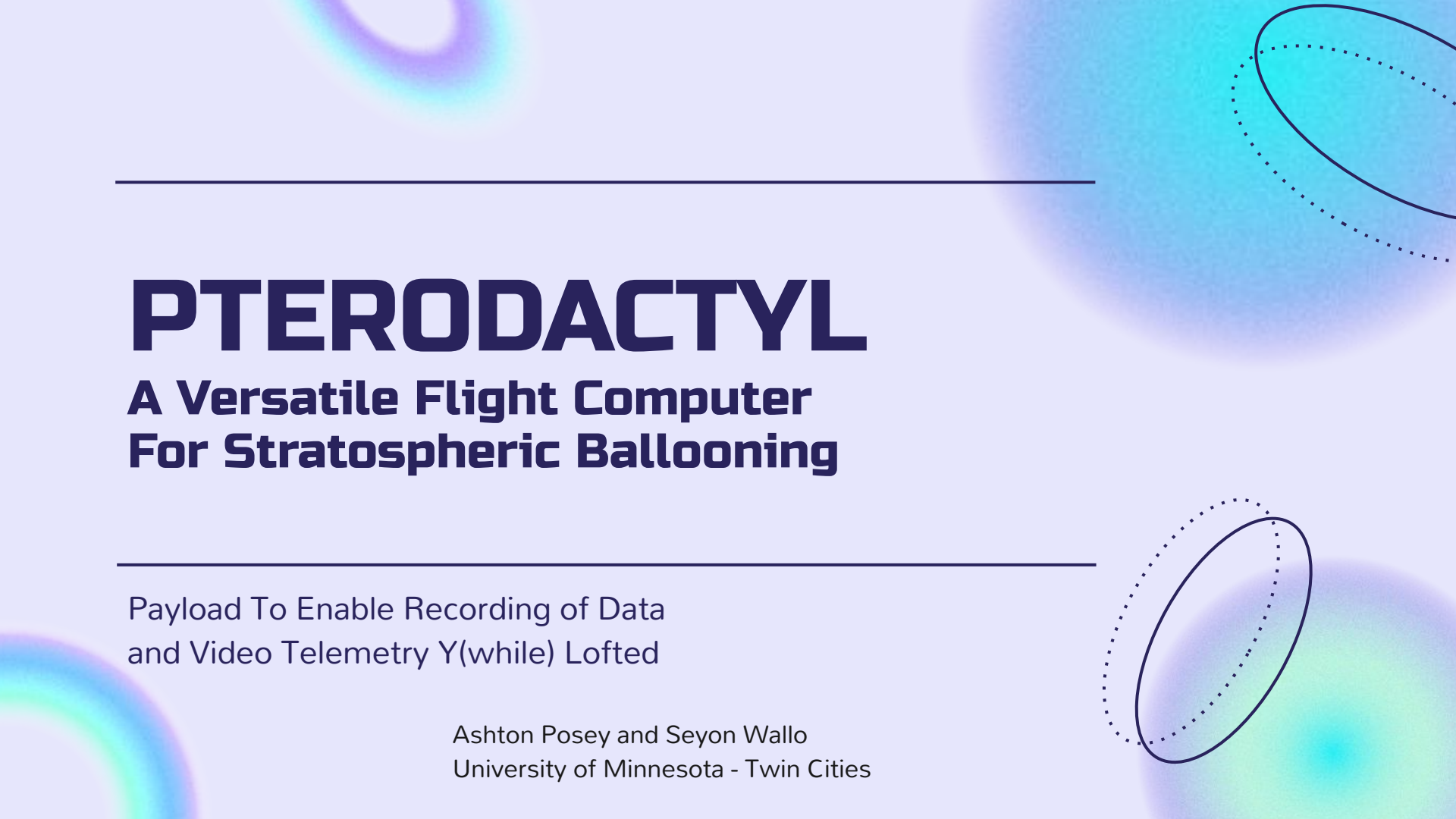

PTERODACTYL

A Versatile Flight Computer For Stratospheric Ballooning

Payload To Enable Recording of Data
and Video Telemetry Y(while) Lofted

Ashton Posey and Seyon Wallo
University of Minnesota - Twin Cities

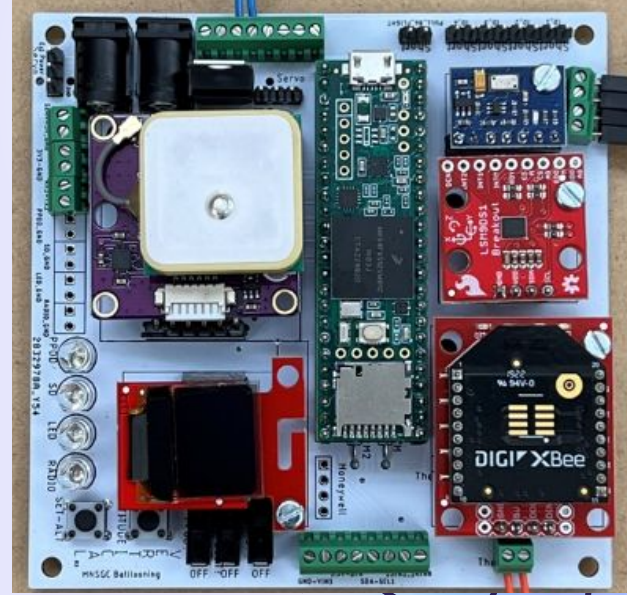


What it is and what it does

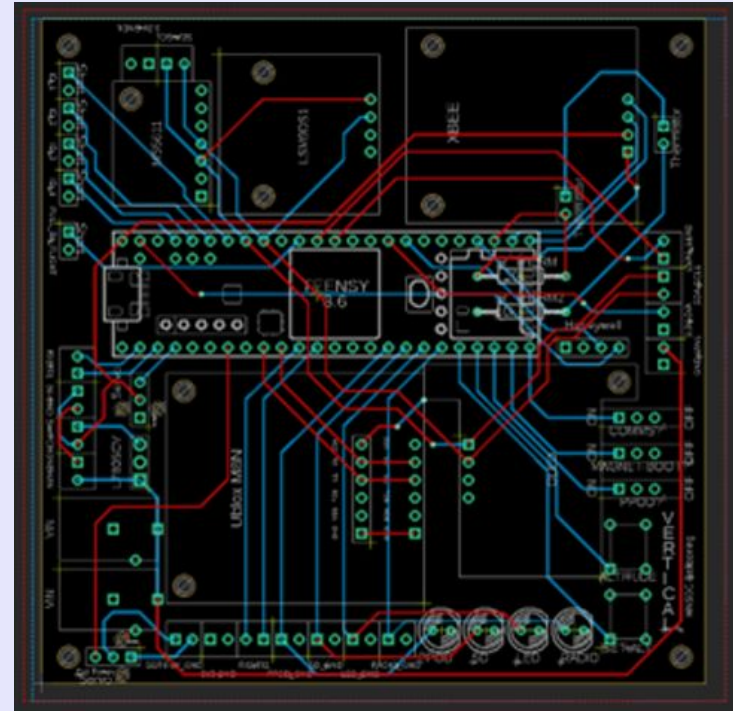
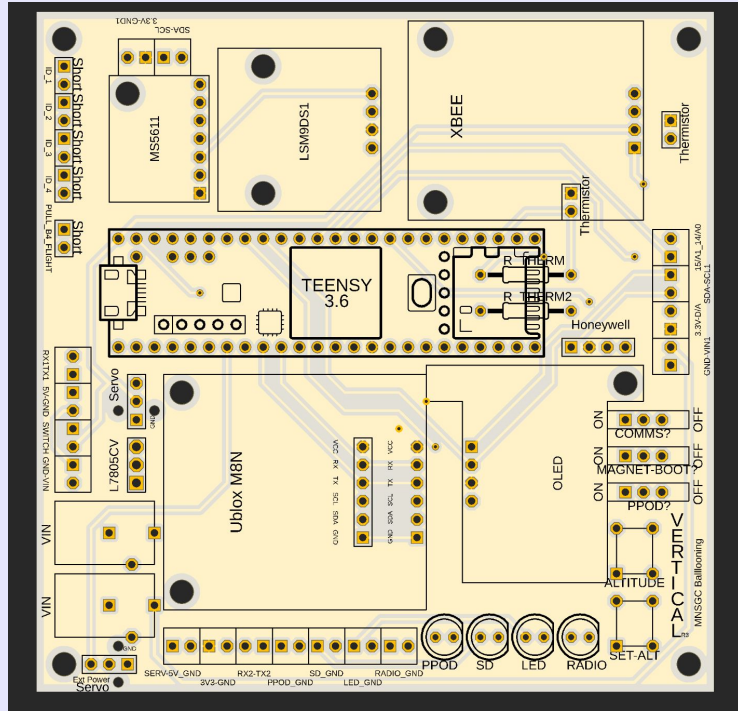
- The PTERODACTYL board is a flight computer that has a ready-to-fly sensor suite with logging and data transmission that allows anyone to become an atmospheric researcher.
- The device takes up a small volume so it can be flown parasitically with other payloads. This allows for supplementary data and additional tracking (gps tags - not necessarily telemetry) to any payload.
- PTERODACTYL only has a mass of 100 grams - add another 40 grams for one 9-volt battery.

1.

