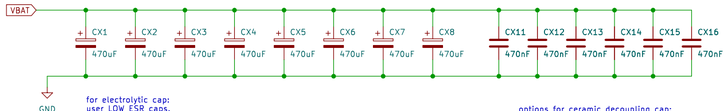
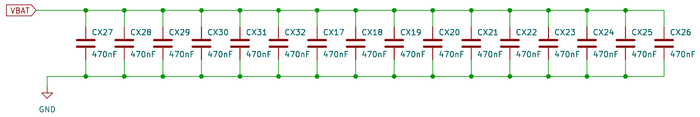
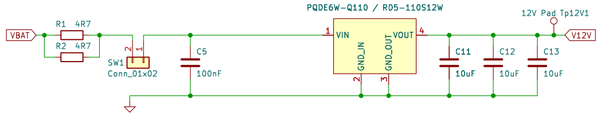


for electrolytic cap:
user LOW ESR caps.
most 160V electrolytic caps have absolutely atrocious ESR (greather than 1R!)
ideal range — 220–470 uF.

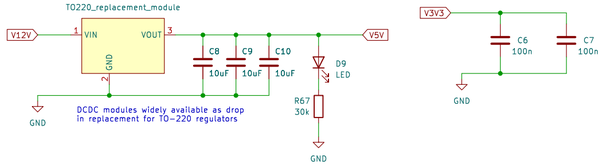
options for ceramic decoupling cap:
200V: NM1206B474K201CEGN / C725802 — 1206
250V: FM32X684K251EGG / C692307 — 1210



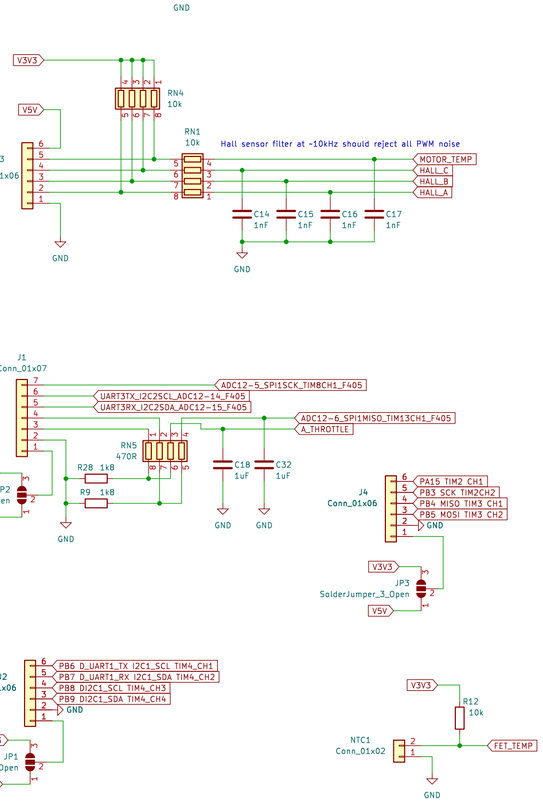
Footprint for CUI isolated module for up to 160V operation.
Only allows 500mA.
HiLink HLK-10D11012
CUI PQDE6W-Q110
Or anything that exceeds your battery voltage and gives 12V out



20...47uF cap is used which together with R1 and R2
creates a sort of LPF protecting the DCDC from high frequency noise/spikes.

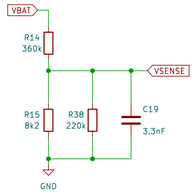


DCDC modules widely available as drop
in replacement for TO-220 regulators



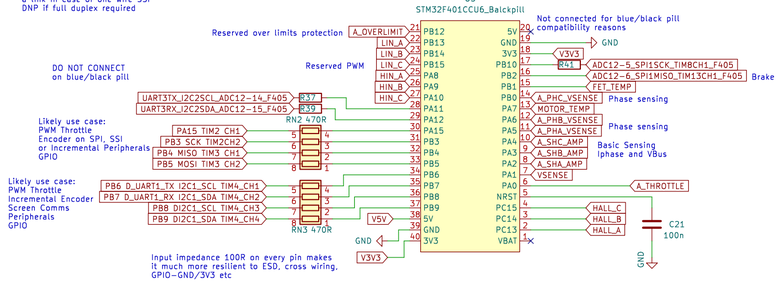
R4, R15 and R38 were chosen to have exactly the same ratio as the phase voltage sense dividers,
but significatnly less current, since they are not also when ESC is off.

So you can use the 3.3k and 150k values exclusivly in the software, error is 0.18%, less than resistor tolerances



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

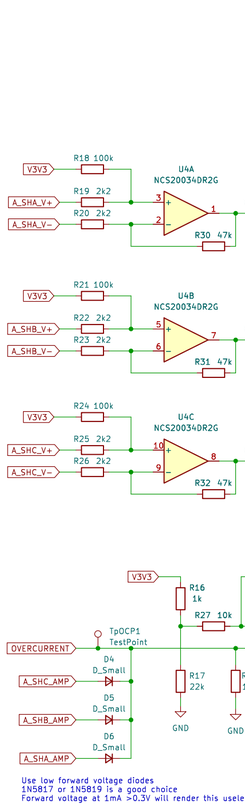
The "Pill" is chosen as a generic STM32 module that should
allow easy compatibility with multiple firmwares:
VESC with GD32F303CG pill (Netzpfuscher mod, note CG)
VESC with STM32F405 pill (Owhite) (github.com/davidmolony/F405_pill)
EBICS with F103 Bluepill (Stancecoke)
SmartESC V3 (Casainho)
SmartESC 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.



