BLDC DRIVER PROJECT 2024

DRIVER

File: driver.kicad_sch

CPU

File: CPU.kicad_sch

POWER

File: power.kicad_sch

TODO for 1.0:
- Add testpoints

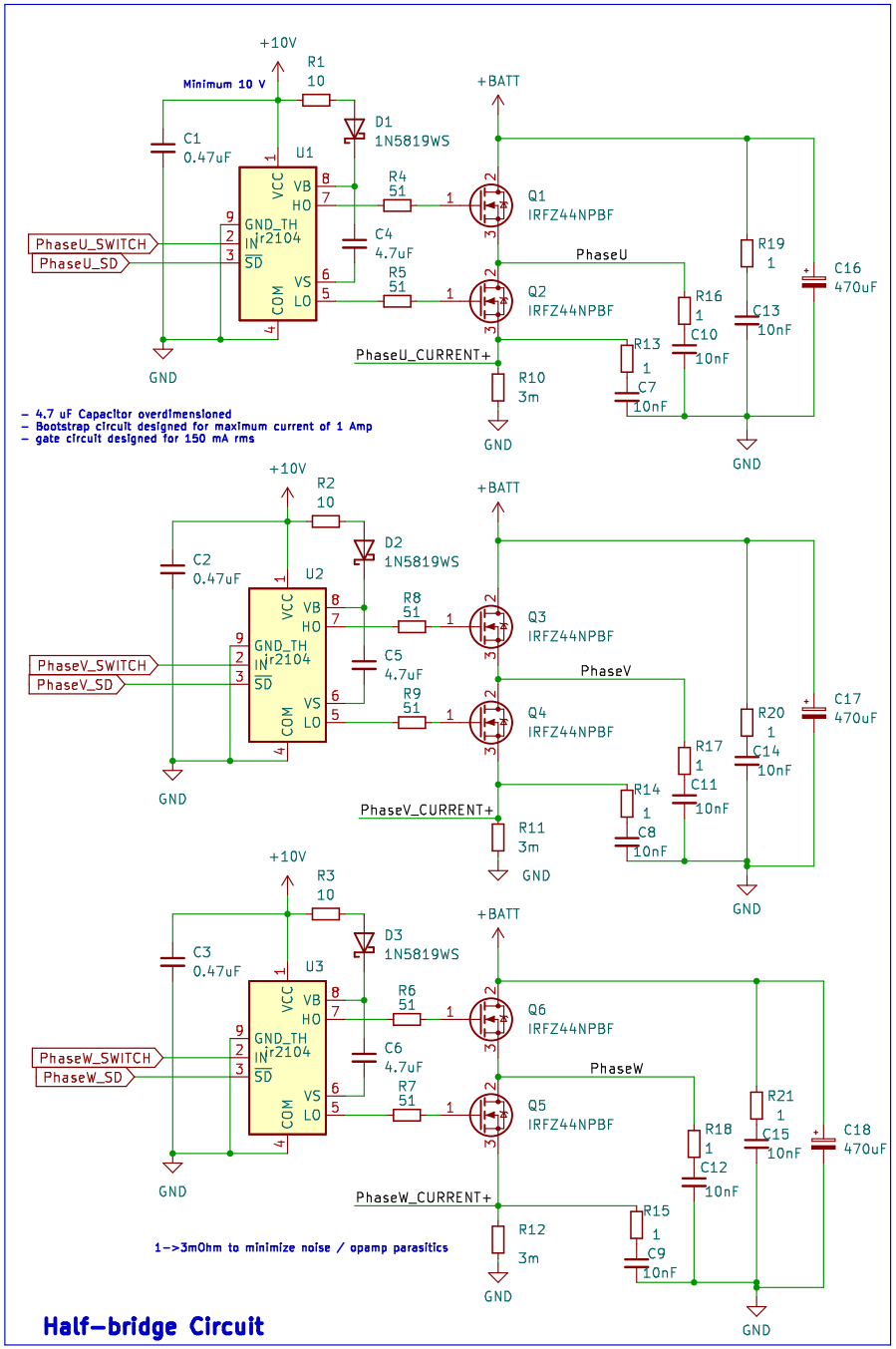
TODO for 1.1:
- Add connectors for Power and phases instead of solder-pads
- Add wireless com.
- Modify Bulk Capacitance after simulation and testing
- Modify crystal resistor after testing stm-oscillator drive strength
- Check if USB power filtering is necessary
- Check if keeping stm32 analog and digital ground separate has an effect on stm32 adc performance.
- Add a 30 amp fuse to avoid the whole circuit from burning down
- Add an extra sensor input for an encoder

