ETERNAL FLIGHT

Fall 2018 Final Design Review

DEVELOPMENT TEAM

Aditya Wadaskar (Lead)	Latching and Battery Switching
Kyle Douglas	Controls & Electronics
Richard Boone	Embedded Systems
Sang Min Oh	Design and Construction
Sayali Kakade	Computer Vision

INTRODUCTION

Applications of Unmanned Aerial Vehicles (UAVs) expanding in various industries

Problem: Short battery life

- Limited range
- Current Approach: Drones must land and recharge or switch battery
- Need more infrastructure to enable mesh network of drones
- If drone close to losing battery life before reaching station, it may not reach station before crashing - potentially costly, liability concerns

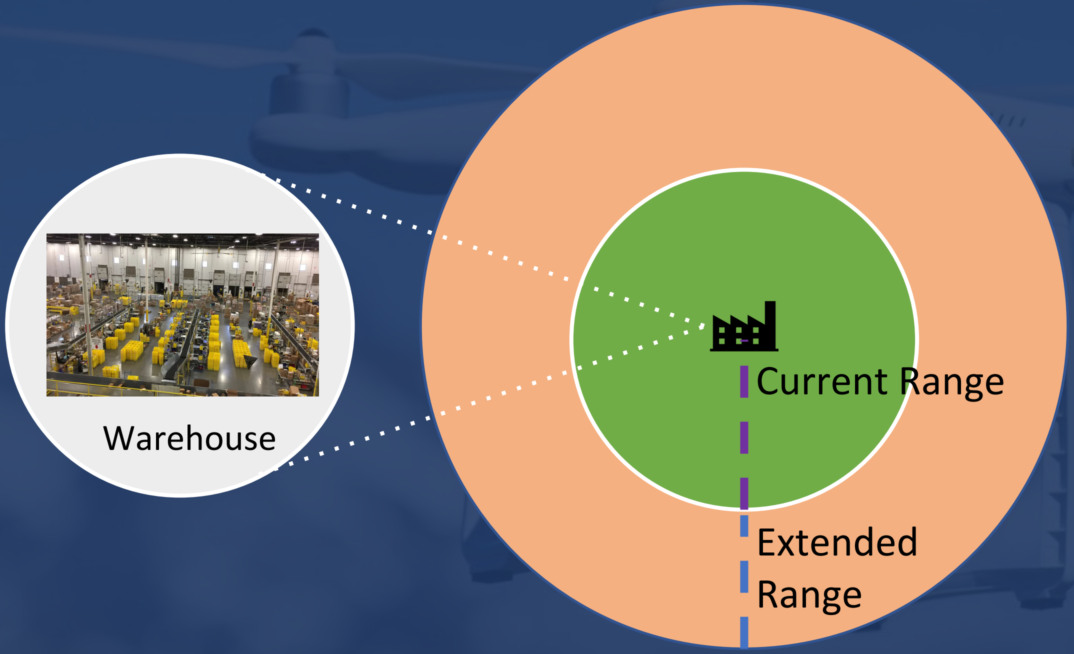
PROJECT DESCRIPTION

Goal: Switch drone’s battery in flight to allow “eternal flight”

System will use a large drone (parent) to replace the battery of a smaller drone (child)

- Parent locates child using GPS
- Child calibrates and lands on parent using computer vision
- Drones latch using electromagnets
- Parent switches drained battery while keeping child powered on
- After battery is replaced, child drone undocks and flies away

