SwSP-100 SPACECRAFT

Rapid IV Spacecraft Catalog

Southwest Research Institute® (SwRI®) is a nonprofit, independent, world-class developer of space flight hardware and missions, with a 4-decade history of successfully developing and delivering flight designs at all system levels from mechanisms and avionics boards to complete missions. We are an industry leader in mission design and management, flight avionics, instruments, and small S/C design and assembly, with full lifecycle capabilities. Our approach begins with understanding the mission objectives and progresses to the completion of innovative, unbiased, mission-centric designs.

SwRI's 100 kg Rapid Spacecraft Development Office (RSDO) Rapid IV S/C, the SwRI Spacecraft Platform (SwSP-100), is a direct evolution of the SensorSat S/C with upgrades to address obsolescence and improve payload accommodation capability. The SwSP-100 design enables a "digital clone" approach that when coupled with our industrial team mates enables rapid serial production to meet critical mission deployment schedules of proliferated constellation scale missions. The SwSP-100 is based on a single-string architecture with functional and selective redundancy included for critical areas to increase system reliability while maintaining cost effectiveness. Mission design lifetime is >3 yrs as demonstrated by SensorSat and subsystem similarities to SwRI's eight CYGNSS observatories launched in Dec 2016 and fully functional after four years on orbit. The design includes automated features for fault tolerance and minimizing required ground operations by eliminating unnecessary functionality and failure points. S/C subsystems offer a performance baseline that can be readily modified to address missions across the SmallSat spectrum; from Earth science, heliophysics and astrophysics research to space situational awareness, surveillance and reconnaissance. The baseline SwSP-100 offers a standard payload volume with several clear fields of view for mission flexibility. The S/C structure is designed such that larger external payload volumes and mass requirements can be accommodated with little to no development effort. Solar array and battery options support a significant array of payloads. Flexible vehicle pointing and maneuveringcapability is included to accommodate a wide range of mission scenarios and modes.

SwSP-100 is designed for mission flexibilty and payload accommodation.

SwSP-100 optionally configured Earth nadir pointing

SwSP-100 is a product of Southwest Research Institute

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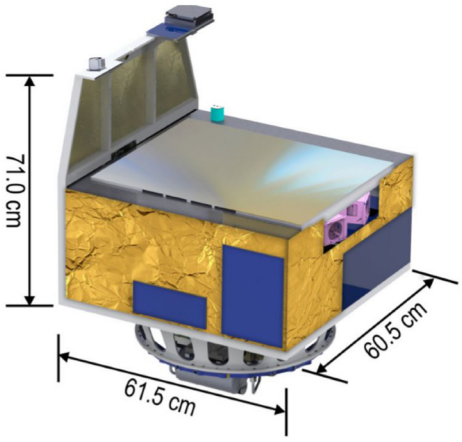
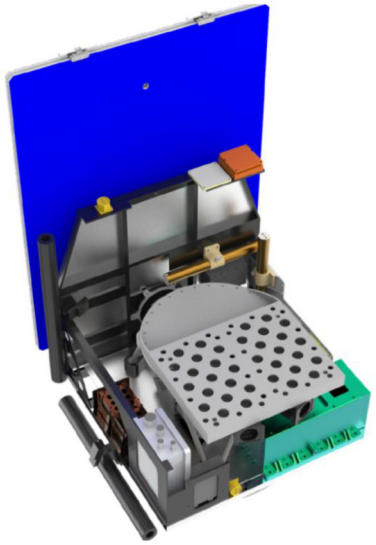
Baseline SwSP-100 Spacecraft Characteristics			
	Mission Life		>2 yrs @ Ps > 0.89; TID: 5 krad (2 RDM)
	Orbit Compatibility		400 – 700 km; all inclinations
	Structure		Machined Aluminum/Composite
	S/C Mass		55.8 kg
	Internal Payload Mass		11 kg (internal), 32.4 kg (external))
	Thermal Control		Heaters, MLI, surface finishes
	Electrical Power		Peak Power Tracking
	Payload Power	Orbital Avg	>64 W
	Battery	Type & Capacity	Li-ion; 8.4 Ahr
		DOD	30%
	Solar Array	Type & Size	Single-axis gimbal, 1.0 m^2
		Deployment	One time deployed
		Cell Type	Triple junction with AR coating
		Cell Efficiency	30% (BOL)
	Communications	Uplink	S-band; selectable to 128kbps
		Downlink	S/X/Ka-band options to 500Mbps
	Command Processing	Formatting	CCSDS; BCH; COP1, AES-256
		Processing	Real-time, conditional, and/or time based
	Data Handling	Payload interface	RS422, SpW, LVDS, others
		Formatting	CCSDS; Type 1 AES-256 encryption
		Storage	>16 GB, options to 4 TB
	Autonomy		Deterministic on-board event response
	Fault Management		Autonomous response, background SEE scrubbing and recovery
	Pointing Type		3-axis stabilized ; nadir, geo-location, solar, or inertial pointing
	Knowledge	Performance	0.012 deg (3σ RSS)
		Star Tracker	Dual; 6 arc-sec (1σ)
		IMU	3 axis; 0.33 arc-sec (1σ)
		Magnetometer	10 nT
		Sun Sensor	6 DOF;
	Control	Performance	0.07 deg (3σ RSS)
		Reaction Wheels	3 axis; 0.015 N·m·sec
		Torque Rods	1.5 Am^2
	Propulsion	H_20 Electrolysis	Isp: 310s, 6.8mN (orbit avg), >200m/s

