PUMPKIN™

SPACE SYSTEMS

Update Q3 2024

Spacecraft Buses

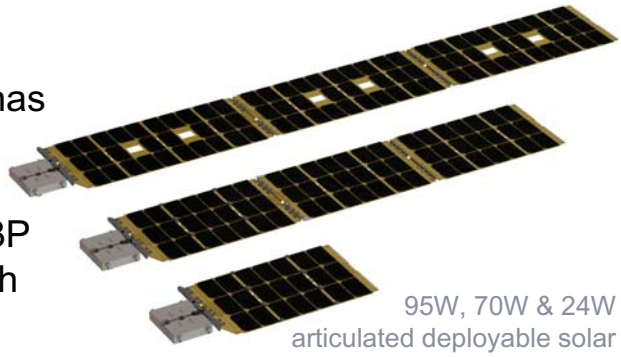
- The USSF SMC EWS RROCI EO/IR mission reached LEO orbit on March 4, 2024; Orion Space Systems (OSS) operates the 12U-size spacecraft. RROCI is based on a Pumpkin SUPERNOVA bus hosting OSS's 8U-size EO/IR payload. Some of the features of Pumpkin's software & hardware architectures that were used during initial commissioning and operations include:

EWS RROCI2
12U SUPERNOVA

  - The EPSM1's high-speed MPPT algorithm delivered solar power during high initial roll rates, and continued to deliver power and charge batteries during uncontrolled attitude conditions
  - Adjusted battery heater setpoints for eclipse power tuning
  - Updated (subsystem) firmware and (OBC) software on-orbit
  - Confirmed dual T&C paths over S/X-band and Iridium SBD links
  - Utilized ground and on-orbit telemetry to refine digital twin model
  - Demonstrated highly predictable behavior throughout all CONOPS
  - Uploaded software application as stand-in for hardware subsystem

Solar

- Pumpkin's family of space-proven solar arrays has been expanded with a new 190W array that is suited for non-canisterized, ESPA-class spacecraft designs. This 10S3P + 8S3P + 10S3P arrangement per side integrates seamlessly with Pumpkin's multichannel EPSM1 power system and BM2 intelligent Li-Ion batteries.

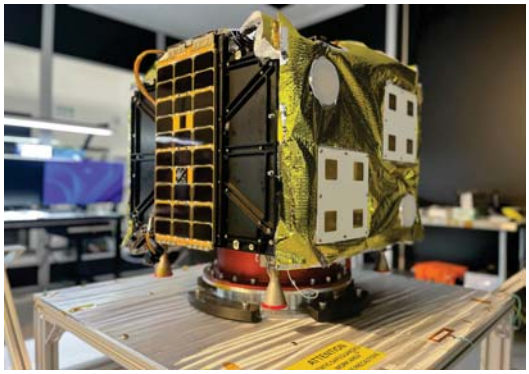


95W, 70W & 24W articulated deployable solar arrays (top to bottom)

Responsive

- In mid-March 2024 AstroForge asked Pumpkin to provide a full spacecraft power system (arrays, SADAs, EPS & batteries) for their redesigned Odin spacecraft. By the end of July, Pumpkin delivered complete EM and FM power systems to AstroForge. These included the latest PMDSAS DASA solar panel array, customized to AstroForge's requirements and in time for Odin's pre-flight test campaign. This AstroForge mission is the first asteroid-seeking application of Pumpkin's integrated power system.

Ad Astra Per Aspera!



AstroForge Odin spacecraft in its integrated configuration

Flight Software

(geeking out a bit here ...)

- The on-orbit commisioning of U.S. Space Force's RROCI spacecraft utilized many of the features in Pumpkin's Rust-based GUTS flight software (FSW). Some of those — with examples — are listed below:

  - Fully dynamic telemetry system — A single command can upload new telemetry workers that gather different bus and/or payload telemetry. The telemetry client also dynamically picks up the telemetry workers and can push to the database independent of configuration. This was used to program in new `raw telemetry workers` to acquire more subsystem telemetry than was initially deemed necessary.
  - Fully dynamic protection system — GUTS can reprogram the protections in the `lifeboat-service` to change parameters or protect a new unwanted state on the spacecraft. This was used to disable some subsystem protections by uploading a new configuration in a single command to the bus, for test/debug purposes.
  - Command scripting system — GUTS stores commands in a stored command sequence file and uses it to conduct different operations on the bus. GUTS can either execute these as a sequence from the ground, push a single command to the bus to be scheduled later, or upload a file to the bus in order for later execution. This feature was used extensively and includes some nifty features like substitutions (to sub in different values (e.g., a `${bm2_heater_sp:<value>}` for a new battery heater setpoint temperature). These are simply a sequence of commands to be executed, all stored in GraphQL format.
  - Responsive telemetry — The MOC can downlink and fill in missing hours or days of telemetry data by enabling the transmitter for only 30 seconds at a time, while also simultaneously receiving real-time data.
  - Simple payload interface — The GUTS `radio-service` allows the user to not worry about turning on switches or configuring the FSW correctly, just connect and go via GUTS' built-in TCP socket and CSSDS support.
  - Flexible architecture — Users can selectively disable certain GUTS features (e.g., Iridium SBD comms) without affecting other mission operations. This enables bus power-saving without compromising the FSW. The FSW image can be configured with different services depending on the mission.
  - Memory safe — Rust with the borrow checker, lifetimes and ownership.
  - Fearless concurrency — The Rust lifetime/ownership model prevents many concurrency/parallel bugs, and has built-in message passing support.

Contact

Pumpkin Space Systems serves demanding government, commercial and educational customers with P-POD and CSD-compatible nanosatellite spacecraft and buses. Our integrated designs are based on our own flight-proven CubeSat Kit™ and SUPERNOVA™ components and have completed flight qualification.

PUMPKIN™ SPACE SYSTEMS

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707-00419-U 07/2024