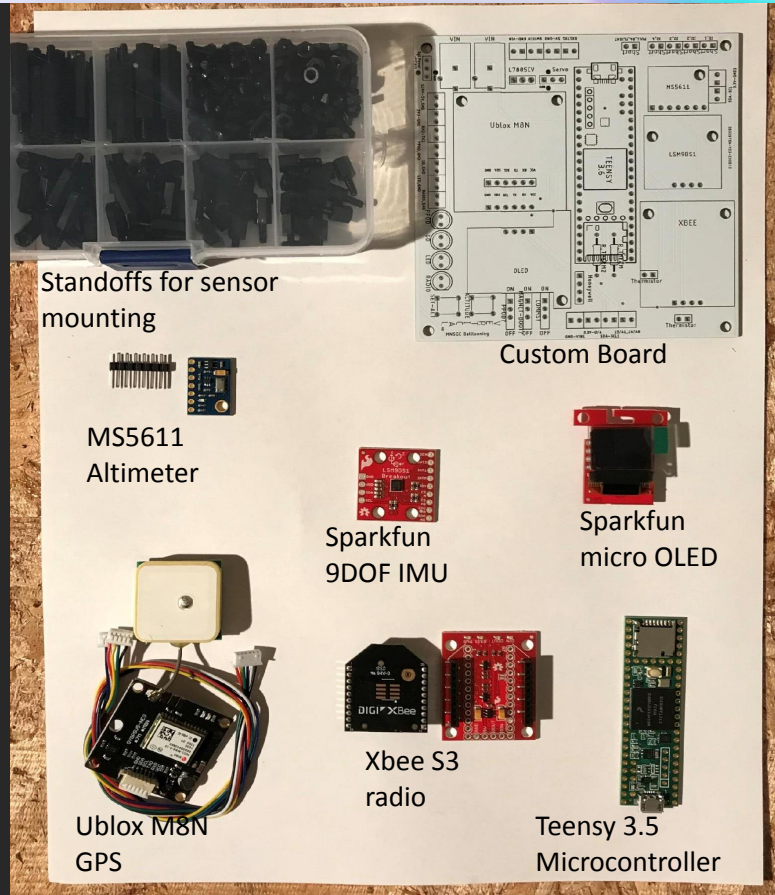
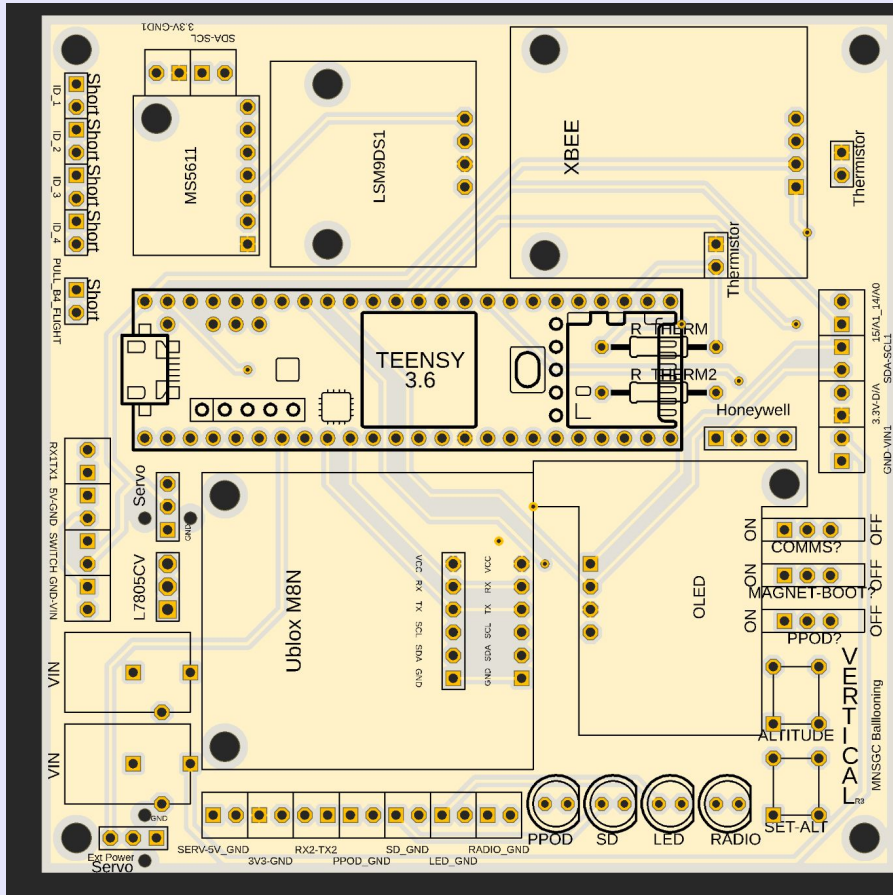
PTERODACTYL V2