APPLICATION



Package Delivery

SYSTEM REQUIREMENTS

Parent Drone

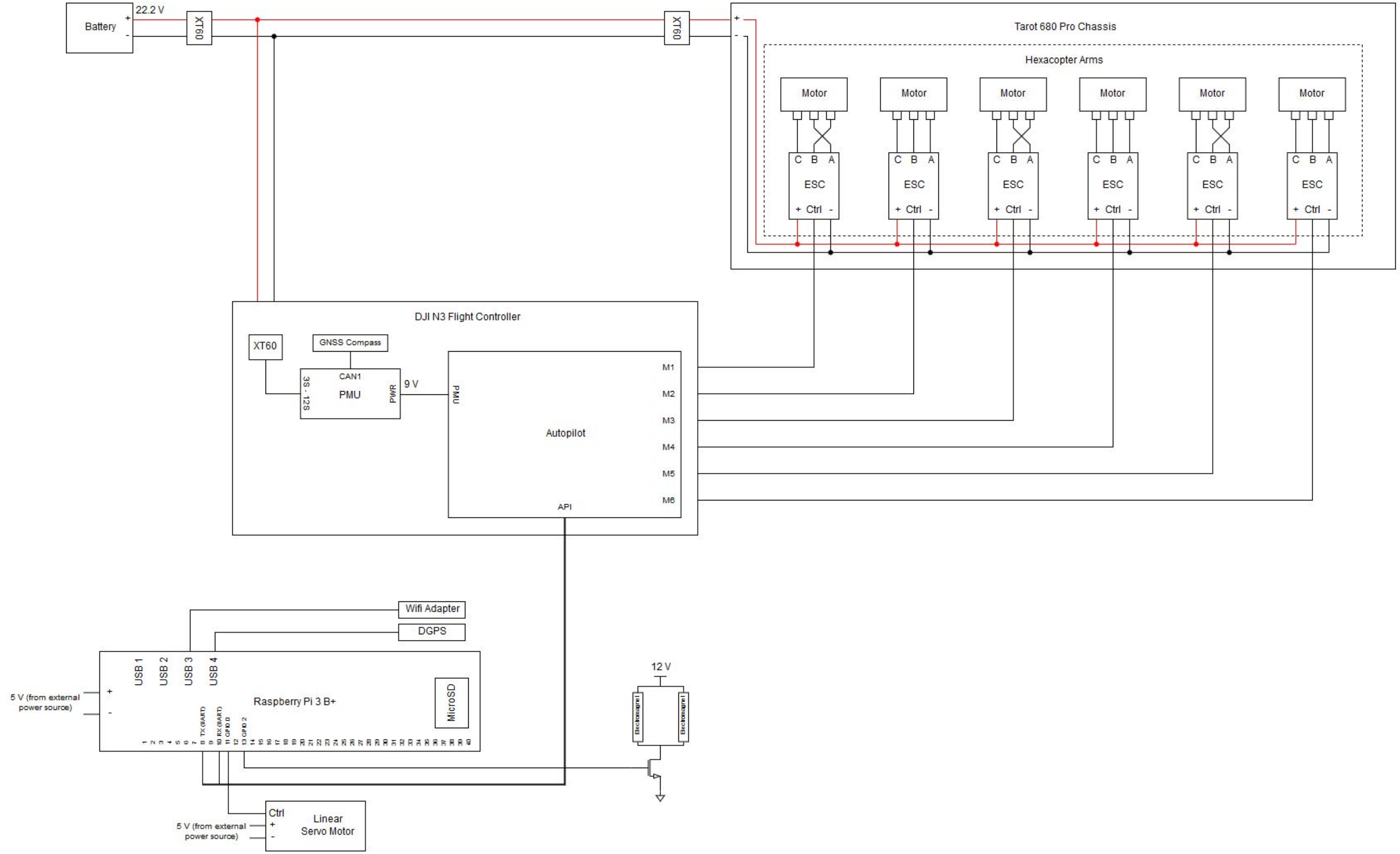
- Capable of carrying weight of battery switching mechanism and child drone
- GPS to determine child drone's geolocation – coordinates received over WIFI
- Advanced Flight Controller to stabilize with newly added weight
- Electromagnetic mechanism to keep child drone steady while switching battery

Child Drone

- Detect parent's position using onboard camera
- Stable Landing – Descend in controlled manner and land and latch to parent drone

