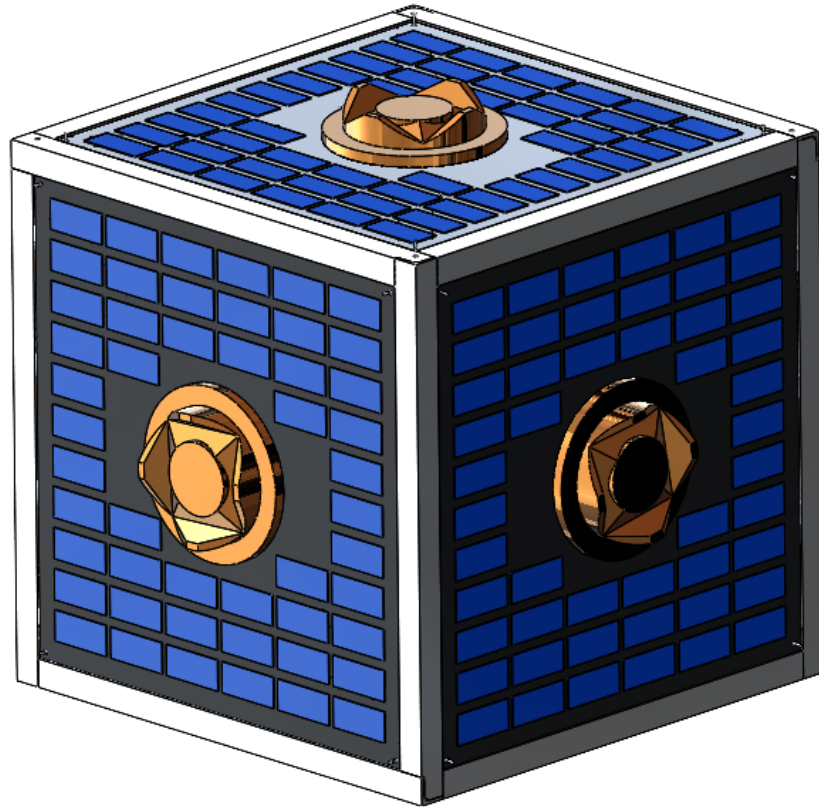


SPACEBOT V1.0

Free Flying Robotic Platform for Orbital Assembly and Servicing



PRODUCT DETAIL DOCUMENT

by

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Abstract

Spacebot v1.0 is a reusable free-flying robot for local assembly, inspection and modular servicing in low Earth orbit. Four rechargeable battery packs supply onboard electrical power, while nitrogen cold-gas thrusters provide translation and attitude control. A dedicated service station supports recharge, refuelling and orbital transfer. The platform integrates a 500 mm cubic chassis, a 23.8 L propellant tank and six docking interfaces for attachment to the station, work structures and compatible tools.

This document defines the mission, specifications, subsystem architecture, engineering budgets, interfaces, manufacture, operation and verification of Spacebot v1.0. Design values and estimates are distinguished from verified hardware performance. Marked spaces accommodate product images and engineering drawings.

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List of abbreviations

Table ii Abbreviations

Term	Meaning
BMS	Battery management system
CAD	Computer aided design
COPV	Composite overwrapped pressure vessel
DOF	Degree of freedom
EPS	Electrical power system
FEA	Finite element analysis
GNC	Guidance navigation and control
ICD	Interface control document
LEO	Low Earth orbit
MLI	Multilayer insulation
OBC	Onboard computer
PDU	Power distribution unit
RCS	Reaction control system
SOC	State of charge
TBC	To be confirmed

Chapter 1 Product Overview and Mission

1.1 Product purpose

Spacebot v1.0 supports inspection, component positioning, tool transfer and anchored assembly or servicing. Robots return to the station for battery charging and nitrogen replenishment. Manipulators and task tools are mission accessories with separately defined mass, power and interface requirements.

1.2 Mission architecture

The station matches the target orbit and relative trajectory before deploying robots. It provides orbital-transfer propulsion, power generation, bulk gas storage, charging and refuelling. Robots perform local worksite operations and remain secured during station orbital transfers.

The nominal station altitude is 500 km, within the 400–600 km LEO operating region. Deployment requires compatible orbital plane, phase and relative velocity, together with a safe return trajectory.

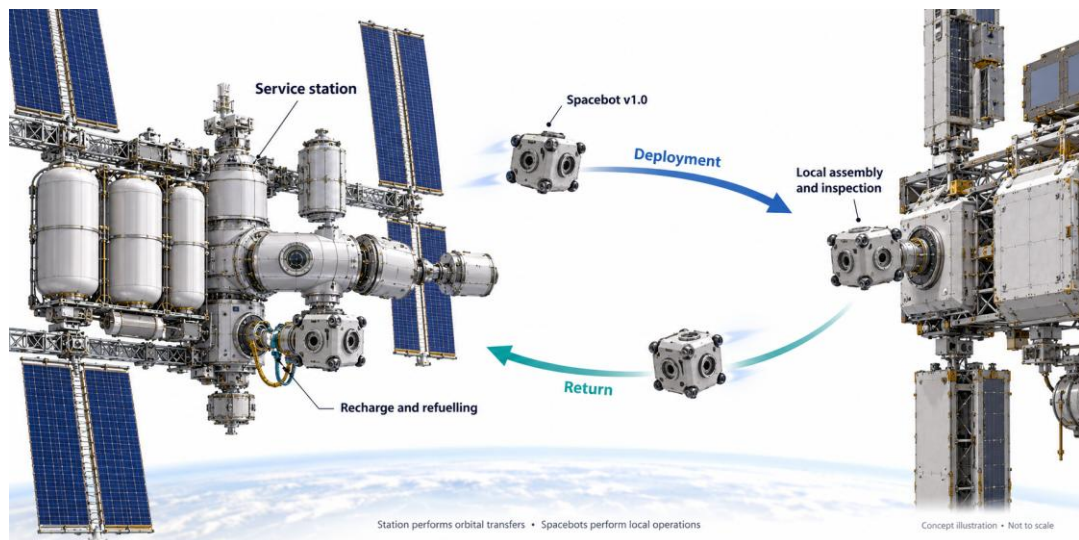


Figure 1.1 Station supported mission architecture

1.3 Operating sequence

A sortie comprises health and resource checks, controlled release, relative navigation, approach and capture, task execution, return and docking. Replenishment begins only after mechanical, electrical and fluid interlocks are verified.

1 4 Boundaries and exclusions

Battery energy, thermal limits and return feasibility define the mission envelope. Mechanical attachment is preferred for extended work; prolonged radial hovering increases gas consumption. Flight software, swarm coordination and station implementation require separate development and verification.

1 5 Product advantages and dependencies

The compact cubic envelope supports close-proximity work and modular attachment. Stored energy supports operation through changing illumination, while station replenishment enables repeated sorties. Multi-robot missions require sufficient berth capacity, communications and traffic coordination.