PTERODACTYL v2 Hardware



Wiring Diagram + CAM Preview



Standoffs for sensor mounting

Custom Board

MS5611
Altimeter

Sparkfun
9DOF IMU

Sparkfun
micro OLED

Ublox M8N
GPS

Xbee S3
radio

Teensy 3.5
Microcontroller

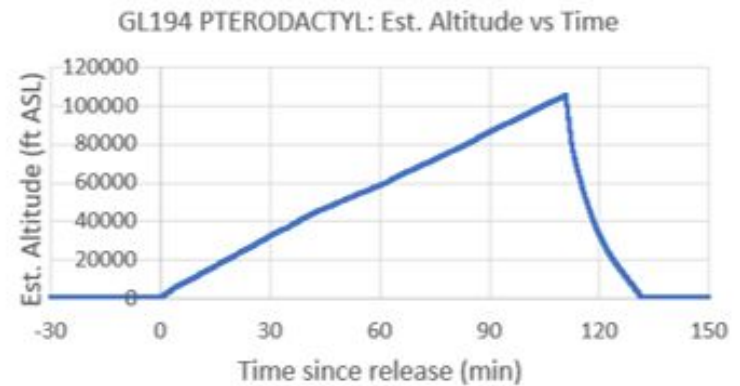
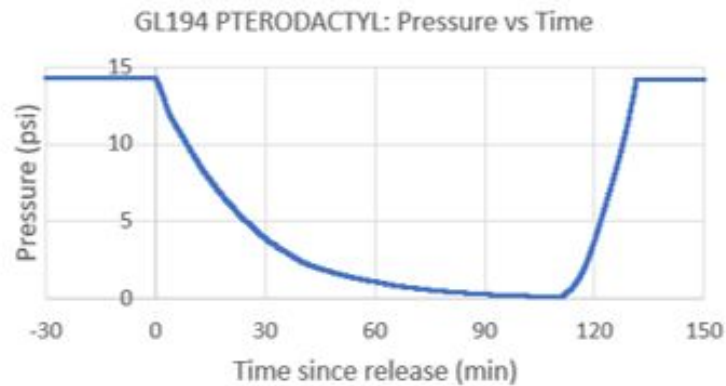
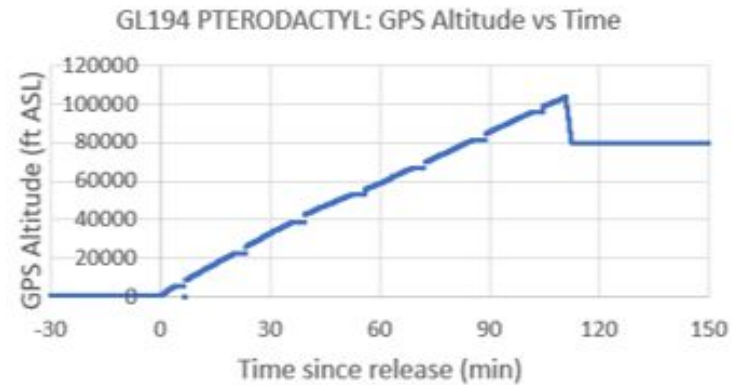
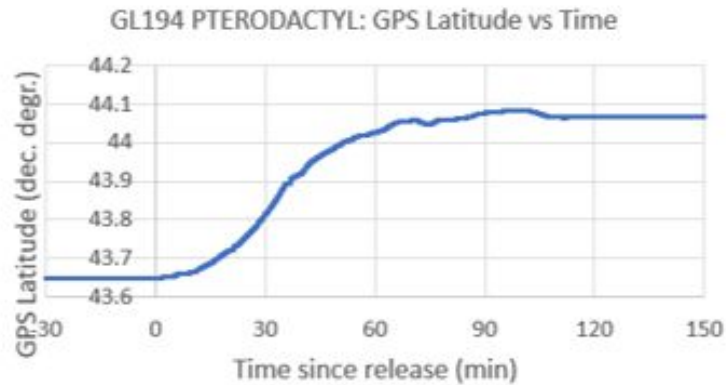
PTERODACTYL v2 Software

- The flight software is written in Arduino using the Arduino IDE to run on the Teensy 3.5 microcontroller. Most sensors utilize open-source libraries to interface with the microcontroller, providing intuitive functions for users.
- Currently, sensor data is transmitted and logged as an ASCII text string in the units shown.

Transmitted Data	Units
Date	month/day/year
Time	hour:minute:second
Latitude	decimal degrees
Longitude	decimal degrees
GPS Altitude	Feet ASL
Altitude From Pressure	Feet ASL
Internal Temperature	Degrees Fahrenheit
External Temperature	Degrees Fahrenheit
Altimeter Temperature	Degrees Fahrenheit
Altimeter Pressure	PSI
Time since bootup	seconds
Recent xbee message	N/A

