Fall 2020

ECE477 MIDTERM DESIGN REVIEW: TEAM #4

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OUTLINE

- Project Overview
- Major Components
- Block Diagram
- Packaging Design
- Electrical Schematic
- PCB Layout
- Prototyping Progress
- Software Development Status
- Project Timeline
- Questions

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PROJECT OVERVIEW

Always have a plan Bee

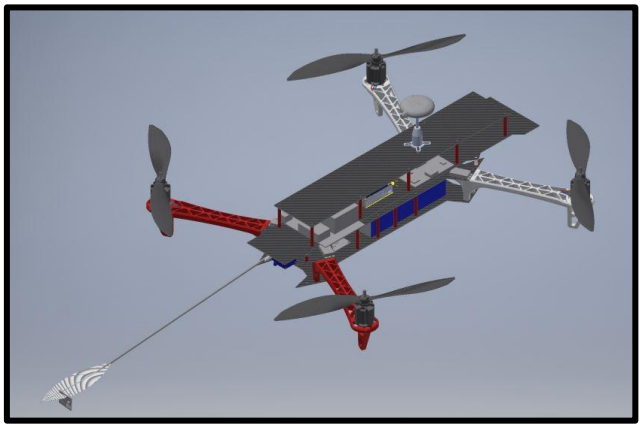

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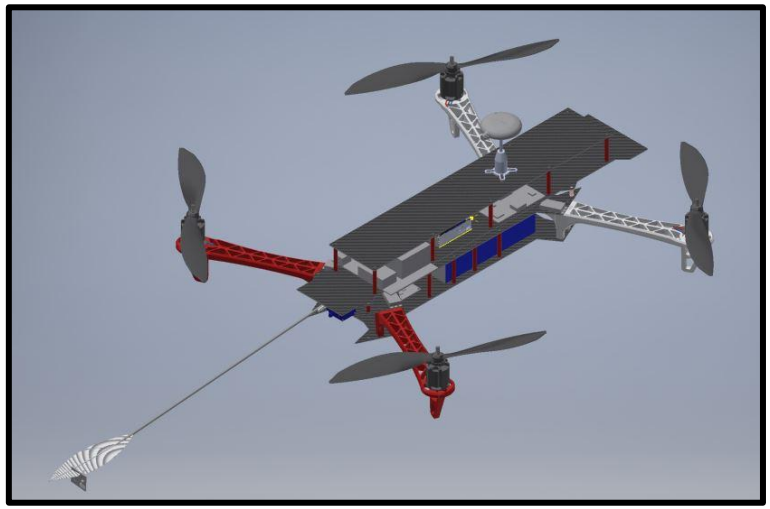
Image Source: Wikipedia.org

PROJECT OVERVIEW

Always have a plan Bee

- Pollination Drone
- Used to pollinate medium-sized apple orchards
- Fully autonomous with manual takeover
- Competition: hand pollination, large tractor pollination, dropcopter, common honeybee



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PSSCS

- PSSC #1: An ability to detect the location of a flower in an image(s) frame.
- PSSC #2: An ability to communicate flower positional data between the STM32 and the Jetson Nano.
- PSSC #3: An ability to actuate and detect contact with a capacitive switch on the pollen collecting appendage.
- PSSC #4: An ability to monitor battery life with the STM32 during drone flight.
- PSSC #5: An ability to communicate with the flight controller over the mavlink protocol.

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MAJOR COMPONENTS

Microcontroller

STM32H745ZI

- 32-bit ARM Cortex M4 & M7
- 3.3 V; 620mA
- 480 MHz (M7) and 240 MHz (M4)
- 8 USART/UART channels
- 4 I2C channels
- 16 DMA channels
- 2 MB Flash; 1 MB SRAM

Purpose

- Communication between jetson and flight controller
- flight decisions and battery monitoring
- actuation and sense of appendage

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MAJOR COMPONENTS

Voltage Regulation

P7805-2000-s

- Battery to 5V switching regulator
- max current: 2 A
- efficiency: 90%

LP3852EMP-3.3/NOPB

- 5V to 3.3V LDO regulator
- max current: 1.5 A

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MAJOR COMPONENTS

SBC for Image processing

Jetson Nano B01

- Quad Core ARM A57 1.43 GHz
- 5 V; 2 A (power delivery from BEC external to PCB)
- 3x UART
- 2x CSI camera interface
- UNIX system

Purpose

- color blob detection
- stereo vision

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MAJOR COMPONENTS

Camera

IMX219-77

- 8 MegaPixel Sensor
- Sensor: Sony IMX219
- 77° FOV
- Camera Serial Interface (CSI)

Purpose

- Obtain optical camera data
- Communicates with Jetson Nano

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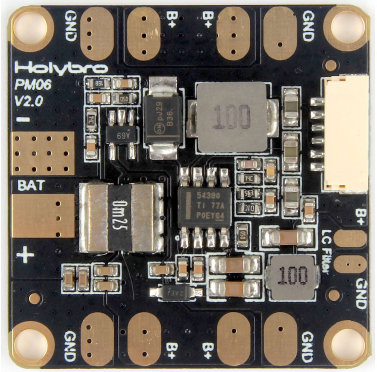
MAJOR COMPONENTS

Drone Parts

Pixhawk 4 mini + GPS
- flight controller
- 3.3 V; UART



PM06 v2
- Power Distribution Board
- 7-42V; 120A

SunnySky X2216 KV880
- 20 A max
- 1360g thrust with 10” prop

Turnigy Multistar BLHeli-S
- Electronic Speed Controller (ESC)
- 30 A

FrSky x4r-sb
- radio receiver

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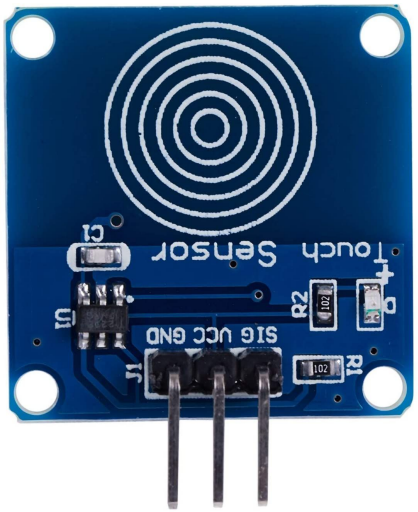
MAJOR COMPONENTS

Appendage

TTP223B Cap. Touch Switch

- 2-5.5 V
- Price: $0.749/unit
- Weight: 22 g



SG90 Micro Servo

- Torque 2.5 Kg/cm
- Price: $0.899/unit
- 4.8-6 V
- 50 Hz
- Weight: 14.7 g

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MAJOR COMPONENTS

Battery Monitor and Battery

BQ29330DBT

- LiPo battery monitoring IC
- CLK provided by STM
- I2C
- Slave only device

Turnigy Heavy Duty LiPo

- 4 cell (14.8 V)
- 5000 mAh
- 60 C (continuous 300 A)

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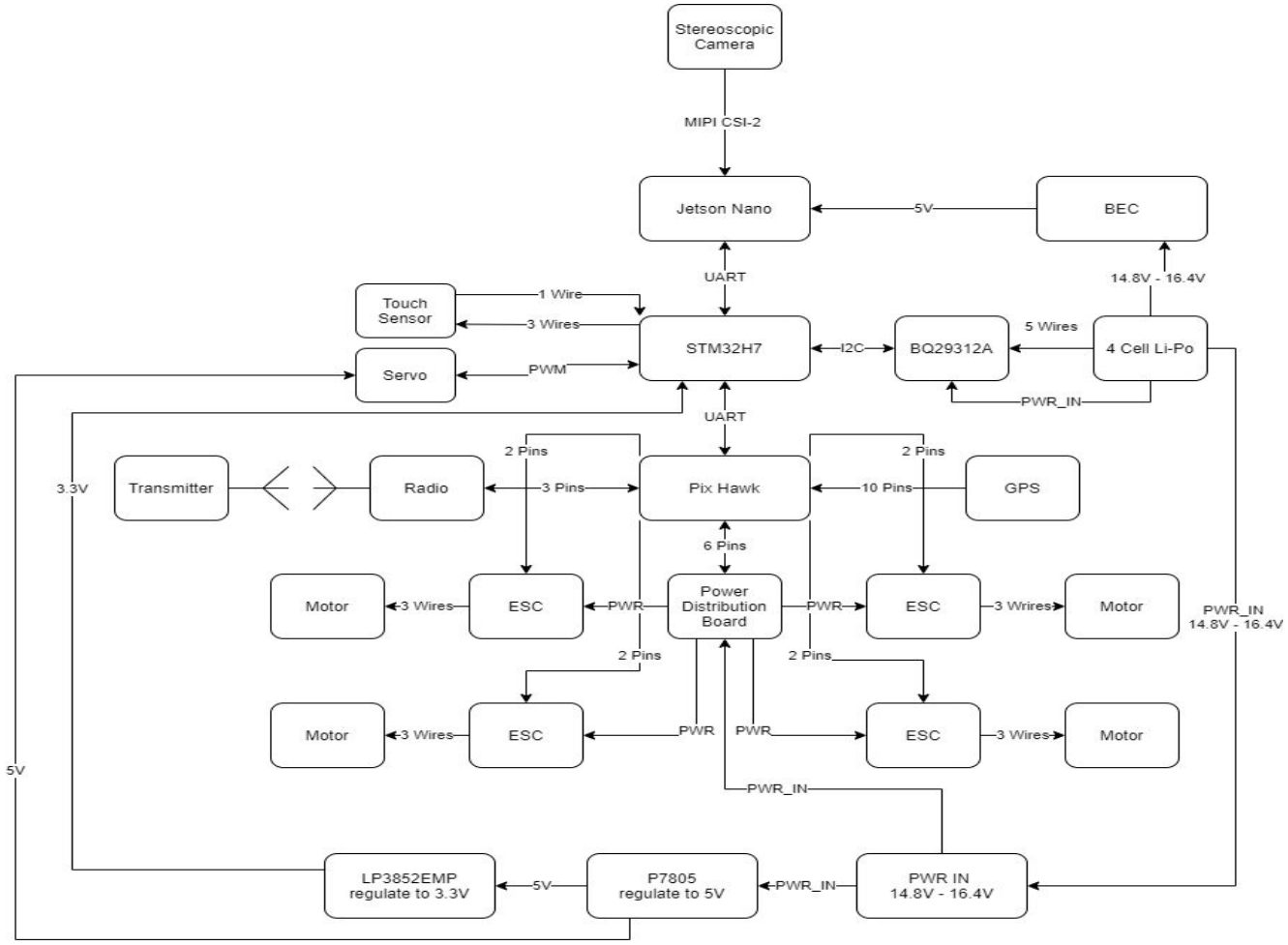
BLOCK DIAGRAM