Chapter 2 Design Specifications

2.1 System level specification

Table 2.1 Spacebot V1 specification

Parameter	Specification
Body envelope	500 × 500 × 500 mm
Configuration	Reusable cubic free flyer
Operating region	Local operations in 400–600 km LEO
Station nominal orbit	Approximately 500 km
Orbital transfers	Performed by station
Propulsion	Nitrogen cold gas
Thrusters	24; three per corner at eight corners
Nominal thrust	1.0 N per thruster
Reaction wheels	None
Tank	23.8 L COPV; approximately 360 mm OD
Fill pressure	200 bar absolute at specified fill temperature
Nitrogen inventory	Approximately 5.0 kg; actual fill by real-gas data
Docking interfaces	Six face interfaces based on HOTDOCK
Battery packs	Four protected 8S3P packs; 96 cells
Battery reference energy	1536 Wh using 16 Wh per cell
Bus voltage	28.8 V nominal; 32.8 V charge ceiling
Nominal routine energy	Approximately 664 Wh at delivered loads
Sortie target	6–8 h for a low-duty mixed mission
Wet mass	50 kg sizing reference; final mass TBC
Task payload and arm	Excluded from reference wet-mass sizing

2.2 Functional requirements

Table 2.2 Functional requirements

ID	Requirement	Verification
FR 01	Control translation and attitude in all six DOF	Geometry and allocation analysis
FR 02	Dock and undock at a compatible worksite	Capture demonstration
FR 03	Return before protected energy or gas reserves are entered	Mission simulation
FR 04	Recharge the onboard battery packs at the service station	EPS interface test
FR 05	Refill nitrogen through a separately qualified service interface	Fluid interface test
FR 06	Isolate a faulty battery pack and a commanded-off valve branch	Fault injection
FR 07	Inhibit plume impingement on sensitive target surfaces	Geometry and trajectory checks
FR 08	Secure the robot during station orbital transfers	Structural and retention test

2.3 Performance limitations

The 500 mm dimension covers the core body. The final envelope must include nozzles, docking fittings, antennas and tools. Payload rating and worksite range require mission-specific analysis; directional thrust depends on the actual nozzle geometry and allocation constraints.

Chapter 3 Mechanical Design

3.1 Chassis and load paths

The primary structure uses aluminium 7075-T73 members and reinforced removable panels. Corner beams and bracing connect launch restraints, docking fittings, tank supports and battery mounts. The reference construction includes L beams, M4 fasteners and an 8 mm local plate; dimensions and coverage are drawing controlled.

Tank cradles and battery mounts transfer loads through defined hardpoints. Reinforced docking mounts bypass light covers. Reusable aluminium joints require specified inserts, pull-out strength and tightening torque.

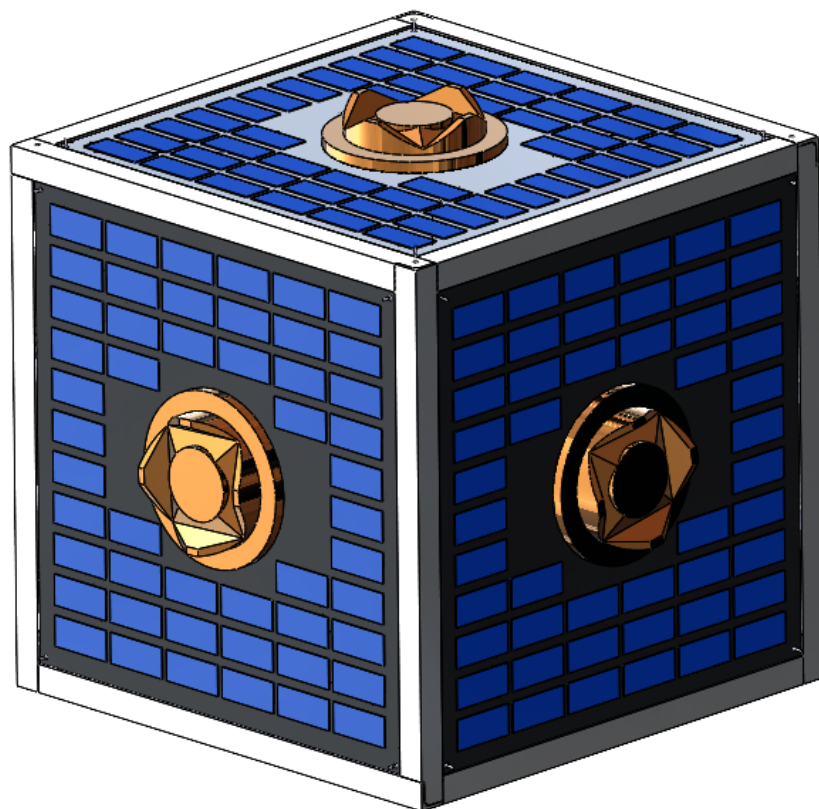


Figure 3.1 Spacebot v1.0 complete assembly

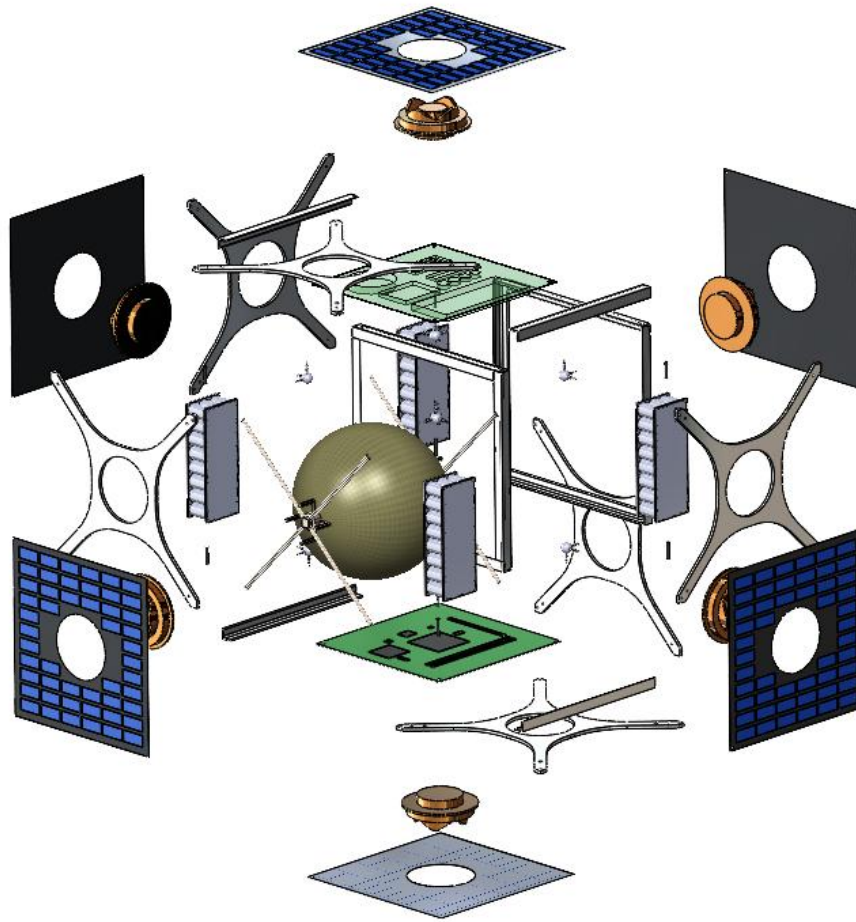


Figure 3.2 Exploded structural arrangement

3 2 Packaging and maintainability

The 125 L gross cube contains a 24.43 L spherical tank envelope. Four proposed $230 \times 160 \times 80$ mm battery envelopes total 11.78 L. Volume availability alone does not establish geometric fit.

A centred 360 mm tank leaves only 70 mm between its surface and the centre of each outer cube face. An 80 mm pack therefore requires offset positioning or a different cell-tray arrangement. CAD must close clearances without changing the 500 mm body envelope.

Access panels must permit battery removal, valve inspection and sensor alignment. Routing needs bend-radius allowances, strain relief and service access. Symmetric battery placement limits centre-of-mass displacement.