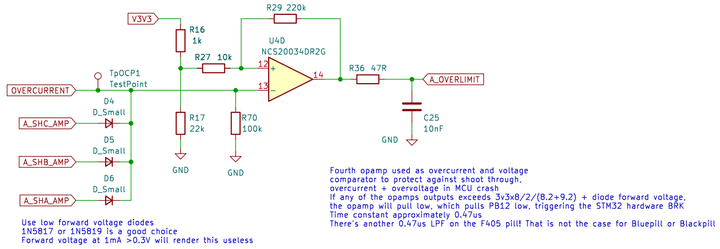
Likely use case:
PWM Throttle
Encoder on SPI, SSI
or Incremental Peripherals
GPIO

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



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
algorithm, don't skimp on this part.
Using the wrong opamp can cause nasty failures like phase
inverted currents, saturated outputs...

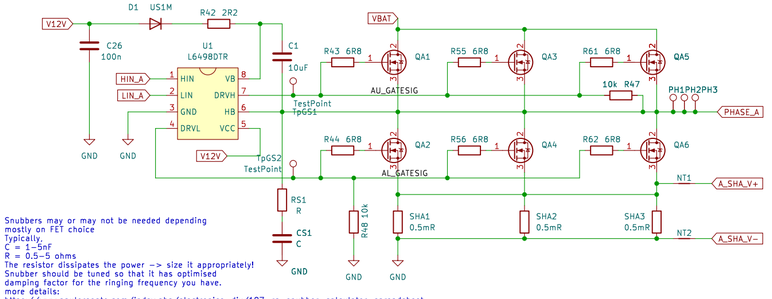


Use low forward voltage diodes
1N5817 or 1N5819 is a good choice
Forward voltage at 1mA >0.3V will render this useless

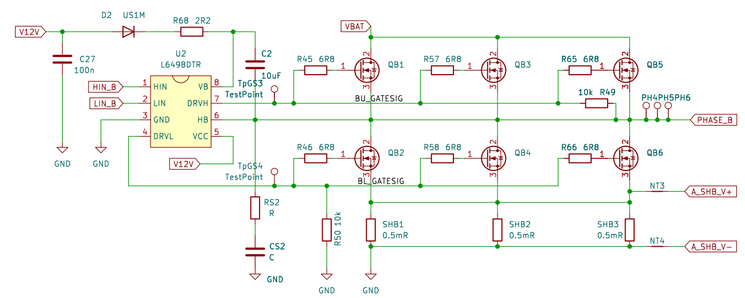
Fourth opamp used as overcurrent and voltage
comparator to protect against shoot through.
overcurrent + overvoltage in MCU crash
If any of the opamps outputs exceeds 3v3x8/2/(8.2+9.2) + diode forward voltage,
the opamp will pull low, which pulls PB12 low, triggering the STM32 hardware BRK
Time constant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

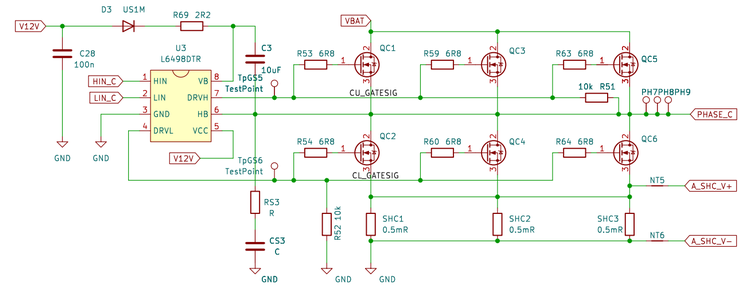
Notes on power stage design:

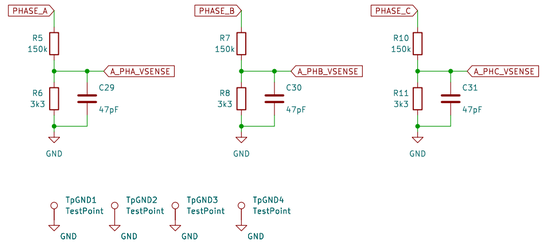
Pulldowns optional, most gate drivers pull down the FETs when UVLO
MOS should have good Cgs/Crss ratio
Ciss/Crss>Vbat minimises the chance of parasitic turn-on.
Target gate time constant ~300ns:
RG = 1R8(fet) + 6R8 (ext) + 1R (gate driver *3)
Ciss = 11.4nF
RC = 11.4nF x 26.6R = 303.24ns



Snubbers may or may not be needed depending
mostly on FET choice
Typically,
C = 1–5nF
R = 0.5–5 ohms
The resistor dissipates the power -> size it appropriately!
Snubber should be tuned so that it has optimised
damping factor for the ringing frequency you have.
more details:
https://www.paulorenato.com/index.php/electronics-diy/197-rc-snubber-calculator-spreadsheet







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