System Block Diagram



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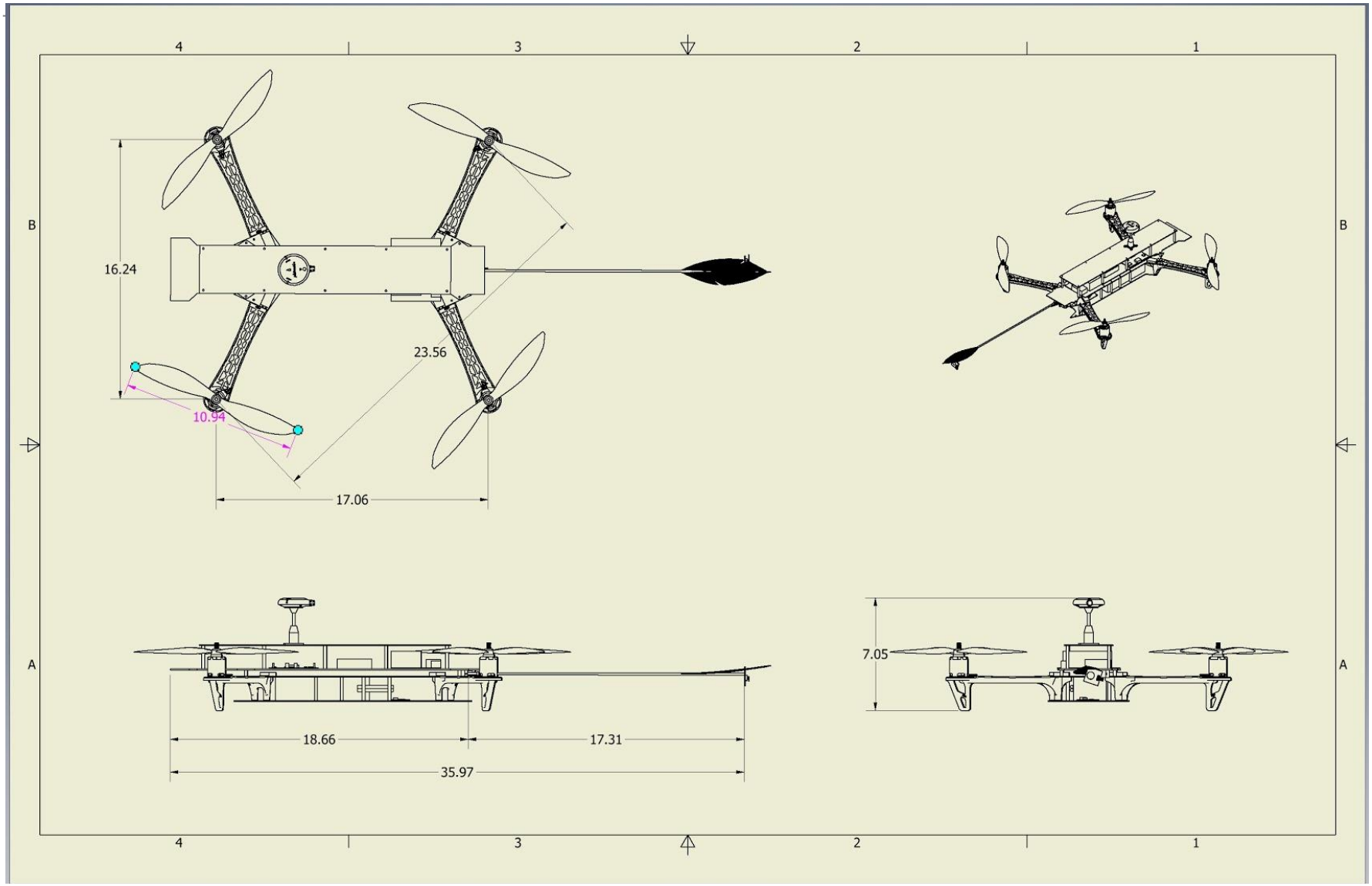
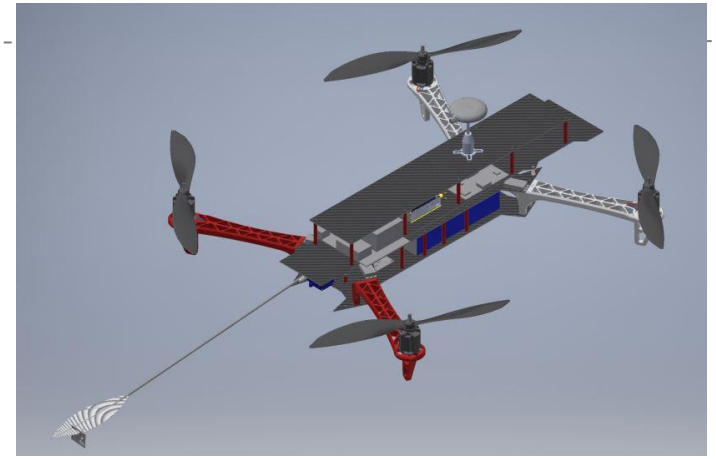
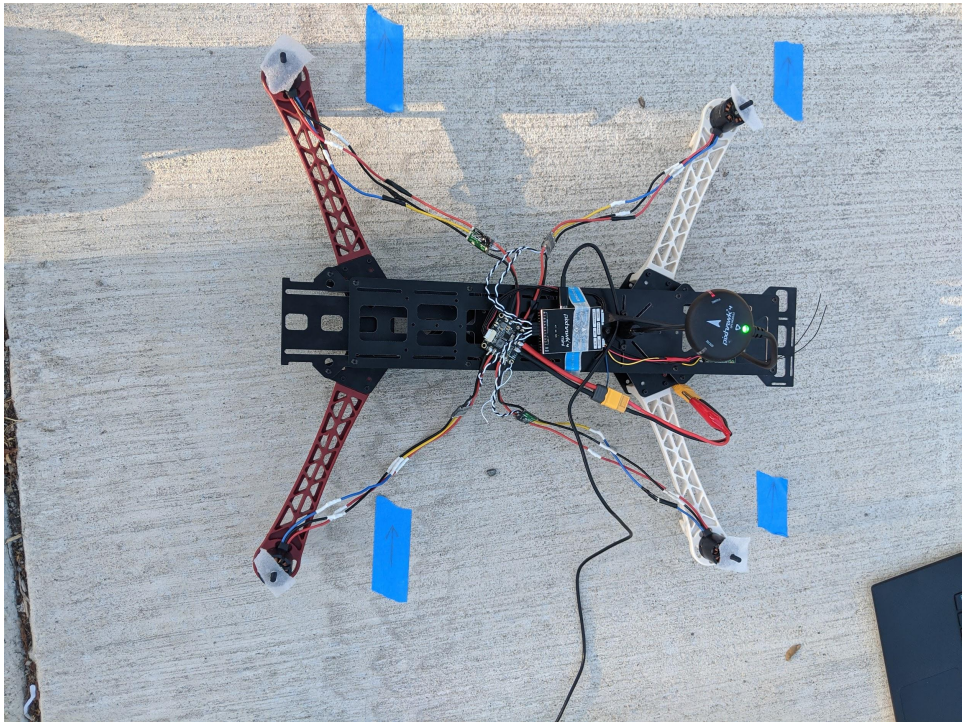
PACKAGING DESIGN



PACKAGING DESIGN

- No human interfacing needed on packaging
- Weatherproofing - not needed
- 1805 g





