

I. Introduction

The Motor Test Project led by team ThrustMIT 2024-25 focuses on testing and analyzing the performance of M-Class Solid Rocket Motor and J-Class Solid Rocket Motor. This document contains both Concept of Operations Overview and the Operating Procedure Checklist for the Avionics subsystems reference for the Motor Test scheduled on the {num} of October 2024.

II. Background

The Commercial M-Class Solid Rocket Motor is situated on a testbed, mounted on a load cell. The Avionics system is divided into two parts: Testbed and Ground station. Testbed uses an Arduino Uno R3 and ground station uses Arduino MKR ZERO microcontroller, while wireless communication between them is facilitated by RYLR 998 module.

The ground station controls the ignition with two switches which toggle between three states: SAFE, ARMED, and LAUNCH. These states are managed by a Finite State Machine on both systems to ensure safe phase transitions. The motor side logs peripheral data to an SD card via peripheral modules. The ground side also consists of a live plotter which displays the current state of testbed and the plots the data once the LAUNCH switch is turned on.

The testbed consists of a weight indicator TP400- mini which allows Arduino UNO R3 to obtain data from the load cell via analog interface. The data is communicated to the ground station via RYLR998 module.

III. Phase Transitions

The phase transitions are initiated via the switches on the ground station and handled via the FSM installed onto Arduino MKR ZERO. The FSM defines three states involved on either side: SAFE, ARMED, and LAUNCHED. these states are structured as such:

SAFE: At the ground side, when no switch is activated both the ground station and testbed are at SAFE state and no information is communicated between them.

ARM: At the ground side, when the ARM switch is turned ON it sets the both the ground station and testbed as ARM state which is an intermediate state between LAUNCH and SAFE.

LAUNCH: Once the LAUNCH switch is turned ON the D4184 MOSFET on the testbed is latched igniting the propellant. The LAUNCH signal also starts the communication between the testbed Arduino and the ground station Arduino, and the data received on the ground station is logged and plotted in real time.

IV. OPERATIONS AND MATERIALS CHECKLIST

PRELAUNCH: (before leaving the workshop)

1. Check Test Side System connections
2. Check Ground Station system connections
3. Keep three 7.4V LiPos
4. Charge LiPos if low on voltage
5. Motor System Power Bank Packed
6. Load Cell, Load Indicator and Adapter for Load Indicator packed
7. Carry plastic bags to carry apparatus in case of rain
8. Check Rylr998 connections
9. Walkie-Talkies ready for Comms.
10. Clear SD Card

Pack:

1. Jumpers (Male-Male, Male-Female, Female-Female)
2. Screwdrivers
3. Stripper
4. Scissors
5. Double Sided Tape, Insulation Tape
6. Extra Breadboard
7. DMM
8. Powerbank, 9V Battery
9. Charger for Powerbank
10. Extra wiring
11. Backup Arduino
12. MIDI Cable for Arduino (two required, two extra)
13. Ignitor Wire

14. Markers
15. Zipties
16. Pliers
17. Soldering Kit
18. Test Bed Side and Ground Side Setup
19. Load Cell and Load Indicator
20. SD cards and SD card reader
21. Umbrellas
22. Extension boards
23. Open wires
24. Measuring tape
25. Three Micro USB Cables

Before Test

1. All items packed
2. All items safely unloaded at the test side
3. Motor mounted securely
4. Arduino Connections Secure
5. Switches Connections Secure
6. Breadboard Connections Secure
7. Rylr998 Connections Secure
8. SD Card Cleared and Inserted in the Reader
9. SD Card reader Connections Secure
10. Plotter Setup
11. PDB Connections Secured

Pre-Launch

- *Test Bed Side*
 1. *Check connections*
 2. *Check Power supply*
 3. *SD cleared and inserted*
 4. *Motor mounted properly*
 5. *Ensure weight indicator and load cell are working*
 - 6.

- *Ground Side*
 1. *Check connections*
 2. *Check PDB power supply*
 - 3.

1. All connections secured
2. LiPos connected
3. Communication established
4. Plotter Working
5. Data Logging established
6. Videos Recording
7. Ensure NO components are heating up

Final Arm and Launch

1. Everyone is away from the test bed
2. Fire department in position
3. Whistles are given out to alert everyone

4. FINAL ARM
5. Launch countdown
6. LAUNCH

Post Launch

1. All components packed
2. SD cards and Video recording recovered
3. Testbed Side cleaned up

****THIS SPACE IS INTENTIONAL****

VII. PROCEDURAL CHECKLIST

- ☐ ALL MATERIALS PACKED
- ☐ CONNECTIONS CONFIRMED
- ☐ BATTERY VOLTAGES OPTIMAL

PREREQUISITES READY ☐

- ☐ LOAD CELL CONNECTED + RESPONDING
- ☐ MOTOR MOUNT + CAMERA READY
- ☐ RYLR998 CONNECTED AND RESPONDING
- ☐ D₄₁₈₄ LATCHING PROPERLY
- ☐ DATA LOGGER SETUP AND WORKING

MOTOR SYSTEM READY ☐

- ☐ GROUND STATION + SWITCHES RESPONDING
- ☐ COMMS. WORKING
- ☐ PLOTTER SETUP AND WORKING
- ☐ DATA LOGGER SETUP AND WORKING

GROUND SYSTEM READY ☐

- ☐ SAFETY PROVISIONS APPLIED

SYSTEMS ALL CLEAR ☐

Signature of Attendee

Safety Recommendations:

- Have Fire Department on site
- Have a First Aid Kit
- Assign clear roles and ensure everyone knows their responsibilities
- DO NOT let unauthorized personnel be around the test site
- Handle Motor with care and wear necessary gear while handling the motor
- Secure the Motor to the test stand properly
- Have everyone at a distance from the test bed before starting testing
- Give loud call outs
- Be alert at all times