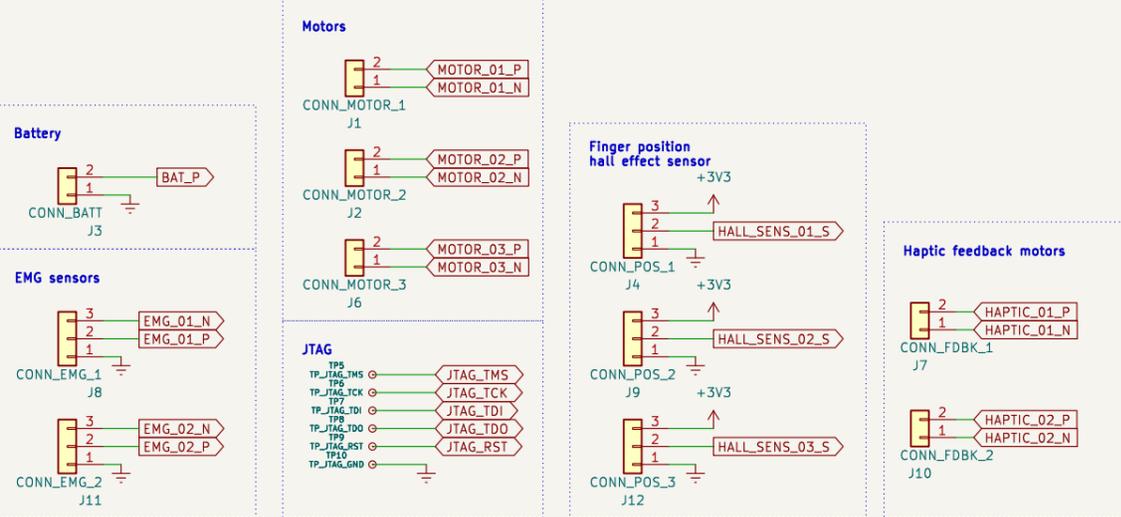
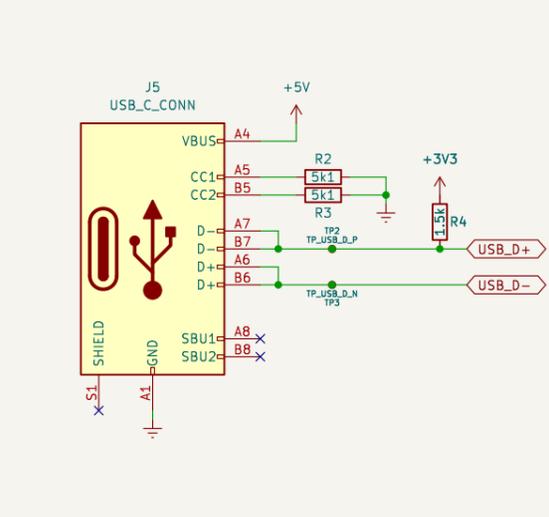