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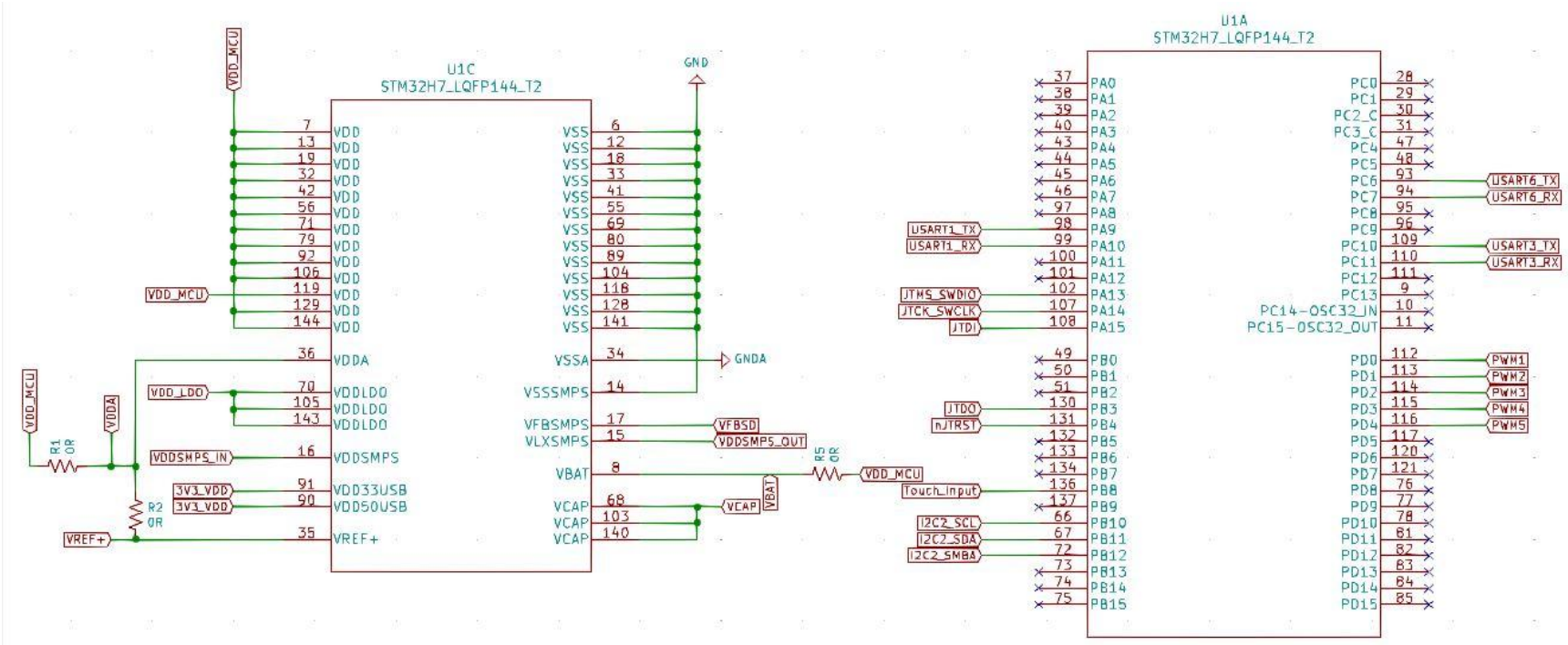
ELECTRICAL SCHEMATIC

STM32 PWR & Pinouts



https://engineering.purdue.edu/477grp4/Files/refs/stm32h745zg_datasheet.pdf

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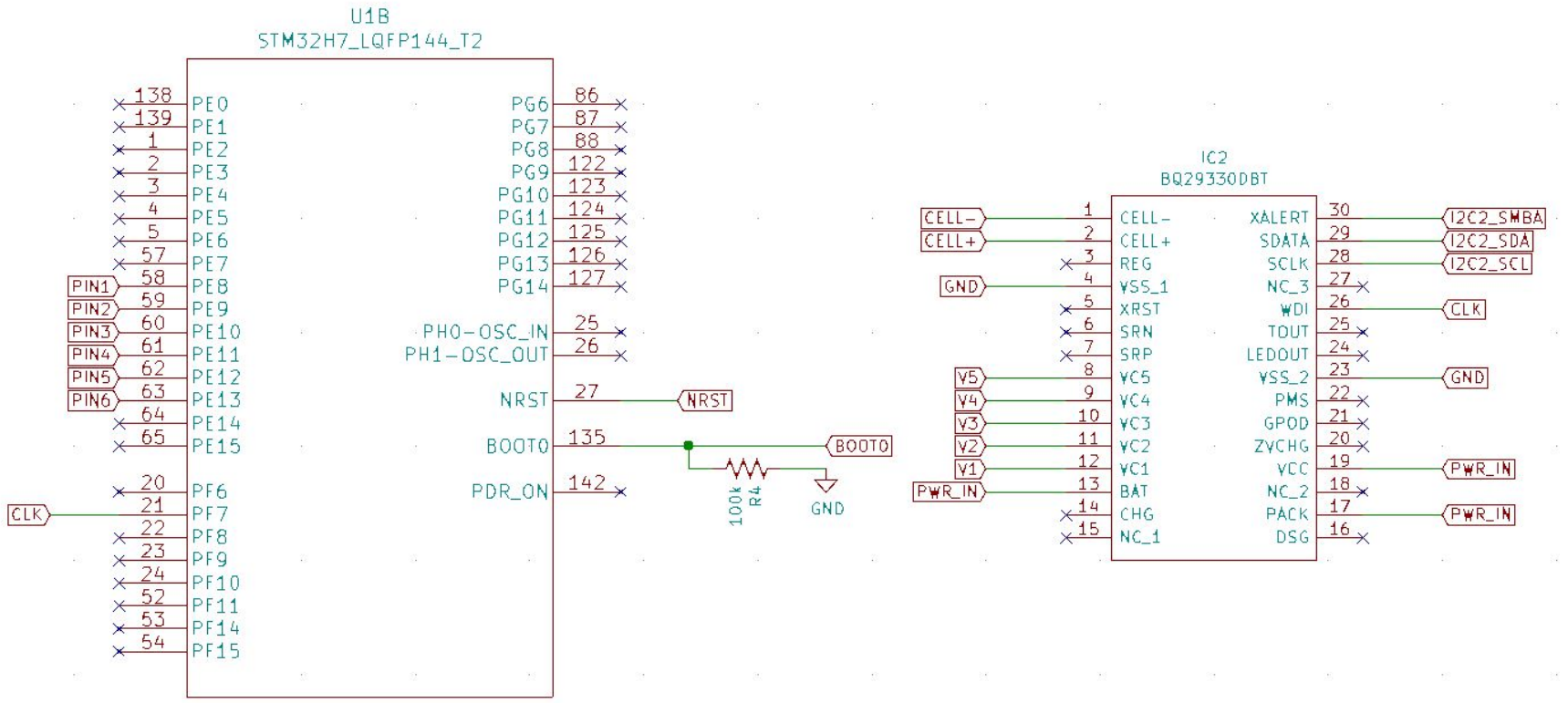
ELECTRICAL SCHEMATIC

STM32 Pinout and Battery Monitor



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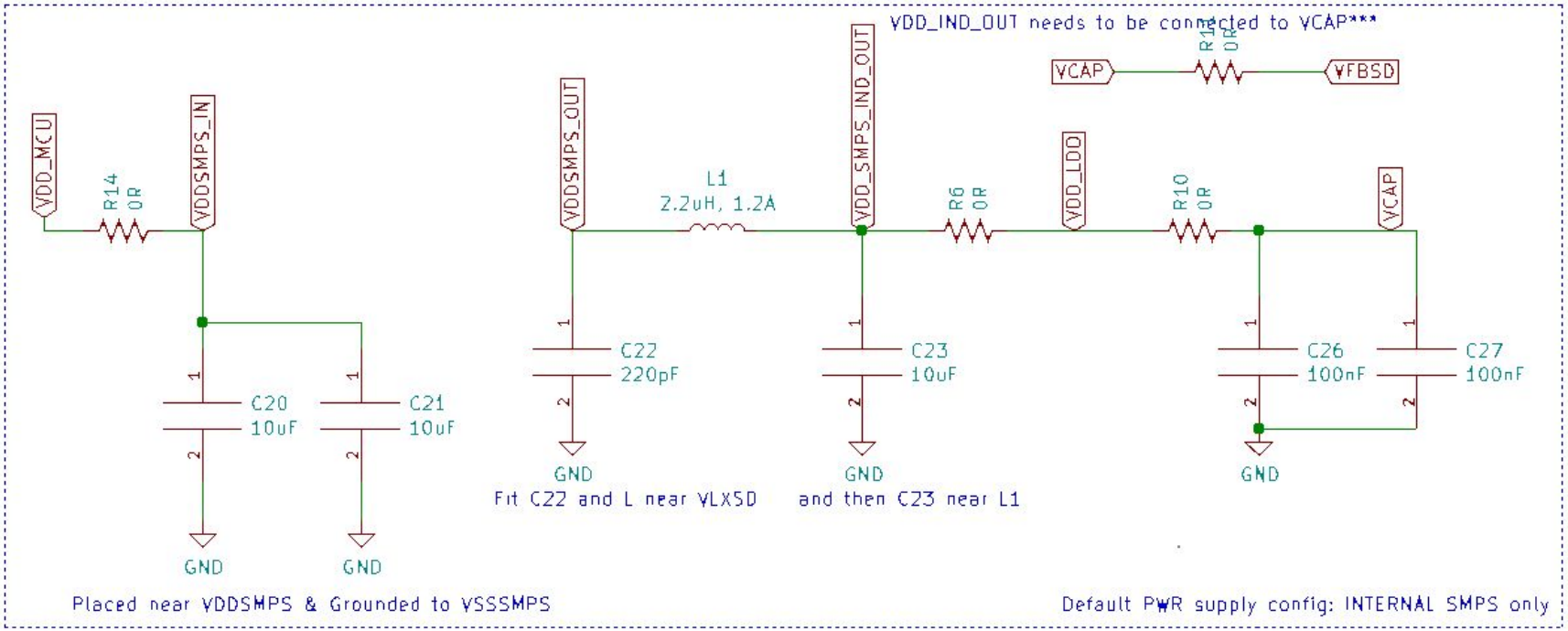
ELECTRICAL SCHEMATIC

