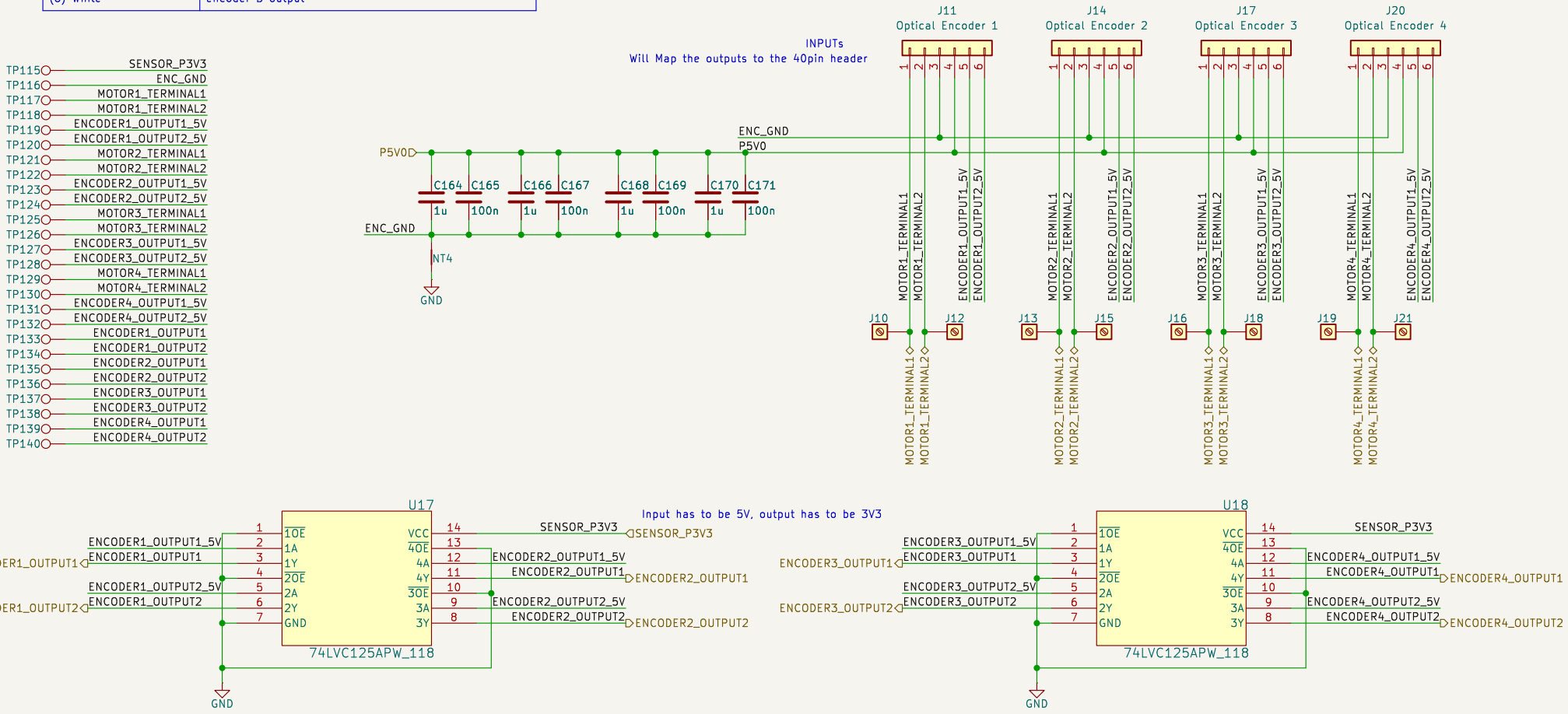
Cin:
Dmax = Vout / Vin(MIN) = 24 / 25.6 = 0.938
Delta_I_L(@Vin_MIN) = 24 / (2.2u * 400k) * (1 - 24 / 25.6) = 1.7A
I_CIN(RMS) = SQRT(D * ((1 - D) * I_out^2 + Delta_I_L^2 / 12)) = SQRT(0.938 * ((1 - 0.938) * 20^2 + 1.7^2 / 12)) = 4.88A(RMS)
Delta_V_Supply = 1% * 25.6V = 0.256V = 0.25V
C_in >= (I_out * D * (1 - D)) / (F_sw * Delta_V_Supply) = (20 * 0.938 * (1 - 0.938)) / (400k * 0.25) = 11.6uF -> 22uF effective

Soft Start:
* From datasheet: I_ISET (internal) is 10uA
* Delta_V = 1V (voltage ramp from 0 to 1)
For a slower start on this high-power line, let's select C_ISET = 22nF
T_SSCC = (C_ISET * Delta_V) / I_ISET = (22n * 1) / 10u = 2.2ms




| | | |
|---|---|---|
| Sheet: /Motor Control Board/Motor 24V Line/ | | |
| File: Motor 24V Line.kicad_sch | | |
| **Title:** | | |
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 22/33 |