IW

Sheet: /
File: bldc_project.kicad_sch

Title: BLDC Driver Project

Size: A4	Date:	**Rev: 1.0**
KiCad E.D.A. kicad 7.0.11-7.0.11-ubuntu22.04.1		Id: 1/4


+10V
Minimum 10 V
R1
10
D1
1N5819WS
C1
0.47uF
U1
VCC
VB
HO
VS
LO
COM
GND_TH
IN
SD
IR2104
+BATT
R4
51
C4
4.7uF
R5
51
Q1
IRFZ44NPBF
Q2
IRFZ44NPBF
PhaseU_SWITCH
PhaseU_SD
PhaseU
R19
1
C16
470uF
R16
1
C10
10nF
C13
10nF
PhaseU_CURRENT+
R13
1
C7
10nF
R10
3m
GND
- 4.7 uF Capacitor overdimensioned
- Bootstrap circuit designed for maximum current of 1 Amp
- gate circuit designed for 150 mA rms
R2
10
D2
1N5819WS
C2
0.47uF
U2
R8
51
R9
51
Q3
IRFZ44NPBF
Q4
IRFZ44NPBF
C5
4.7uF
PhaseV_SWITCH
PhaseV_SD
PhaseV
R20
1
C17
470uF
R17
1
C11
10nF
C14
10nF
PhaseV_CURRENT+
R14
1
C8
10nF
R11
3m
R3
10
D3
1N5819WS
C3
0.47uF
U3
R6
51
R7
51
Q6
IRFZ44NPBF
Q5
IRFZ44NPBF
C6
4.7uF
PhaseW_SWITCH
PhaseW_SD
PhaseW
R21
1
C18
470uF
R18
1
C12
10nF
C15
10nF
PhaseW_CURRENT+
R15
1
C9
10nF
R12
3m
1->3mOhm to minimize noise / opamp parasitics
Half-bridge Circuit
PhaseU
PhaseV
PhaseW
PAD
P1
P2
P3
Phase Output
PhaseW
PhaseV
PhaseU
R22
33k
R25
33k
R28
33k
R23
33k
R26
33k
R29
33k
R24
33k
R27
33k
R30
33k
PhaseW_DIV
PhaseV_DIV
PhaseU_DIV
R31
33k
R32
33k
R33
33k