Decoupling Capacitors



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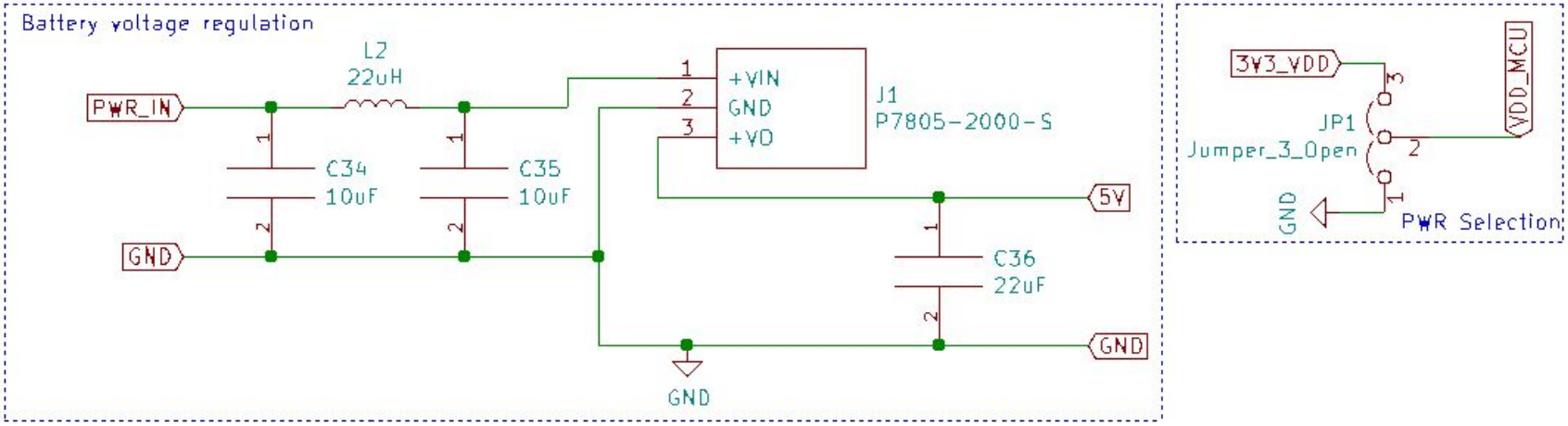
ELECTRICAL SCHEMATIC

Battery In Voltage Regulation



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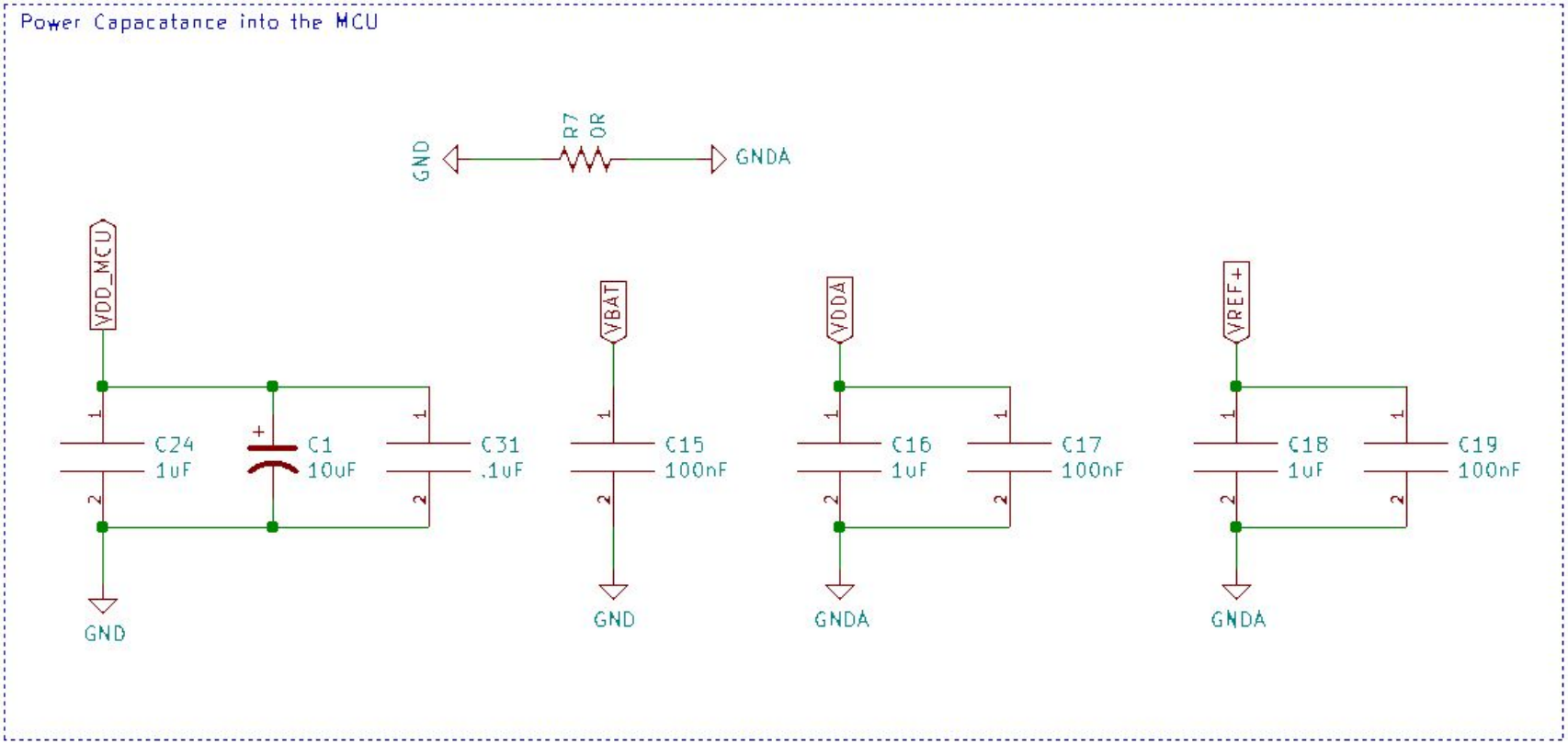
ELECTRICAL SCHEMATIC

Power Delivery Capacitors



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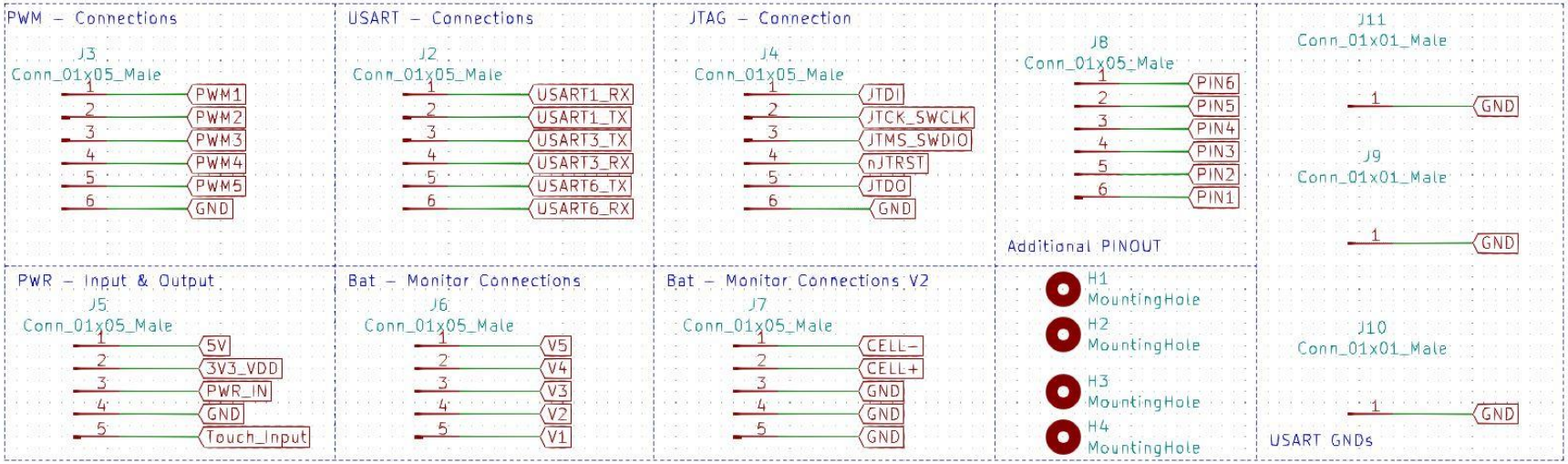
ELECTRICAL SCHEMATIC