CONNECTORS

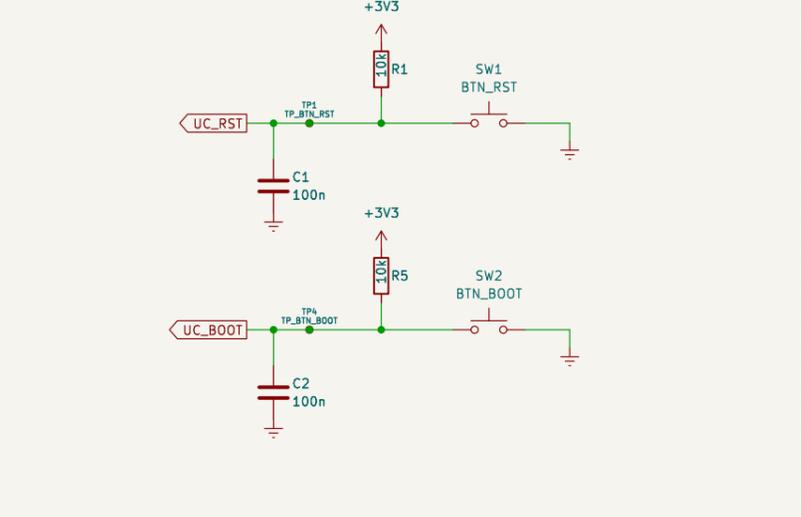


USB



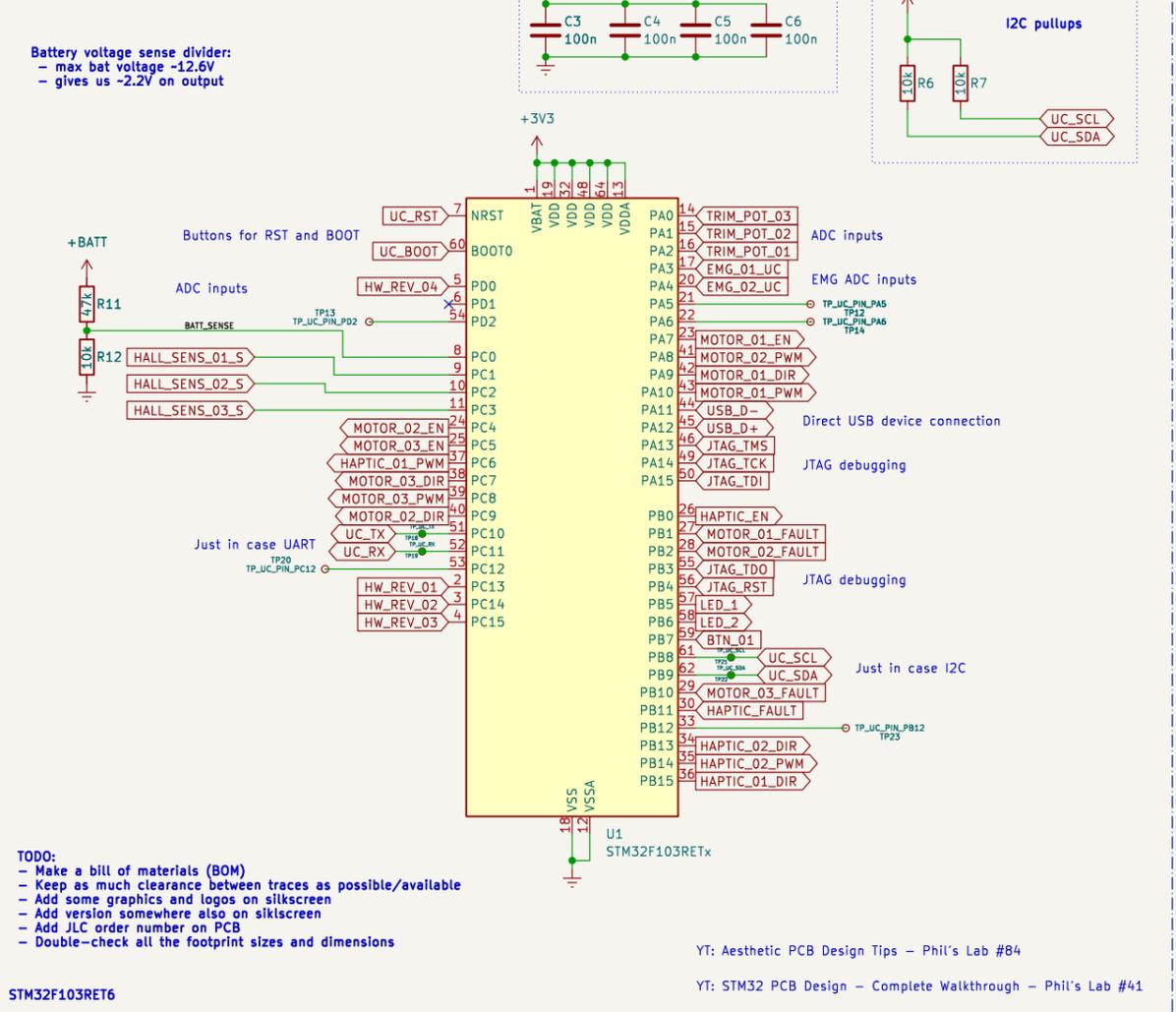
USB Type C connector

UC BUTTONS



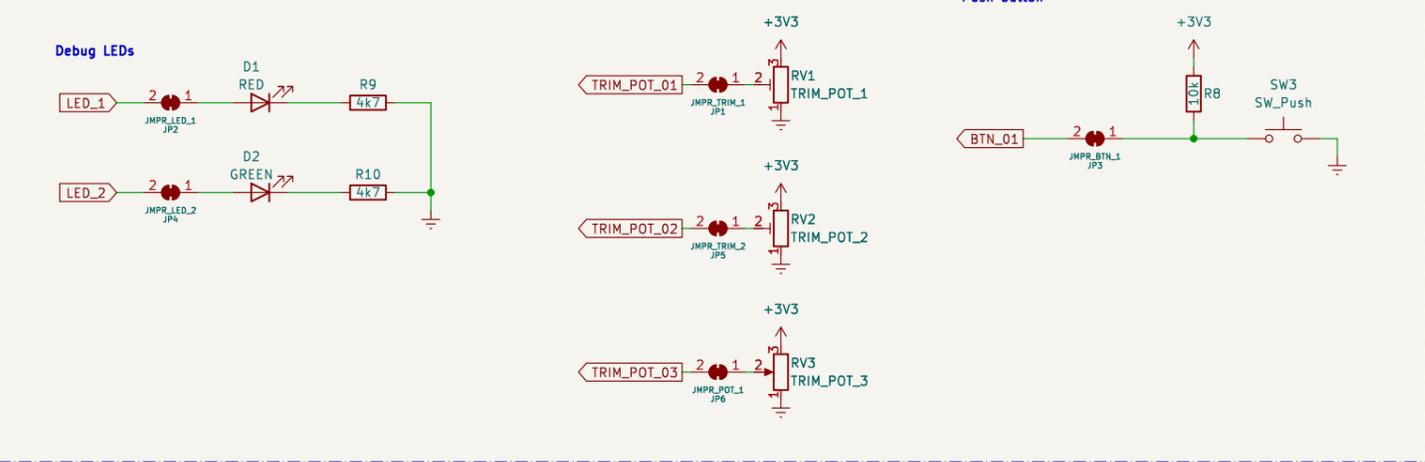
For resetting/programming the board

MICROCONTROLLER

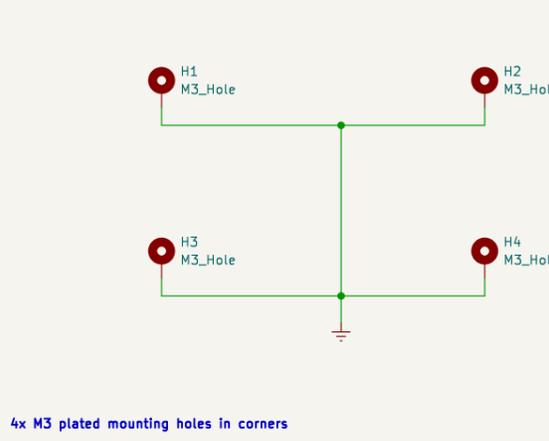


YT: Aesthetic PCB Design Tips - Phil's Lab #84
 YT: STM32 PCB Design - Complete Walkthrough - Phil's Lab #41

USER INTERFACE

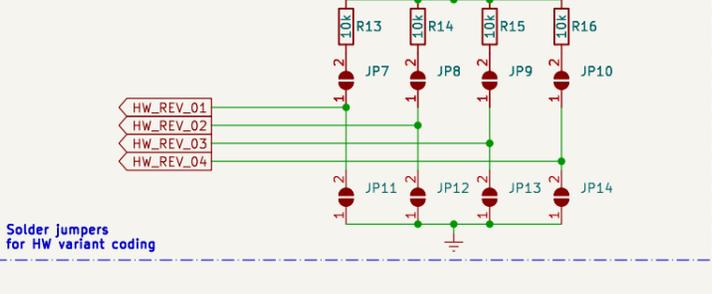


MOUNTING



4x M3 plated mounting holes in corners

HW REV



Solder jumpers for HW variant coding

PCB design parameters:
 - min trace width 0.2mm and spacing 0.2mm
 - via hole size/diameter: 0.3mm / 0.5mm