3.3 Material specification

Table 3.1 Material and process basis

Part	Material basis	Definition needed
Primary frame	Al 7075-T73	Sections coating joint details
Local inserts	Compatible metallic threaded inserts	Pull-out data and torque
Tank overwrap	Carbon fibre epoxy; T800 stated in evaluation	Qualified vessel design and winding
Tank liner and bosses	Supplier-selected pressure-compatible liner and bosses	Permeation seals material selection
Gas tubing	C10100 OFHC annealed copper in evaluation	Pressure fatigue support and cleaning
Nozzles	17-4PH stainless steel H900 in evaluation	Thermal compatibility and finish
Panel faces	CFRP or aluminium sandwich skins	Laminate isolation and bonding
Panel core	Aluminium or CFRP honeycomb	Density inserts venting
Thermal finish	AZ-93 or silvered quartz SSM where justified	Optical properties and placement
Internal shielding	Local HDPE or polyimide where justified	Thickness radiation mass trade

4 Side panels and thermal surfaces

Rigid sandwich panels carry protective finishes, radiators, sensors and access features. MLI provides thermal insulation rather than structural support. Keep radiators, apertures, service fittings and thruster paths clear of blankets.

CFRP with BNNT additions, heat-pipe honeycomb, polymer lining and thin metal foil remain candidate panel treatments. Credit radiation protection only after thickness, areal mass, manufacturability and secondary-radiation effects are assessed.

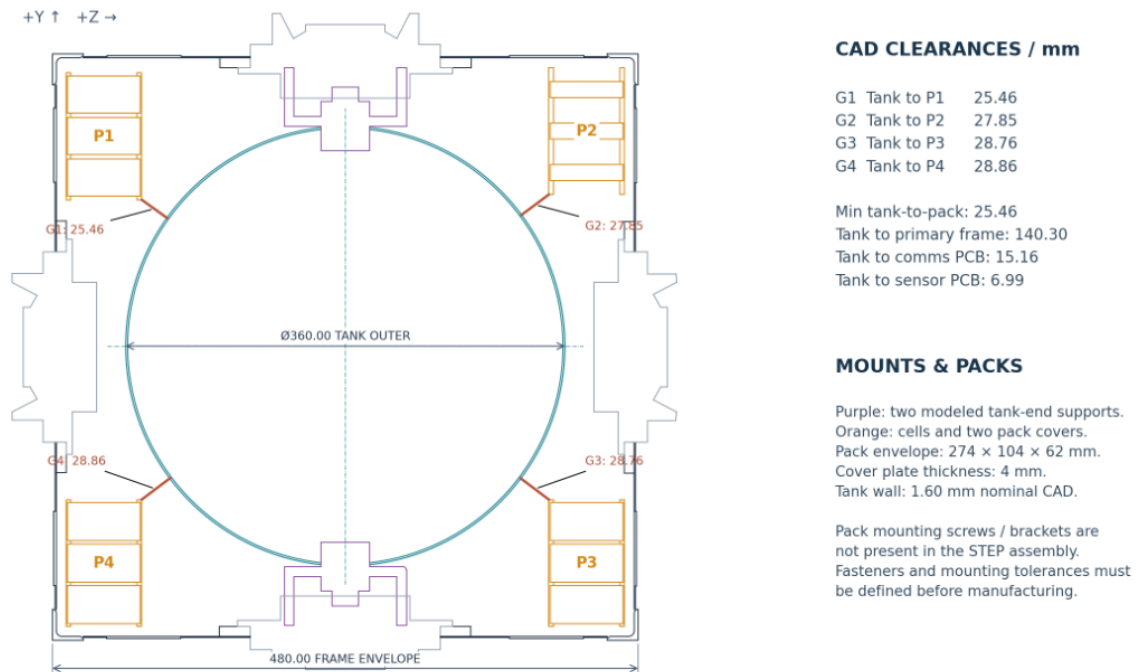


Figure 3.3 Orthogonal section and spacing

Chapter 4 Propulsion and Gas Storage

4 1 System arrangement

The nitrogen circuit includes a refill coupling, isolation valves, COPV, pressure and temperature sensing, regulator, filter, manifold and 24 controlled nozzle branches. Regulator-failure protection and safe venting must be specified. Docked filling must not produce unintended thrust.

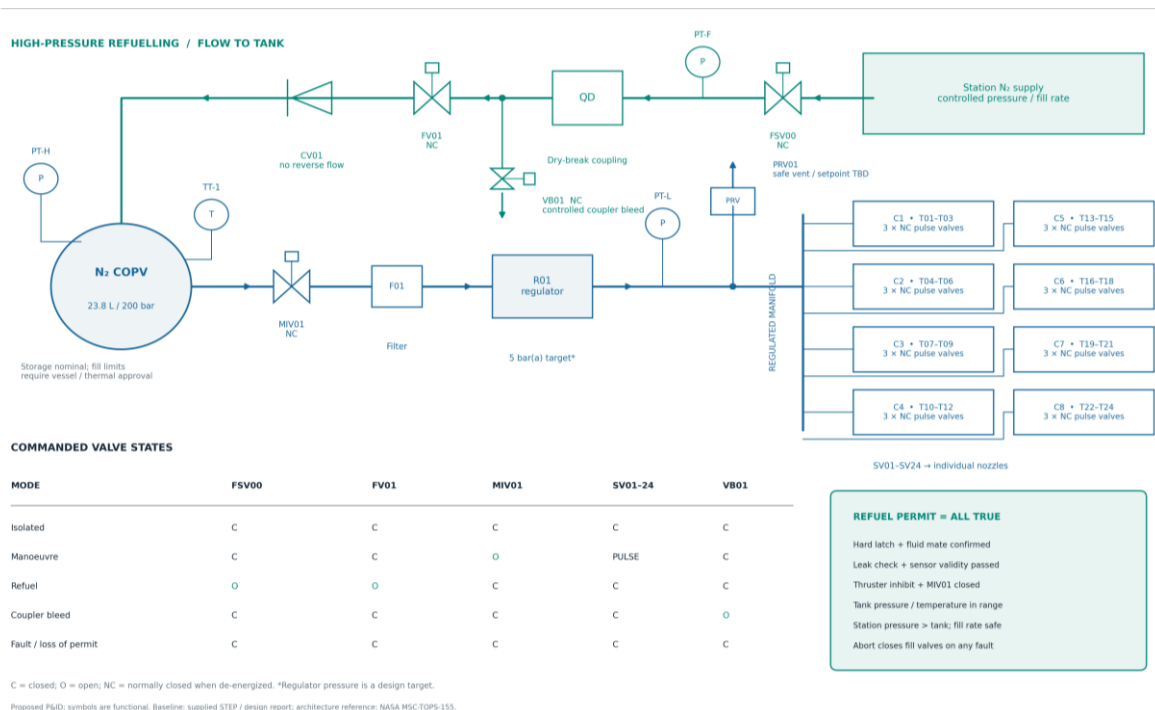


Figure 4.1 Nitrogen circuit and service path

4 2 Tank specification and inventory

Table 4.1 Pressure vessel and gas basis

Parameter	Value or requirement
Usable internal volume basis	23.8 L subject to supplier vessel drawing
Nominal outer diameter	360 mm; internal volume and shell thickness must reconcile
Gas	Dry clean nitrogen
Nominal fill pressure	200 bar absolute
Calculation fill temperature	293 K

Parameter	Value or requirement
Nitrogen specific gas constant	296.8 J/(kg K)
Ideal-gas inventory	5.474 kg at 200 bar and 293 K
Illustrative real-gas inventory	4.976 kg when $Z = 1.10$
Allocated routine gas	4.18 kg including return
Allocated emergency reserve	0.40 kg
Allocated unexpended residual	0.40 kg
Gas budget total	4.98 kg; rounded system inventory approximately 5.0 kg

Fill mass depends on internal volume, pressure, temperature and nitrogen compressibility. Confirm the charge with real-gas data and adjust allocations for the actual fill and regulator residual requirement.

