A FOC Controlled Smart Knob

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ELEC3300 Group 5

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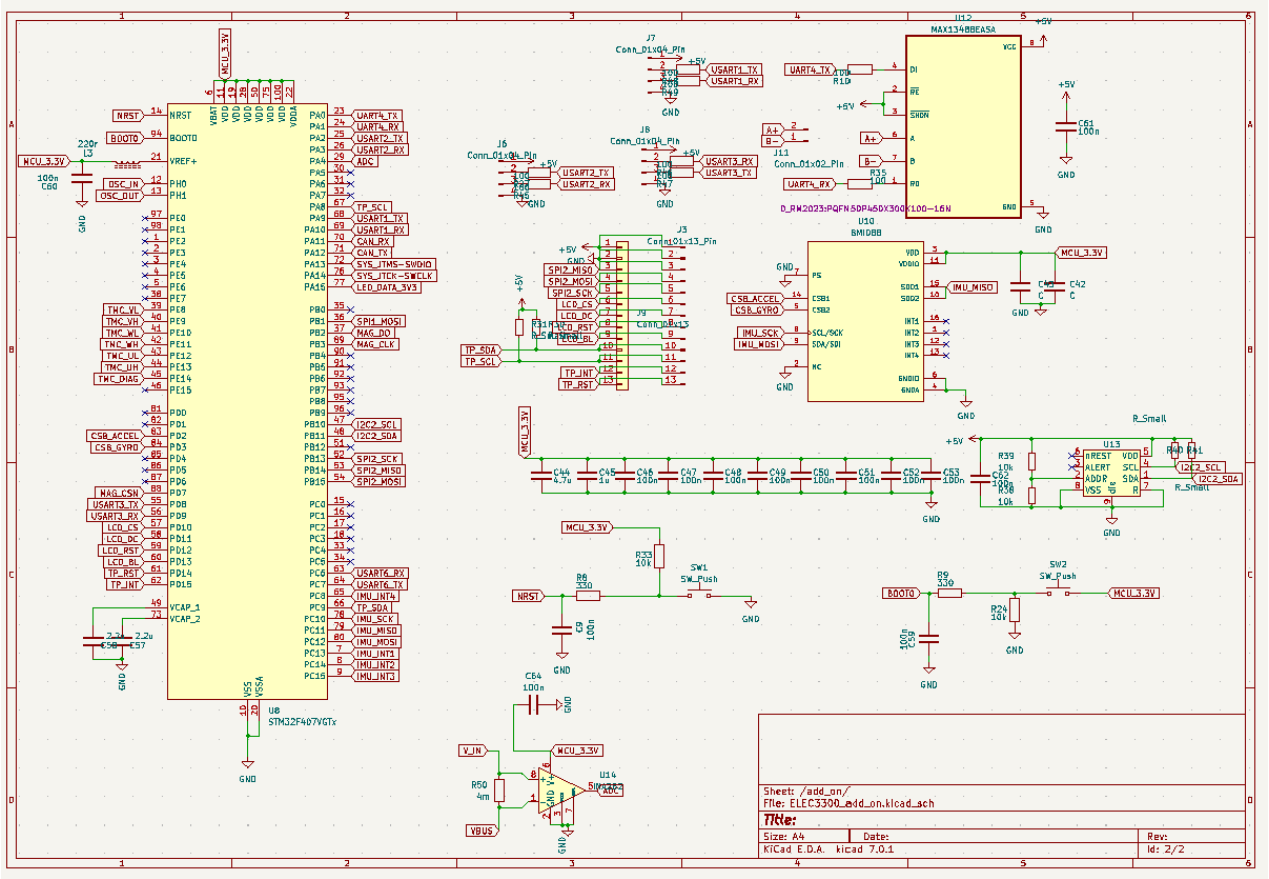