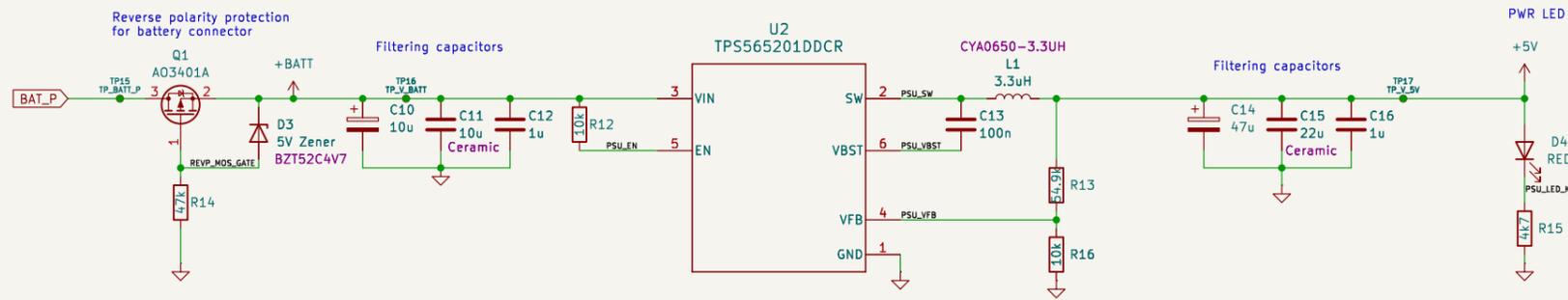
Aleksa Heler

Sheet: /
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Title: OpenHand prosthetic hand controller project

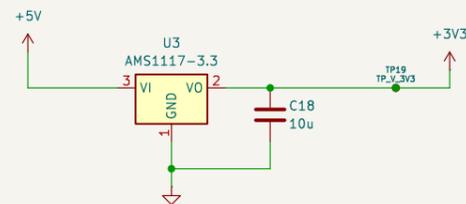
Size: A3	Date: 2024-01-31	Rev: v1.0
KiCad E.D.A. 9.0.0		Id: 1/4

Buck regulator – 5V, MOTORS



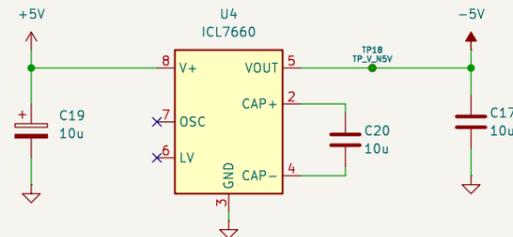
Note: Use same layout as in the IC datasheet
TPS565201DDCR switch mode buck converter

Linear regulator – MCU, ADC



Linear regulator for MCU and sensors

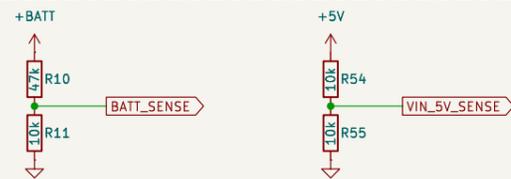
Negative voltage regulator – EMG



Note: If V+ voltage is > 3.5V, LV is left floating
Negative rail regulator for EMG sensors (ICL7660M)

Supply uC feedback

Battery voltage sense divider:
- max bat voltage -16.8V
- gives us ~2.93V on output