ELECTRONICS OVERVIEW

PARENT DRONE SCHEMATIC

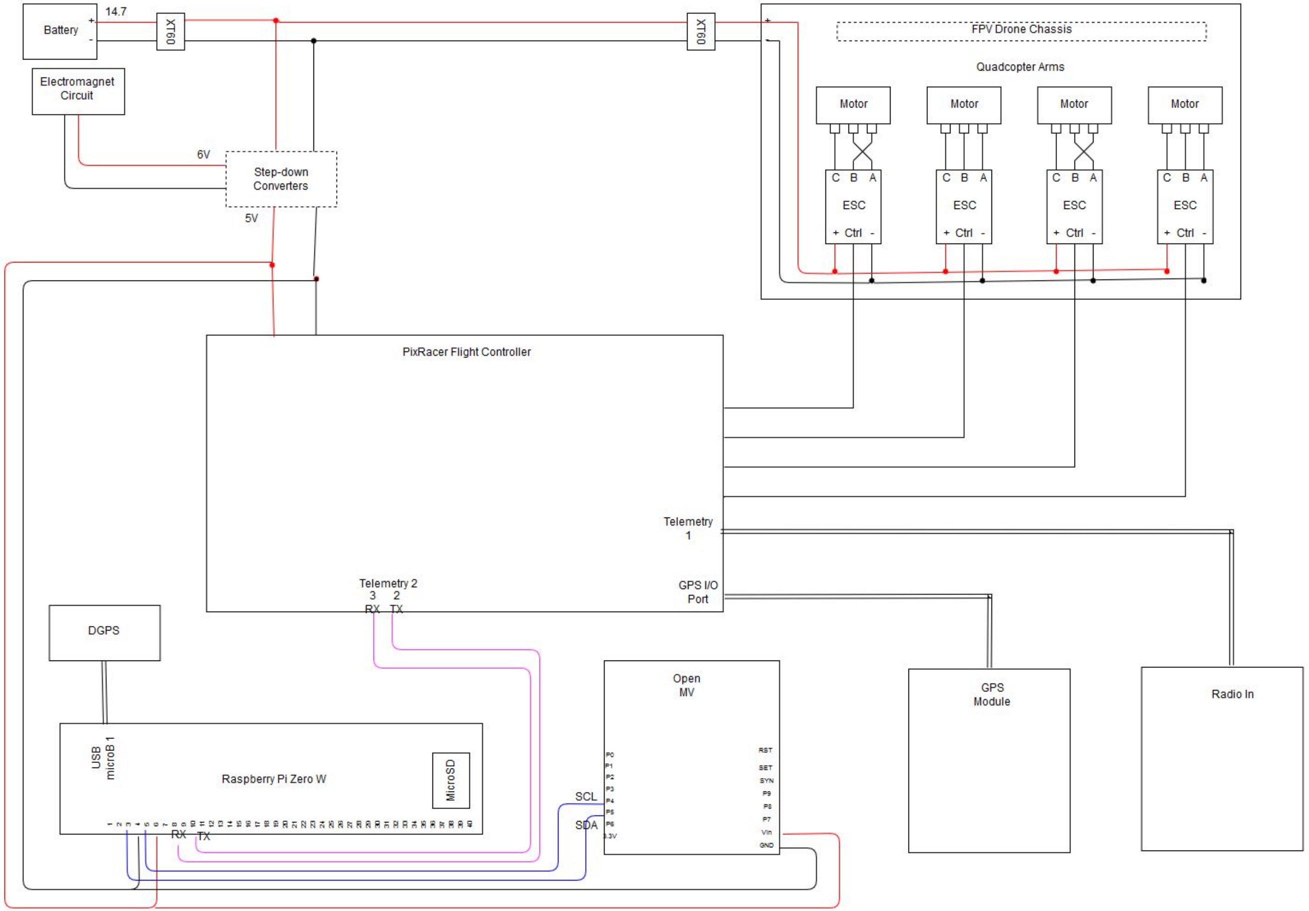


PARTS OVERVIEW - PARENT

- Tarot 680 Pro Frame
  - Tarot 4108 High-Power Brushless Motor
  - HobbyWing XRotor 40A-OPTO-ESC
- DJI N3 Flight Controller
- Raspberry Pi 3 B+
- Turnigy 6S 20C LiPo Battery
- Linear Actuator
- ublox Neo M8P-2 DGPS