Figure: schematic 1

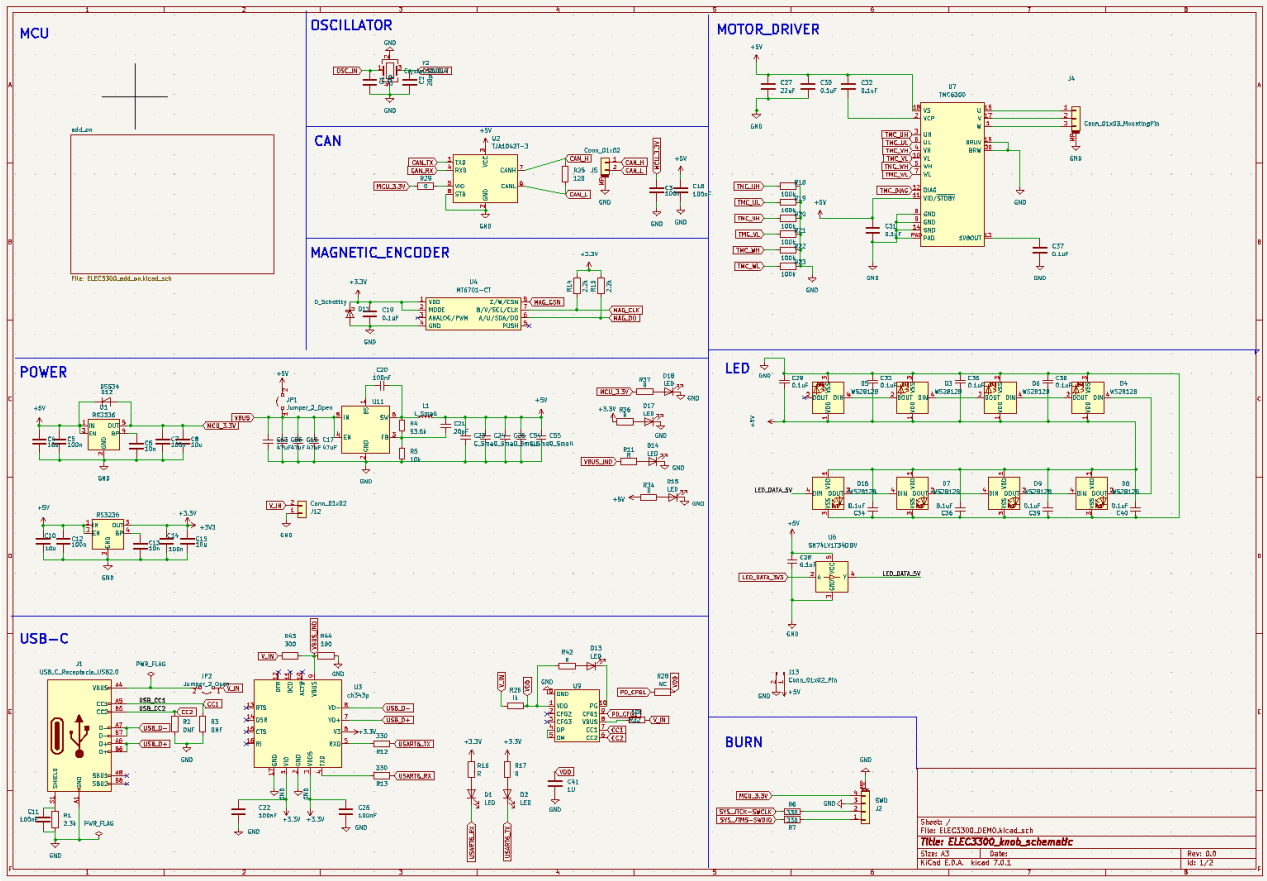
