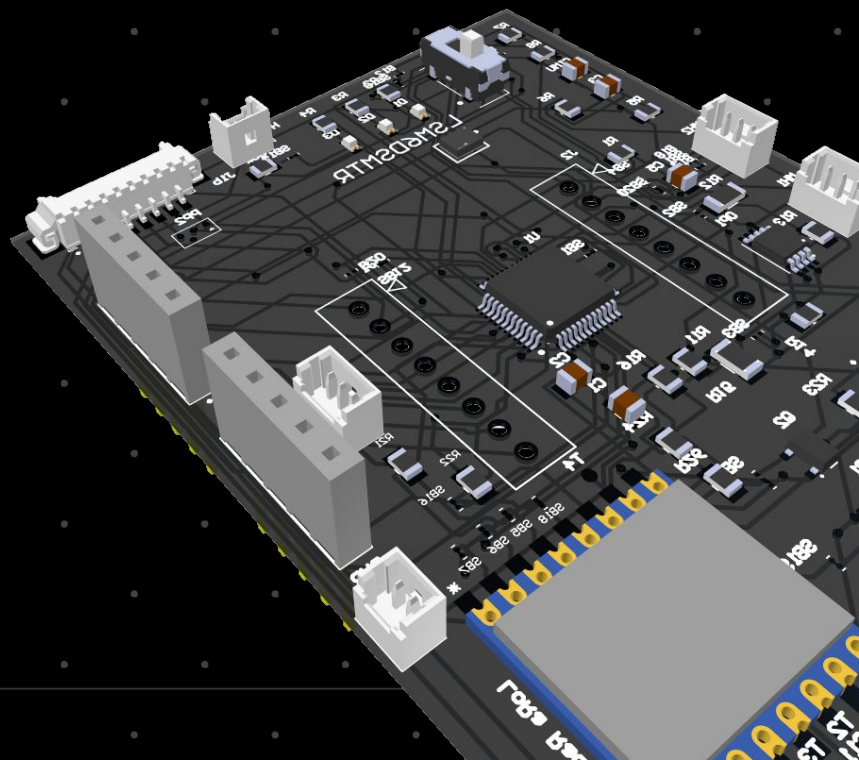
Q-Sat PDR

Preliminary Definition Review

Names: Anton, Jasper, Joel, Taine, William
Team: Questionable Satellites
Date: 2024-12-01

github.com/questionable-innovations/APSS-Reference-PCBs



PDR Outline

1. **Concept**
   a. Concept Definition
   b. Measures of Effectiveness
   c. Technical Schedule
   d. Requirements
2. **Solution**
   a. Design Solution Definition
   b. Diagrams
   c. Subsystems & ConOp
   d. Interfaces
   e. Implementation Plans
   f. Technical Measures of Effectiveness
   g. Validation Plans

1. Concept

Flying A Camera

Concept Review

The MOST RETRO PSAT

Measures of Effectiveness

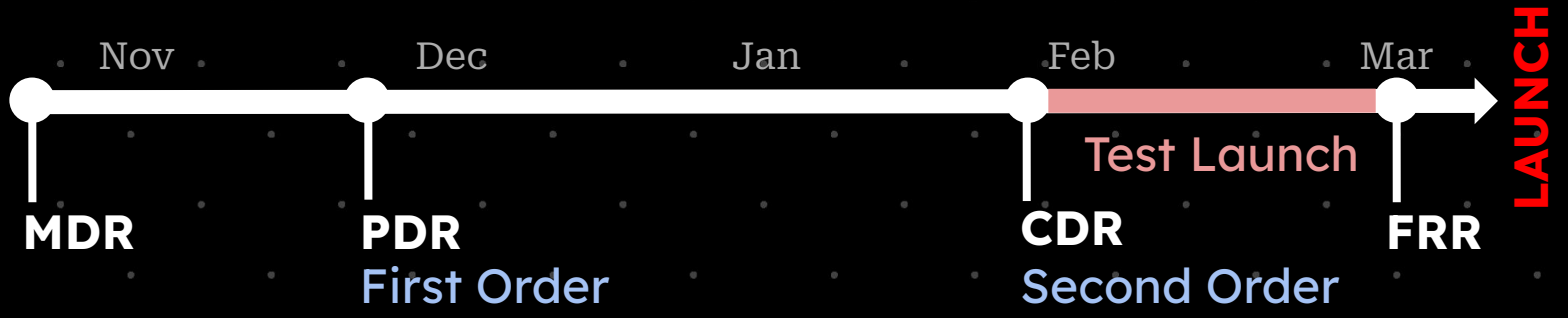
1. Number of photos taken
2. Quality of film post-flight
3. Quality of photos post-development

Target: Take at least one photo of identifiable features.

