**Satellite System Requirements Specification (SRS)**

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Prepared for: System Integration & Test

# 1. Introduction

This document specifies testable, verifiable, and allocatable system requirements for a small Earth-observation satellite. Requirements are written to be necessary, unambiguous, complete, correct, and feasible. Verification methods are defined using the standard taxonomy: Test (T), Analysis (A), Inspection (I), and Demonstration (D).

## 1.1 Scope

The scope includes the space segment (bus and payload), flight software, and relevant ground segment interfaces necessary to command, control, and retrieve data from the spacecraft.

## 1.2 Definitions and Acronyms

T = Test, A = Analysis, I = Inspection, D = Demonstration; EPS = Electrical Power Subsystem; C&DH = Command and Data Handling; GNC = Guidance, Navigation, and Control.

# 2. System Overview

The system consists of a three-axis stabilized satellite in Low Earth Orbit (LEO) carrying an electro‑optical payload. The satellite communicates with ground stations via S-band for TT&C and X-band for payload downlink.

## 2.1 Operational Environment

Nominal orbit: 500–550 km sun-synchronous LEO. On-orbit thermal environment shall consider hot/cold cases and eclipses. Launch environment per rideshare provider limits for random vibration, shock, and acoustic load.

# 3. Requirements

All requirements below are uniquely identified and include verification method and acceptance criteria.