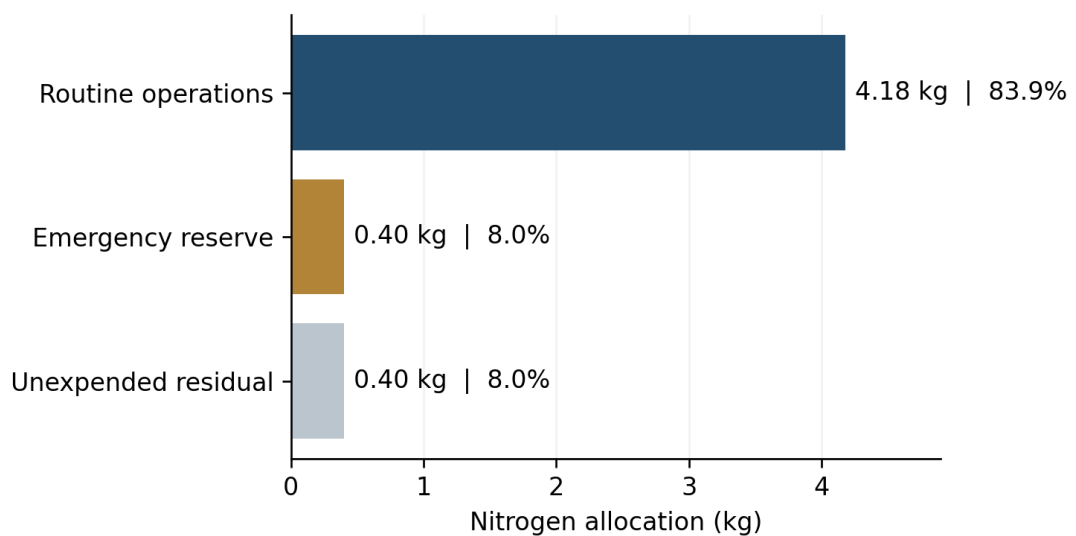


Figure 4.3 Nitrogen allocation at approximately 4.98 kg fill Preliminary budget

A 0.40 kg residual corresponds to about 14.6 bar absolute at 293 K using an ideal-gas approximation. Regulator dropout, withdrawal cooling and minimum-pressure flow require verification. Vessel mass includes liner, overwrap, bosses, fittings and supports.

4 3 Thrusters and geometry

The 24 jets are grouped three per corner. Ideal axis-aligned geometry allows four jets to provide 4 N translation with cancelling moments, or about 1 N m torque with cancelling net force. Final capability requires CAD vectors and measured thrust.

The nozzle basis is a 1.30 mm throat and 2.10 mm exit, giving area ratio 2.61. Preliminary sizing uses approximately 5 bar chamber pressure and 66 s Isp. At 1 N, mass flow is 1.545 g/s; final performance requires consistent analytical or supplier data.

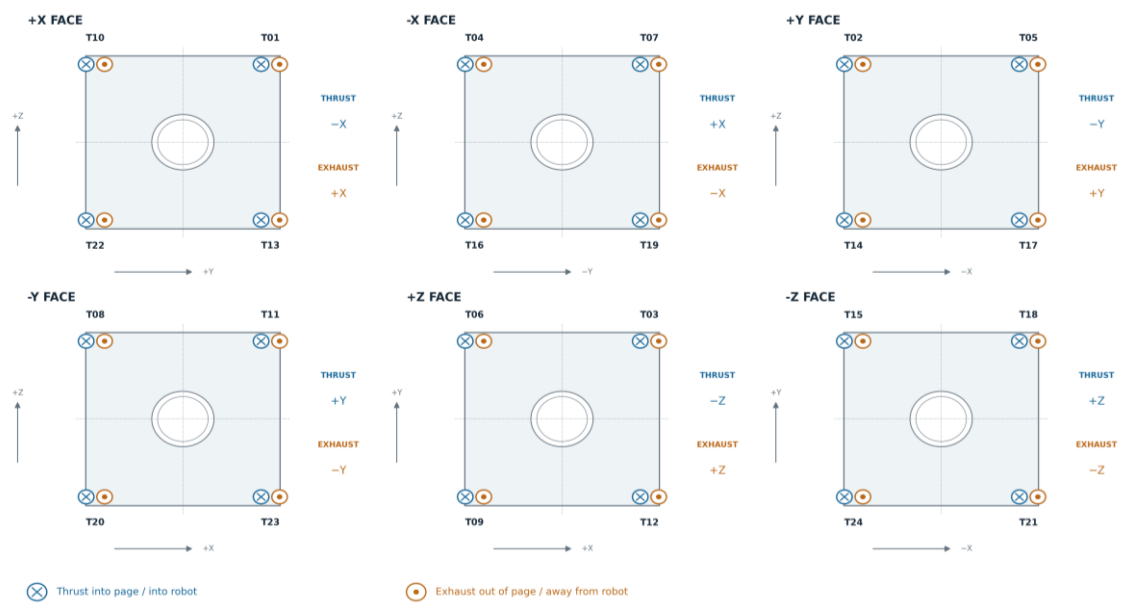


Figure 4.2 Thruster numbering and body axes

4 4 Plume constraints and fault response

Nozzle records distinguish body force from the opposite exhaust direction. Allocation inhibits plumes toward targets, tools, nearby robots and the station. Stuck-open and failed-closed cases require analysis; jet count alone does not establish fault tolerance.

Chapter 5 Electrical Power and Battery System

5.1 Battery architecture

Four independently protected 8S3P packs feed a common bus through isolation and controlled connection circuits. Each pack contains eight series groups of three parallel cells. The 96-cell installation is equivalent to 8S12P when all packs share current; packs are not placed in series.