Technical Schedule

Timeline:

- 30th November - 1st order due & Preliminary Design Review (PDR)
- 20th January- 2nd order due & Critical Design Review (CDR)
- February - Test Launch
- Start of March - Launch & Flight Readiness Review (FRR)



High-Level Requirements

Req Code	Description	Parent Requirement	Reasoning
REQ-01	Shall Deploy at Apogee	REQ-02, REQ-03	Payload must eject from the rocket body for the camera to take a photo
REQ-02	Shall take up to 4 photos during deployment, and up to 20 photos during descent	Objective	Mission Objective
REQ-03	Shall record time-stamped data and digital photography	Objective	Objective validation and photograph info
REQ-04	Shall be recoverable	Objective	Mission Objective - Film must be recovered for processing

Subsystem Requirements - Electrical

Req Code	Description	Parent Requirement	Reasoning
ELEC-01	Shall supply a maximum of 0.63A to servos (stall current - for winding)	REQ-02	Required for camera operation. (Objective)
ELEC-02	Shall supply a maximum of 400mA to computing and data systems	REQ-02, REQ-03, REQ-04	Should be able to support each digital subsystem all running at max power draw
ELEC-03	Battery must supply at least 1000mAh	ELEC-01	Roughly calculated energy requirements given power draw of components

Subsystem Requirements - Command & Data

Req Code	Description	Parent Requirement	Reasoning
CDH-01	Shall take and store digital photos at the same time as film	REQ-03	Objective validation and photograph info
CDH-02	Shall report live data back to the ground control unit via LoRa	REQ-04	Monitoring to help ensure objective will be attained and unit recovered
CDH-03	Shall store timestamped accelerometer and gyro data as well as when photos are taken	REQ-03	Keeps data for validation and statistics purposes
CDH-04	Shall have a processor to read data and activate shutter	REQ-02	We need a way to interpret the data and send commands to activate shutter servo

Subsystem Requirements - Camera & Environment

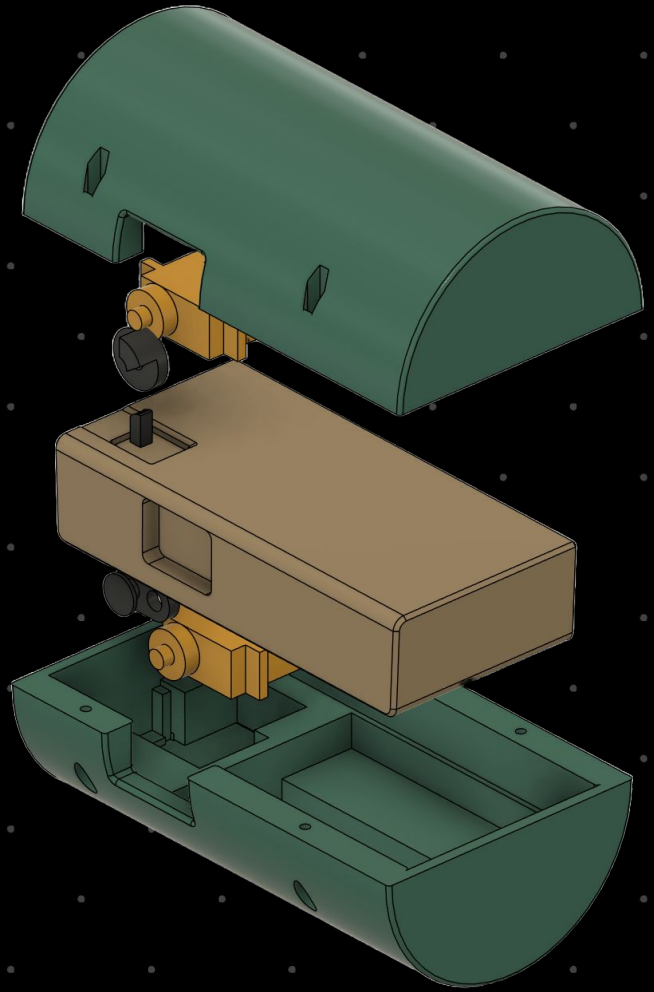
Req Code	Description	Parent Requirement	Reasoning
CMEV-01	Shall allow access to film pre & post flight	Objective, REQ-04	Needs access for Pre-launch processing & Post launch Recovery
CMEV-02	Shall not leak light in its modified form	REQ-04	If the film is prematurely exposed, then exposing the film for photos will have no effect
CMEV-03	Shall not allow for significant damage of camera upon landing	CMEV-01, CMEV-02, REQ-04	Film & camera must be intact to consider recovery a success. So camera can be reused and film can be developed

Subsystem Requirements - Mechanical

Req Code	Description	Parent Requirement	Reasoning
MECH-01	Shall repeatedly reload Film	REQ-02, REQ-03	Film must be reloaded to allow for multiple photos, sometimes more then once per photo
MECH-02	Shall repeatedly activate shutter	REQ-02, REQ-03	Shutter must be repeatedly pressed to take multiple photos
MECH-03	Shall hold all parts stable through flight	REQ-04, REQ-02, REQ-03	Boards, mechanisms & PSat body needs to be held together through flight and deployment to keep internal system stable
MECH-04	Shall fit into rocket body when stowed for flight	Objective	To Allow for launch, the whole PSat must fit in the body alongside the parachute, shock cord & nose cone lip