PCB Pinouts and Mounting Holes



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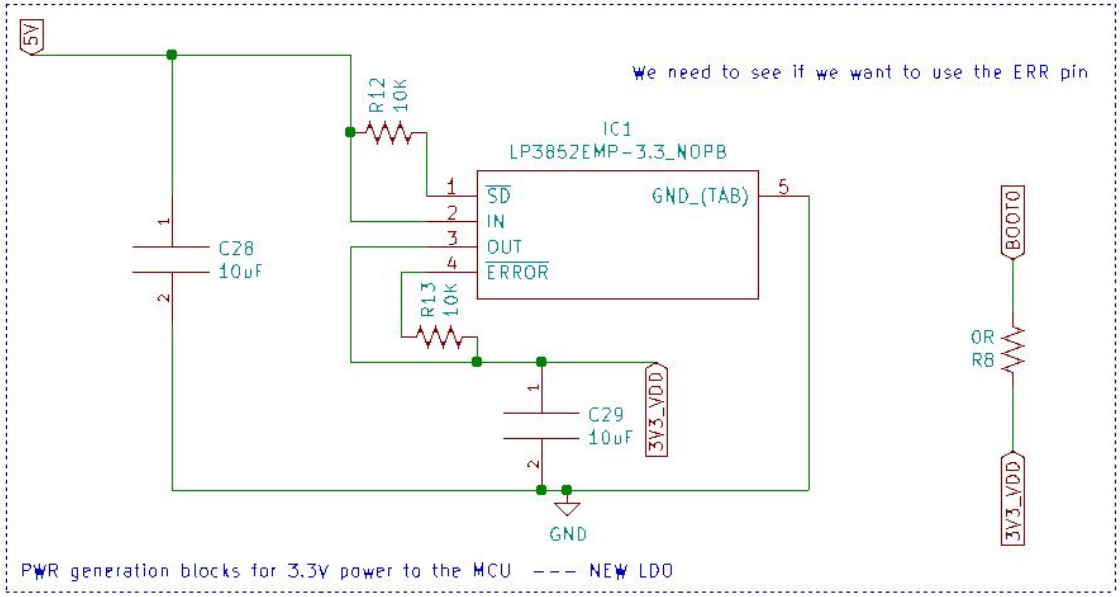
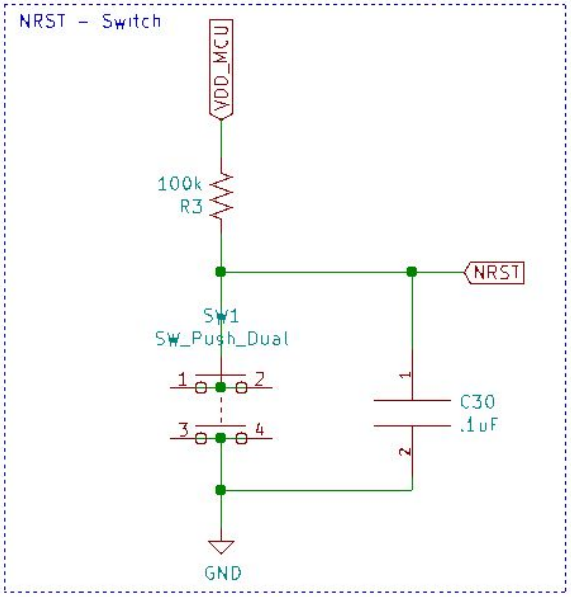
ELECTRICAL SCHEMATIC

5V to 3.3V regulation and NRST





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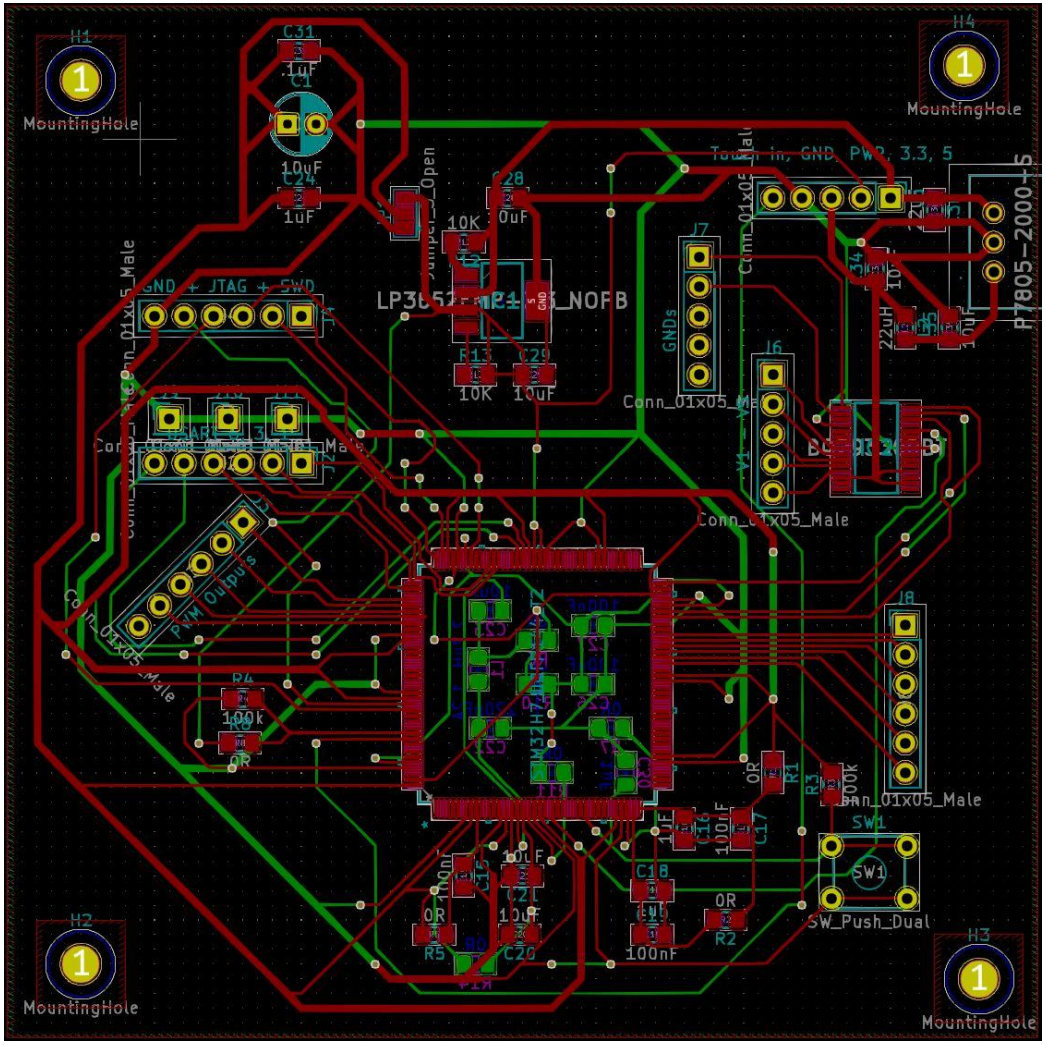
PCB LAYOUT

Full Board

Specs:

- 89mm X 89mm
- 0805 SMD capacitors & resistors
- 10uF electrolytic Power Capacitor
- 2.54mm Headers
- M3 Mounting Holes

Board is being built and mounted on Drone.



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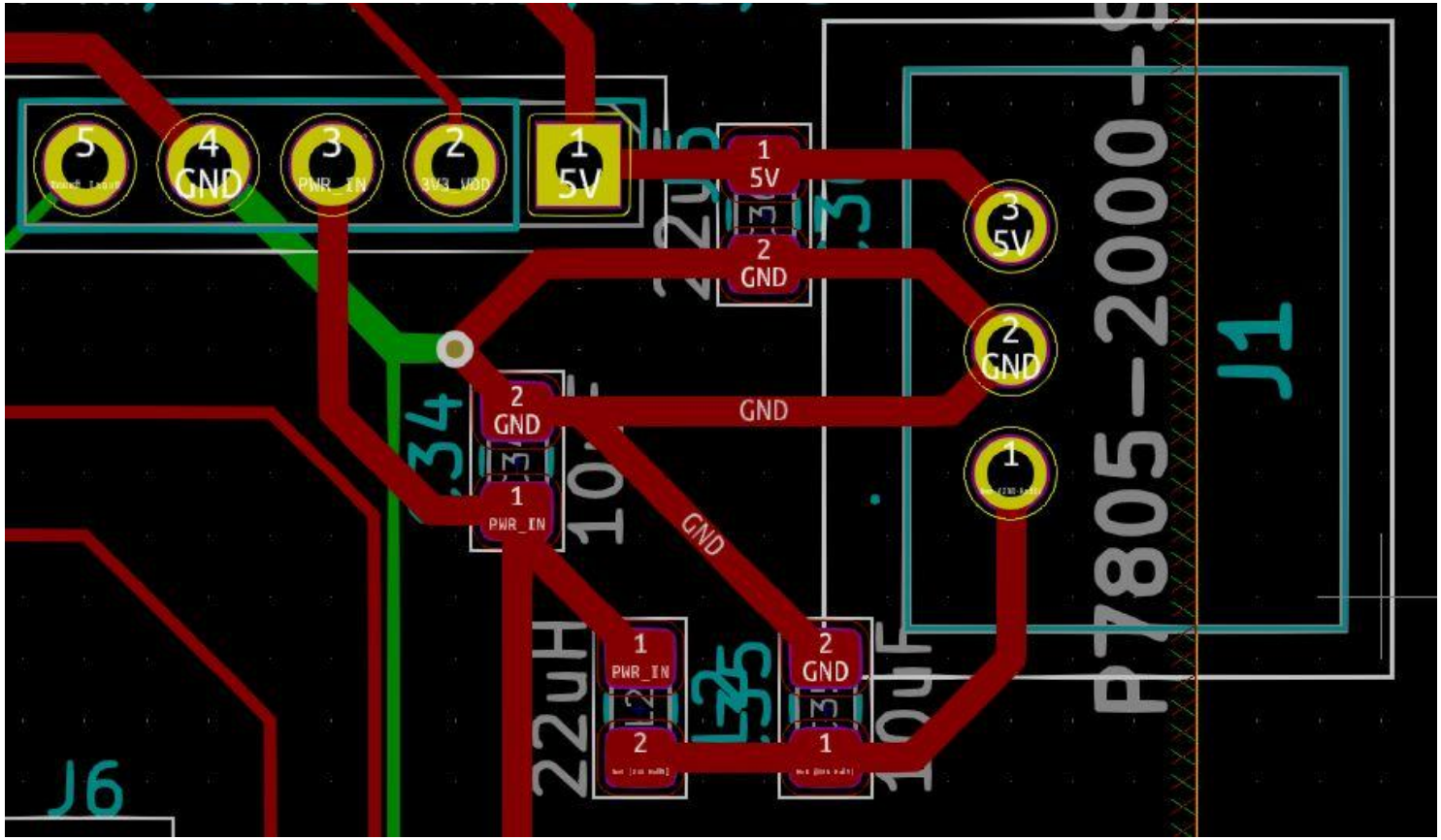
PCB LAYOUT