Phase_GVIRTUAL
EMF resistive bridge
+3.3V
min. 0.1 uF (datasheet)
C19
0.1uF
C20
0.1uF
C21
0.1uF
PhaseU_CURRENT+
PhaseU_CURRENT
U4
INA180A2IDBVR
PhaseV_CURRENT+
PhaseV_CURRENT
U5
INA180A2IDBVR
PhaseW_CURRENT+
PhaseW_CURRENT
U6
INA180A2IDBVR
Current measurement
Make sure to minimize distance between the - and + of measuring resistor for routing
IW
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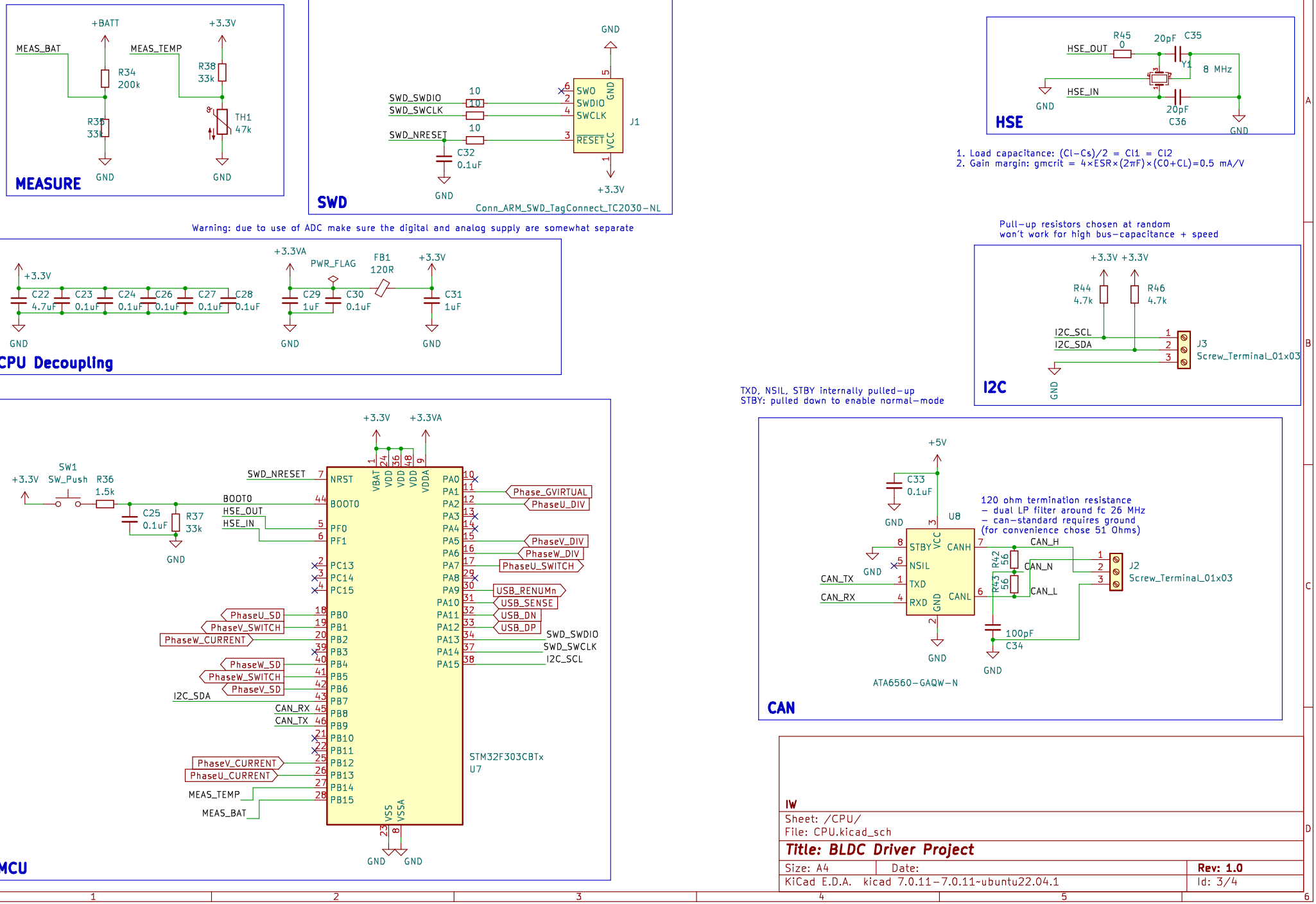
MEASURE
+BATT
MEAS_BAT
R34
200k
R35
33k
GND
+3.3V
MEAS_TEMP
R38
33k
TH1
47k
GND
SWD
GND
SWD_SWDIO
SWD_SWCLK
SWD_NRESET
10
10
10
C32
0.1uF
GND
SWO
SWDIO
SWCLK
RESET
GND
VCC
J1
5
6
2
4
3
1
+3.3V
Conn_ARM_SWD_TagConnect_TC2030-NL
HSE
HSE_OUT
R45
0
20pF
C35
Y1
8 MHz
HSE_IN
20pF
C36
GND
GND
1. Load capacitance: (Cl-Cs)/2 = Cl1 = Cl2
2. Gain margin: gmcrit = 4×ESR×(2πF)×(C0+CL)=0.5 mA/V
Warning: due to use of ADC make sure the digital and analog supply are somewhat separate
CPU Decoupling
+3.3V
C22
4.7uF
C23
0.1uF
C24
0.1uF
C26
0.1uF
C27
0.1uF
C28
0.1uF
GND
+3.3VA
PWR_FLAG
FB1
120R
+3.3V
C29
1uF
C30
0.1uF
C31
1uF
GND
GND
Pull-up resistors chosen at random
won't work for high bus-capacitance + speed
I2C
+3.3V
+3.3V
R44
4.7k
R46
4.7k
I2C_SCL