2. Solution

Mission Design

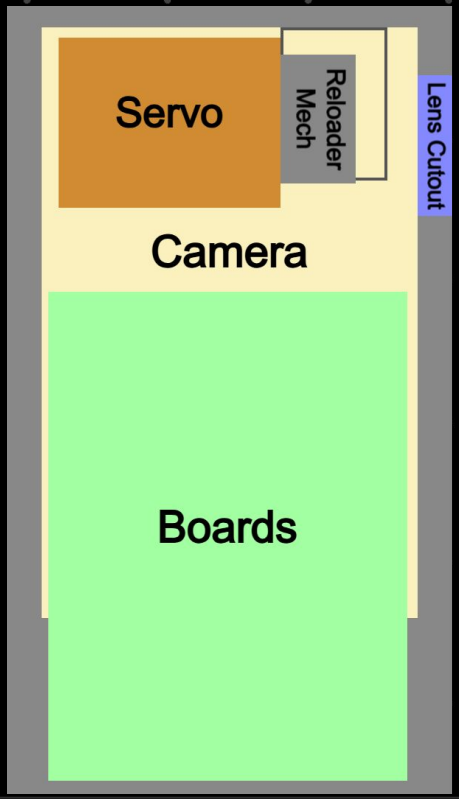


Design Solution Definition

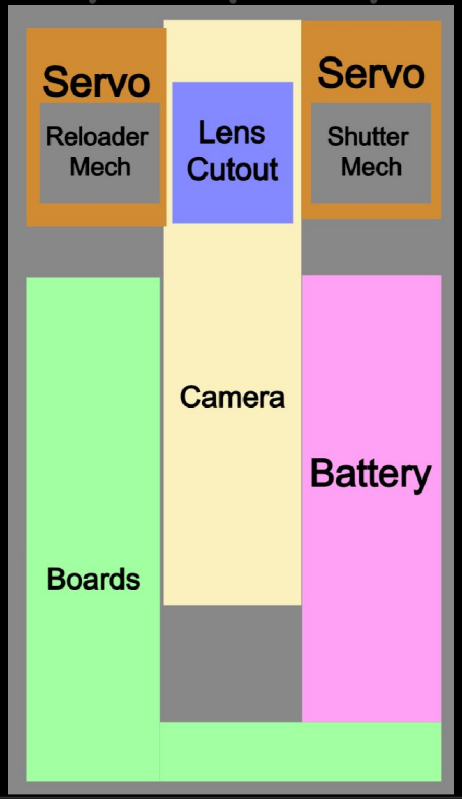
- One member found a small film camera to take photos. We will mount it to a capsule & create a system to automatically take photos.
- There will be a lot of chaotic movement on descent, so need a way to stablize the camera on descent.
- Photos will look best at apogee, but will have high motion blur at deployment. So the shutter will be programmed to fire at set times.
- Film must be contained onboard, and in the dark at all times. We will be removing the camera's viewfinder which means we cannot rely on the camera's body to block all the light.