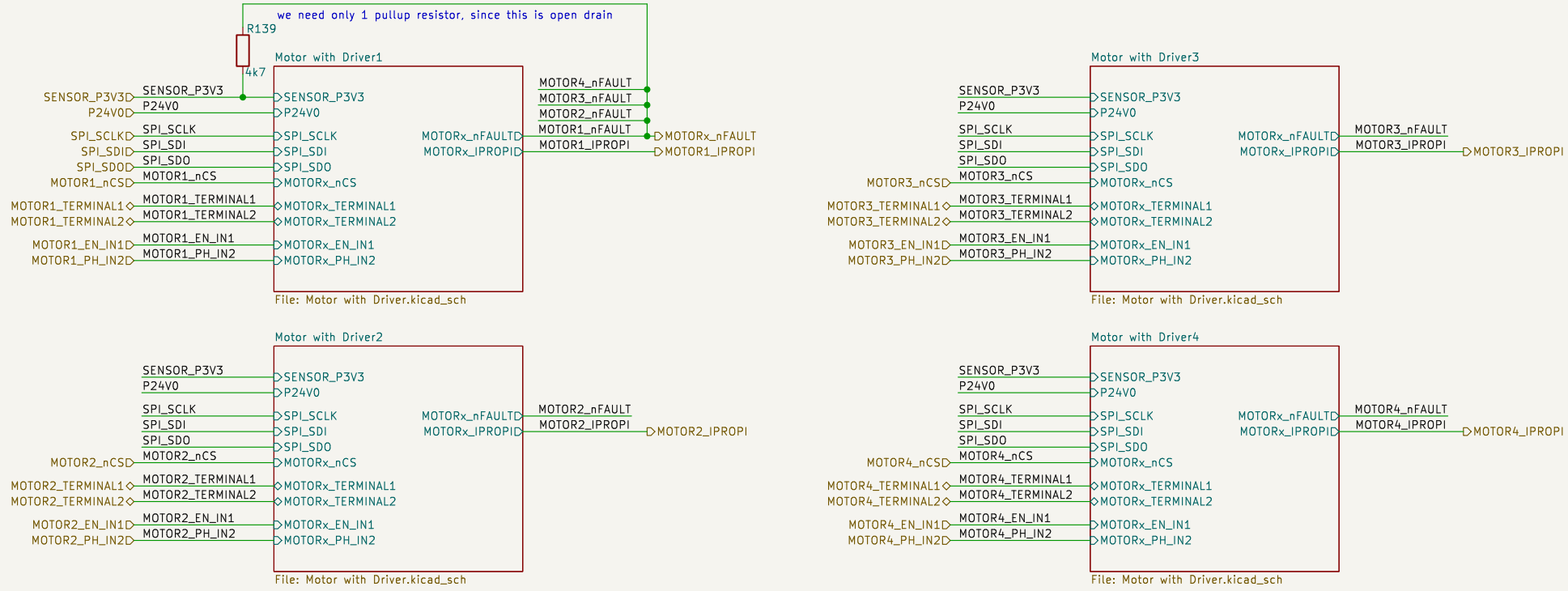
| | |
|---|---|
| (1) Red | motor power (connects to one motor terminal) |
| (2) Black | motor power (connects to the other motor terminal) |
| (3) Green | encoder GND |
| (4) Blue | encoder Vcc (3.5 – 20 V) |
| (5) Yellow | encoder A output |
| (6) White | encoder B output |




Sheet: /Motor Control Board/Optical Encoder Headers/
File: Optical Encoder Headers.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 24/33 |



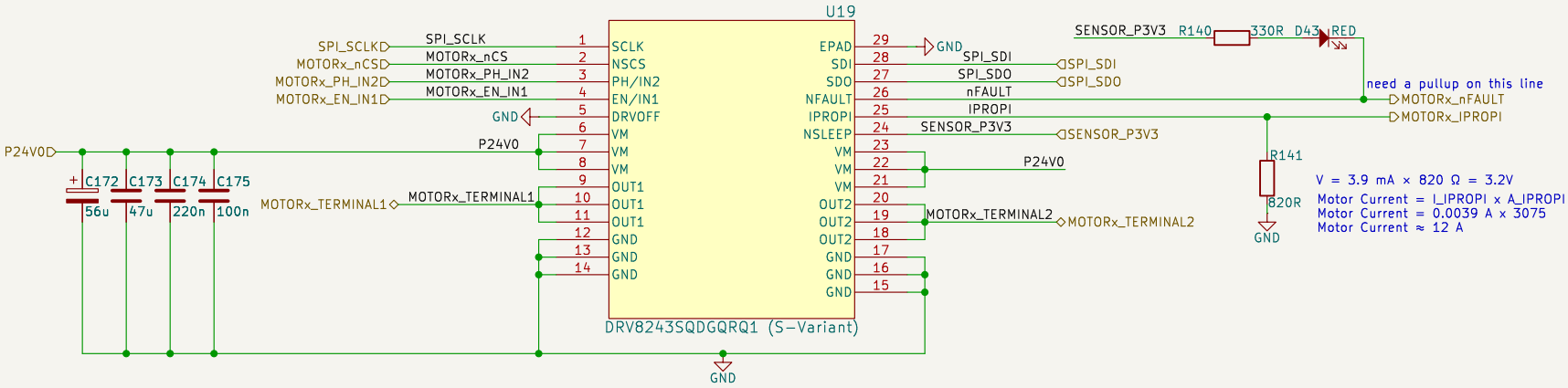

Sheet: /Motor Control Board/Motor Drivers/
File: Motor Drivers.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 25/33 |

For the SPI (P) variant, you can set the SCLK frequency up to 10 MHz.