PWR IN Regulation



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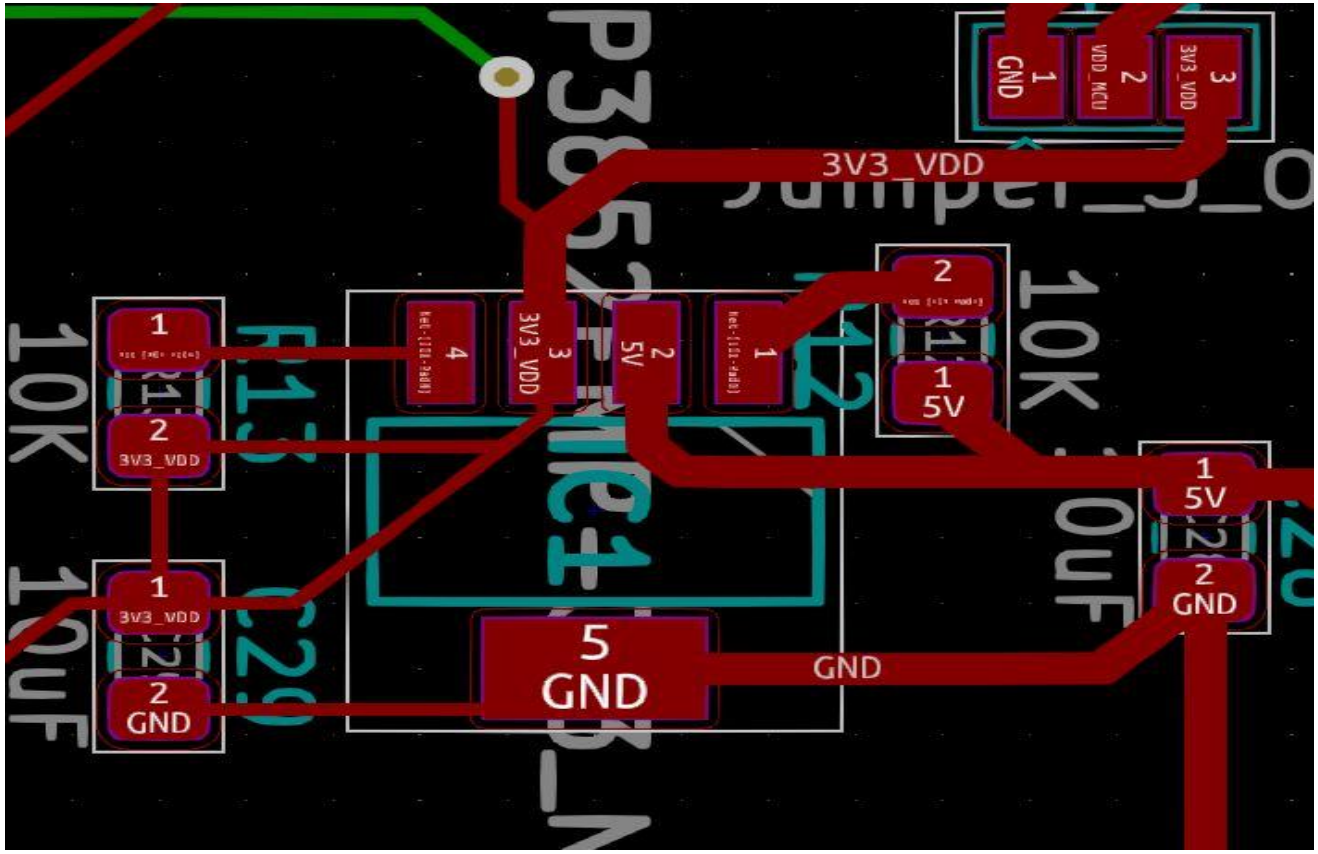
PCB LAYOUT

5V to 3.3V Regulation



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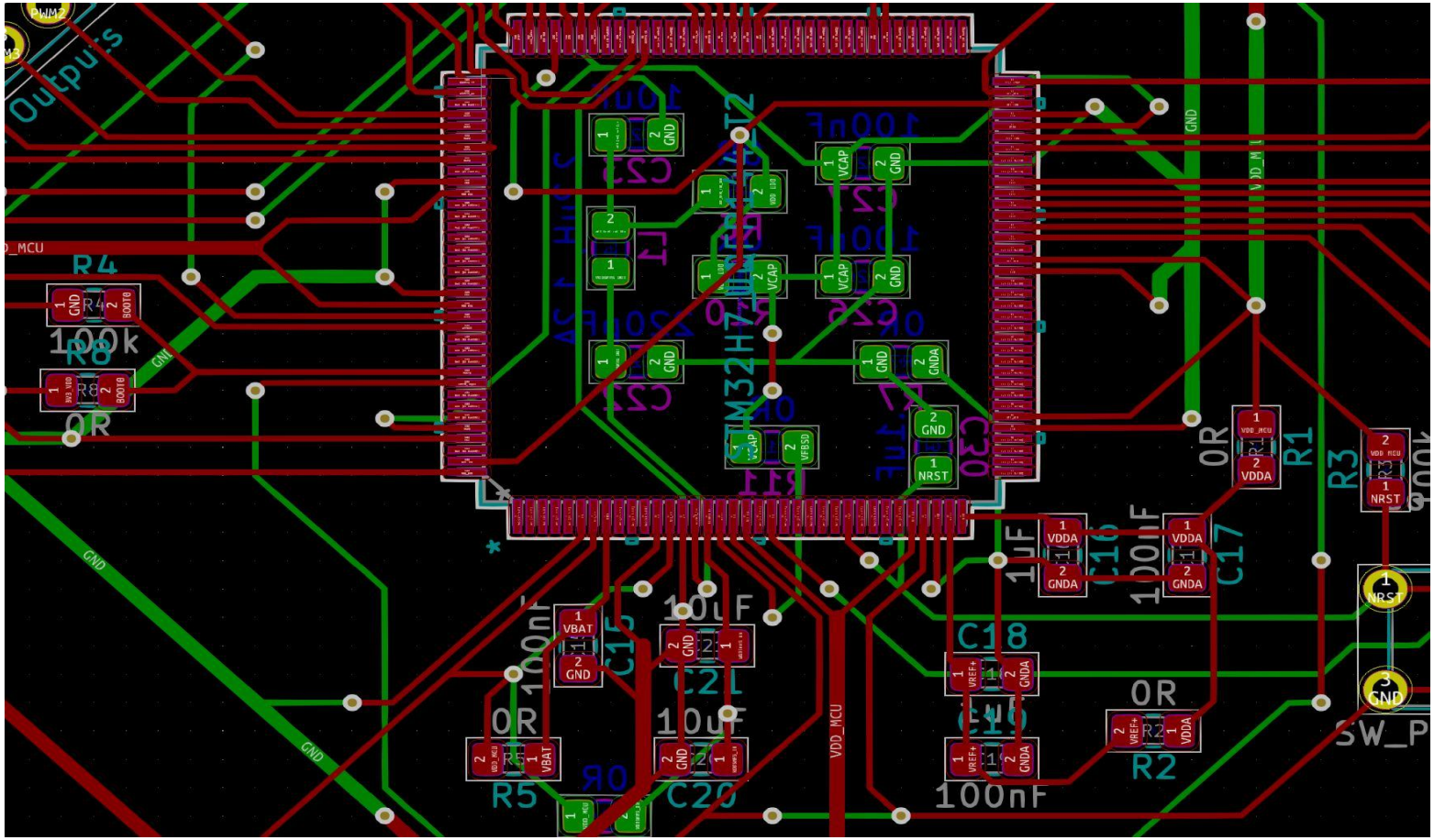
PCB LAYOUT