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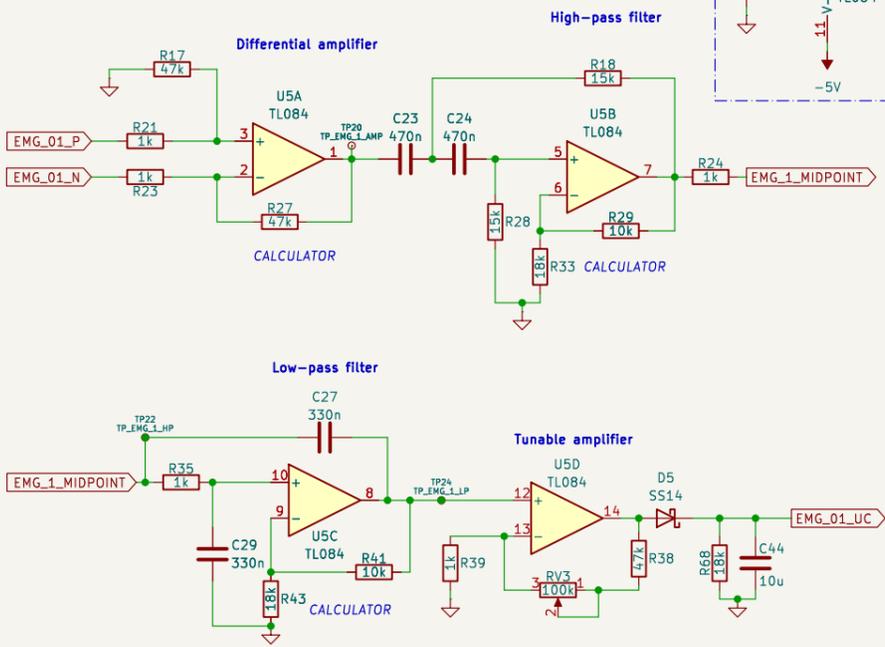
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KiCad E.D.A. 9.0.0

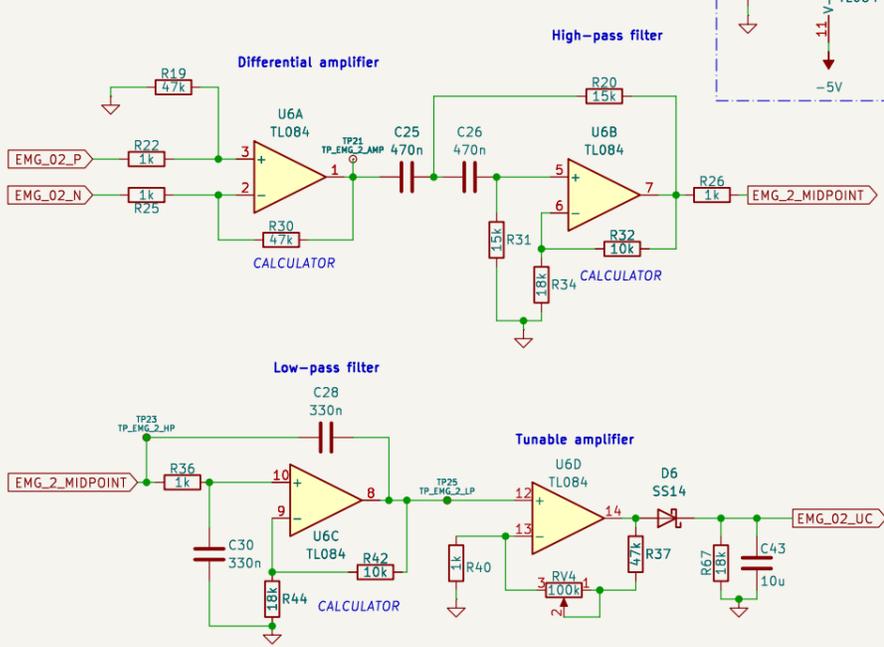
Rev: v3.0
Id: 2/4

EMG SENSOR



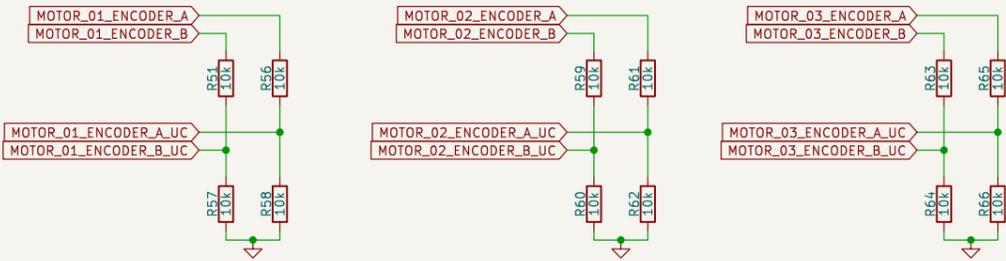
(OpenEMG project by charleslabs.fr)