Total Cost: $ 1179.69

CHILD DRONE SCHEMATIC



PARTS OVERVIEW - CHILD

- ReadyToSky FPV Drone Frame
- CrazePony Motors
- OpenMV Camera
- Pixracer Flight Controller
- Raspberry Pi Zero W
- HolyBro GPS Module
- HolyBro Radio Controller
- ublox Neo M8P-2 DGPS

Total Cost: $494.41

POWER DISTRIBUTION

Parent Drone Requirements (24V Battery)

- 7V (600mA)
    - Electromagnets (400mA)
- 5V (1A)
    - Linear Actuator (400mA)
    - Raspberry Pi 3 B+ (350mA)

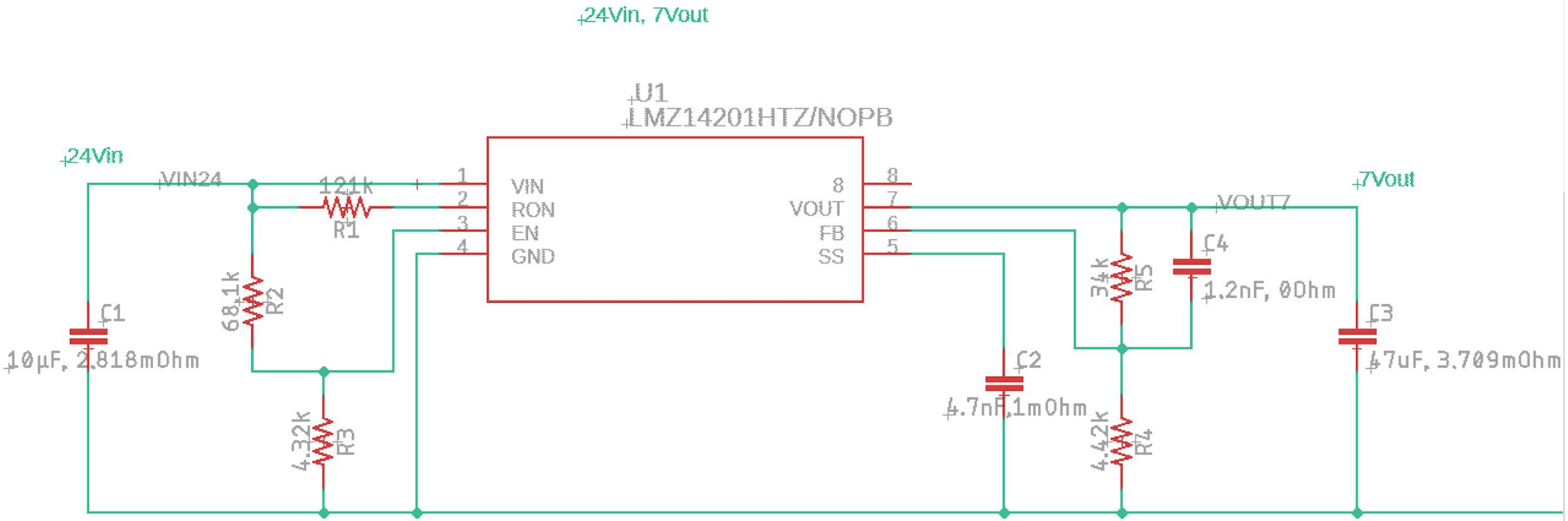
Child Drone Requirements (14V Battery)

- 5V (2A)
    - PixRacer
    - Raspberry Pi Zero W (250mA)
- 3.3V (500mA)
    - OpenMV Camera (150mA)