STM32 Mount



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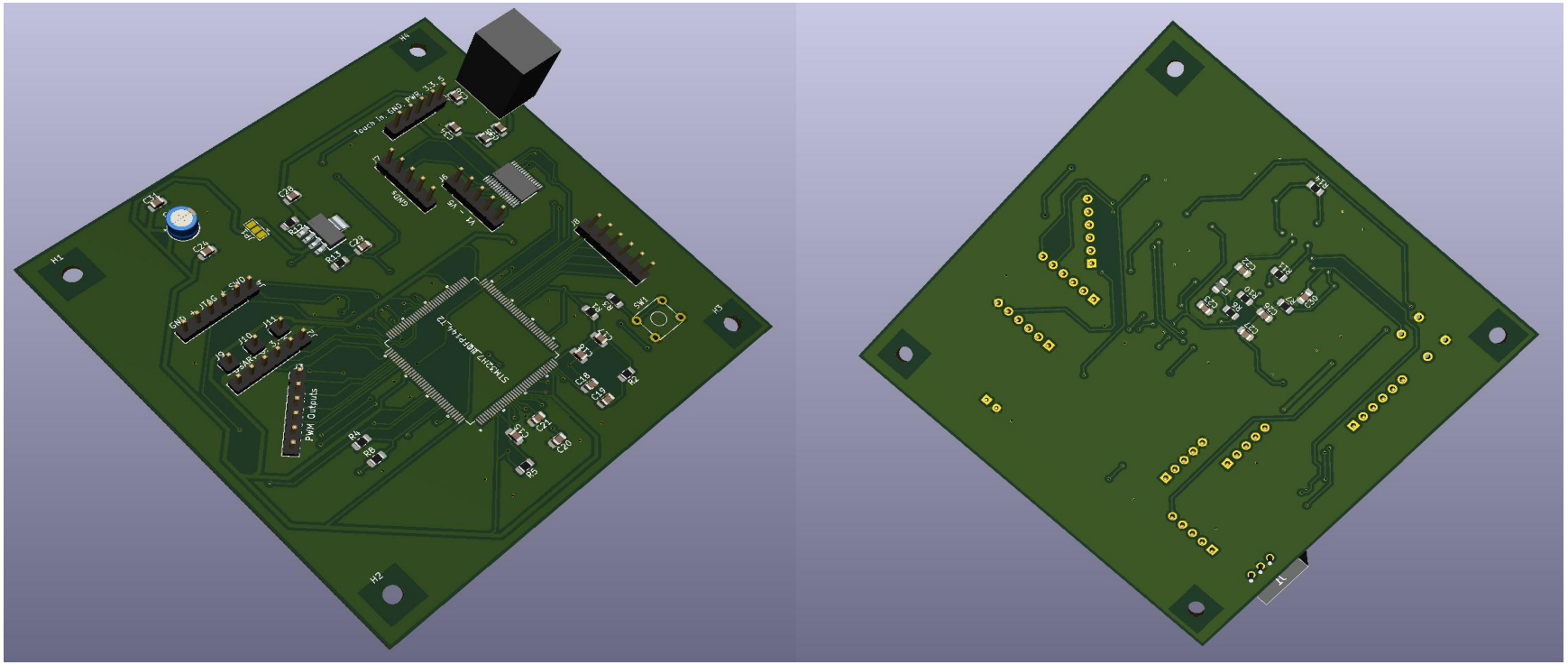
PCB LAYOUT

3D View of Board



PROTOTYPING PROGRESS

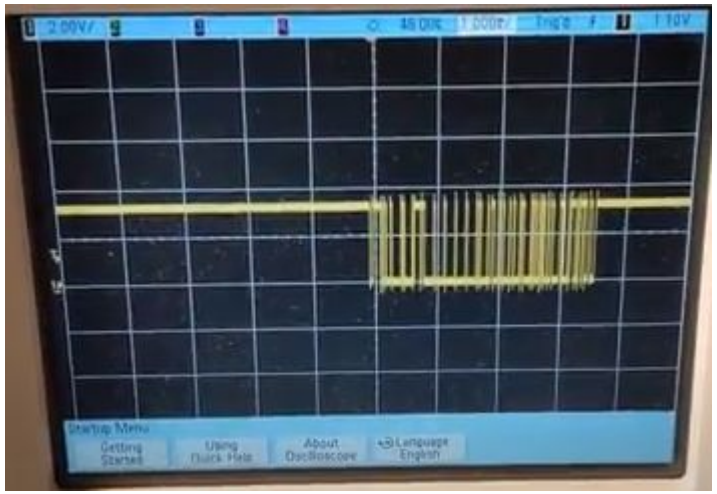
Drone/PixHawk

Completed:

- Flight achieved!

Needs Development and Testing:

- Basic flight with simple instructions sent from STM
- Flight with hardware mounted (under tight weight constraint)



Mavlink heartbeat

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PROTOTYPING PROGRESS

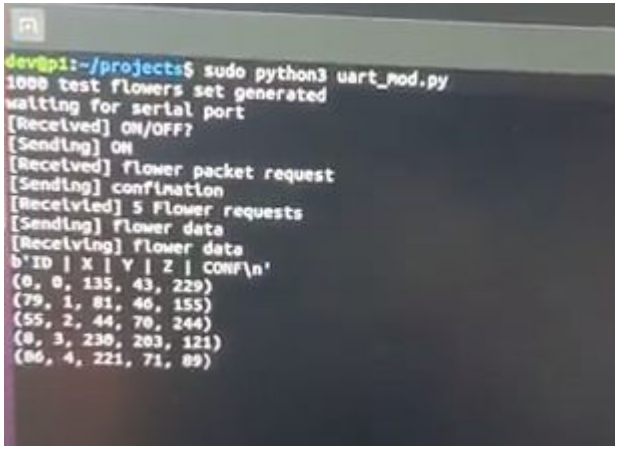
Jetson Nano

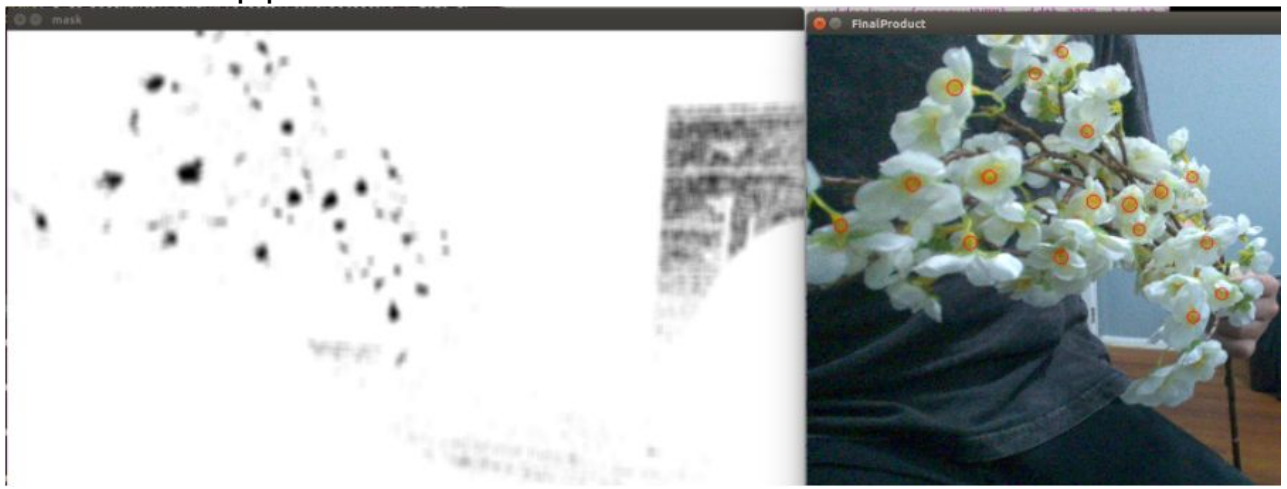
Completed:

- UART communication achieved with simulated flower data
- Dual camera connection Achieved
- Live blob detection achieved

Needs Development and Testing:

- Stereo Depth perception
- Verify operation of camera to nano to stm pipeline





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PROTOTYPING PROGRESS

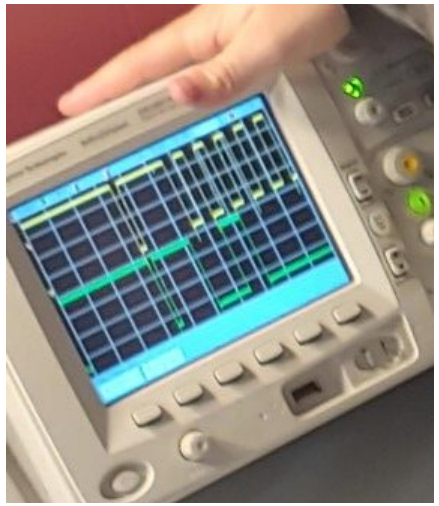
STM32H7

Completed:

- Appendage sensor GPIO initialization and functionality
- I2C Initialization and verification
- Mavlink - dual-core mavlink heartbeat and command protocol implemented

Needs Development and Testing:

- I2C receive
- Relative position computation
- Flight startup and instruction generation for PixHawk
- Interrupt Service Routines and Verification
  - Battery level ISR
  - Safe land