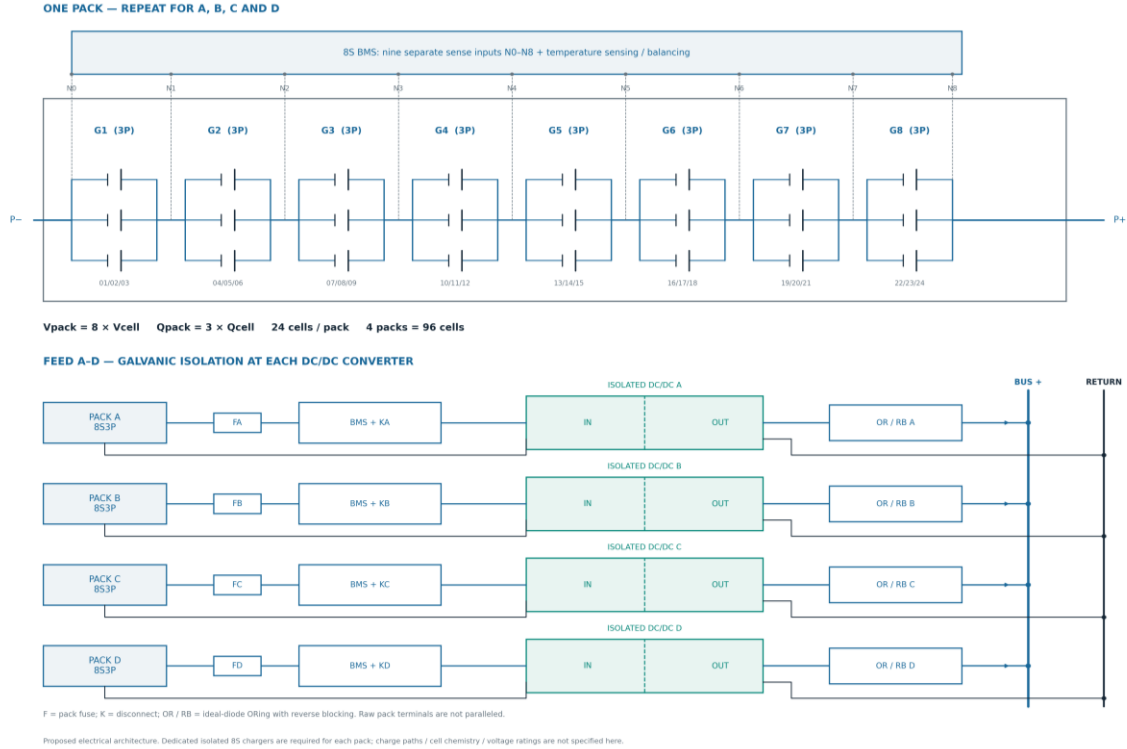
The Saft VES16 reference cell is rated at 4.5 Ah and 16 Wh, with approximately 3.6 V mean voltage, 4.1 V end-of-charge, $\varnothing 33 \times 60$ mm size and 0.155 kg mass [2]. The proposed 8S3P pack is a custom assembly.

Table 5.1 Battery electrical and physical basis

Parameter	One pack	Four packs
Configuration	8S3P	Four protected packs on common bus
Cell count	24	96
Nominal voltage	28.8 V	28.8 V
End-of-charge ceiling	32.8 V	32.8 V
Nameplate capacity	13.5 Ah	54 Ah
Energy from 16 Wh cell rating	384 Wh	1536 Wh
Voltage $\times$ Ah approximation	388.8 Wh	1555.2 Wh
Bare-cell mass	3.72 kg	14.88 kg
Installed mass allocation	Approximately 4.25 kg	Approximately 17 kg
Proposed pack envelope	$230 \times 160 \times 80$ mm	11.78 L envelope volume total

Use the 16 Wh cell rating for the 1536 Wh energy basis. Nominal voltage $\times$ capacity gives 1555.2 Wh because the voltage is rounded; this is not extra energy. Pack envelopes remain subject to holder, BMS, connector and tank-clearance checks.

Figure 5.1 Battery pack connection and protection



5 2 Protection and power distribution

Each pack requires group-voltage, temperature and current monitoring, balancing, overcurrent protection and isolation. Precharge limits inrush; reverse-current protection prevents cross-feeding. Connect packs only after voltage and temperature compatibility checks.

The PDU and converters must support the four 8S packs and all regulated loads. Verify current capacity, transients, isolation and environmental suitability. Set the discharge floor from supplier limits and converter requirements.

5 3 Usable energy and sortie planning

Routine energy is 1536×0.80 capacity factor $\times 0.80$ discharge factor $\times 0.90$ conversion efficiency $\times 0.75$ mission share = 663.55 Wh. These factors are planning assumptions.

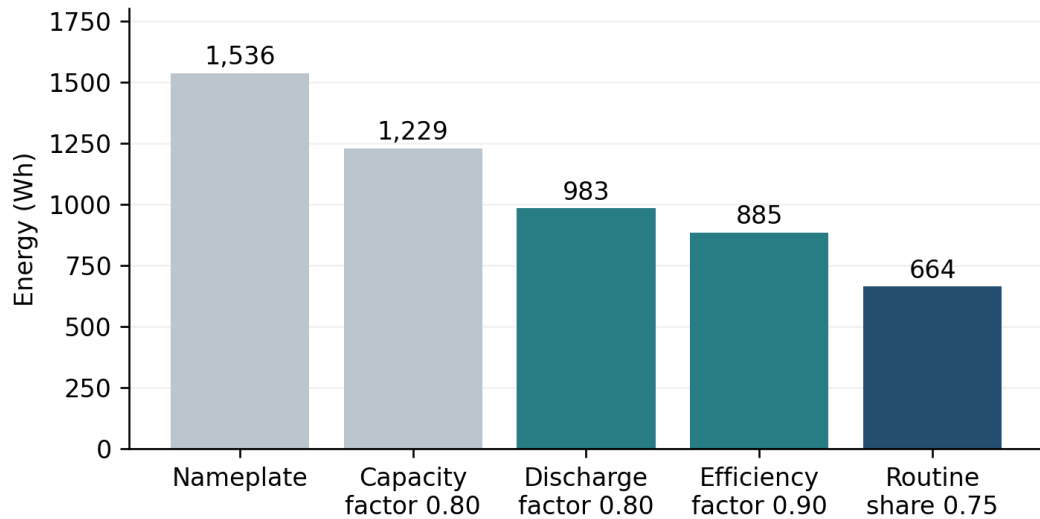


Figure 5.2 Battery energy allowances Successive planning reductions

After capacity, discharge and conversion allowances, 884.74 Wh remains: 663.55 Wh routine energy and 221.18 Wh protected recovery energy. Turn back using predicted return demand, not SOC alone.

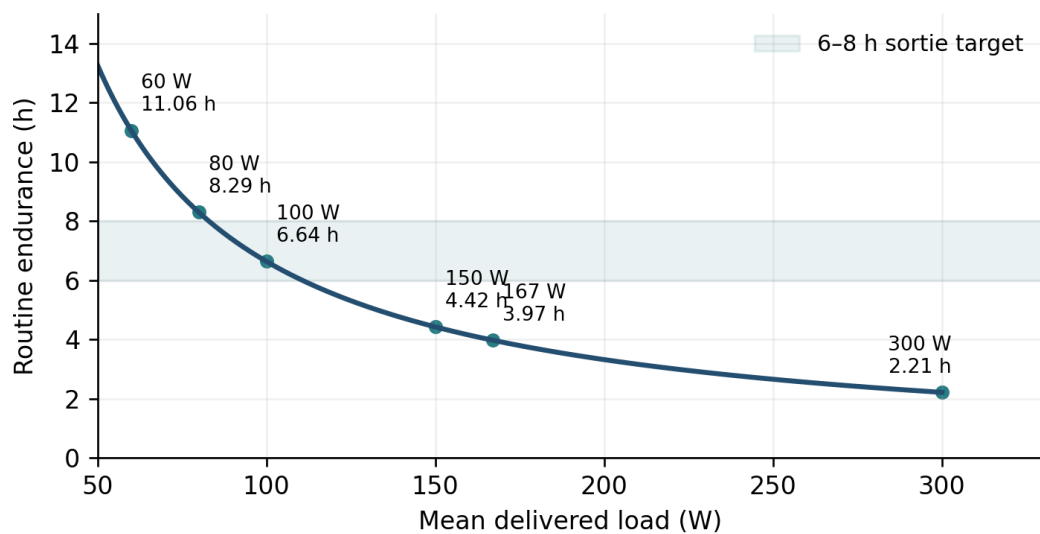


Figure 5.3 Endurance versus load 663.55 Wh routine allowance

A 6–8 h sortie requires mean delivered power no greater than approximately 111–83 W. The 300 W case is an energy-only bound; sustained operation requires electrical and thermal verification.