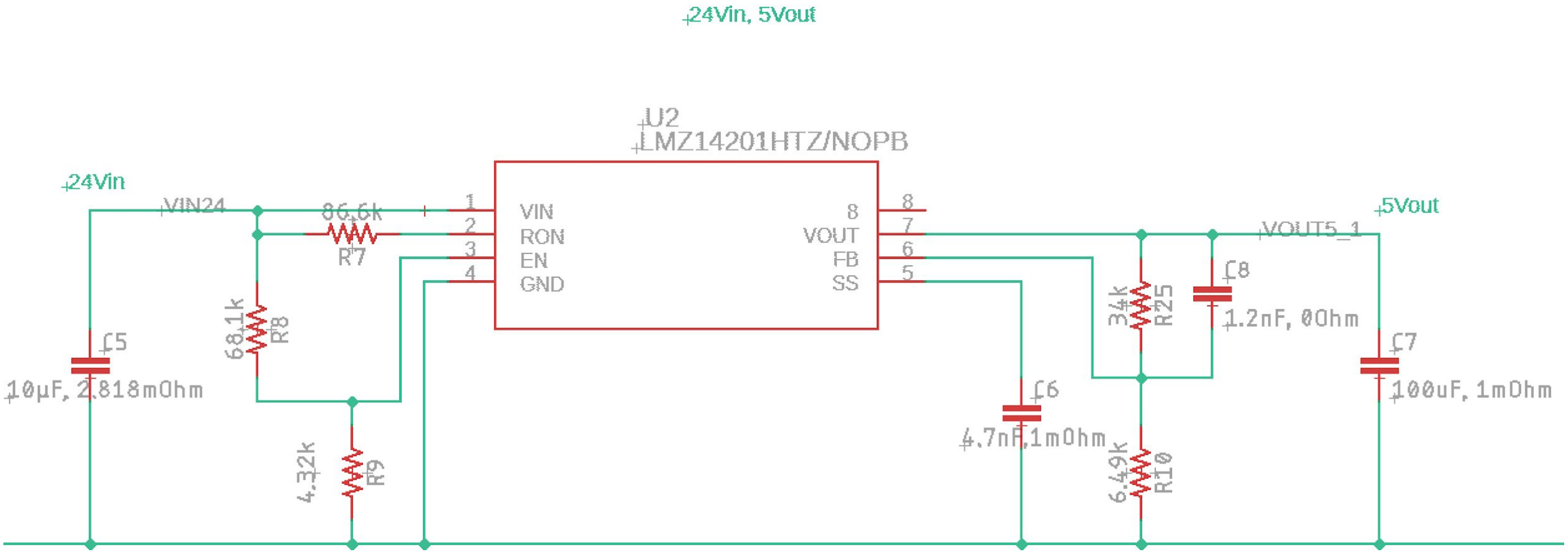
POWER DISTRIBUTION - PARTS

- **One unified PCB**
- **2x LMZ14201H**
  - **24V → 5V 1A Power Source**
  - **24V → 7V 0.6A Power Source**
- **1x MAX1774**
  - **14V → 5V 2A Power Source**
  - **14V → 3.3V 1A Power Source**