Design Diagrams

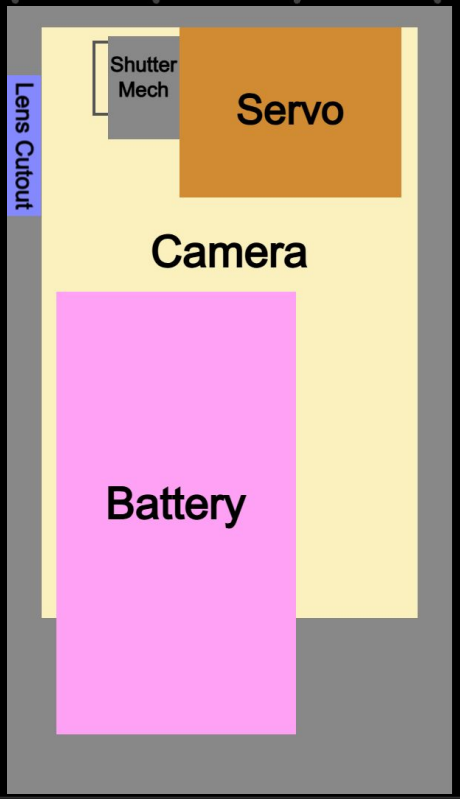
Left



Center

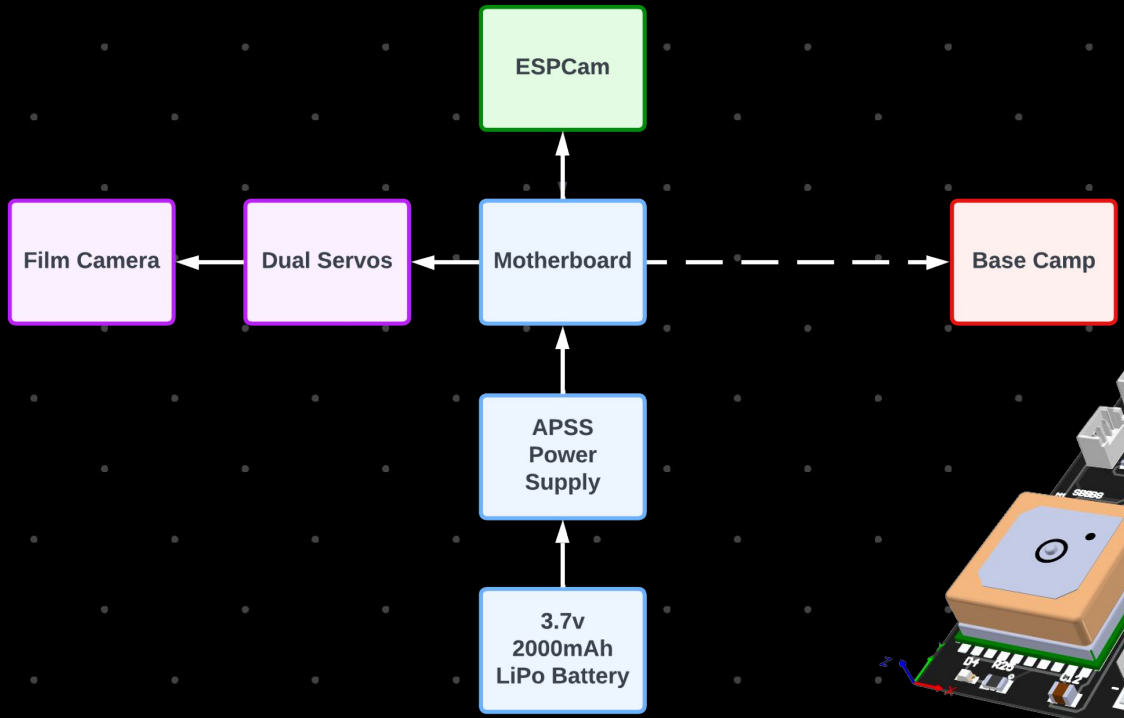


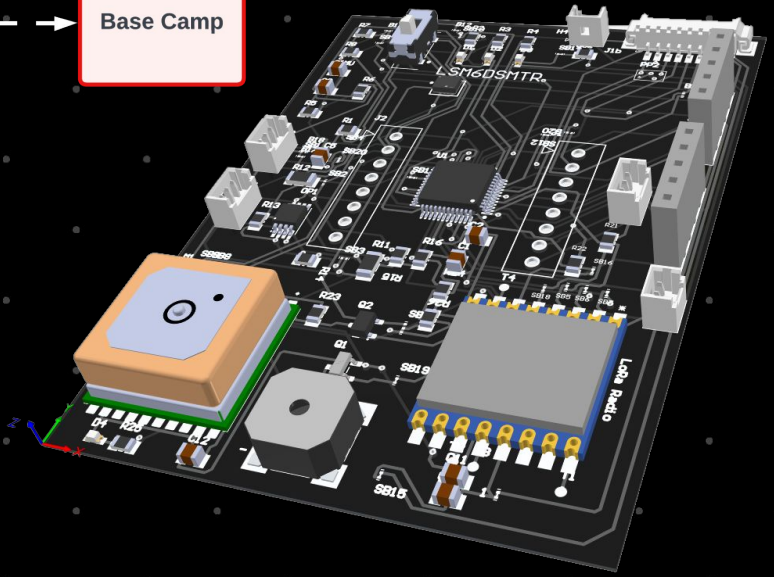
Right



Electrical Subsystem

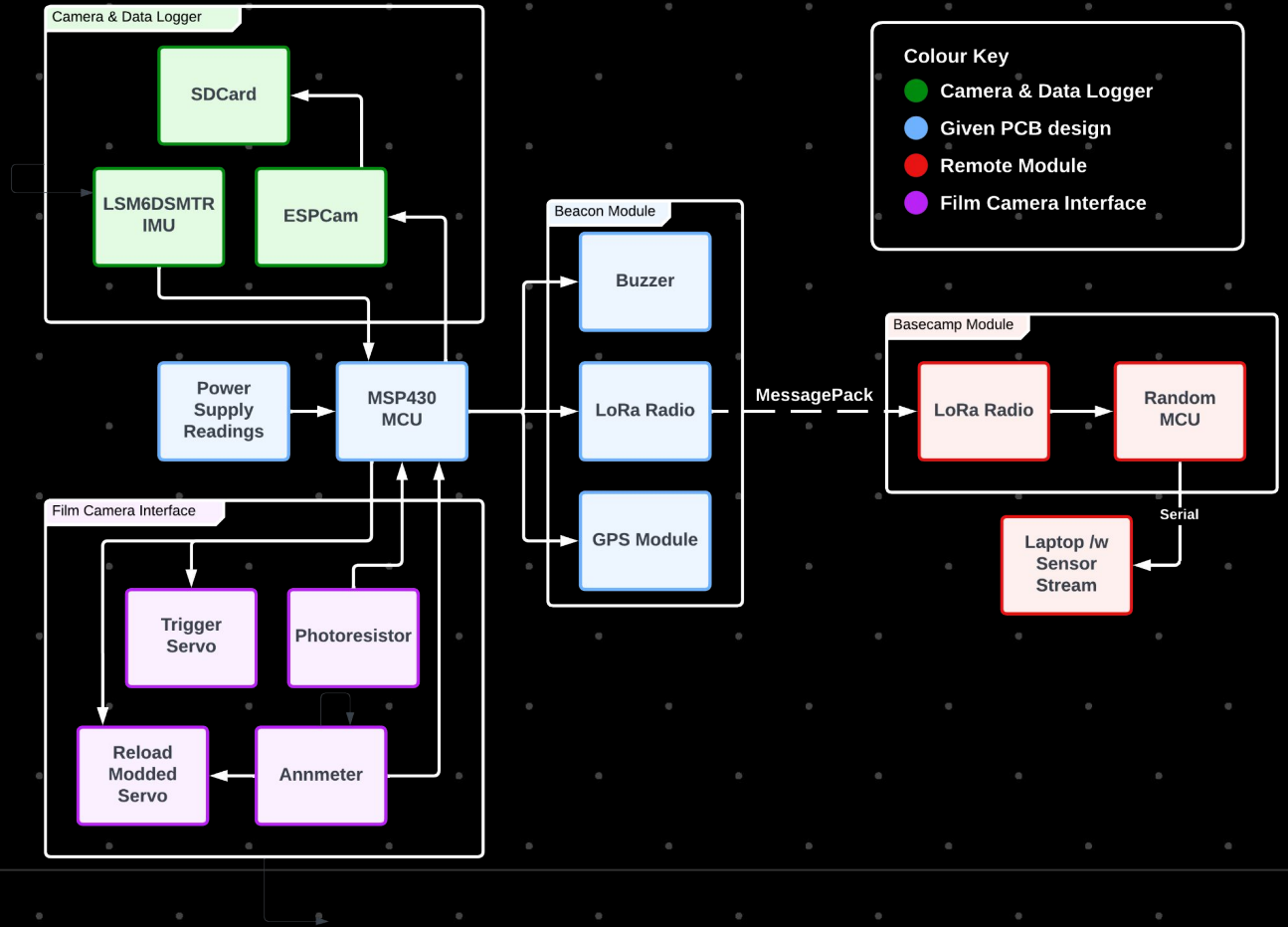
OVERVIEW





Electrical Subsystem

