Small Satellite Research Laboratory
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StateMachine Component Documentation

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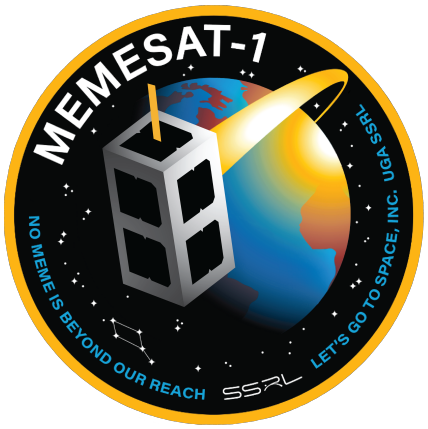

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1 List of Acronyms

BBS Bulletin Board System
CDH Command and Data Handling
EPS Electrical Power System
GDS Ground Data System
FSM Finite State Machine
FSW Flight Software
MCU Microcontroller Unit
MS-1 MEMESat-1
OBC On-Board Computer
OSAL Operating System Abstraction Layer
OTA Over-The-Air
OTAU Over-The-Air Updater
TLM Telemetry
UART Universal Asynchronous Receiver-Transmitter
UHF Ultra High Frequency

2 Revision History

Changes	**Authors**	**Version**
[06-30-2023] Document Created.	Olivia Beattie	1.0.0
[03-11-2024] Updated commands and telemetry to remove difference cruise modes. Updated for Feasibility Review	Olivia Beattie	1.1.0
[04-01-2025] Updating to reflect changes to state transitions and control flow.	Samuel Lemus	1.2.0

3 Purpose

This document is meant as an overview of the StateMachine component, which is the F' component that is acting as the overarching state machine for the system.

4 Overview

The state machine component is the state machine on MEMESat-1's OBC and is responsible for keeping track of the state of the system and controlling the transitions between states. The state machine has 7 states: Start-Up, Cruise-Dormant, Cruise-Active, Critical-Power-Mode, Reboot, Shutdown, and Eps-Anomaly. The system can only enter Cruise-Active from a command initiated from the Ground Station, and while in Cruise-Active, 'MEME's and BBS messages will be sent and received. The state machine will transition to other states given distinguished criteria detailed in this document. When the system is in a critical state, communications will be contrained to the ground station only. Health beacons will be sent every 60 seconds in the Cruise states and Anomalous state. The system will be sent to the Critical Power state in scenarios distinguished later in this document. If the system goes into the Critial Power state, the OBC will turn off and the satellite will be commanded by the microcontroller until conditions allow the system to return to a more stable state.

Description of Directory Files:

- StateMachine.fpp - Contains fprime interactions for the component.
- StateMachine.hpp - Used as a container for function signatures.
- StateMachine.cpp - Implementation of the fprime interactions.
- StateMachinePorts.fpp - Contains custom ports for the state machine.
- StateMachineTypes.fpp - Contains custom types for the state machine.

5 Interactions

5.1 Components

5.1.1 FileRecycler

The FileRecycler component is used to recycle files that are no longer needed. The state machine will use this component to indicate that the system has triggered a transition to either the Restart or Shutdown state. The FileRecycler will then prepare for system cycle down by emptying any voltatile memory and finshing any ongoing operations.

5.1.2 EpsUart

The EpsUart component is used to communicate with the EPS. The state machine will use this component to trigger the sending of heartbeat packets to the STM and the EpsUart component will indicate to the StateMachine when the EPS has sent an initial heartbeat packet. The state machine will also use the EpsUart component to send commands to the EPS, such as indicating when the system is in a critical power state.

5.1.3 OTAUpdater

Akin to the FileRecycler, due to the nature of the OTAUpdater component, the StateMachine will use a port to indicate that the system is in need of a power cycle. This should trigger the OTAUpdater to prepare accordingly.