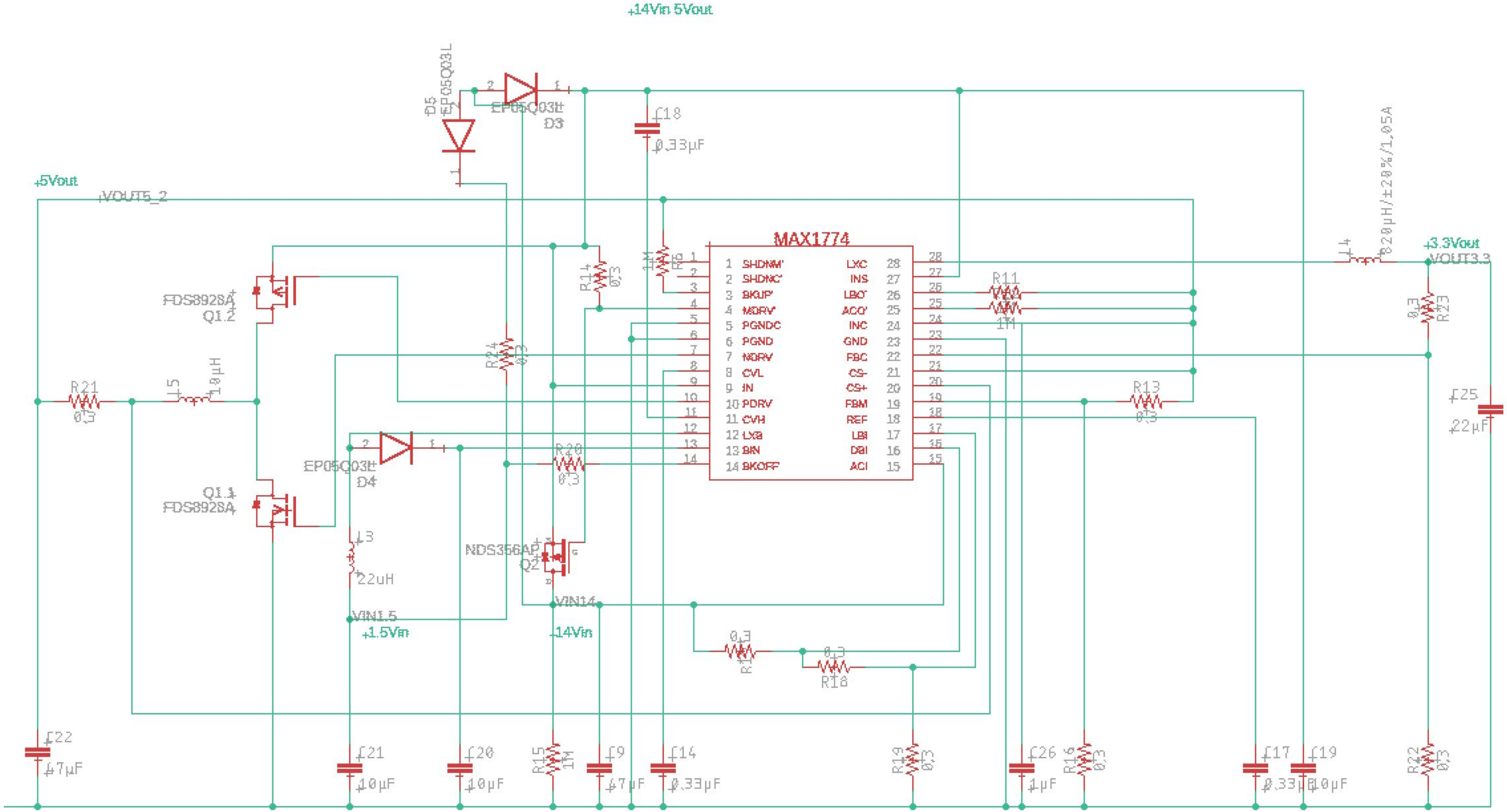
Power Schematic: 24V → 7V

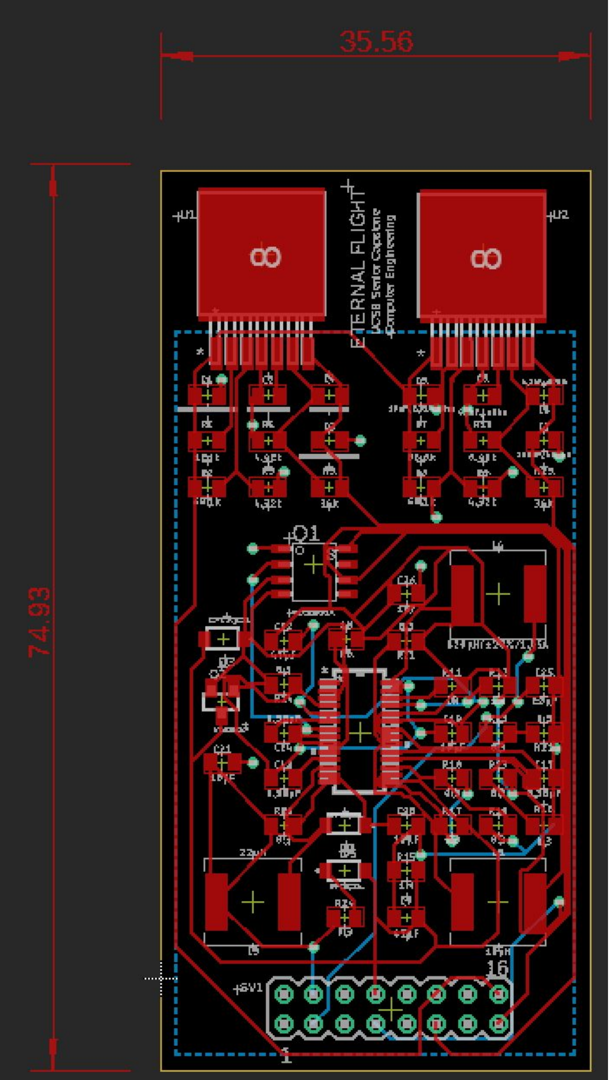


Power Schematic: 24V → 5V



Power Schematic: 14V → 5V



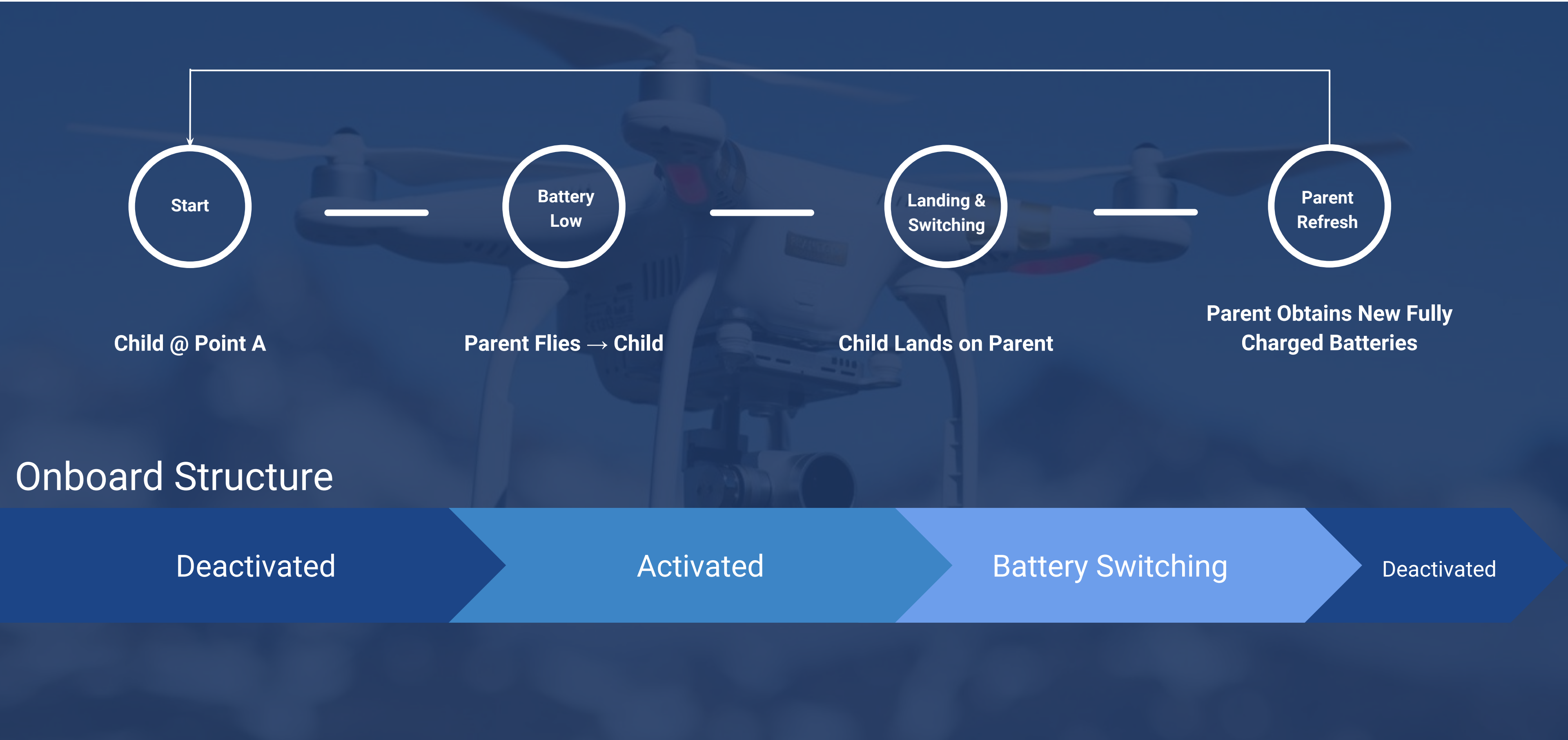


POWER PCB

- **Description:**
  - **2 layer PCB**
  - **75mm x 36mm**
  - **Single level-shifting PCB for both drones**
- **Currently on order from PCBMinions**
- **Will be assembled and tested over winter break**

SOFTWARE STRUCTURE OVERVIEW

OVERALL STRUCTURE



PARENT DRONE SOFTWARE FLOW

State 1 (Deactivated)

while (not activated)
    Ignore child drone
Transition to State 2

State 2 (Activated)

while (communication with child == false)
    Establish communication over WIFI with child drone
Retrieve GPS coordinate of child drone
Fly to N feet below child drone and hover
Activate electromagnets to prepare for child drone landing
while (child latched to parent == false)
    hover in place
Transition to State 3

State 3 (Battery Switching)

Activate Linear Actuator & Insert new battery into child drone and push out old battery
Signal to child drone to power on and unlatch
While (acknowledgement of signal not received from child)