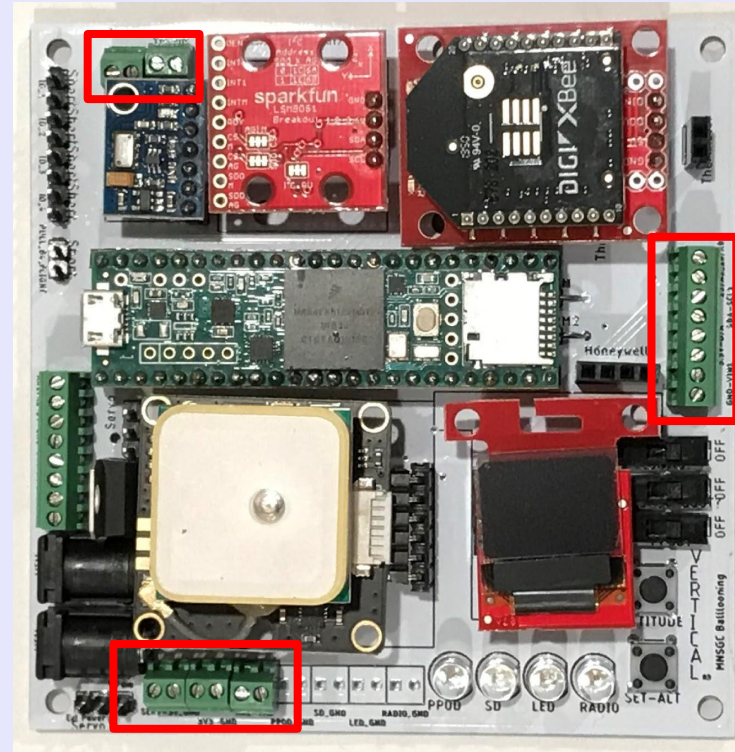
Logged Data	Units
Date	month/day/year
Time	hour:minute:second
Flight Timer	hour:minute:second
Latitude	decimal degrees
Longitude	decimal degrees
GPS Altitude	Feet ASL
Altitude From Pressure	Feet ASL
Internal Temperature	Degrees Fahrenheit
External Temperature	Degrees Fahrenheit
Altimeter Temperature	Degrees Fahrenheit
Altimeter Pressure	PSI
Time since bootup	seconds
Magnetometer X	Gauss
Magnetometer Y	Gauss
Magnetometer Z	Gauss
Accelerometer X	g's
Accelerometer Y	g's
Accelerometer Z	g's
Gyroscope X	degrees /second
Gyroscope Y	degrees/second
Gyroscope Z	degrees/second
Recent xbee message	N/A

Data



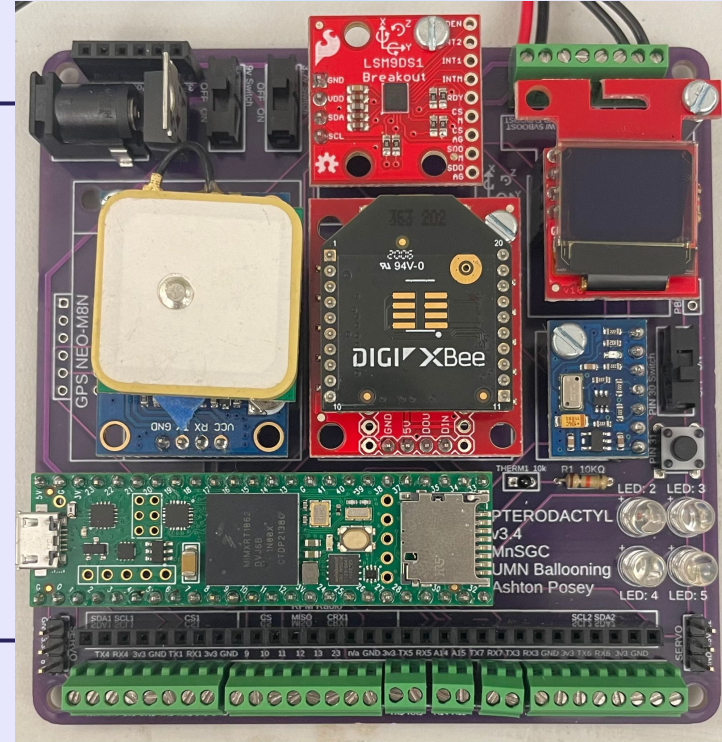
Additional Applications

- Around the PTERODACTYL are terminal ports that allow for additional sensors to be added
- We've added multiple QUIIC sensors for different experiments throughout the years including an ambient light sensor, environmental sensor, and humidity sensor.
- We've also added a second Xbee to use the PTERODACTYL as a relay on our SatCom Project



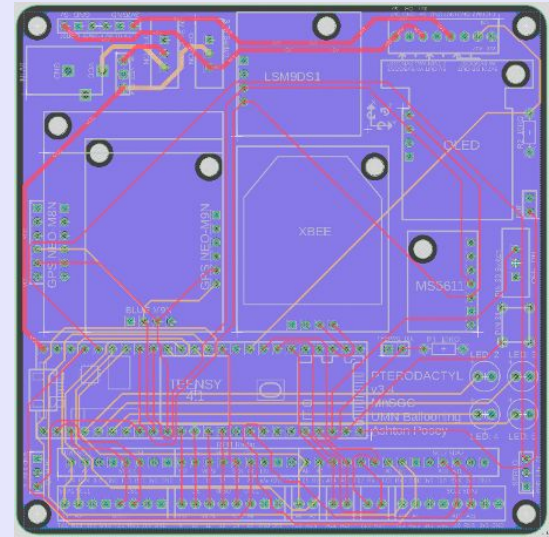
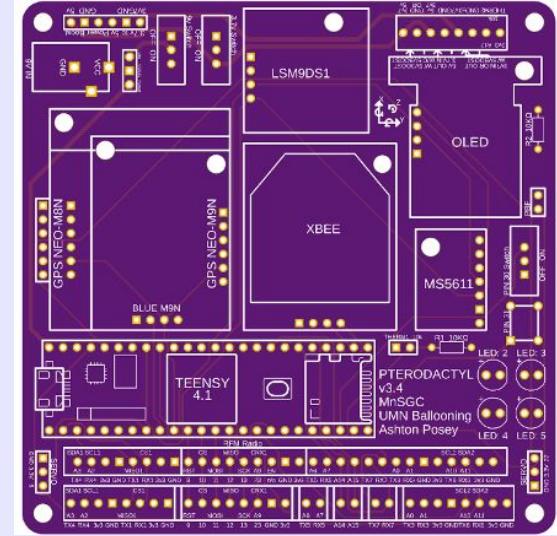
2.