I2C_SDA
J3
Screw_Terminal_01x03
GND
TXD, NSIL, STBY internally pulled-up
STBY: pulled down to enable normal-mode
CAN
+5V
C33
0.1uF
GND
U8
120 ohm termination resistance
- dual LP filter around fc 26 MHz
- can-standard requires ground
(for convenience chose 51 Ohms)
STBY
NSIL
TXD
RXD
VCC
CANH
CANL
GND
CAN_TX
CAN_RX
CAN_H
CAN_N
CAN_L
R42
56
R43
56
J2
Screw_Terminal_01x03
100pF
C34
GND
GND
ATA6560-GAQW-N
MCU
+3.3V
+3.3VA
SW1
+3.3V
SW_Push
R36
1.5k
C25
0.1uF
R37
33k
GND
SWD_NRESET
BOOT0
HSE_OUT
HSE_IN
NRST
BOOT0
PF0
PF1
PC13
PC14
PC15
PB0
PB1
PB2
PB3
PB4
PB5
PB6
PB7
PB8
PB9
PB10
PB11
PB12
PB13
PB14
PB15
VBAT
VDD
VDD
VDD
VDDA
PA0
PA1
PA2
PA3
PA4
PA5
PA6
PA7
PA8
PA9
PA10
PA11
PA12
PA13
PA14
PA15
Phase_GVIRTUAL
PhaseU_DIV
PhaseV_DIV
PhaseW_DIV
PhaseU_SWITCH
USB_RENUMn
USB_SENSE
USB_DN
USB_DP
SWD_SWDIO
SWD_SWCLK
I2C_SCL
PhaseU_SD
PhaseV_SWITCH
PhaseW_CURRENT
PhaseW_SD
PhaseW_SWITCH
PhaseV_SD
I2C_SDA
CAN_RX
CAN_TX
PhaseV_CURRENT
PhaseU_CURRENT
MEAS_TEMP
MEAS_BAT
STM32F303CBTx
U7
VSS
VSSA
GND
GND
IW
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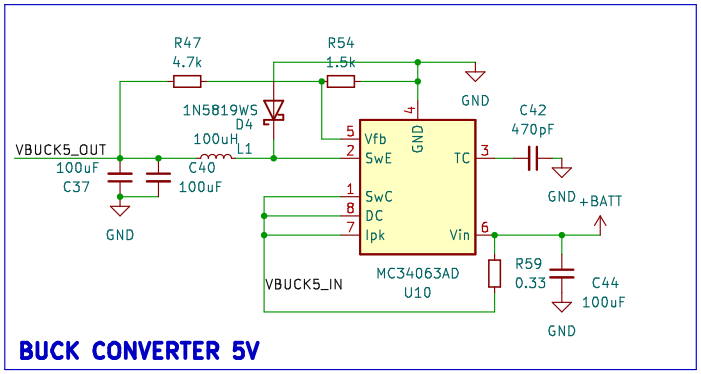
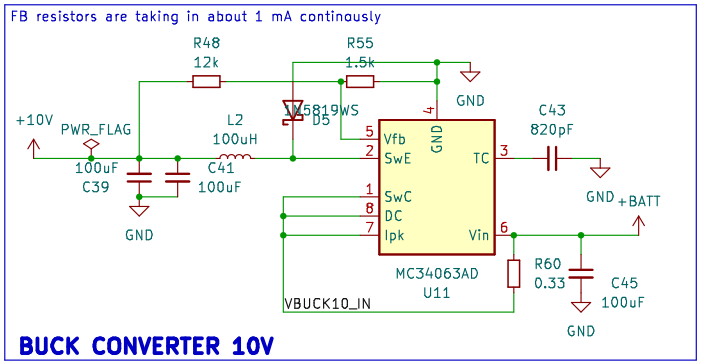
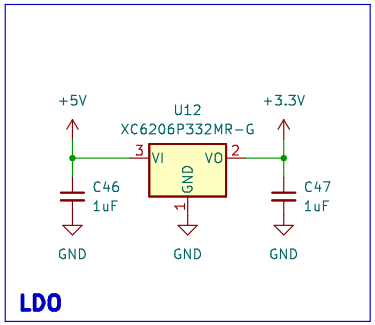