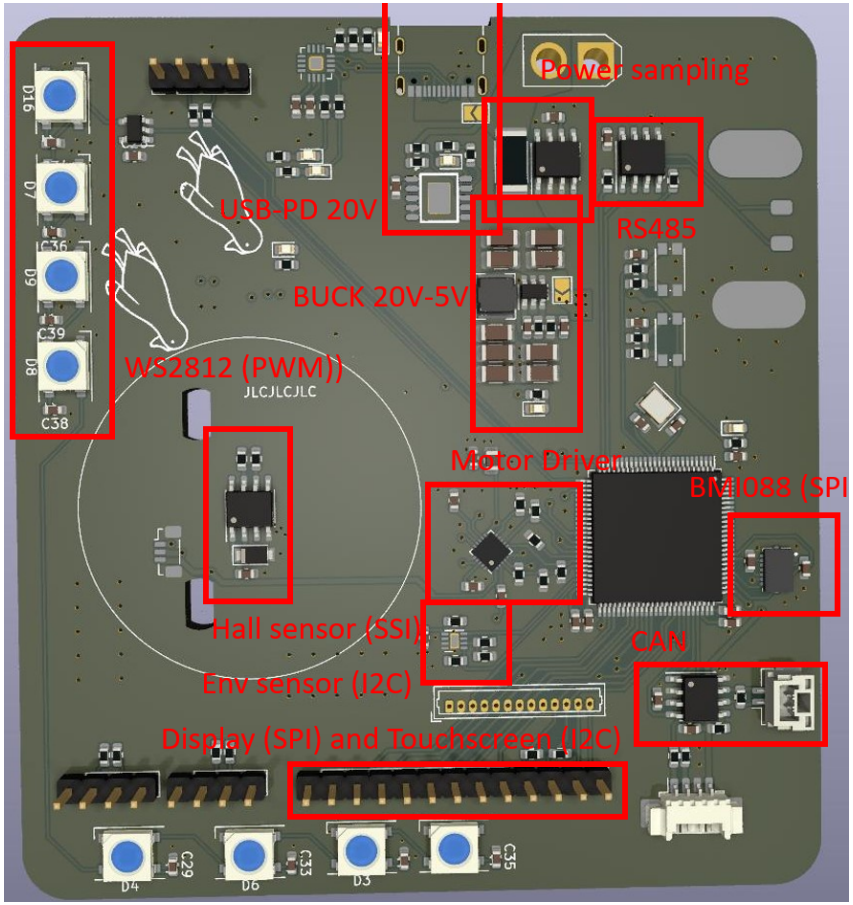