PTERODACTYL v3.4



PTERODACTYL V3 Hardware

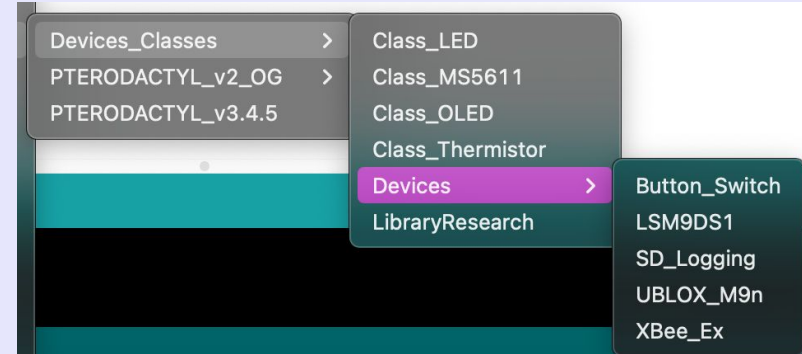
- Upgraded to Teensy 4.1
- Same 10cmx10cm design
- Using all the same sensors as the PTERODACTYL v2
- 9v Battery dropped to 5v, 3.7v Lipo boosted to 5v with a PowerBoost 1000mAh, and 5v Micro-USB powerable device
- 5v Outputs for external 5v devices
- Power inputs/outputs located at the top
- Breakout for data pins and 3.3v/GND located at the bottom
 - Added RFM radio slot
 - Two servo connections
- User information outputs on the right side



PTERODACTYL V3 Software

- The flight software is written in Arduino using the Teensyduino IDE to run on the Teensy 4.1 microcontroller.
- Coded classes for certain devices to slim down the main code and focus on the methods executed by the Teensy
- Hid the classes in Libraries & created examples in order to make it easy to learn about all of the devices on the PTERODACTYL
- Setup() procedure example
 - GPS offline example
- Relay/Data Logging example

```
#include <PT_LED.h>
#include <PT_Thermistor.h>
#include <PT_OLED.h>
#include <PT_MS5611.h>
#include <SparkFunLSM9DS1.h>
#include <UbloxGPS.h>
#include <SoftwareSerial.h>
#include <OneWire.h>
#include <Wire.h>
#include <SPI.h>
#include <SD.h> //
```



Data Set

PTER01

T(h:m:s)	FT(h:m:s)	T(sec)	Date	Time	Lat	Lon	Alt(m)	Alt(ft)	Sats	intT(C)	intT(F)	extT(C)	extT(F)	msTemp(C)	msTemp(F)	msPress(PSI)	msPress(ATM)	msAlt(ft)	msAlt(M)	magnetometer x	magnetometer y	magnetometer z	accelerometer x	accelerometer y	accelerometer z	gyroscope x	gyroscope y	gyroscope z	xbee message
0:00:20	N/A/N/A/N/A	20	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0	22.42	72.36	21.37	70.50	23.90	75.02	14.43	0.98	535.03	163.08	0.03	0.10	-0.85	0.00	-0.04	0.99	0.46	0.52	1.18	
0:00:21	N/A/N/A/N/A	21	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0	22.42	72.36	21.39	70.50	23.91	75.04	14.43	0.98	535.03	162.99	0.03	0.10	-0.85	0.00	-0.04	1.00	0.49	0.45	1.26	
0:00:22	N/A/N/A/N/A	22	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0	22.44	72.40	21.39	70.50	23.92	75.06	14.43	0.98	535.86	163.25	0.03	0.10	-0.84	0.00	-0.04	1.00	0.33	0.26	1.07	
0:00:23	N/A/N/A/N/A	23	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0	22.44	72.36	21.46	70.50	23.93	75.07	14.43	0.98	534.75	163.16	0.03	0.10	-0.83	0.00	-0.04	1.00	0.40	0.43	1.33	
0:00:24	N/A/N/A/N/A	24	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0	22.44	72.40	21.39	70.50	23.93	75.07	14.43	0.98	534.48	162.99	0.02	0.10	-0.83	0.00	-0.05	1.00	0.39	0.33	1.26	

