Project Overview

Electric Bike Planning

Plan:

- Build Electric bike add on with hub motor, speed controller (ESC), and other gadgets
- TODO: Design, build PCB and test with smaller BLDC. If works well —> start buying stuff to make actual e-bike

Functions:

- Throttle to control speed
- Screen to display battery percentage, speed, battery temp
- Regenerative braking

Materials

- Hub Motor (48V, 1000W)
- Smaller test motor (No HAL sensors)
- High voltage battery (48V, 10A, 30A BMS shutoff)
- Display: Nextion 2.4" Display
- BAFANG Throttle
- Thermistor for battery temp
- Suitable wires connecting battery, motor, PCB
- Regular road bike
- ESC PCB (4-layer design w/ ESC and MCU on either side)

Pages

- MCU
- Peripherals
    - Battery temp
    - Speed (HAL sensor)
    - Display
    - USB-C
    - Throttle
    - Buzzer
- Battery management
    - Bucks, LDO, etc..
    - Battery percentage reader (voltage divider and other stuff)
- Motor Control (Separate side of PCB)
    - ESC (MOSFETS)
    - Screw terminal for motor input
    - Terminal for throttle input
    - Battery input (XT60 connection, use screw terminal for now
    - Regenerative braking circuitry

Root

Everything

- Power: Filtration stuff
- Throttle uses cap for low-pass filtration and zener diode to stabilize signal
- External crystal for increased accuracy / precision
- BR_SOx signals are from DRV8302 Op-Amp: Use low-pass filter to reduce noise from Op-amp output

Battery

- 48v, 10A continuous current, 30A BMS shut off

Power Control

Component explanations:

- Selected DRV8302 and TC2117 b/c Vedder uses them and they're pretty cheap.
- XT60 battery input b/c thats what my battery connects with

DRV8302 Pin wirings explanation

- RT_CLK - Similar to datasheet, 220k more common resistor value
- COMP - Similar to datasheet, 15k more common resistor value
- VSENSE - voltage divider to get 5v → 0.8v to internally adjust buck
- PWRGD - Useless pin to read from, other ways to get battery voltage
- OCTW - GPIO output into MCU, reads warnings
- FAULT - GPIO output into MCU, reads faults
- DTC - Resistor value adjusts DRV dead-time, 10k pretty calm value provides good cushion and still fast
- M_PWM - Low to specify 6 separate PWM inputs (one for each FET)
- M_OC - High so that when over-current detected things shut down (safety)
- DC_CAL - GPIO accepting input, pull high during initialization to get zero state
- GVDD - Caps act as current reservoir and stabilization for internal LDO. Added another 2.2 for redundancy
- CP1 / CP2 - wired like datasheet
- EN_GATE - GPIO input from MCU, enabling IC
- INH_A → INL_C - PWM signals for each FET from MCU
- DVDD - Like datasheet, but added extra cap for redundancy (2.2, b/c common value)
- AVDD / AGND - Like datasheet (2.2 more common)
- SS_TR - Soft start the Buck. Gradually gets it up to 5v, identical to datasheet and shouldn't make a difference in timing
- EN_BUCK - switch between float / gnd allowing to switch buck on off
- PVDD2 - Small + big caps to decouple / filter noise on VBAT line
- BST_BK / PH / BIAS - identical to datasheet
- Rest of Pins identical to datasheet
    - SN1, SP1, SN2, SP2 added low pass filter (go to motor control)

TC2117 Wiring

- LDO (5v - 3.3v)
- Input switches between USB VBUS and 5v rail from DRV8302 Buck
- 10u input cap, datasheet recommendation
- 100nF shunts high frequency + 100uF provides necessary output resistance for LDO
- LED + Resistor, visual indicator of current flow

Bulk Caps + IC Protection + 5v

- 3 bulk caps to split current + reduce individual heat allowing for greater protection and durability
- 10u caps b/c vedder does it and covers higher frequency noise
- 5v caps, similar idea just lower values because of lower range of frequencies / dips

Motor Control

FETs

- 2.2u DC-link decoupling provides instantaneous current, suppress voltage spikes (ringing/overshoot) from parasitic inductance, and stabilize the DC bus voltage during fast switching
- 10r gate resistor, slows switching speed slightly, reducing peak current into mosfet which also reduces EMI

Voltage Sensing

- Voltage divider to step down battery voltage so MCU can read individual phase voltage
- Big resistor on high side to limit current into MCU
- Bidirectional TVS diode to shunt high + voltages and low - voltages, protecting MCU
- Battery voltage sensing has 100n cap to create low-pass filter (reducing noise going into MCU)

Current Sense

- Shunt resistor across two phases, third current calculated using KCL
- Cap between differential pairs to reduce noise and create low-pass filter, minimizing noise from motor

HAL sensors

- Standard circuitry. Pull-ups b/c HALL sensors can only pull down signal lines
- Low-pass filter to again filter out high frequency noise / switching

Peripherals

Everything

- Standard datasheet connections for basically everything
- Throttle connection uses TVS diode for electric static protection. Voltage divider to scale down throttle input
- Battery thermistor connection uses pull down to create voltage divider