5.4 Station charging

Charging requires secure capture, verified contacts, acceptable pack temperatures and inhibited local propulsion. Pack-level control follows the cell charging algorithm and 32.8 V eight-cell charge ceiling. Interface current and voltage remain ICD items.

Replacing 635 Wh delivered energy requires about 706 Wh at the battery and 784 Wh from the station at the assumed 90 percent discharge and charge efficiencies. A 300 W charger needs at least 2.61 h before taper and thermal limits; this is not a selected charge rate.

Chapter 6 Docking Navigation and Electronics

6.1 Docking interfaces

Six face-centred HOTDOCK-based positions support attachment, tool exchange, power and data. Identify faces by $\pm X$, $\pm Y$ and $\pm Z$. Select active or passive variants and transmit interface loads through reinforced hardpoints.

The project capture target is below 50 N, with a 6000 N axial service-load target. The cited manufacturer sheet rates one configuration at 3 kN pulling and 300 N m [3]; confirm the variant before declaring 6000 N capability. Use a separately qualified nitrogen refill coupling.

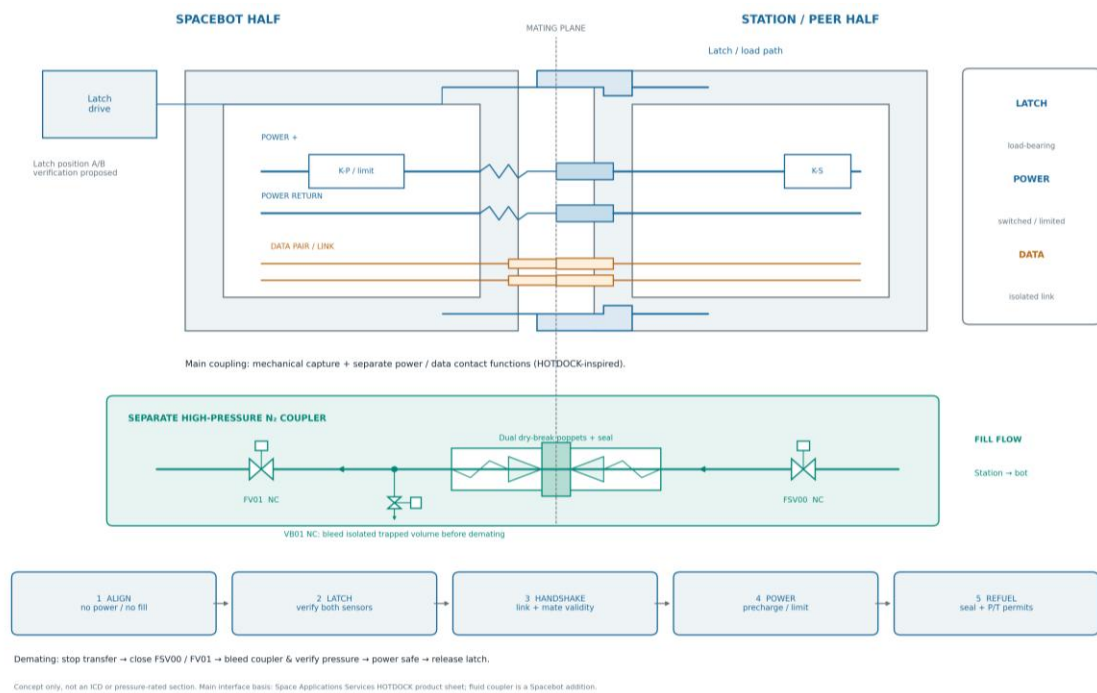


Figure 6.1 Docking interface and station service connection

6.2 Approach and capture

Final-contact speed is provisionally 0.05 m/s. Specify hold points, capture corridor, tolerances and retreat path. Confirm latch closure before enabling task loads or services. Sensor loss, contact anomalies or latch disagreement require hold, retreat or recovery.

6 3 Navigation and control

Navigation combines IMU, camera, ranging and inertial attitude sensing. Relative sensors establish target pose and closure; the star tracker provides inertial attitude. Account for glare, eclipse, occlusion and sun-exclusion limits.

The 6×24 allocation matrix uses each thrust vector and $r \times F$ about the current centre of mass. Rank six gives linear nullity 18, but directional authority must also be checked under one-way thrust, failures and plume restrictions.

6 4 Candidate electronics

Table 6.1 Candidate component register

Function	Reference component	Current integration status
Onboard computer	Xiphos Q7S	Candidate; power and qualification TBC
IMU	ADIS16495	Candidate; mounting and thermal bias TBC
Star tracker	ST-16RT2	Candidate; exclusions and placement TBC
Navigation camera	Basler daA1280-54uc	Functional reference; space suitability TBC
Range sensor	LIDAR-Lite v3HP	Functional reference; range and vacuum suitability TBC
Radar	Ainstein US-D1	Functional reference; space suitability TBC
Sun sensor	Bradford CSS	Candidate for thermal and exclusion awareness
UHF transceiver	EnduroSat Type II	Candidate; link budget TBC
Antenna	ISIS deployable antenna	Candidate; deployment and blockage TBC
Sensor processing	Zynq-7020	Candidate; radiation mitigation TBC
PDU and BMS	Custom or supplier-selected for 8S packs	Voltage current and protection compatibility TBC

Function	Reference component	Current integration status
Valve and latch drivers	Load-matched protected drivers	Driver current and load compatibility TBC

6 5 Communications and software functions

The station coordinates telemetry and commands using crosslinks and store-and-forward data. Define link budgets, synchronization, authentication, throughput and loss-of-link recovery for the deployed fleet.

Flight software requires state estimation, bounded trajectories, thrust allocation, docking control, resource accounting and fault management. Task commands specify worksite, duration, allowable contact loads, plume limits and return conditions.

Chapter 7 Design Calculations

7.1 Mass reconciliation

The mass budget includes structure, vessel, gas, battery, docking interfaces, electronics, thermal hardware, harnesses and margin. Record mass and location for every component. Mission tools and manipulators are additional.

Use 50 kg as a sizing reference, not a verified product mass. With 5 kg nitrogen and 17 kg installed batteries, 28 kg remains for other dry hardware. Final mass and inertia require supplier data and a CAD roll-up.