SwSP-100 Internal Layout



Stowed SwSP-100 compatible with all ESPA & VCLS launch vehicles



Internal SwSP-100 component configuration enables rapid integration. Central payload support structure with integrated star trackers enables fine pointing capability.

The SwSP-100 S/C platform is designed and implemented to maintain the safety of the Observatory without ground intervention. The design maximizes fault tolerance by eliminating unnecessary functionality and failure points by employing a simple architecture and a simple operational scheme. S/C elements perform many autonomous functions allowing the S/C to operate with minimal routine commanding to accomplish operations. In areas where modifications may be necessary on-orbit, parameters allow modification by ground personnel during the course of the mission.

Structures and Mechanisms – Machined Al primary structure is used for the avionics deck as the core of the SwSP-100; all other components are mounted to this backbone with structural extensions included to accommodate the solar arrays and payload assemblies. Observatory mechanisms are limited to heritage solar array deployment devices, solar array gimbal, and 3-axis reaction wheels. The "bi-fold" solar array performs a one-time deployment into a gimbaled position along the side of the S/C.

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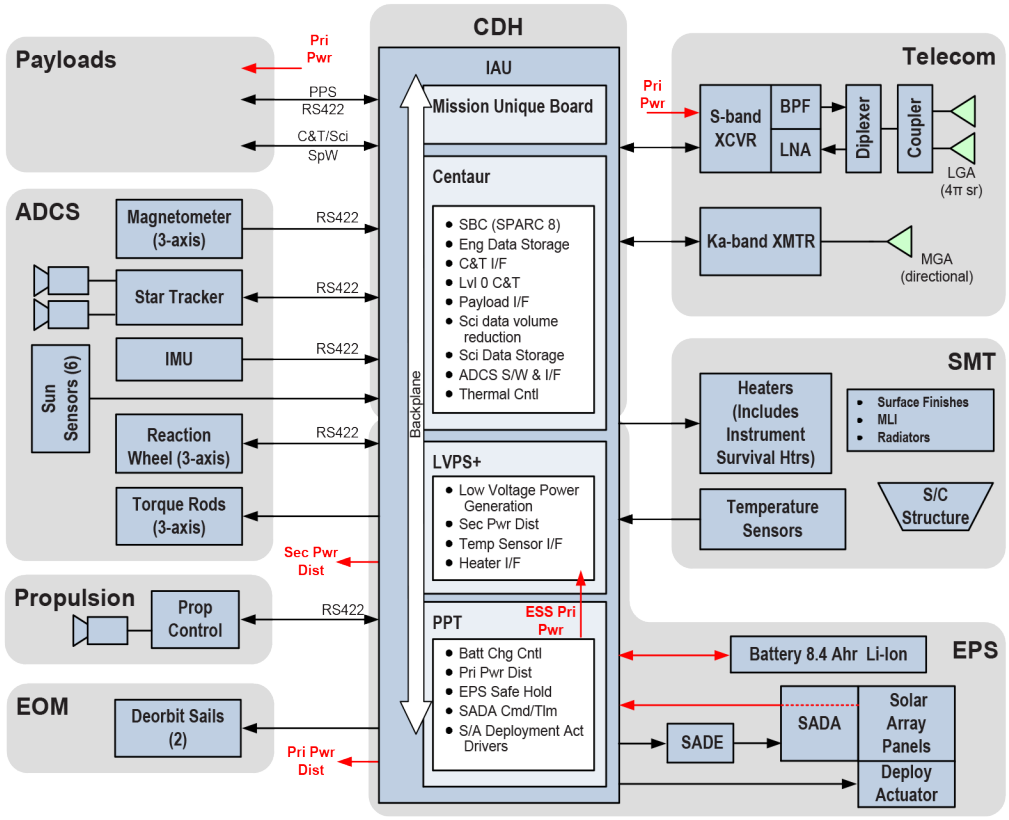
Electrical Power - The EPS is designed to perform battery charging without interrupting payload data acquisition. It is based on a 28 Vdc primary power bus with electrical power generated by the 2-panel solar array.