For the SPI (S) variant, the maximum is 10 MHz, but you should reduce it to 8 MHz if you have a 20 pF load on the SDO line.



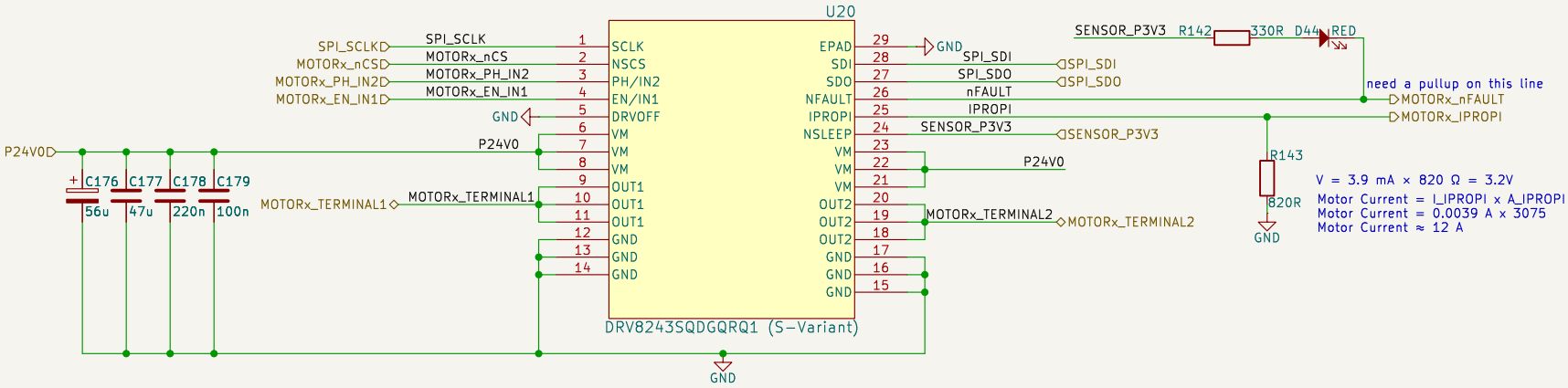

Sheet: /Motor Control Board/Motor Drivers/Motor with Driver1/
File: Motor with Driver.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 26/33 |

For the SPI (P) variant, you can set the SCLK frequency up to 10 MHz.

For the SPI (S) variant, the maximum is 10 MHz, but you should reduce it to 8 MHz if you have a 20 pF load on the SDO line.



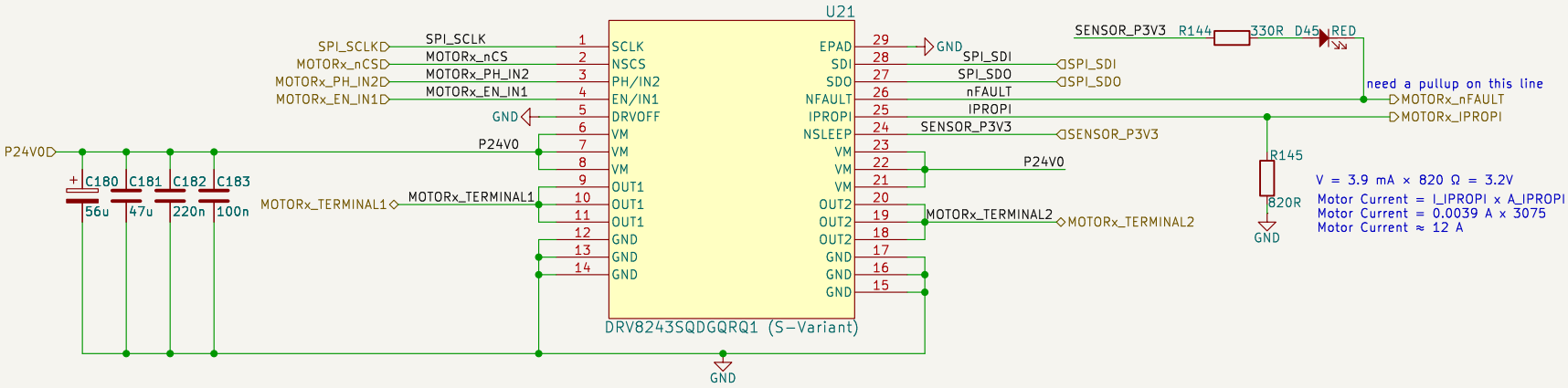

Sheet: /Motor Control Board/Motor Drivers/Motor with Driver2/
File: Motor with Driver.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 27/33 |

For the SPI (P) variant, you can set the SCLK frequency up to 10 MHz.