EMG SENSOR



(OpenEMG project by charleslabs.fr)

MOTOR ENCODERS VOLTAGE DIVIDERS



PCB TEMP SENSORS



Aleksa Heler

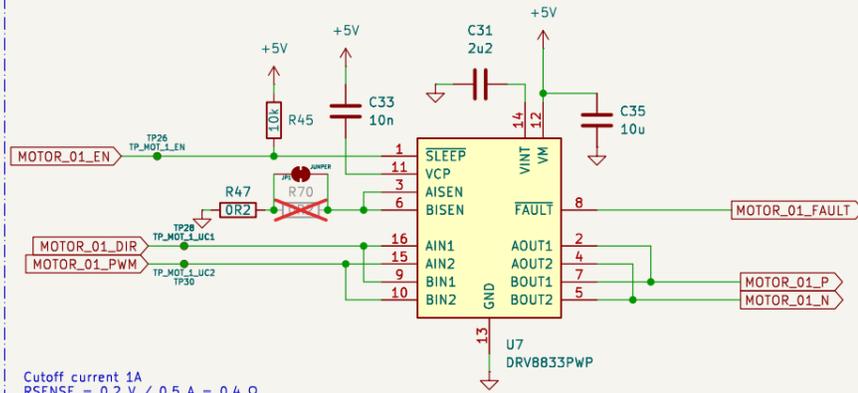
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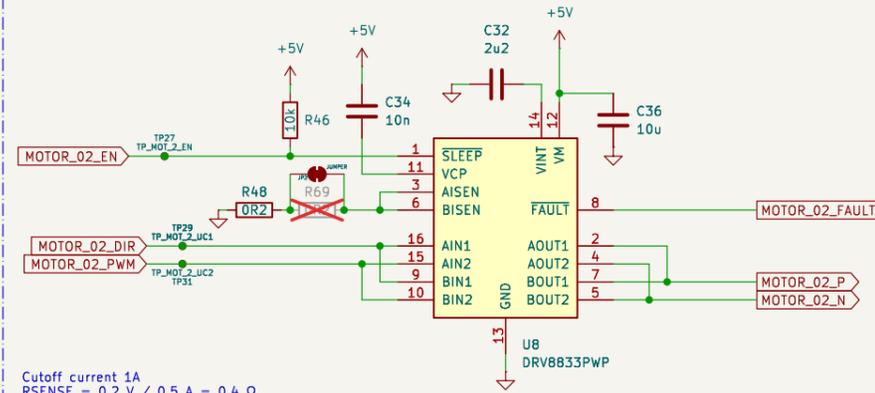
Rev: v3.0
Id: 3/4

MOTOR CONTROLLER #1



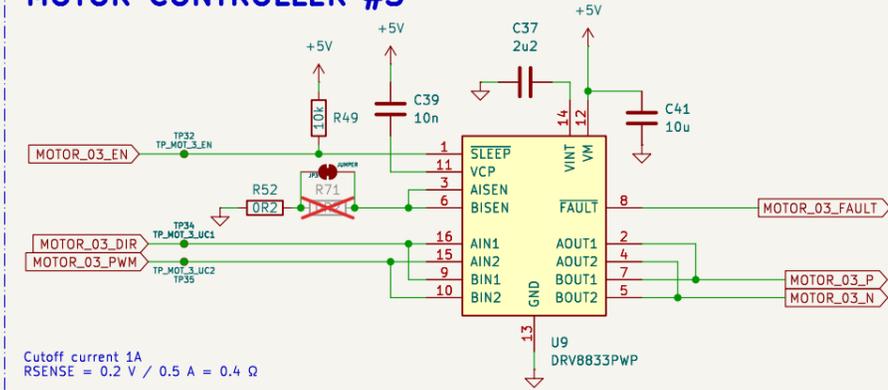
Cutoff current 1A
 $R_{SENSE} = 0.2 \text{ V} / 0.5 \text{ A} = 0.4 \Omega$
DRV8833PWP PWM motor driver