    Continue latching onto child using electromagnets
Deactivate electromagnets
while (child latched to parent == true)
    hover in place
Transition to State 1

CHILD DRONE SOFTWARE FLOW

State 1 (Deactivated)

while (not activated)
    Remain stationary
Transition to State 2

State 2 (Activated)

while (AprilTag not detected)
    Hover in place
while (child not latched to parent)
    read AprilTag information from OpenMV
    provide direction to Pixracer to get closer to parent based on AprilTag readings
Signal to parent that child latched
Transition to State 3

State 3 (Battery Switching)

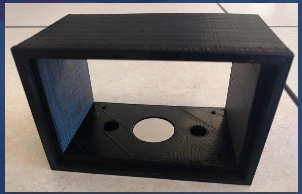
while (signal to unlatch not received from parent)
    remain stationary
Supply power to motors
Send acknowledgement of signal to parent drone
Rapidly take off and return to State 2

TESTING & FUTURE GOALS

CURRENT STATUS

Parent

- Assembled
- Motors function correctly
- Linear actuator design functions
- Battery switching casing 3D printed



Child

- Assembled
- PX4 OS Issues
- Battery switching casing 3D printed

PARENT TESTING

Power Systems

- Individual operation of Pi, flight controller, ESCs, electromagnets
- Ground based flight simulation (combine with Communication tests)

Flight

- Overall stability and GPS accuracy
- Flight response to DJI remote controller signals, directional signals from Pi, in-flight newly added weight

Communication

- Communication with child (GPS placeholder)
- Flight Response to directional wifi signals

CHILD TESTING

Power Systems

- Individual operation of Pi, flight controller, ESCs, electromagnet
- Ground-based battery switching - effect on Pi & Pixracer
- Ground based flight simulation (combine with communication tests)

Flight

- Overall stability and DGPS accuracy
- Flight Response to Pixhawk remote controller, directional signals
- Flight step response (for OpenMV PID control)

Communication

- Communication with child (GPS placeholder)
- Flight Response to directional wifi signals

FUTURE GOALS

End of Fall 2018 Goals:

- Both parent and child drones in flight
- In-flight testing completed

Winter 2019 Goals:

- Finish communication software
- Finish PID control and latching functionality

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Questions?