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| ID | Requirement | Rationale | Verification (T/A/I/D) | Acceptance Criteria |
| SAT-REQ-001 | The satellite shall provide a ground sample distance (GSD) of ≤ 0.9 m from 525 km altitude. | Meets mission imaging resolution. | A,T | Analysis of optical design + on-orbit focus test demonstrate ≤ 0.9 m GSD. |
| SAT-REQ-002 | The payload shall achieve signal-to-noise ratio (SNR) ≥ 50 at 10% albedo for 50% well depth. | Ensures usable image quality. | A,T | Radiometric budget shows SNR≥50; lab radiometric test confirms. |
| SAT-REQ-003 | The system shall support imaging swath ≥ 10 km at nadir. | Coverage efficiency. | A | Geometric model shows ≥ 10 km swath at design altitude. |
| SAT-REQ-004 | The satellite shall store ≥ 256 GB of payload data onboard. | Buffer data between passes. | I,A | Mass memory BOM shows ≥256 GB; C&DH analysis confirms capacity. |
| SAT-REQ-005 | The EPS shall provide ≥ 140 W average power in sunlight at End‑of‑Life (EOL). | Power for bus + payload. | A | Power budget at EOL margin ≥ 0.2 shows ≥140 W avg. |
| SAT-REQ-006 | The battery shall support eclipse loads for ≥ 35 minutes without depth of discharge exceeding 25% at EOL. | Battery longevity. | A,T | EPS analysis + battery test show DoD ≤25% for 35 min eclipse. |
| SAT-REQ-007 | The satellite shall autonomously shed non-critical loads when state of charge < 20%. | Survivability. | T,D | Functional tests show load shedding occurs at SOC threshold. |
| SAT-REQ-008 | The spacecraft shall support S-band full-duplex TT&C with uplink ≥ 2 kbps and downlink ≥ 32 kbps. | Command and housekeeping. | T | RF link test shows data rates achieved with margin. |
| SAT-REQ-009 | The spacecraft shall support X-band payload downlink ≥ 150 Mbps at 5° elevation with 2 m GS antenna. | Timely data delivery. | A,T | Link budget ≥ 3 dB margin; end-to-end test validates ≥150 Mbps. |
| SAT-REQ-010 | The TT&C link shall maintain BER ≤ 1×10⁻⁶ at 0 dB Eb/N0 margin. | Reliable command/telemetry. | A,T | Lab modem test shows BER ≤1e-6 at specified margin. |
| SAT-REQ-011 | The spacecraft shall provide pointing knowledge ≤ 0.02° (1σ) and control ≤ 0.05° (3σ) during imaging. | Image sharpness. | A,T | ADCS analysis + HWIL test show performance meets limits. |
| SAT-REQ-012 | The spacecraft shall slew between two targets 20° apart within ≤ 60 s. | Targeting agility. | T | Slew command test shows ≤60 s between targets. |
| SAT-REQ-013 | The spacecraft shall maintain off-nadir imaging up to 25° with image smear ≤ 0.2 pixels. | Improve access. | A | Line-of-sight stability analysis shows smear limit met. |
| SAT-REQ-014 | All components shall maintain operation within vendor temperature limits across hot/cold worst cases. | Reliability. | A,T | Thermal model shows compliance; TVAC test confirms. |
| SAT-REQ-015 | The payload detector temperature shall be stabilized within ±0.1°C during imaging. | Radiometric stability. | T | Thermal control test shows ±0.1°C regulation. |
| SAT-REQ-016 | The satellite fundamental frequency shall be ≥ 100 Hz in launch configuration. | Avoid coupling. | A,T | Modal analysis & sine test confirm ≥100 Hz. |
| SAT-REQ-017 | The satellite shall withstand random vibration per provider spec with ≥ 3 dB margin. | Survive launch loads. | T | Random vibration test with acceptance profile +3 dB. |
| SAT-REQ-018 | All deployables shall latch positively and provide telemetry of latch state. | Deployment assurance. | I,T | Inspection verifies latch design; test verifies telemetry state. |
| SAT-REQ-019 | The C&DH shall time-tag all payload images with absolute timing accuracy ≤ 10 ms. | Geolocation accuracy. | T | Time sync test with GPS reference ≤10 ms error. |
| SAT-REQ-020 | The FSW shall support autonomous safe-mode entry within 1 s of loss of attitude knowledge. | Fault tolerance. | T,D | Fault injection shows safe-mode in ≤1 s. |
| SAT-REQ-021 | The system shall support over-the-air software update with rollback capability. | Maintainability. | D,T | Demonstration of OTA update + rollback succeeds. |
| SAT-REQ-022 | Payload data shall be losslessly compressed with ratio ≥ 1.5:1 on average scenes. | Downlink efficiency. | A,T | Compression algorithm analysis + test show ≥1.5:1. |
| SAT-REQ-023 | Housekeeping telemetry shall be logged at ≥ 1 Hz during imaging. | Anomaly diagnosis. | T | Telemetry rate check shows ≥1 Hz logging. |
| SAT-REQ-024 | The system shall meet a predicted reliability of ≥ 0.85 at 1 year (mission life). | Mission success. | A | Reliability block diagram & part counts show ≥0.85. |
| SAT-REQ-025 | The system shall implement latch-up detection and power-cycle recovery on all critical rails. | Radiation tolerance. | I,T | Design inspection + bench test show detection & recovery. |
| SAT-REQ-026 | Single-event upset (SEU) cross-section shall be mitigated to prevent loss of command during passes. | Ops continuity. | A | Radiation analysis shows mitigation meets ops needs. |
| SAT-REQ-027 | All command links shall be encrypted (AES‑256 or stronger) and authenticated. | Prevent unauthorized access. | I,T | Security inspection + crypto test confirm encryption/auth. |
| SAT-REQ-028 | The ground-to-space uplink shall enforce role-based access control (RBAC). | Least privilege. | I,T | Interface control & ops test show RBAC enforced. |
| SAT-REQ-029 | The satellite shall conform to ICD‑001 for all TT&C packet formats. | Interoperability. | I,T | ICD review + packet test validate conformance. |
| SAT-REQ-030 | The payload electrical interface shall provide 28 V ± 5% with inrush limited to ≤ 2 A. | Power integrity. | I,T | Power interface test shows voltage tolerance & inrush limit. |
| SAT-REQ-031 | The satellite shall tolerate total ionizing dose (TID) of ≥ 10 krad (Si) over mission life. | Radiation environment. | A | Radiation budget shows ≥10 krad margin on parts. |
| SAT-REQ-032 | Outgassing of materials shall meet ASTM E595: TML ≤ 1.0% and CVCM ≤ 0.1%. | Optics protection. | I | Materials certs show compliance to ASTM E595. |
| SAT-REQ-033 | The spacecraft shall support contact scheduling with 24 h look‑ahead and automatic pass execution. | Operational efficiency. | D | Ops demo shows automated plan exec. |
| SAT-REQ-034 | Nominal commanding latency from ground operator action to onboard execution shall be ≤ 5 s. | Timely control. | T | Integrated test measures ≤5 s latency. |
| SAT-REQ-035 | The ground segment shall deliver Level‑1B products within ≤ 30 minutes after pass end. | User responsiveness. | T | E2E timing test shows ≤30 min delivery. |
| SAT-REQ-036 | All mission data products shall include metadata compliant with STAC 1.0. | Discoverability. | I | Product inspection shows STAC 1.0 metadata present. |
| SAT-REQ-037 | Each requirement shall be uniquely traced to design, verification, and test procedures. | Traceability. | I | DOORS/Jama export shows full trace matrix. |
| SAT-REQ-038 | All verification procedures shall state objective, configuration, steps, and acceptance criteria. | Test rigor. | I | Procedure review confirms completeness. |
| SAT-REQ-039 | The project shall conduct a Test Readiness Review (TRR) prior to environmental testing. | Quality gate. | I | TRR minutes and action closure recorded. |
| SAT-REQ-040 | The project shall conduct a Flight Readiness Review (FRR) before delivery to launch provider. | Readiness gate. | I | FRR minutes and approval recorded. |

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