For the SPI (S) variant, the maximum is 10 MHz, but you should reduce it to 8 MHz if you have a 20 pF load on the SDO line.



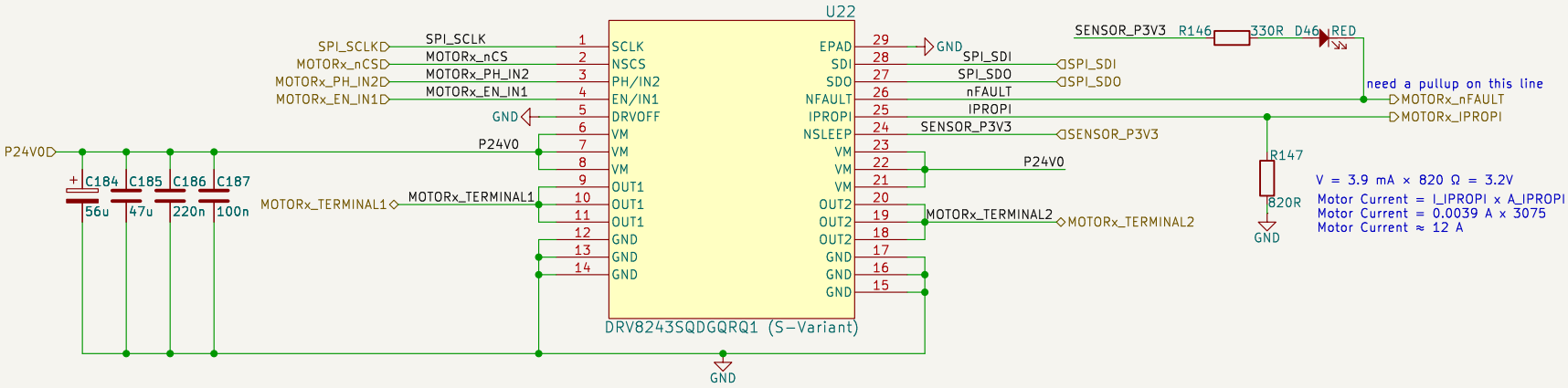

Sheet: /Motor Control Board/Motor Drivers/Motor with Driver3/
File: Motor with Driver.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 28/33 |

For the SPI (P) variant, you can set the SCLK frequency up to 10 MHz.

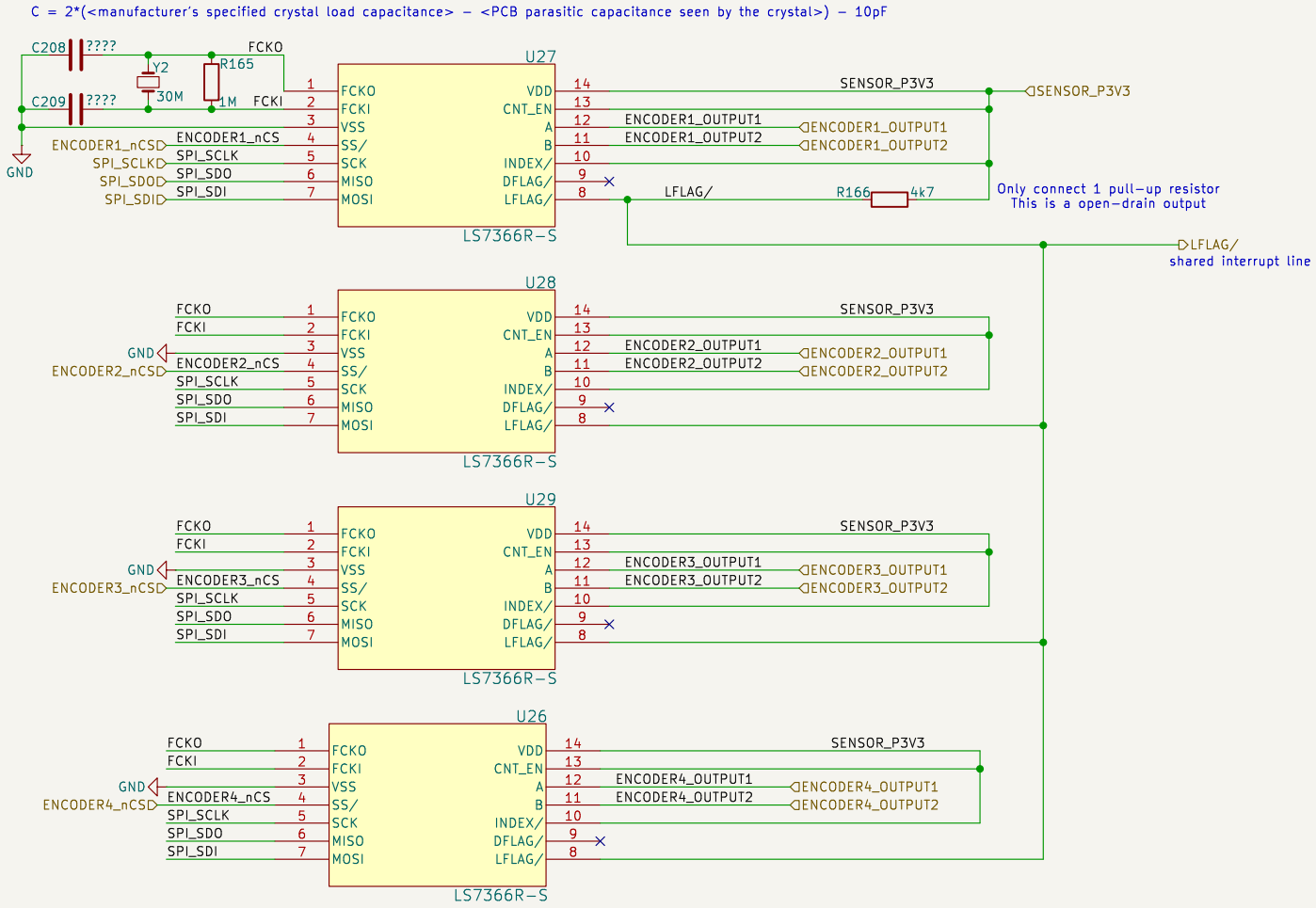
For the SPI (S) variant, the maximum is 10 MHz, but you should reduce it to 8 MHz if you have a 20 pF load on the SDO line.