Communications and Data Handling - S/C uplink and downlink communication links provide operational interfaces to the Observatory. The Communications and Data Handling subsystem also contains the S/C control processor with the associated Flight Software necessary to manage operations of each of the S/C subsystems and the payload. Data is stored in on-board non-volatile data storage until commanded for downlink.

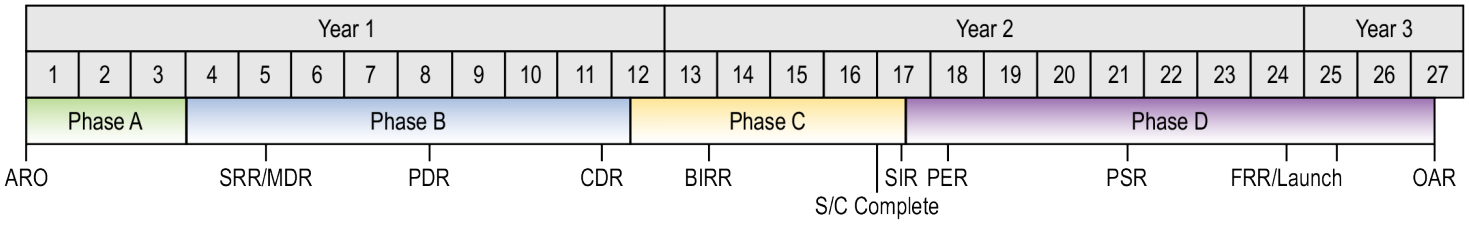
Attitude Determination and Control - The SwSP-100 ADCS is a 3-axis, star tracker/reaction wheel design. A magnetometer and 3-axis electromagnetic torque rods provide for reaction wheel momentum desaturation. The full featured ADCS software supports nadir, geo-location, solar, or inertial pointing mission pointing scenarios.



Mission specific optional capabilities include:

- Mission Concept Development
- Mission PM, SE, and SMA
- External Payload accommodation to 50 kg
- S/C Structure Size Expansion
- Solar Array Capability Increase
- Solar Array gimbal
- Battery Capacity Increase
- Payload Data Processing
- Increased data storage of >1 TB
- Downlink Rate Increase; X-band or Ka-band
- Type 1 encryption/decryption
- High Performance Pointing
- Pointing Agility
- Solar Electric Propulsion
- Access to space; Rideshare or Primary payload
- Mission Operations

Up to 4 SwSP-100 S/C ready for delivery in less than 16 months, fully integrated and tested SwSP-100 Observatory delivered on-orbit in less than 26 months , subsequent deliveries on 1month intervals



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The 75,000 sq-ft SwRI Spacecraft Manufacturing Facilities co-located in San Antonio, TX, includes all development and production infrastructure required for the design, production, assembly, integration, and test of avionics, instruments, S/C, and fully integrated SwSP-100 observatories. Our facilities accommodate customer payload needs from initial delivery, through integration with the S/C and integrated system-level testing.

SwRI integration facilities include over 9000 sq-ft of cleanroom space, including two 950 sq-ft ISO 7 (Class 10k) and two 500 sq-ft ISO 6 (Class 1k) cleanroom. The mirrored facilities are configured to allow SwRI to perform commercial/civil projects in parallel with classified projects. Adjacent environmental test bays enable thermal vacuum, acoustic, vibration, and EMC/EMI testing without ever leaving the building.

The SwRI Mission Operations Center (MOC), located in the Boulder CO, uses a straight forward approach to manage ongoing and future SwSP-35 and SwSP-100 satellites.The facility is specifically designed to efficiently manage spacecraft constellations. Support for mission operations stages available to the U.S. Government include: Launch and Observatory deployment, Commissioning, and Science Operations.

SwRI's S/C AI&T Facility provides end-to-end S/C AI&T capabilities under one roof

SwRI's Multi-Mission Operations Center is specifically designed for SmallSat constellations

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