OPERATIONS



Mechanical Subsystem

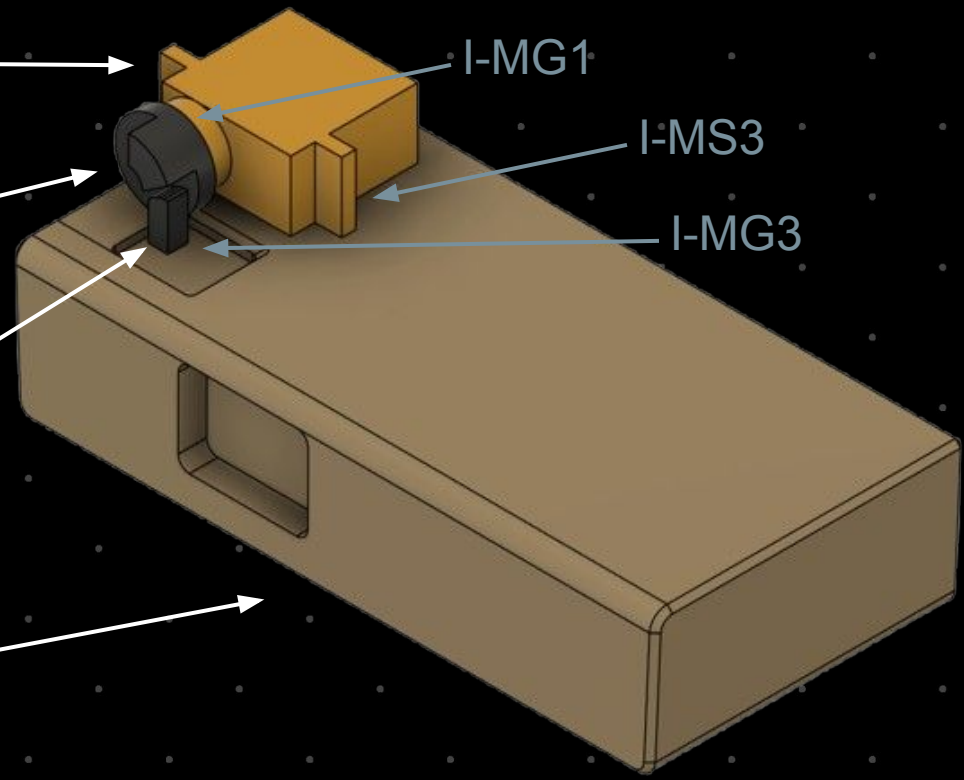
SHUTTER

9 Gram Servo
Supplied
2x M2, 6mm Screws

Shutter Swing Arm
3D Printed
Used To Push Pusher Arm
Glued Onto Servo Arm

Pusher Arm
3D Printed
Pushes On Shutter Button
Glued Onto Shutter

Camera
