R38 and R40 values for Vsense dividers – for different power stage Voltages.

Since the we're going with the NVMTSC4D3N15MC MOSFETs, Vsense will be for 150V:
150V max 30s lipo, overvoltage cutoff at 137V) – 13k (LCSC C22797)
100V max 20s lipo, overvoltage cutoff at 92.6V) – 47k (LCSC C25819)
80V max 16s lipo, overvoltage cutoff at 75.6V) – Do not fit at all!

Notes on power stage design:

Pulldowns optional, most gate drivers pull down the FETs when UVLO
MOS should have good Ciss/Crss ratio
Ciss/Crss>Vbat minimises the chance of parasitic turn-on.
Target gate time constant ~200ns:
RG = 1R8(fet) + 15R (ext) + 3R33/3 (gate driver)
Ciss = 11.4nF
RC = 11.4nF x 16.9R = 192.66ns

Footprint for CUI isolated module for up to 160V operation.
Only allows 500mA.
Hilink HLK-10D1012
CUI PQDE6W-Q110
Or anything that exceeds your battery voltage and gives 12V out

The "Pill" is chosen as a generic STM32 module that should
allow easy compatibility with multiple firmwares:
VESC with GD32F303CG pill (Netzpfuscher mod, note CG)
VESC with STM32F405 pill (Owhite) (github.com/davidmolony/F405_pill)
EBICS with F103 Bluepill (Stancecoke)
SmartESC V3 (Casainho)
SmartESC V2 (Netzpfuscher/Koxx3)
MESC with F401 Blackpill (MxlemmingFOC)
STM32 Motor Control Workbench (F401, F103)
Maybe others?
Pills are simply boards with an MCU, a regulator, USB and Boot0 button.

MISO and MOSI are useful to have
a link in case of one wire SSI
DNP if full duplex required

Snubbers may or may not be needed depending
on FET choice.
Typically,
C = 1–5nF
R = 0.5–5 ohms
The capacitor determines the power dissipated
The resistor dissipates the power.
Snubber should be tuned so that it has optimised
damping factor for the ringing frequency targeted
Rough approximation, RC = 1/2 ringing period
e.g. 30MHz ringing -> 3ns period -> 1.5ns RC
2nF 1ohm is a good starting point
Highest damping factor usually where Csnub -=Coss MOS

C4675I0
Confirm zener sized correctly? Current spec is 3W.
Is the 5W C2917871 a reasonable alternate?
Note: placement will be on underside of PCB.

Likely use case:
PWM Throttle
Encoder on SPI, SSI
or Incremental Peripherals
GPIO

Likely use case:
PWM Throttle
Incremental Encoder
Screen Comms
Peripherals
GPIO

Input impedance 100R on every pin makes
it much more resilient to ESD, cross wiring,
GPIO–GND/3V3 etc

Not connected for blue/black pill
compatibility reasons

Brake

Phase sensing

Phase sensing

Basic Sensing
Iphase and VBus

Please confirm C531304 is correct specs

First TVS is on front – for SMT assembly.
Needs to be changed or not fitted for bigger that 20s batteries.
Optionally a 20...47uF cap can be used which together with R1 and R2
creates a sort of LPF protecting the DCDC from high frequency noise/spikes.
Second TVS on the back – for hand soldering, in case a different / bigger one is wished.

Caps for pill

MP2–DFN PUNCHLIST:
- Clean / uninterupted VBus and GND layers
- Restructured vbat and gnd buses for copper bus bars
- Restructured phase buses
- Differential lines for shunt resistors
- Heatsink mounting holes
- Different lines for (DRVH with HB) (DRV + GND)
- MOSFETS changed to DFNW format (NVMTSC4D3N15MC)
- Added gate to source 4.7nF capacitors (CGS1–18)
- Protective 470 ohm resistors (RN7) between the drivers and PWM pill pins
- Phase sense caps (C29, C30, C33) set to 10nF for 10kHz range filtering
- Added zener diode (D10) protection between gate drivers and 12/5 DCDC
- Rearranged mosfet driver area to fit 12/5 DCDC
- Larger distance between edge and all copper fills
- Added on board thermister
- Restructured ceramic caps, added radial caps
- Manual review of all parts / values / footprints in comparison to BOM
- Removed many test points to conserve space; pins can
  be soldered to FETs for testing.

Hall sensor filter at ~10kHz should reject all PWM noise

Opamp is a standard SOIC14 pinout. There are many that will fit.
However, certain characteristics are needed:
GBP (GBW) Gain BandWidth Product >4MHz
Rail to rail output
No phase inversion with exceeded limits
Input includes lower rail
Options are plentiful, preferred:
NCS20034 (NCS20074 might work)
TLV824
Current sensing ultimately defines the performance of your FOC
algortithm, don't skimp on this part.
Using the wrong opamp can cause nasty failures like phase
inverted currents, saturated outputs...

Use low forward voltage diodes
1N5817 or 1N5819 is a good choice
Forward voltage at 1mA >0.3V will render this useless

Fourth opamp used as overcurrent and voltage
comparator to protect against shoot through,
overcurrent + overvoltage in MCU crash
If any of the opamps outputs exceeds 3v3x8/2/(8.2+9.2) + diode forward voltage,
the opamp will pull low, which pulls PB12 low, triggering the STM32 hardware BRK
Time constant approximately 0.47us
There's another 0.47us LPF on the F405 pill! That is not the case for Bluepill or Blackpill

CAUTION WITH ORDERING -- FIX BOM FOR 150V VSENSE

This was 47pF. Use 10nF for a response in
the 10kHz kind of range.

Sheet: /	
File: MP2_DFN.kicad_sch	
Title: MP2_ESC_Main	
Size: A2	Date:
KiCad E.D.A. kicad 7.0.2–0	Rev:
	Id: 1/1