6 Design

6.1 Requirements

Requirement	Description	Verification Method
SM-001	The component shall provide a command that allows the ground station to change the state of the system.	Unit testing
SM-002	The component shall provide a port that allows other components to change the state of the system.	Unit testing, Integration testing
SM-003	The component shall prevent invalid transitions that would put the system at risk.	Unit testing
SM-004	The component shall report important events and telemetry to keep the ground station informed of important actions on board.	Unit testing
SM-005	The component shall log all persistent data to keep track of total shutdowns and restarts.	Unit testing

6.2 Ports

The StateMachine component has 5 ports: 2 input ports and 3 output ports. The Run port is connected to the Svc::Sched port, which is used to invoke components used in the scheduling of the application. The ChangeState port is a custom port with a custom-type State and it is used to change the state of the StateMachine. Any components that need to change the state of the StateMachine must have a ChangeState port. EpsUart, the components responsible for reporting values from the EPS System, is the main component responsible for influencing the state of the StateMachine. The readyForPowerOff port is connected to the FileRecycler component and the OTAUpdater component and is used to tell them to close their operating directories until the system is ready to be turned back on. The epsCommand port is connected to the EpsUart component and is used to tell the component that the system needs to shut down and the MCU will then take over radio communications instead of the OBC handling them.

Port Data Type	Name	Direction	Kind	Usage
Svc.Sched	Run	input	asynchronous	Used to run the state machine and update the state of the system.
ChangeState	ChangeState	input	asynchronous	Port for changing the state of the state machine.
readyForPowerOff_port	readyForPowerOff	output		Port for readying the system for power off.
Fw.BufferSend	epsCommand	output		Port for sending a command to EPS_UART
radioCommand_port	radioCommand	output		Port for sending a command to the radio

6.3 Custom Ports

The StateMachine component has 3 custom ports that are used to send communications to and from other F' components.

Name	Parameter and Type	Description
Change State	state: State	The state of the component
readyForPowerOff_port	result: bool	The state of power off
radioCommand_port	state: State baud: U32	The state of the component The baud rate of the radio

6.4 Custom Types

The StateMachine component has 2 custom types. The State type is an enumeration that contains all of the possible states of the StateMachine. The CruiseMode type is another enumeration that contains the different modes of the cruise state.

Name	Type	Argument/Parameter	Description
State	enum	START_UP	Start up state
		CRUISE	Cruise state
		SAFE_ANOM	Safe Anomaly state
		SAFE_CRIT_PWR	Critical Power State
		RESTART	Restart State
		SHUTDOWN	Shutdown State
CruiseMode	enum	MEME	Meme Mode
		BBS	BBS Mode

6.5 Commands

The StateMachine component has 1 command. The CHANGE_STATE command is used to change the state of the StateMachine and it is the only way the StateMachine can be set to the Cruise-Active state.

Mnemonic	Arguments	Synchronization	Description
CHANGE_STATE	state: State	Asynchronous	A command that tells the component to change the state of the state machine.

6.6 Events

The StateMachine component has various events that are used to relay important information to the ground station.

Name	Severity	Arguments	Description
STATE_CHANGE	activity high	state: State; The state the state machine is moving to	Event that indicates the state of the state machine has changed.
AUTO_SWITCH_TO_CRUISE	warning high		Event that indicates the state machine attempted to auto-switch to cruise mode.
SHUTDOWN	activity high		Event that indicates the system has shut-down.
RESTART	activity high		Event that indicates the system has restarted.
PERSISTENT_DATA_ERROR	warning low		Event that indicates there is an error with the persistent data file.
INVALID_STATE_CHANGE	warning low		Event that indicates that the state machine has attempted to make an invalid transition between states.

6.7 Telemetry

The StateMachine component reports multiple telemetry values to the ground station to keep track of important events that take place on-board the satellite. All of the telemetry values are updated on change, which ensures that the telemetry will only be sent when a change has been made to the state of the StateMachine.

Name	Data Type	Update	Description
STATE	State	on change	The state of the state machine.
RESTART_COUNT	U32	on change	The amount of times the system has restarted.
SHUTDOWN_COUNT	U32	on change	The amount of times the system has shut down.