Supplied



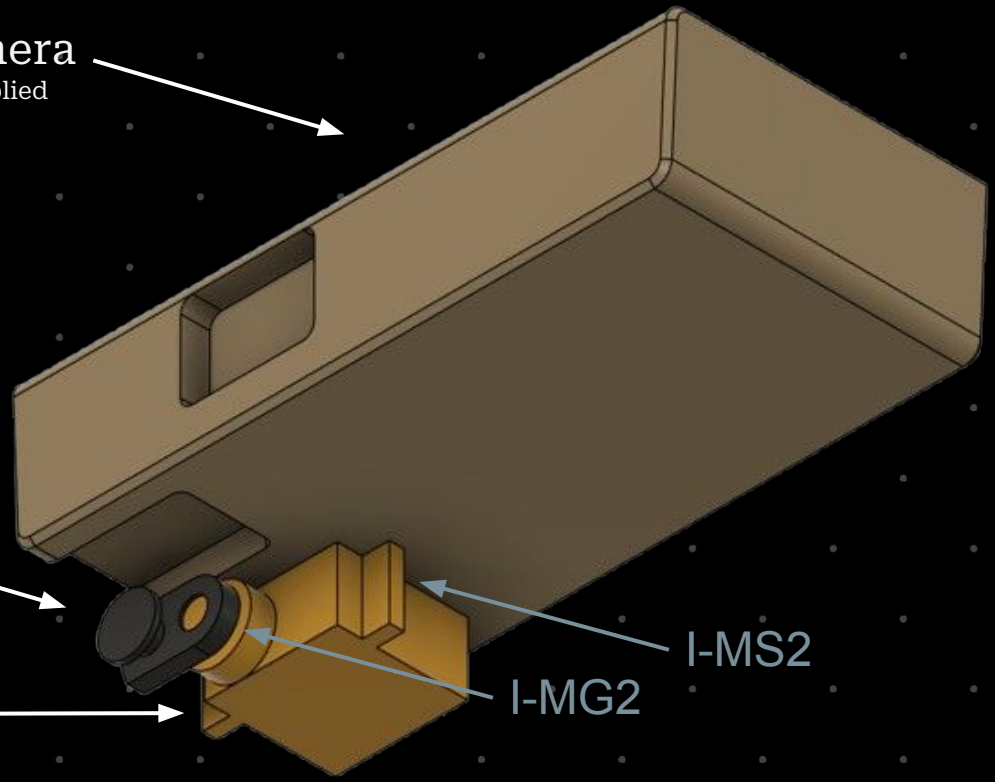
Mechanical Subsystem

RELOADER

Camera
Supplied

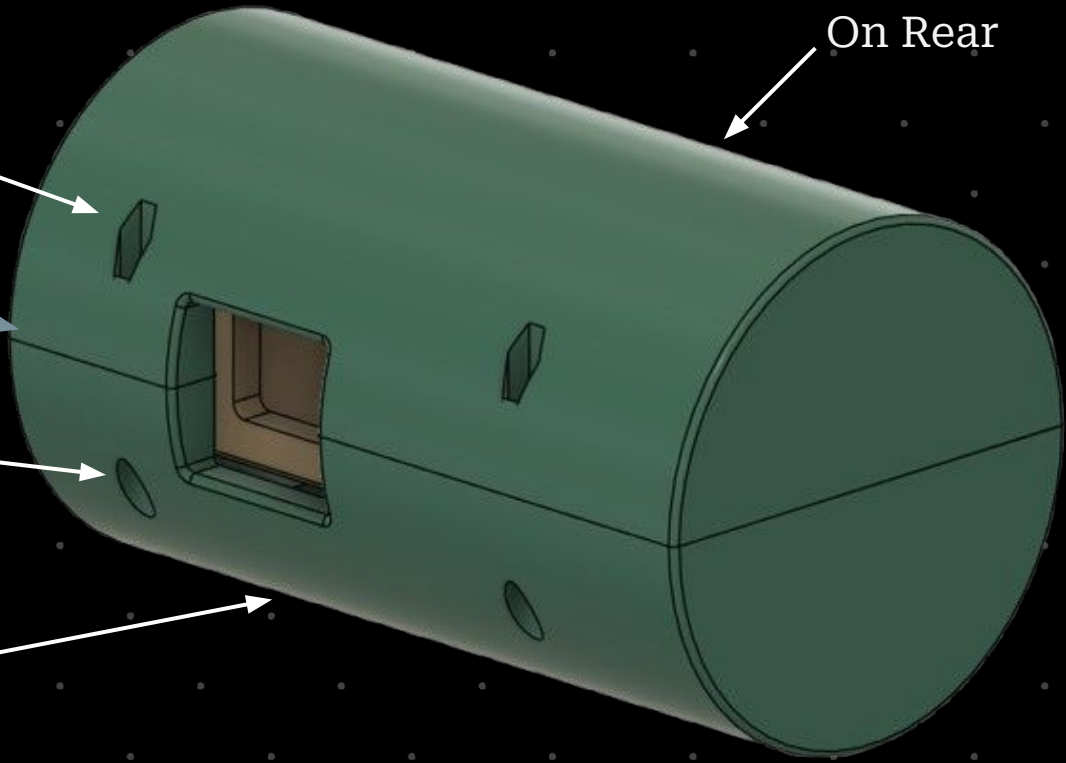
Reloader Swing Arm
3D Printed
Used To Pull Reloader Via Fishing Line
Camera Has Built In Spring For Return
Glued Onto Servo Arm