Sheet: /Motor Control Board/Motor Drivers/Motor with Driver4/
File: Motor with Driver.kicad_sch

**Title:**

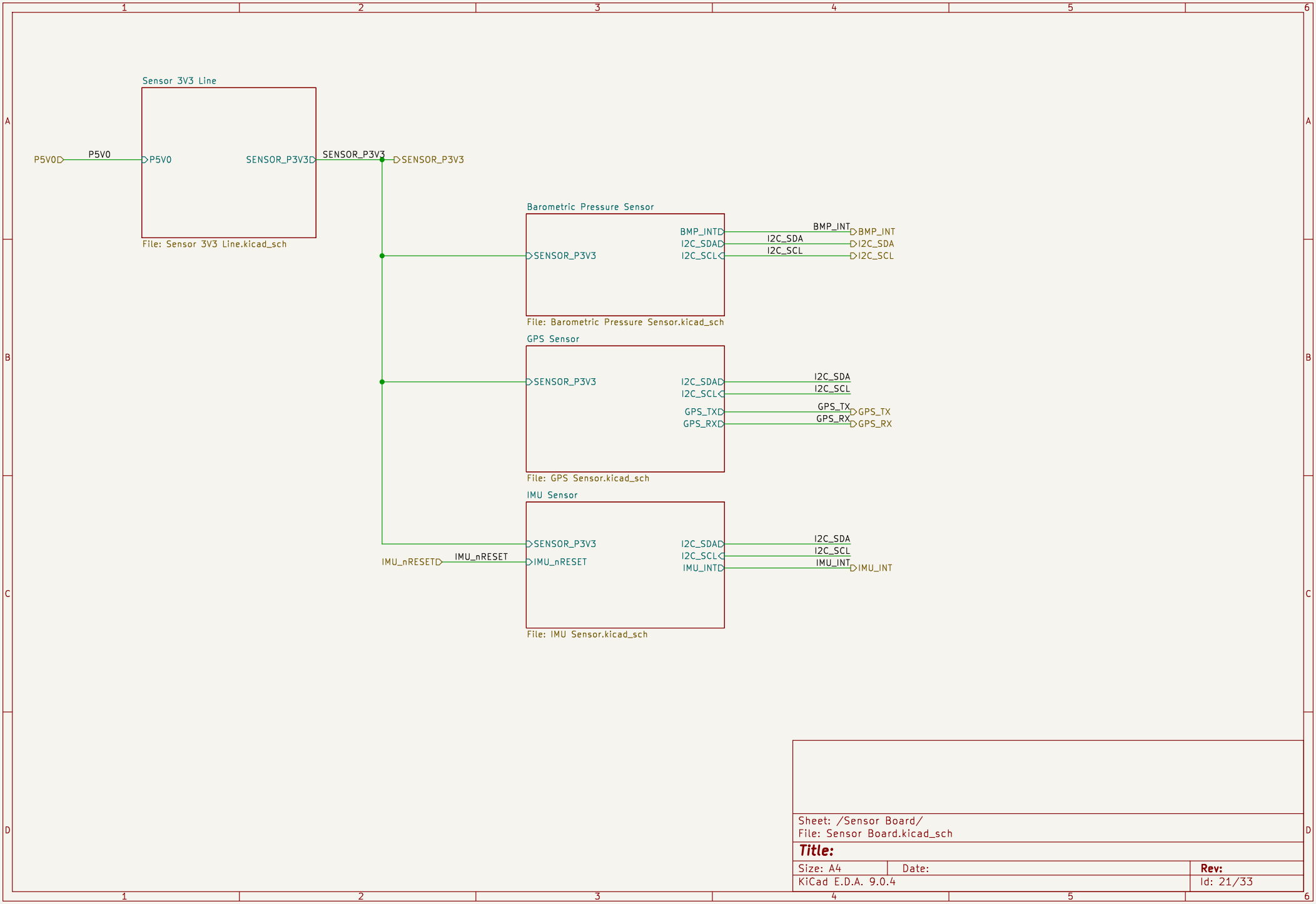
| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 29/33 |