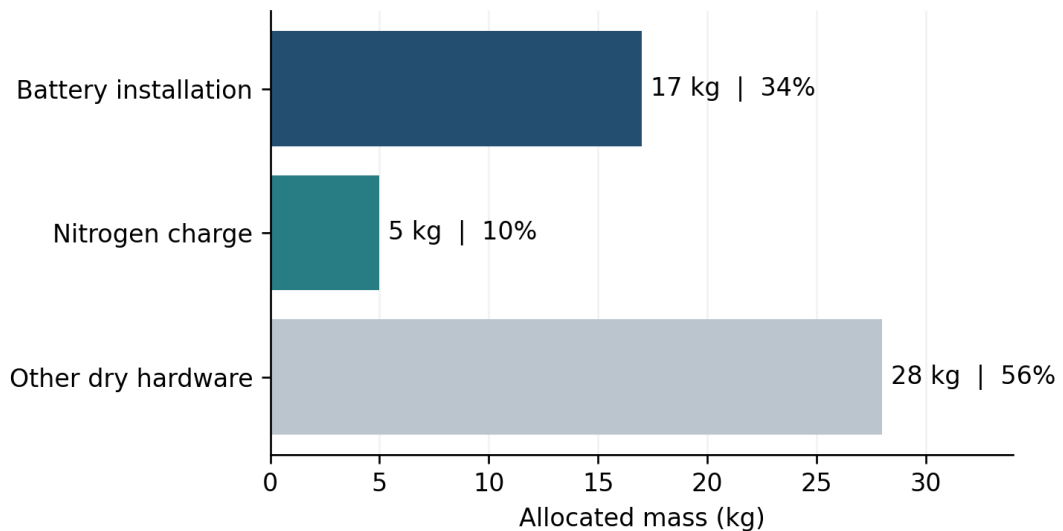


Figure 7.1 Reference mass allocation 50 kg sizing basis excluding tools

Table 7.1 Mass definition and closure

Quantity	Current value	Basis
Bare cells	14.88 kg	$96 \times 0.155 \text{ kg}$
Battery installation	Approximately 17 kg	Preliminary packaging allocation
Nitrogen charge	Approximately 4.98 kg	$Z = 1.10$ illustrative fill
Sizing wet mass	50 kg	Reference for calculations only
Implied dry allowance	45 kg	Rounded wet less rounded gas

Quantity	Current value	Basis
Other dry hardware allowance	28 kg	Dry allowance less battery installation
Manipulator and payload	Not included	Add actual module and tool masses
Final wet mass	TBC	CAD BOM plus actual charge plus margins

7 2 Inertia and acceleration

The uniform-cube inertia estimate is $I = mL^2/6 = 2.083 \text{ kg m}^2$ per axis at 50 kg. Replace it with CAD inertia, including off-diagonal terms and any attached tool.

At 50 kg, a 1 N jet gives 0.020 m/s^2 ; balanced 4 N translation gives 0.080 m/s^2 . Ideal braking from 0.05 m/s takes 0.625 s and 15.6 mm . Operational clearance must include delays, pulse response and relative dynamics.

Ideal torque of 1 N m produces 0.480 rad/s^2 . A 90 degree zero-rate bang-bang slew takes 3.62 s and about 22.4 g with four active jets. Practical rate and plume limits increase slew time.

7 3 Gas impulse and equivalent velocity change

At 66 s Isp , effective exhaust velocity is 647.24 m/s . Routine gas provides 2705.5 N s ; emergency gas adds 258.9 N s . Residual is not credited. Routine gas equals approximately 2706 single-jet seconds or 676 s of four-jet firing.

At 50 kg initial mass, routine gas yields 56.50 m/s ideal equivalent Δv ; including emergency gas yields 62.18 m/s . Attitude couples, braking and constrained allocation reduce useful translation.

A 15 m/s scalar allocation requires approximately 1.145 kg . A 0.15 m/s increment requires about 11.6 g . Docking-cycle capacity must also include approach, retreat, attitude and handling demand.

7.4 Illustrative eight hour sortie

Table 7.2 Battery only mission energy example

Phase	Time h	Mean load W	Energy Wh
Deployment and checks	0.5	100	50
Outbound approach	1.0	100	100
Anchored intermittent work	4.0	75	300
Inspection and repositioning	1.5	70	105
Return and docking	0.5	100	50
Contingency within routine allocation	0.5	60	30
Total	8.0	79.4 average	635

The illustrative 8 h profile uses 635 Wh and leaves 28.6 Wh routine headroom plus the separate 221.2 Wh recovery reserve. Intermittent anchored work is assumed; continuous high-power tools shorten endurance. Verify return and thermal feasibility separately.

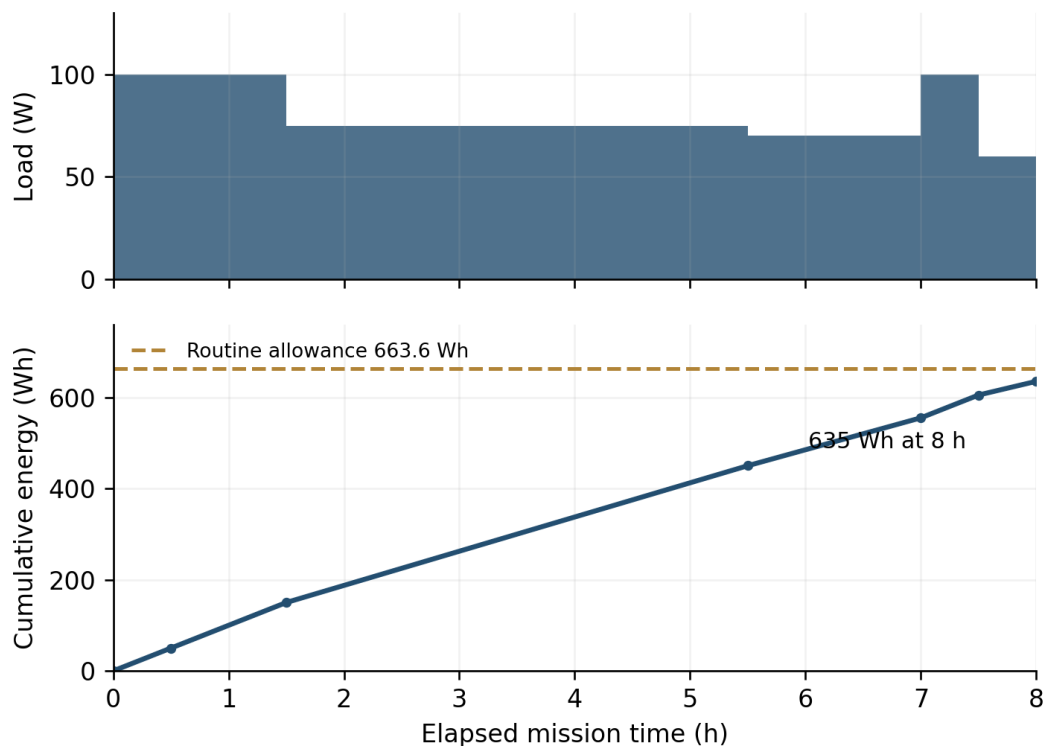


Figure 7.2 Illustrative eight hour mission load and cumulative energy

7.5 Thermal design

Thermal analysis combines internal dissipation, direct sunlight, Earth infrared and albedo. Electrical consumption must be reconciled with actual heat generation, emitted energy and mechanical work.

At 293 K and emissivity 0.8, ideal cold-space radiation is approximately 334 W/m². Direct sunlight can add about 102 W to a 0.25 m² face at absorptivity 0.3. The graph gives internal-load-only area, not final radiator sizing.

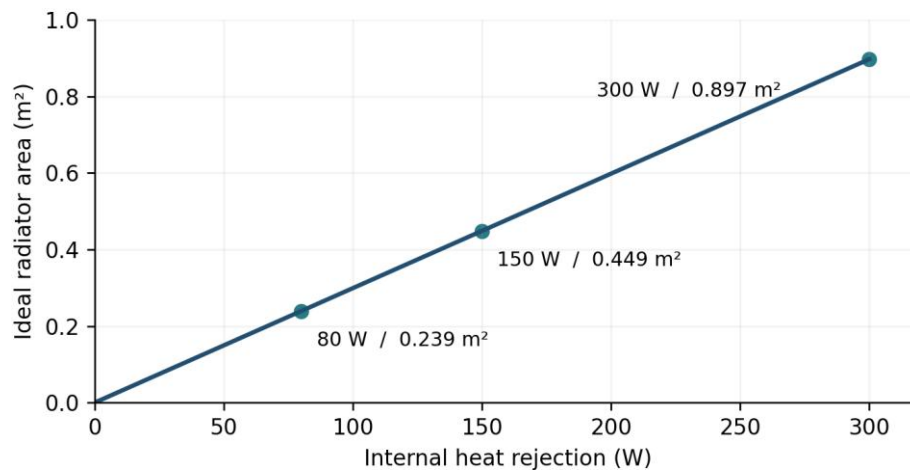


Figure 7.3 Ideal radiator area at 293 K External heating excluded

Conductive spreaders connect batteries and electronics to exposed radiators. MLI insulates other surfaces. Peak operation requires both current and thermal-capacity checks; temperature limits are component specific.