9 Gram Servo
Supplied
2x M2, 6mm Screws



Mechanical Subsystem

BODY



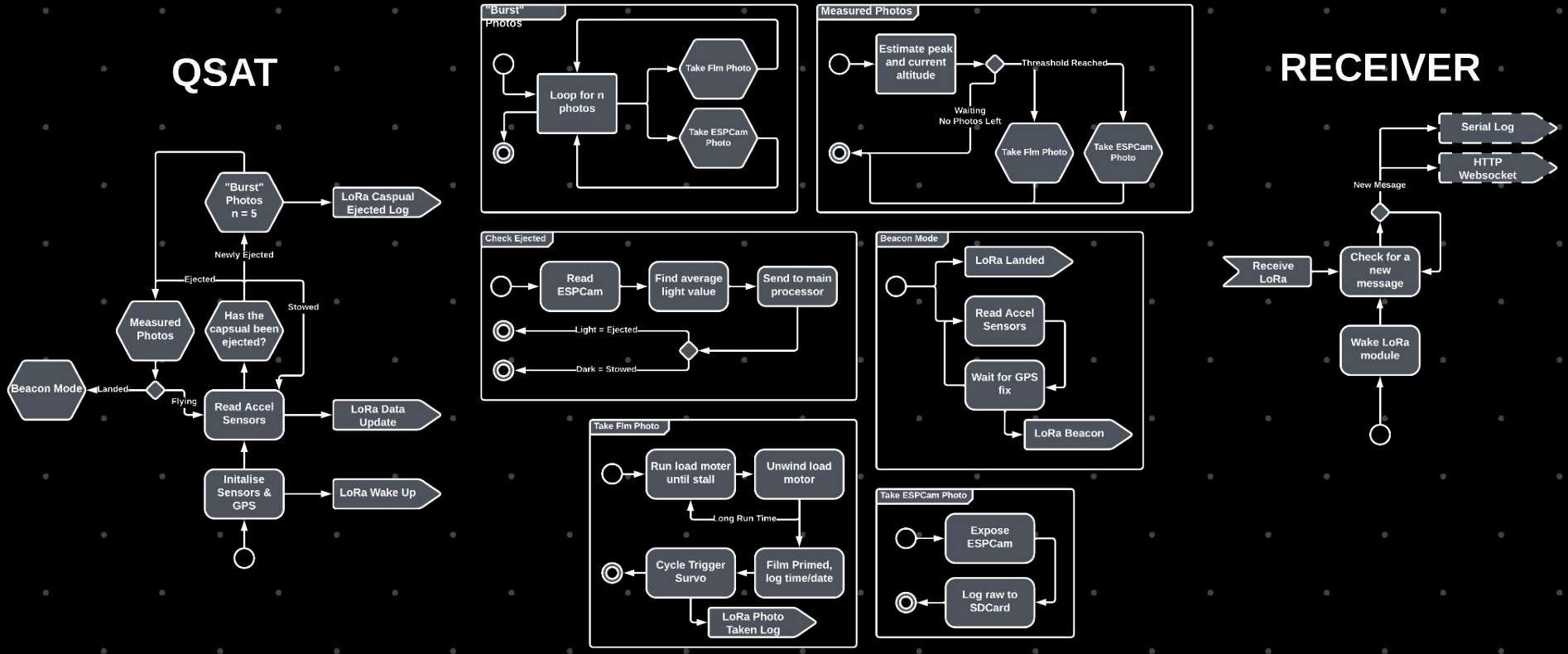
Hex Nut
M2.5
Sits In Hex Cavity

I-MS1

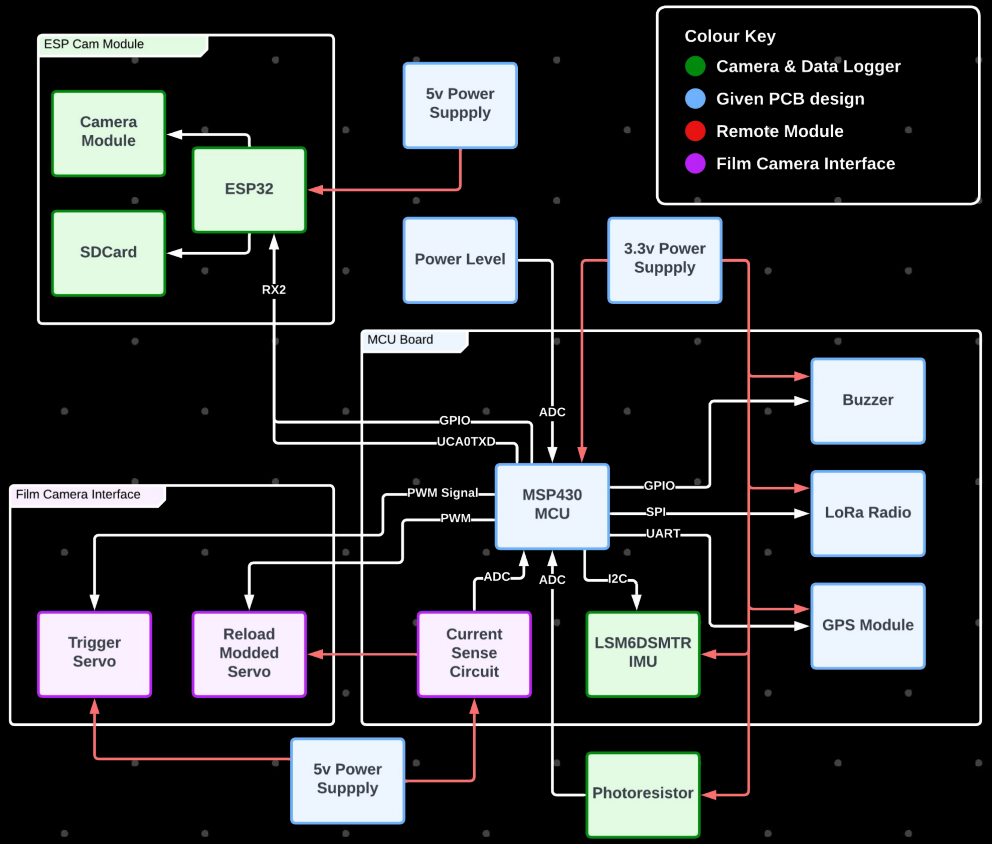
Screws
M2.5
Phillips
20mm long
Sits In Cylindrical Cavity