MOTOR CONTROLLER #2



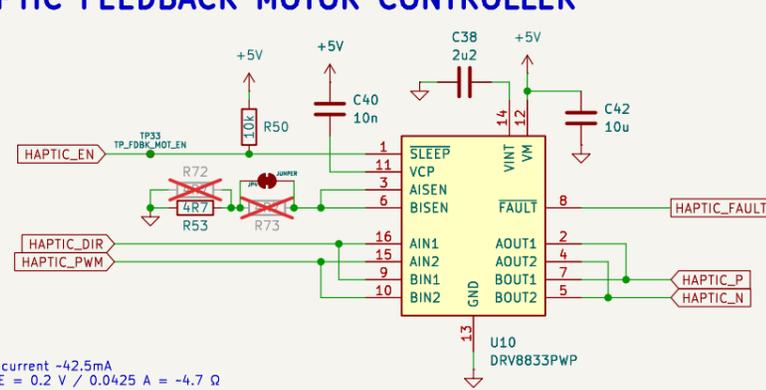
Cutoff current 1A
 $R_{SENSE} = 0.2 \text{ V} / 0.5 \text{ A} = 0.4 \Omega$
DRV8833PWP PWM motor driver

MOTOR CONTROLLER #3



Cutoff current 1A
 $R_{SENSE} = 0.2 \text{ V} / 0.5 \text{ A} = 0.4 \Omega$
DRV8833PWP PWM motor driver

HAPTIC FEEDBACK MOTOR CONTROLLER



Cutoff current -42.5mA
 $R_{SENSE} = 0.2 \text{ V} / 0.0425 \text{ A} = -4.7 \Omega$
DRV8833PWP PWM motor driver

Using PWM and GPIO signals on pins xIN1 and xIN2, we can control the speed (current) and direction of connected DC motors. Looking at the datasheet, we can use xIN2 as PWM for speed, and xIN1 as direction input (HIGH for forward, LOW for reverse). PWM frequency should be 50kHz.

When the voltage on pin xISEN exceeds VTRIP (0.2 V), current regulation is activated. The RISENSE resistor should be sized to set the current cutoff level:
 $R_{ISENSE} = 0.2 \text{ V} / I_{CHOP} \rightarrow$ To set ICHOP to 1 A, $R_{ISENSE} = 0.2 \text{ V} / 1 \text{ A} = 0.2 \Omega$ (finger linear actuator motors)
 To set ICHOP to -42.5mA, $R_{ISENSE} = 0.2 \text{ V} / 0.0425 \text{ A} = -4.7 \Omega$ (haptic feedback motors)

Using nSLEEP pin (EN) we can turn the specific IC off (by setting the pin to LOW) for lower power consumption, or just to turn the motors off. If pin is HIGH, the device operates normally. When returning from sleep mode, some time (up to 1 ms) needs to pass before the motor driver becomes fully operational. Device also features internal over-temperature protection (at -160 °C), it will auto shut off, nFAULT pin will be driven LOW, and once the temperature falls operation resumes and nFAULT pin will be HIGH. Same behaviour in case of over-current detection over RISENSE resistors.

On ICs for main finger motor control, we double up the channels (connect them in parallel) for double the current (and power) for that given motor. We do this to give us room for thermal design and possibly more powerful motors in future.

Aleksa Heler

Sheet: /Motor Control/
 File: MotorControl.kicad_sch

Title: OpenHand prosthetic hand controller project

Size: A3 Date: 2025-01-31
 KiCad E.D.A. 9.0.0

Rev: v3.0
 Id: 4/4