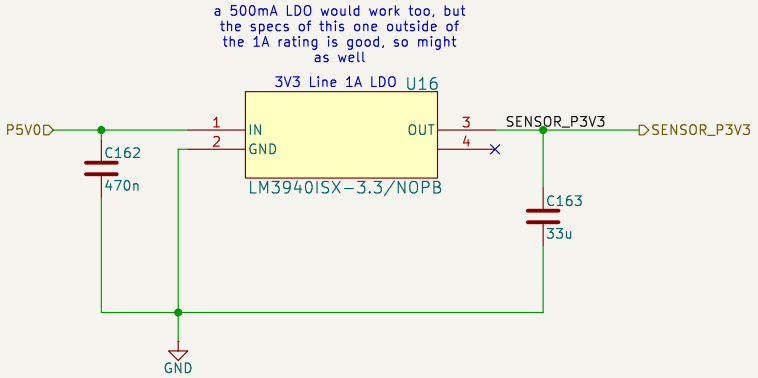



Sheet: /Motor Control Board/Quadrature Counter/
File: Quadrature Counter.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 33/33 |

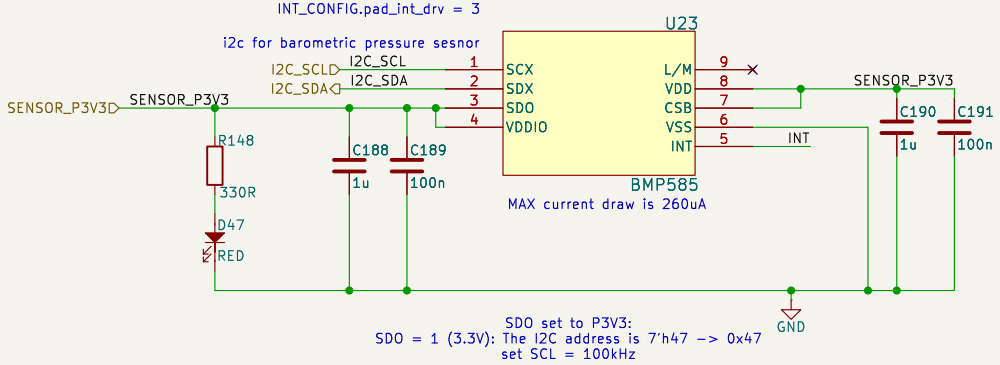

Sensor 3V3 Line
P5V0
P5V0
P5V0
SENSOR_P3V3
SENSOR_P3V3
SENSOR_P3V3
File: Sensor 3V3 Line.kicad_sch
Barometric Pressure Sensor
SENSOR_P3V3
BMP_INT
I2C_SDA
I2C_SCL
BMP_INT
I2C_SDA
I2C_SCL
BMP_INT
I2C_SDA
I2C_SCL
File: Barometric Pressure Sensor.kicad_sch
GPS Sensor
SENSOR_P3V3
I2C_SDA
I2C_SCL
GPS_TX
GPS_RX
I2C_SDA
I2C_SCL
GPS_TX
GPS_RX
GPS_TX
GPS_RX
File: GPS Sensor.kicad_sch
IMU Sensor
SENSOR_P3V3
IMU_nRESET
IMU_nRESET
IMU_nRESET
I2C_SDA
I2C_SCL
IMU_INT
I2C_SDA
I2C_SCL
IMU_INT
IMU_INT
File: IMU Sensor.kicad_sch
Sheet: /Sensor Board/
File: Sensor Board.kicad_sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. 9.0.4
Id: 21/33

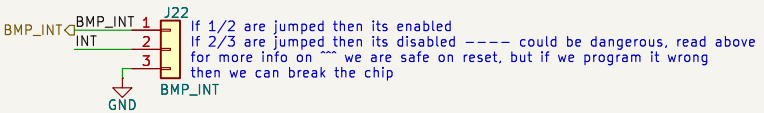



| | | |
|---|---|---|
| Sheet: /Sensor Board/Sensor 3V3 Line/ | | |
| File: Sensor 3V3 Line.kicad_sch | | |
| **Title:** | | |
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 23/33 |

Per the datasheet, the unused INT pin is tied to GND to prevent a floating input.
CRITICAL: The interrupt pin must be disabled in software to prevent a short circuit.
Ensure the 'int_en' bit in the INT_CONFIG register (0x14) remains disabled (set to 0).