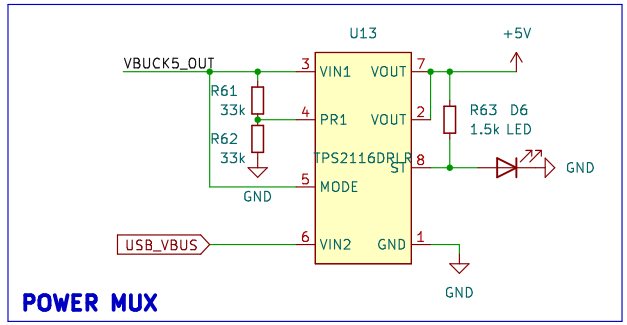
Ct: determines ton (ramp-up)
L: ramp-down time of the inductor current to 0 -> determines off-time.
Co: the higher, the lower the output Voltage ripple.

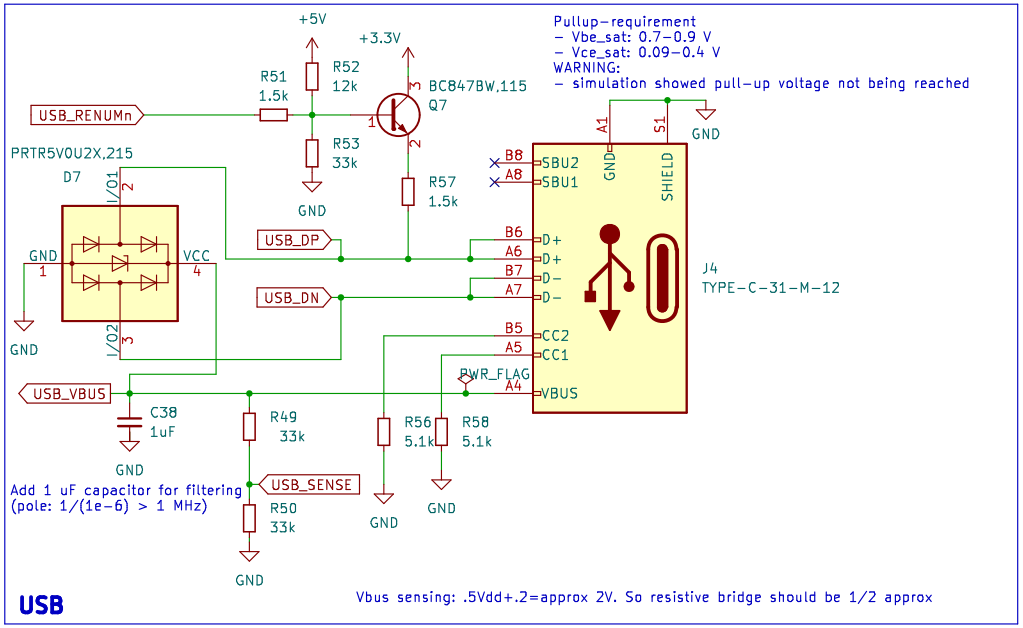
Input cap: CMIN
=(Iout.DC.(1-DC).1000)/(fsw.Vp(max))
=0.25*0.463*(1-0.463)*1000/(12*0.1)
= 51.798125 uF

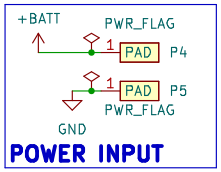


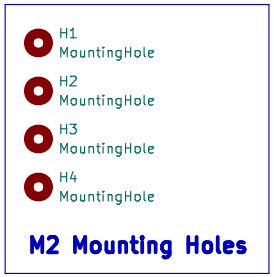


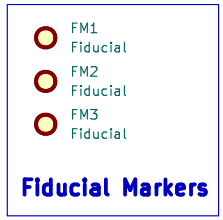
PR1 should be > Vref (1 V)
MODE: Pull-up - priority











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