I2C addressing and clock

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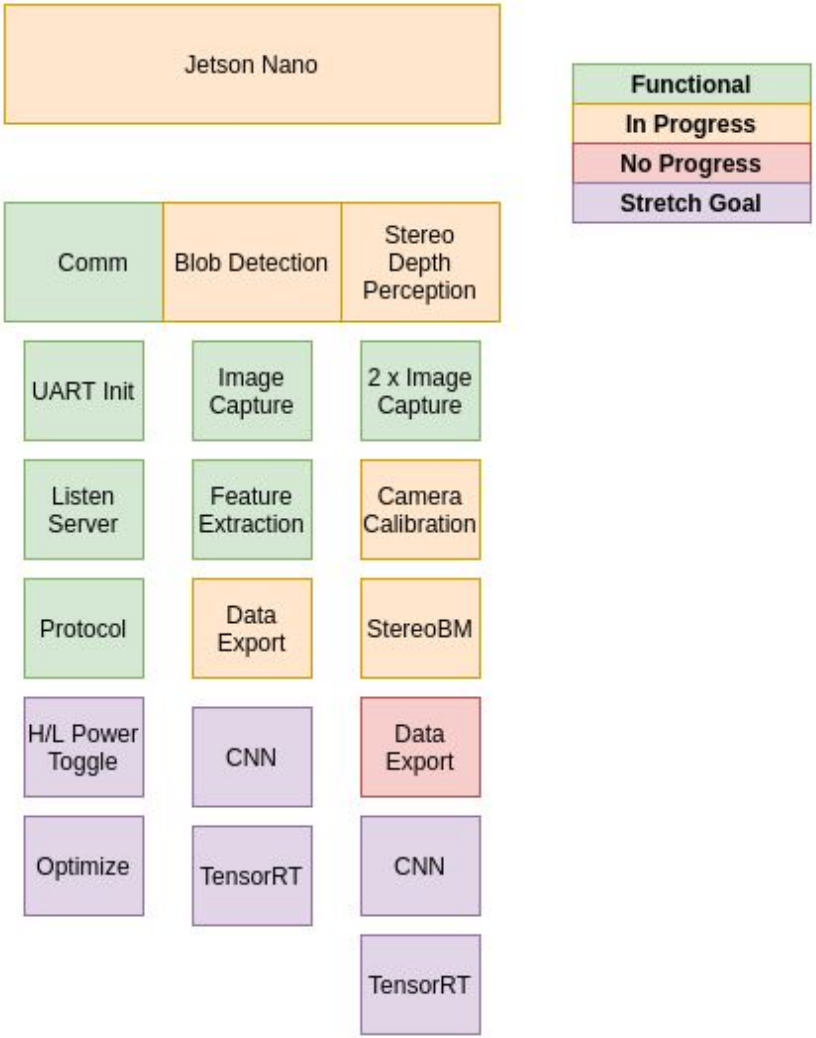
SOFTWARE DEVELOPMENT STATUS

Jetson Nano



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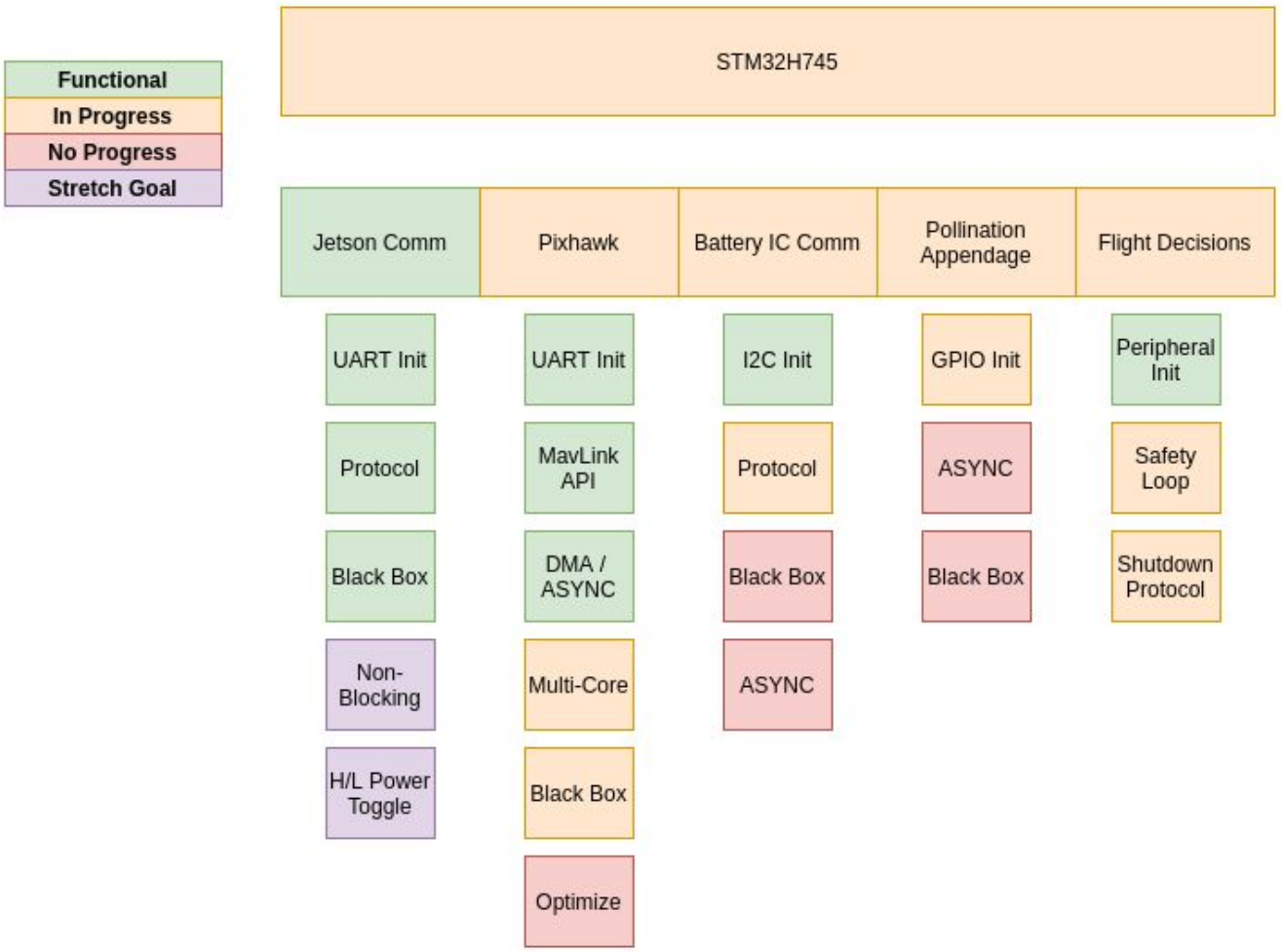
SOFTWARE DEVELOPMENT STATUS

STM32H745



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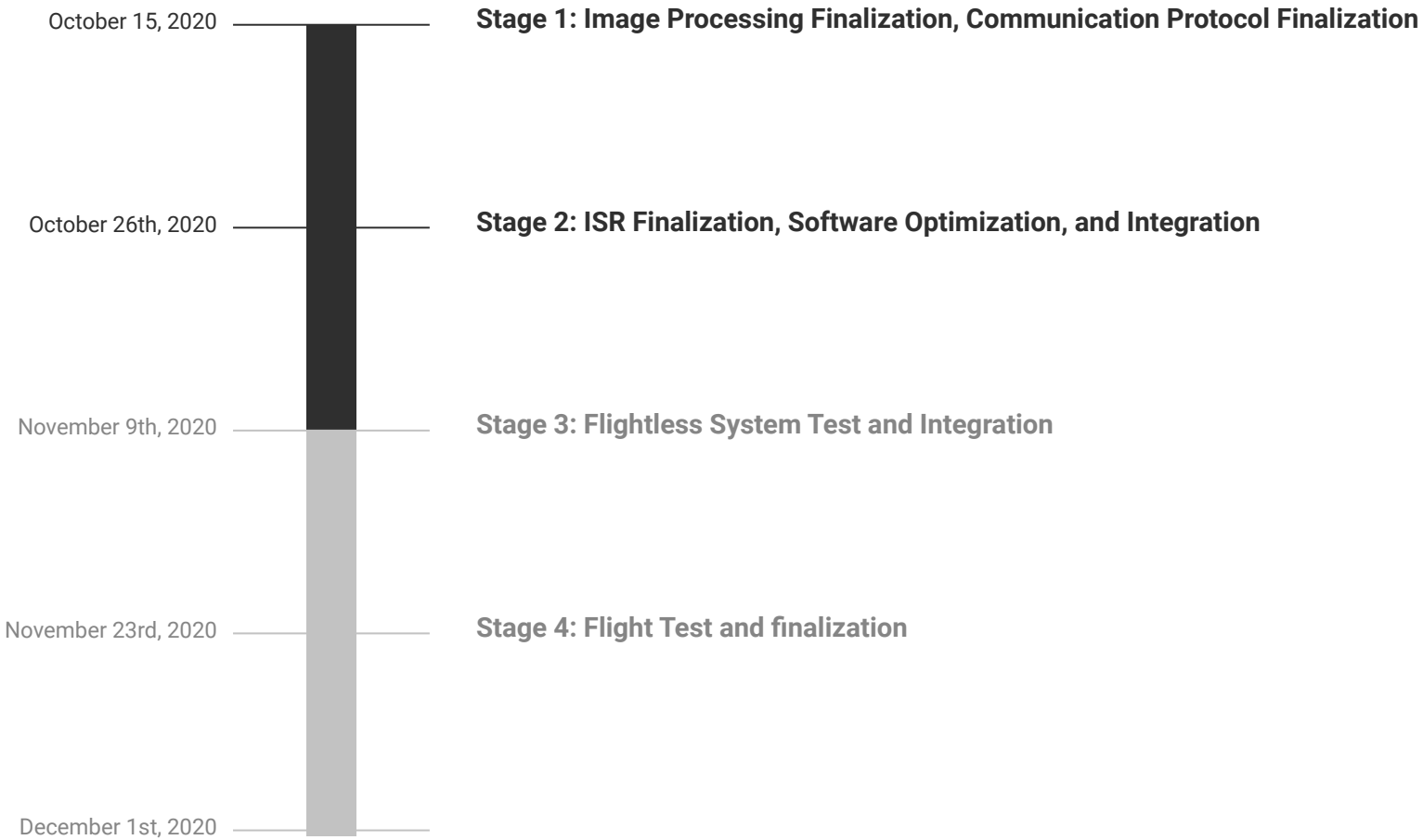
PROJECT TIMELINE



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Questions?