7.6 Orbit loads and capture

A circular 500 km orbit has a period of approximately 94.6 min. Eclipse depends on beta angle and season; the beta-zero spherical-Earth estimate is about 35.7 min. Eclipse affects thermal balance and station recharge scheduling.

At 50 kg, preliminary 8g axial and 3g lateral cases give 3923 N and 1471 N. Four 10 × 10 mm restraint areas imply 9.81 MPa average axial stress. Verify joints, bending, buckling and dynamic amplification with actual launch restraints.

For 0.05 m/s capture against a fixed target over 0.5 s, mean force is 5 N and kinetic energy is 0.0625 J. A provisional three-times peak factor gives 15 N. Contact dynamics and reduced mass govern the actual peak.

Chapter 8 Manufacturing Operation and Verification

8 1 Manufacturing and assembly

Manufacture the frame and panels to released drawings with traceable materials, controlled finishes, inserts and bonds. Pressure components require qualified design, cleanliness, inspection and test procedures.

Assemble frame and hardpoints, pressure hardware, batteries, docking fittings, avionics, thermal paths and harnesses before external closure. Inspect routing, access, nozzle alignment and sensor views; then measure mass properties.

8 2 Bill of materials

Table 8.1 Product bill of materials at assembly level

Item	Qty	Definition and status
Primary cubic frame	1 set	7075-T73; drawing dimensions TBC
Side and access panels	6 face positions	Cut-outs and local radiator design TBC
Nitrogen COPV	1	23.8 L; 200 bar fill basis
Tank supports	1 set	Qualified support geometry TBC
Thruster nozzles and valves	24 each	1 N target with load-matched actuation
Regulator and main isolation	1 circuit	Flow capacity and dropout TBC
Fill and relief equipment	1 set	Separate service coupling and safe vent
Pressure and temperature sensing	1 set	Tank and regulated-line instrumentation
VES16 reference cells	96	Four 8S3P packs
Pack enclosure and BMS	4 sets	Custom mechanical and protection design
PDU and converters	1 set	Matched to actual bus and load rails
Face docking interfaces	6	Active/passive mix and variant TBC

Item	Qty	Definition and status
Avionics and navigation sensors	1 suite	Candidate register Table 6.1
Communications and antenna	1 suite	Station link and ground link TBC
Thermal and shielding materials	1 set	Thickness area and heat paths TBC
Harness and fasteners	1 set	Part numbers routing and torque TBC
Task manipulator or payload	Mission dependent	Accessory outside base mass

Complete the BOM with part numbers, masses, costs, lead times and serial traceability. Separate recurring hardware cost from design, qualification, software and station infrastructure.

8 3 Operational states

Table 8.2 Operational state requirements

State	Permitted activity	Exit condition
Secured storage	Station retention and health checks	Release approved
Charging or refuelling	Interlocked station service	Health and replenishment complete
Release	Controlled separation	Clear of station exclusion zone
Transit	Relative navigation and bounded thrust	Worksite hold point reached
Approach	Low-speed capture corridor	Latch confirmation or retreat
Anchored work	Bounded tool operation	Task complete or limit reached
Return	Reserved recovery trajectory	Station capture
Safe hold or recovery	Mission-dependent stable action	Station intervention or approved resume

8 4 Refuelling and recharge sequence

After capture, verify the latch, inhibit local thrust, confirm contacts and establish the service link. Authorize charging by pack temperature and health. Meter nitrogen filling with pressure, temperature and leak monitoring.

The station needs adequate pressure head or transfer equipment to achieve the bot fill target. Isolate and leak-check the circuit, confirm charge inventory, disconnect services and complete release checks before undocking.

8 5 Failure management

Table 8.3 Principal fault conditions

Condition	Required response
Low predicted return energy	Stop task and return within reserved energy
Unexpected gas loss	Isolate suspected branch; recompute reachable recovery
One pack offline	Recompute current and endurance; controlled return
Valve stuck open	Counteract if feasible; isolate supply branch
Navigation confidence lost	Stop approach and execute valid hold or retreat
Docking latch disagreement	Inhibit services and task loads
Battery overtemperature	Reduce load; inhibit charging as required
Loss of station link	Execute stored recovery policy for present trajectory
Blocked radiator or sensor	Restrict task and attitude until limits recovered

Chapter 9 Conclusion

9.1 Configuration summary

Spacebot v1.0 combines a 500 mm cubic body, 24 nitrogen thrusters, a 23.8 L tank, four protected 8S3P packs and six docking positions. It performs recoverable local inspection, positioning, assembly and servicing, supported by station orbital transfers and replenishment.

The principal planning budgets are 1536 Wh nameplate energy, 664 Wh routine energy, approximately 17 kg installed battery and approximately 4.98 kg nitrogen. The 8 h mission example uses 635 Wh. Duration remains constrained by energy, temperature and return feasibility.

9.2 Product documentation package

The product package includes released specifications, CAD, BOM, interface diagrams, calculation records, operating procedures and verification evidence. All items must reference the same Spacebot v1.0 configuration and revision.

9.3 Publications and intellectual property

Publications are pending. Patent application is intended subject to eligibility assessment and filing. This statement does not assert that a patent has been filed or granted.

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- [4] Perera S R. ME7401 Final Report Updated Figures Appendices. University of Ruhuna. Project engineering report and document-format reference.
- [5] Project configuration decisions of 9 and 10 October 2026. Station orbital transfers, retained 500 mm cube, four 8S3P packs, 23.8 L tank and exclusion of reaction wheels. Spacebot v1.0 configuration basis.
- [6] Analytical calculations in this document. Stated mass, temperature, compressibility, energy allowances and idealized geometry form the calculation basis; derived performance remains subject to hardware validation.

Appendices

Appendix A Spacebot CAD Drawings

Appendix B Hotdock CAD Drawings

Appendix A Spacebot CAD Drawings

SB-001	Spacebot v1.0 - General Assembly
SB-002	Primary Frame - Multibody Part
SB-003	Side Face - Type 1
SB-004	Side Face with Rod Features
SB-005	Side Face - Type 12
SB-006	Longitudinal L-Beam
SB-007	PCB Support Pin
SB-008	Tank and Support Assembly
SB-009	Spherical Tank
SB-010	Tank End Support
SB-011	Dock-Side Cover Panel
SB-012	Three-Nozzle Corner Assembly
SB-013	Corner Nozzle Mount
SB-014	Cold-Gas Nozzle
SB-015	Communications PCB Envelope
SB-016	Sensor PCB Envelope
SB-017	Docking Interface Envelope
SB-018	8S3P Battery Pack Assembly
SB-019	Battery Pack Cover
SB-020	Battery Cell Envelope
SB-021	Primary Frame Beam - Body Detail