Figure: schematic 2

PCB layout



- FOC Algorithm Close loop Controlled Motor as knob (Algorithm)
- Magnetic Hall effect sensor feedback (SPI)
- Brushless DC motor driver (Half Bridges Driver)
- Implement our own ESC (SVPWM)
- Bluetooth and usb-ttl controlled (UART)
- Usb-C PD power delivery with buck converter (GPIO)
- Power adc sampling (ADC)
- WS2812 LEDs (PWM)
- IMU wake detection (SPI)
- LCD touch screen (SPI + I2C)
- Smooth and Fast Refresh UI (Double-Buffer DMA)
- Humidity and Temperature Sensor (I2C)

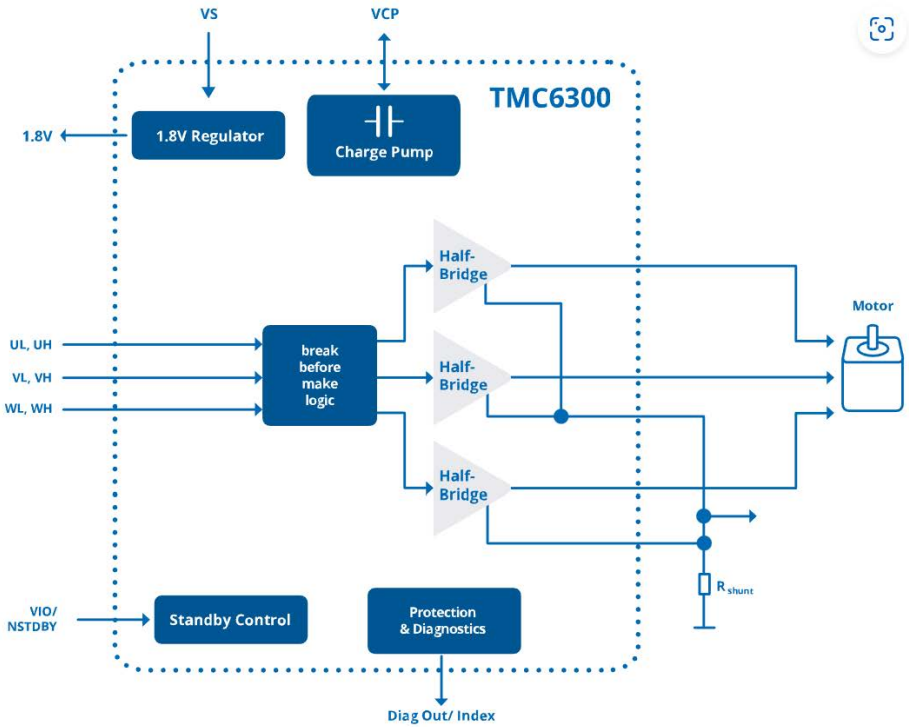
Figure: PCB Layout

UI Design

- DMA double buffer to increase frame rate
- Async parallel display flush
  - Rendering complete will trigger a callback
  - DMA will be used to flush to the display afterward
- LVGL UI elements design

FOC

Where is ESC for the knob?
We implement our own ESC using Field Oriented Control!



Sine PWM (Good)

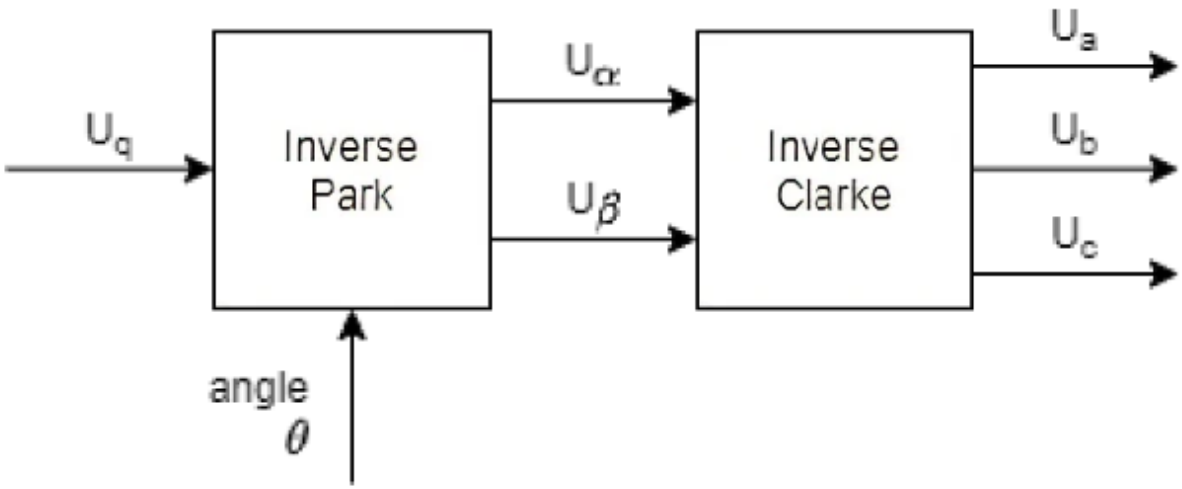


Figure: sine pwm

Sine PWM (Good)

1. Inverse Park transformation

- $U_\alpha = -U_q sin(\theta)$
- $U_\beta = U_q cos(\theta)$

2. Inverse Clarke transformation

- $u_a = U_\alpha$
- $u_b = \frac{-U_\alpha + \sqrt{3}U_\beta}{2}$
- $u_a = \frac{-U_\alpha - \sqrt{3}U_\beta}{2}$

to SV PWM (Better)