Shells
3D Printed

Concept Of Operations



Interface Definitions - Electrical



MSP Pin Definitions

# Pin PT	SIGNAL NAME (1) (2)	SIGNAL TYPE(3)	BUFFER TYPE(4)	POWER SOURCE	RESET STATE AFTER BOR(5)	Useable	USE CLASS	USE NOTES
1	P1.2	I/O	LVCMOS	DVCC	OFF	☑	LoRa	SPI Master Out
	UCB0SIMO	I/O	LVCMOS	DVCC	–			
	UCB0SDA	I/O	LVCMOS	DVCC	–			
	TB0TRG	I	LVCMOS	DVCC	–			
	OA0-(6)	I	Analog	DVCC	–			
	A2	I	Analog	DVCC	–			
	Veref-	I	Analog	DVCC	–			
2	P1.1	I/O	LVCMOS	DVCC	OFF	☑	LoRa	SPI Clock
	UCB0CLK	I/O	LVCMOS	DVCC	–			
	ACLK	O	LVCMOS	DVCC	–			
	OA0O(6)	O	Analog	DVCC	–			
	COMP0_1	I	Analog	DVCC	–			
	A1	I	Analog	DVCC	–			
3	P1.0	I/O	LVCMOS	DVCC	OFF	☐	MSP Config	Vref+
	UCB0STE	I/O	LVCMOS	DVCC	–			
	SMCLK	O	LVCMOS	DVCC	–			
	COMP0_0	I	Analog	DVCC	–			
	A0	I	Analog	DVCC	–			
	Veref+	I	Analog	DVCC	–			
4	TEST	I	LVCMOS	DVCC	OFF	☐	Nothing Assigned	
	SBWTCK	I	LVCMOS	DVCC	–			
5	RST	I/O	LVCMOS	DVCC	OFF	☐	Nothing Assigned	
	NMI	I	LVCMOS	DVCC	–			
	SBWTDIO	I/O	LVCMOS	DVCC	–			
6	DVCC	P	Power	DVCC	N/A	☐	Nothing Assigned	
7	DVSS	P	Power	DVCC	N/A	☐	Nothing Assigned	
8	P2.7	I/O	LVCMOS	DVCC	OFF	☑	LoRa	Lora Reset
	TB0CLK	I	LVCMOS	DVCC	–			
	XIN	I	LVCMOS	DVCC	–			
9	P2.6	I/O	LVCMOS	DVCC	OFF	☑	LoRa	LoRa IRQ (DIO0)
	MCLK	O	LVCMOS	DVCC	–			
	XOUT	O	LVCMOS	DVCC	–			
10	P2.5	I/O	LVCMOS	DVCC	OFF	☑	LoRa	LoRa Configurable DIO1 (RadioLib wants it?)
	COMP1.0	I	Analog	DVCC	–			
11	P2.4	I/O	LVCMOS	DVCC	OFF	☑	ESP32 Cam	Hopefully will be used for OneWire commication with the ESPCam
	COMP1_1	I	Analog	DVCC	–			
12	P4.7	I/O	LVCMOS	DVCC	OFF	☑	Accelerometer	LSM6DSMTR I2C SCL
	UCB1SOMI	I/O	LVCMOS	DVCC	–			
	UCB1SCL	I/O	LVCMOS	DVCC	–			
13	P4.6	I/O	LVCMOS	DVCC	OFF	☑	Accelerometer	LSM6DSMTR I2C SDA
	UCB1SIMO(7)	I/O	LVCMOS	DVCC	–			
	UCB1SDA	I/O	LVCMOS	DVCC	–			
14	P4.5	I/O	LVCMOS	DVCC	OFF	☐	Nothing Assigned	

Interface Definitions - Mechanical

Interface Code	Definition
I-MS1	4 screws to hold shell together. M2.5, 20mm long. 92005A077 on McMaster Received by 4 Hex nuts to sandwich shells. 90592A080 on McMaster
I-MS2	2 screws for attaching the Reloader Servo. M2, 6mm long. 94209A343 on McMaster Screws straight into 3D print
I-MS3	2 screws for attaching the Shutter Servo. M2, 6mm long. 94209A343 on McMaster Screws straight into 3D print
I-MG1	Glued attachment of shutter swing arm to shutter servo. Exact attachment dependant on state of servo on arrival. Most likely superglue
I-MG2	Glued attachment of reloader swing arm to reloader servo. Exact attachment dependant on state of servo on arrival. Most likely superglue
I-MG3	Glued pusher arm to shutter button. Most likely Hot glue to not damage camera too much

Implementation Plans

- PDR & Order 1 - Dec 1st
  - Whole Team
- Preliminary Firmware Written - Jan 1st
  - Electronics Team
  -
- 1st Order Mechanical Assembly - Jan 10th
  - Mechanical Team
- 1st Order Electronics Assembly - Jan 15th
  - Electronics Team
- 1st Order Total Assembly - Jan 16th
  - Whole Team
- CDR & Order 2 - Jan 20th
  - Whole Team
- FRR & Launch - Launch Day
  - Whole Team

Order 2 Evolution Plans

- Finalise Internal Structure
- Impliment Parachute Attachment Points
- Develop Carbon Composite Outer Shell
- Cut Down Camera Size
- Develop Lignt Blocking Measures
- Develop Pre-Launch Process & Recovery Process

Technical Measures of Effectiveness

- Have we successfully taken a picture?
- Is the film recoverable/processable?
- How many film photos did we capture?
- Are the objects in the film identifiable?

Validation Plans

- Fit Checks - Jan 16th
  - Whole Team
- Bench test camera mechanism - Jan 17th
  - Whole Team
- Bench test camera with spare film - Jan 17th
  - Whole Team
- Drop test inside engineering - final test with prototype (incase of RUD) - Jan 17th
  - Whole Team

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