Datasheet sets the IRQ to 0 on start up, so never turn it on
PAGE49: 0x14 on reset is set to 0x35
PAGE49: <int_en 2bits> <int_od 2bits> <int_pol 2bits> <int_mode 2bits LSB>
PAGE51: 8.5, setup for 0x14, <0> <1> <0> <1>
this means: int_mode = latched, int_pol = active low, int_od = open_drain, int_en = disabled
INT_CONFIG.int_en = 0
INT_CONFIG.od = 1
INT_CONFIG.pol = 0
INT_CONFIG.mode = 1
INT_CONFIG.pad_int_drv = 3

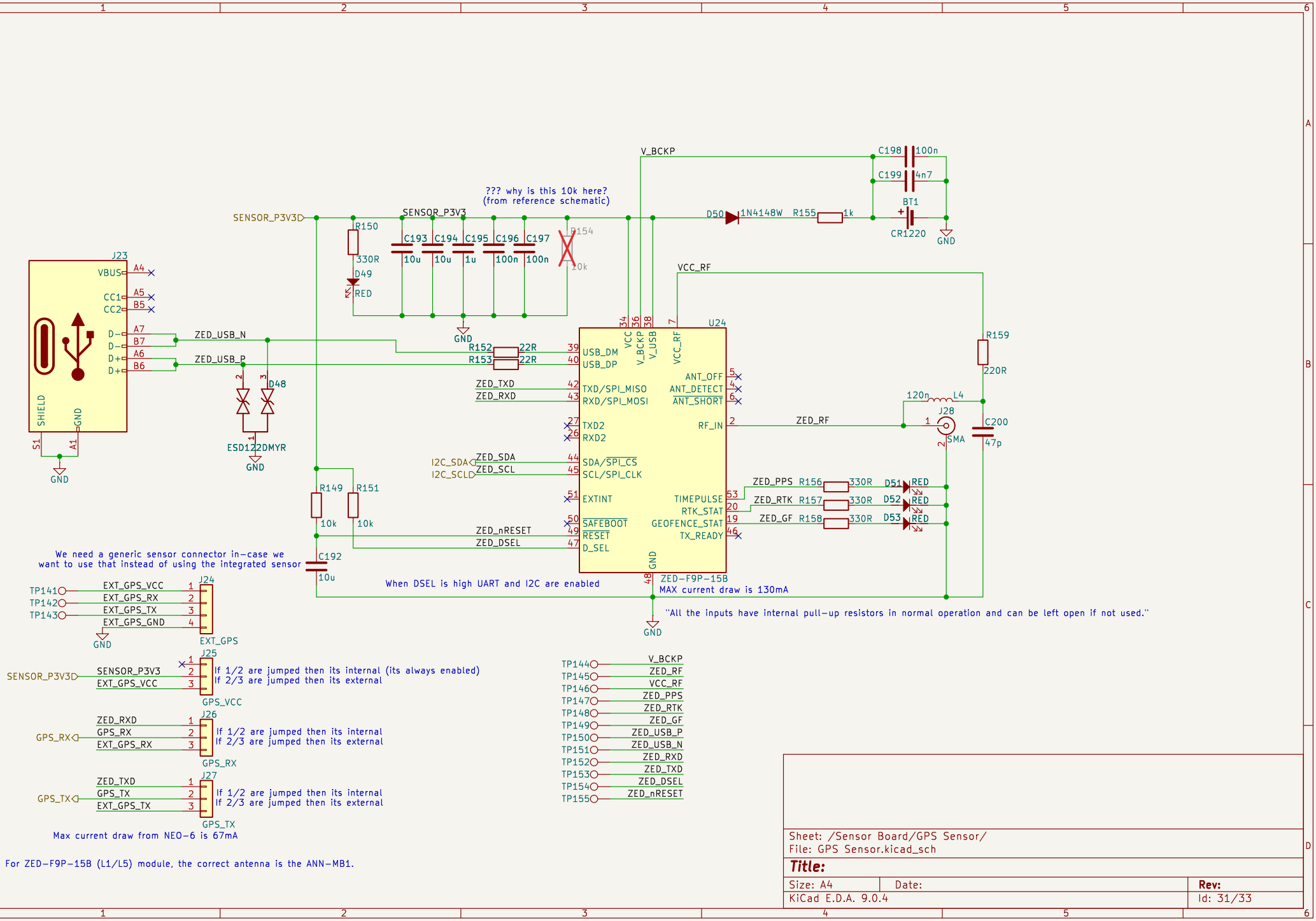


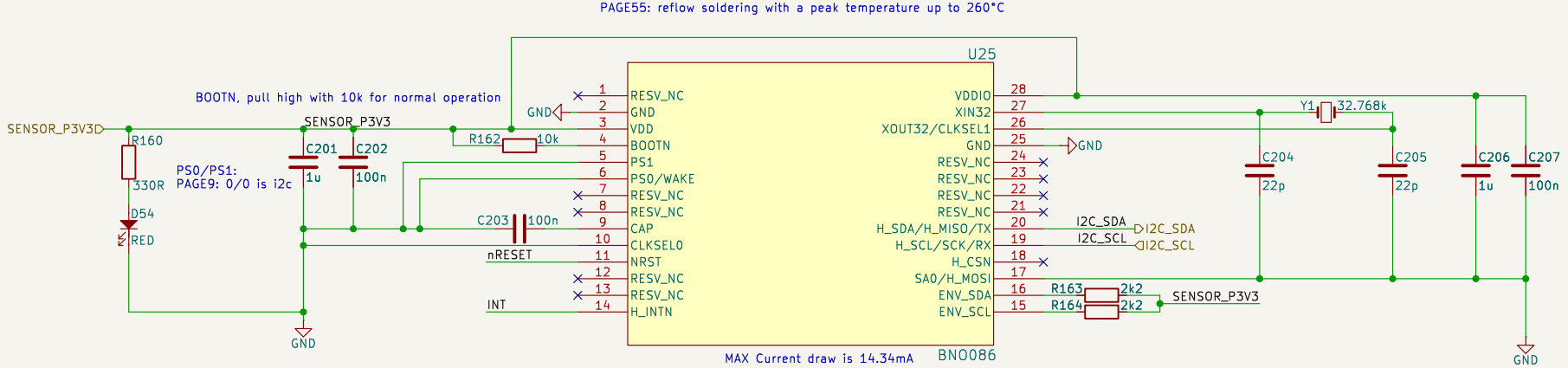




Sheet: /Sensor Board/Barometric Pressure Sensor/
File: Barometric Pressure Sensor.kicad_sch

**Title:**

| Size: A4 | Date: | **Rev:** |
|---|---|---|
| KiCad E.D.A. 9.0.4 | | Id: 30/33 |


V_BCKP
C198 100n
C199 4n7
BT1
CR1220
GND
D50 1N4148W R155 1k
??? why is this 10k here?
(from reference schematic)
SENSOR_P3V3
R150 330R
D49 RED
C193 10u
C194 10u
C195 1u
C196 100n
C197 100n
R154 10k
VCC_RF
R159 220R
J23
VBUS
CC1
CC2
D-
D-
D+
D+
SHIELD
GND
S1
A1
ZED_USB_N
ZED_USB_P
D48
ESD122DMYR
R152 22R
R153 22R
U24
USB_DM
USB_DP
ZED_TXD
ZED_RXD
TXD/SPI_MISO
RXD/SPI_MOSI
TXD2
RXD2
ZED_SDA
ZED_SCL
I2C_SDA
I2C_SCL
SDA/SPI_CS
SCL/SPI_CLK
EXTINT
SAFEBOOT
RESET
D_SEL
ZED_nRESET
ZED_DSEL
ANT_OFF
ANT_DETECT
ANT_SHORT
RF_IN
TIMEPULSE
RTK_STAT
GEOFENCE_STAT
TX_READY
ZED_RF
120n L4
J28 SMA
C200 47p
ZED_PPS R156 330R D51 RED
ZED_RTK R157 330R D52 RED