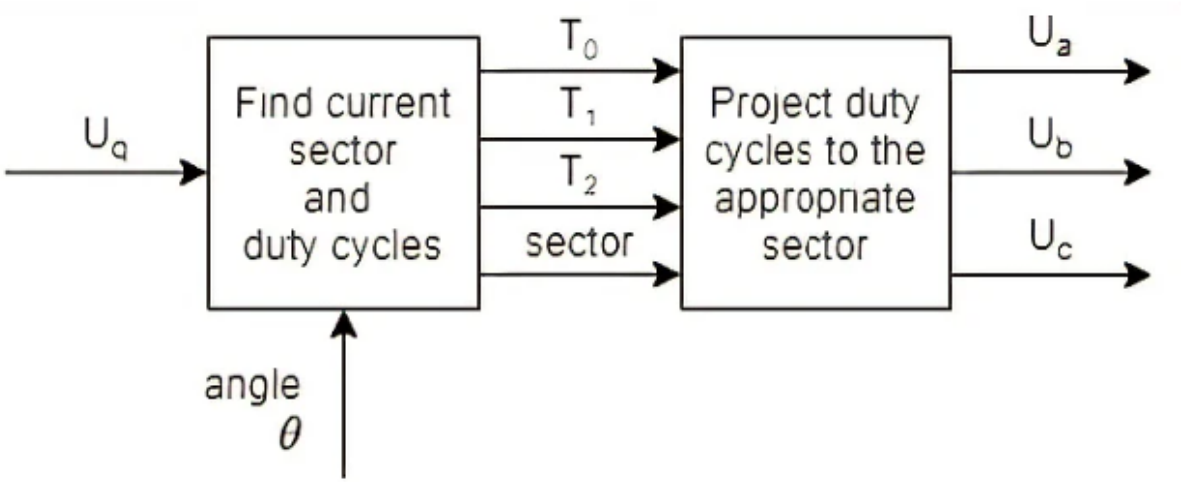


Figure: SV pwm

to SV PWM (Better)

- space vector modulation

- $s = \lfloor \frac{3}{\pi} \rfloor + \theta$
- $T_1 = \sqrt{3} sin(s\frac{3}{\pi} - \theta)$
- $T_2 = \sqrt{3} sin(\theta - (s-1)\frac{3}{\pi})$
- $T_0 = 1 - T_1 - T_2$

FreeRTOS

- FreeRTOS to schedule the tasks

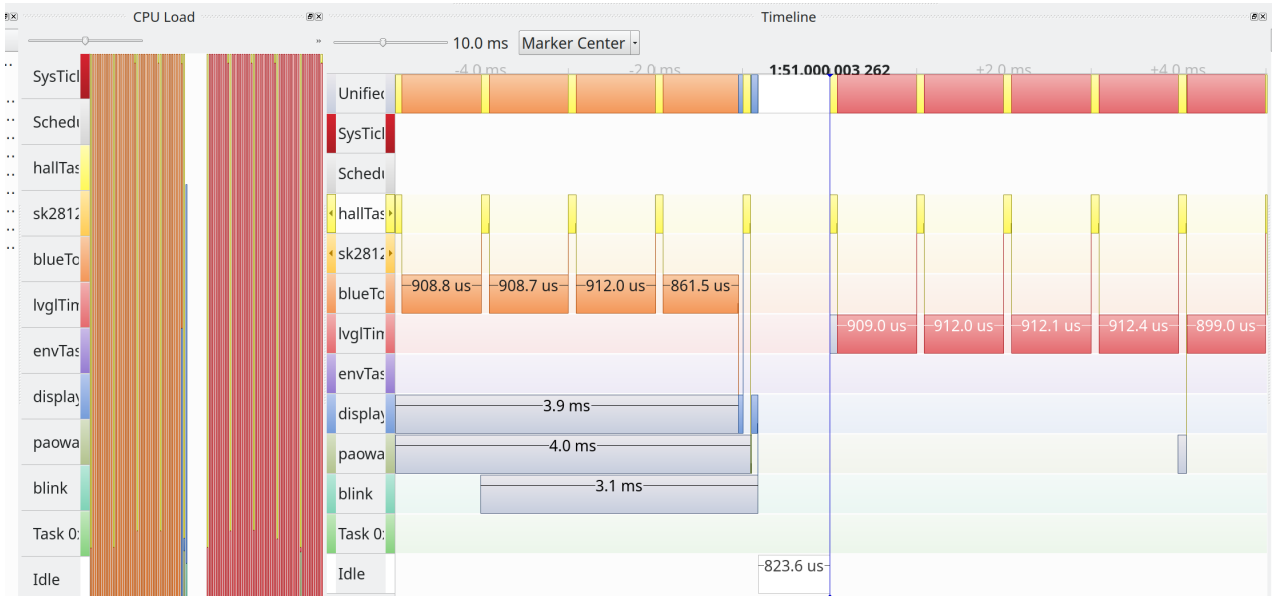


Figure: FreeRTOS Scheduler

That would be all

- Thank you!