XBEE01

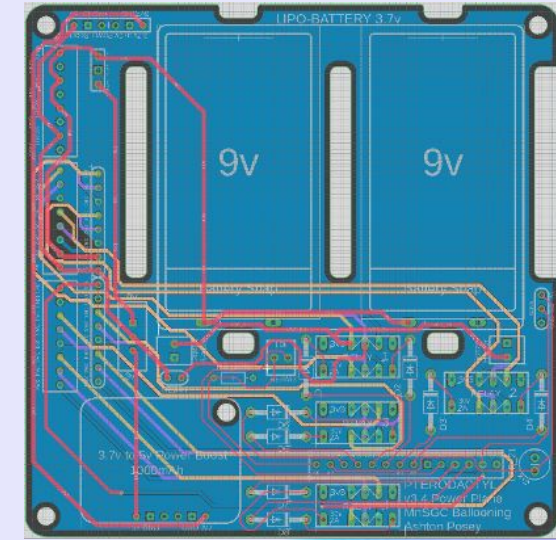
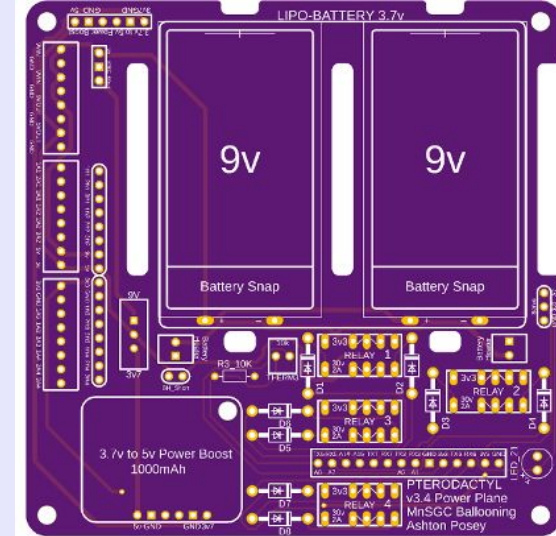
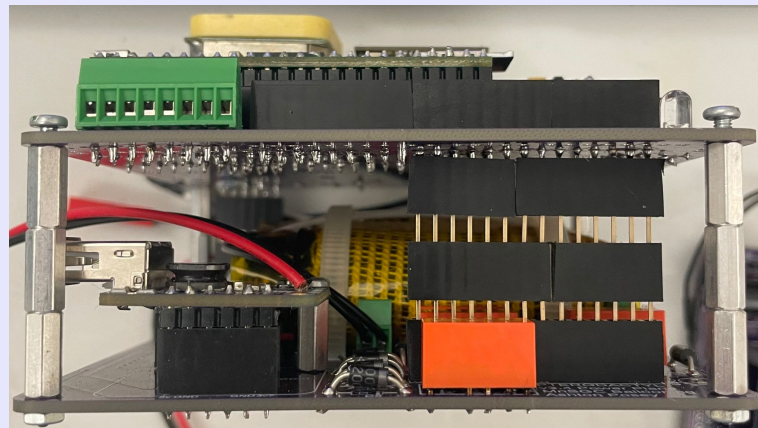
T(h:m:s)	FT(h:m:s)	T(sec)	Date	Time	Lat	Lon	Alt(m)	Alt(ft)	Sats	intT(C)	intT(F)	extT(C)	extT(F)	msTemp(C)	msTemp(F)	msPress(PSI)	msPress(ATM)	msAlt(ft)	msAlt(M)	magnetometer x	magnetometer y	magnetometer z	accelerometer x	accelerometer y	accelerometer z	gyroscope x	gyroscope y	gyroscope z	xbee message		
+++	DATA STRING RECEIVED																														
0:00:51	N/A/N/A/N/A	51	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0			22.97	73.47	21.98	71.57	24.57	76.23	14.43	0.98	531.98	162.06	0.03	-0.04	-0.31	-0.04	-0.02	0.99	2.34	1.96	-3.48	DATA STRING RECEIVED
0:00:56	N/A/N/A/N/A	56	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0			22.97	73.31	22.05	71.65	24.63	76.33	14.43	0.98	531.14	161.98	0.03	-0.03	-0.30	-0.04	-0.02	0.99	2.50	1.99	-3.62	DATA STRING RECEIVED
0:01:01	N/A/N/A/N/A	61	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0			22.93	73.27	22.03	71.65	24.62	76.32	14.43	0.98	531.70	162.32	0.03	-0.04	-0.30	-0.04	-0.02	0.99	2.62	2.24	-3.65	DATA STRING RECEIVED
0:01:06	N/A/N/A/N/A	66	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0			22.93	73.31	22.05	71.73	24.61	76.30	14.43	0.98	531.98	162.32	0.02	-0.03	-0.30	-0.04	-0.02	0.98	2.78	2.15	-3.67	DATA STRING RECEIVED
0:01:11	N/A/N/A/N/A	71	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0			22.91	73.23	22.00	71.61	24.60	76.26	14.43	0.98	532.53	161.98	0.03	-0.04	-0.30	-0.04	-0.02	0.99	2.37	2.00	-3.72	DATA STRING RECEIVED
0:01:16	N/A/N/A/N/A	76	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0			22.93	73.27	21.87	71.53	24.59	76.26	14.43	0.98	532.25	162.32	0.03	-0.04	-0.31	-0.04	-0.02	0.99	2.49	2.20	-3.80	DATA STRING RECEIVED
0:01:21	N/A/N/A/N/A	81	0/0/2000	-5:0:0	0.00000000	0.00000000	0.00	0.00	0			23.04	73.47	22.14	71.85	24.62	76.30	14.43	0.98	532.53	162.06	0.03	-0.03	-0.31	-0.04	-0.02	0.99	2.48	2.14	-3.77	DATA STRING RECEIVED

