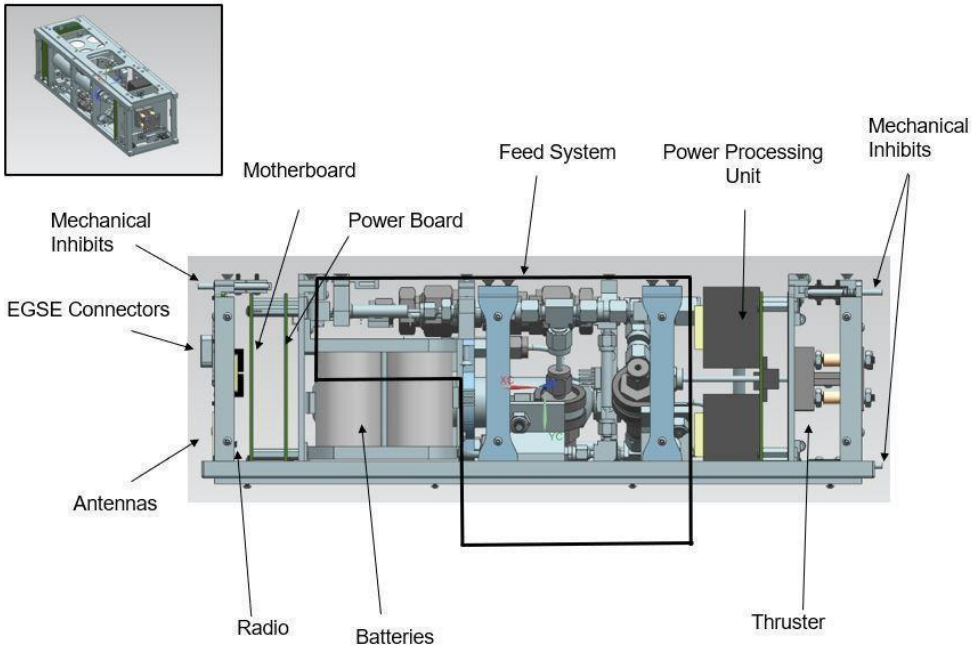
M3 Satellite Technical Description

The overall goalof the Multi-Mode Mission (M3), launched by Missouri University of Science and Technology, is to demonstrate in the space environment a multi-mode-capable thruster. It will use an ionic propellant operating in electric mode with a student-developed power processing unit (PPU).

The 3U CubeSat will be launched as a secondary payload aboard a Spaceflight Inc. Sherpa tug on the SpaceX Falcon 9 Transporter-10 Mission, from Vandenberg Air Force Base, no earlier than January 1, 2024. It will be inserted into a circular Sun Synchronous orbit with altitude 600 km, at 97.6 degrees inclination. Transmission will begin 45 minutes after deployment and cease after complete battery discharge, estimated to be no longer than 52 hours after deployment. Atmospheric drag will slow the satellite and reduce the altitude of the orbit until de-orbiting occurs approximately 13 years after launch. See the Orbital Debris Assessment Report for details.

The spacecraft is a single unit with dimensions of three (3) stacked 10 cm x 10 cm x 10 cm CubeSat modules (giving an overall dimension of 10 cm x 10 cm x 30 cm). The total mass is approximately 3.6 kg.

Figure 1. M3 Overview



(Shown with side panels removed.)

The satellite contains the following systems:

Guidance, Navigation and Control (GNC) Subsystem: The passive GNC system uses a magnet and four hysteresis rods to detumble the satellite upon deployment, reducing the satellite rotation to two rotations per minute about its main axis. An Inertial Measurement Unit (IMU) is included on the motherboard to measure angular velocity.

Command and Data Handling (CDH) Subsystem: The two critical printed circuit boards comprising the CDH subsystem include the Flight Computer (FC) and the Power Distribution (PPU) boards. The boards are ordered and manufactured from JLCPCB then assembled and tested in-house.

Communications Subsystem (COMMS): An NSL Eyestar-S4 Iridium transceiver will be utilized for downlinking thruster test data. In conformance with § 5.107 Transmitter control requirements, all transmission from the satellite can be terminated by a command issued from mission operations via the Iridium system.

Electrical Power Subsystem (EPS): The EPS consists of a four-cell battery pack and the power distribution PCB (the PPU board), as well as a dedicated microcontroller board that controls the 3.3-volt, 5-volt, and 12-volt power distribution.

The PPU steps up the 12-volt supply to 3400 volts to energize the thruster. The battery pack contains four primary (non-rechargeable) EaglePicher LCF-15004 cells in series providing a total capacity of 160 watt-hours. The batteries are designed to maintain charge during extended periods of storage.

Thermal Control Subsystem (TCS): The TCS controls hardware temperature through cold biasing of the thermal design, utilizing heaters to stabilize temperatures. Thermal sensors are wired to the FC board, which hosts thermal control algorithms to control the heater.

Structure Subsystem: The main chassis is constructed of 6061 aluminum.

Propulsion Subsystem: The propellant composition is 1-ethyl-3-methylimidazolium ethyl sulfate. The nitrogen pressurant tank will be pressurized to 30 psia. Temperature throughout the satellite, pressure at the thruster and propellant tank exit, and IMU measurements will be recorded during the electric burns, and telemetered to mission operations. Analysis shows that the thruster burns (of negligible magnitude) will not measurably affect the spacecraft orbit or orbit lifetime. See Propulsion Experiment Analysis exhibit for details.