ZED_GF R158 330R D53 RED
R149 10k
R151 10k
C192 10u
ZED-F9P-15B
MAX current draw is 130mA
When DSEL is high UART and I2C are enabled
"All the inputs have internal pull-up resistors in normal operation and can be left open if not used."
We need a generic sensor connector in-case we want to use that instead of using the integrated sensor
J24
TP141 EXT_GPS_VCC
TP142 EXT_GPS_RX
TP143 EXT_GPS_TX
EXT_GPS_GND
EXT_GPS
J25
SENSOR_P3V3
EXT_GPS_VCC
If 1/2 are jumped then its internal (its always enabled)
If 2/3 are jumped then its external
GPS_VCC
J26
ZED_RXD
GPS_RX
EXT_GPS_RX
If 1/2 are jumped then its internal
If 2/3 are jumped then its external
GPS_RX
J27
ZED_TXD
GPS_TX
EXT_GPS_TX
If 1/2 are jumped then its internal
If 2/3 are jumped then its external
GPS_TX
Max current draw from NEO-6 is 67mA
For ZED-F9P-15B (L1/L5) module, the correct antenna is the ANN-MB1.
TP144 V_BCKP
TP145 ZED_RF
TP146 VCC_RF
TP147 ZED_PPS
TP148 ZED_RTK
TP149 ZED_GF
TP150 ZED_USB_P
TP151 ZED_USB_N
TP152 ZED_RXD
TP153 ZED_TXD
TP154 ZED_DSEL
TP155 ZED_nRESET
Sheet: /Sensor Board/GPS Sensor/
File: GPS Sensor.kicad_sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. 9.0.4
Id: 31/33




| | | |
|---|---|---|
| Sheet: /Sensor Board/IMU Sensor/ | | |
| File: IMU Sensor.kicad_sch | | |
| **Title:** | | |
| Size: A4 | Date: | **Rev:** |
| KiCad E.D.A. 9.0.4 | | Id: 32/33 |