T(h:m:s)	FT(h:m:s)
FLIP	DATA STRING RECEIVED
FLIP	DATA STRING RECEIVED
FLIP	DATA STRING RECEIVED

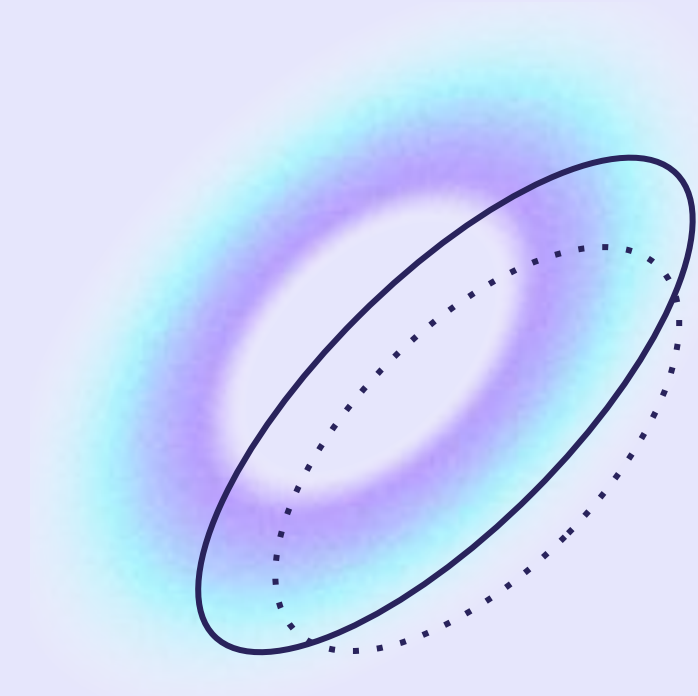
Recent XBee Message

Power Plane v3

- PTERODACTYL Shield that allows it to hold one 10000mAh Lipo Battery or two 9v batteries.
- 4 Relays to power the battery heater and other accessories such as a siren to help with recovery.
- Servo/LED output.
- 5v USB-A output for other microcontrollers, cameras or other devices.



Thank You!
Questions?



Parts List

BASIC PARTS	cost ea	# needed	total cost
PTERODACTYL v3.4 PCB (5 pack) (.zip is the gerber files)	8	0.2	1.6
Teensy 4.1 without headers	26.25	1	26.25
USB 3-way cable for programming Teensy, charging batteries (NO LONGER AVAILABLE)	6.97	1	6.97
9V battery snap no jack	0.71	2	1.42
8 Gig microSD card class 10 with SD adapter	11.95	1	11.95
L7805CV 5V voltage regulator (NOT USED, IF POWERED BY 3.7 V BATTERIES)	0.69	1	0.69
uBlox M8N gps (could switch to M9N instead)	48.99	1	48.99
source for M9N, if you are allowed to order from AliExpress	~48.31	1	
LSM9051 9DOF IMU (RETIRED PRODUCT)	15.95	1	15.95
thermistor 10k	3.74	2	7.48
resistor for thermistor divider (1%) 10k	0.61	2	1.22
MSS611 pressure sensor (3-pack)	ON SALE 17.99	0.333	5.99067
OLED (miniature screen)	18.5	1	18.5
XBee3 radio	25.61	1	25.61
XBee breakout board	11.95	1	11.95
LED (with built-in resistors) (20 pack) (4 colors)	9.95	0.2	1.99
male/male jumper wires (30 pack)	2.45	0.2	0.49
male/female extender wires (40 pack)	3.95	0.1	0.395
battery jack (solder in)	0.82	2	1.64
male headers strips (first option for Teensy)	1.53	3	4.59
female header strips (first option for Teensy)	1.09	3	3.27
passthrough header set (second option for Teensy)	1.95	2	3.9
2-position terminal blocks	1.78	3	5.34
8-position terminal blocks	7.48	3	22.44
HEX STANDOFF M2.5X0.45 ALUM 11MM	0.67	5	3.35
MACH SCREW PAN SLOTTED M2.5X0.45	0.48	5	2.4
HEX NUT 0.197" STEEL M2.5	0.18	5	0.9
Slide switch	0.76	3	2.28
Momentary switch (pushbutton)	0.13	1	0.13