ESPASTAR™: FLEXIBLE, AFFORDABLE ACCESS TO SPACE

Northrop Grumman's ESPAStar platform provides a modular, cost-effective, and highly capable infrastructure resource for hosting technology development and operational payloads. The ESPAStar platform uses a customized EELV Secondary Payload Adapter (ESPA) ring as part of its structure and is capable of being launched aboard any launch vehicle that meets the Evolved Expendable Launch Vehicle (EELV) standard interface specification. The ESPAStar platform's six payload ports are capable of accommodating combinations of hosted or separable (fly-away) payloads. The payload interface at each port has been standardized, allowing for hosted and separable payload interchangeability, late payload integration, and manifest changes. The ESPAStar platform leverages the available mass margin from any EELV launch to provide an affordable path to space for payloads. The platform is optimized for GEO missions, but is adaptable for LEO and MEO missions and can be modified to support missions beyond GEO.

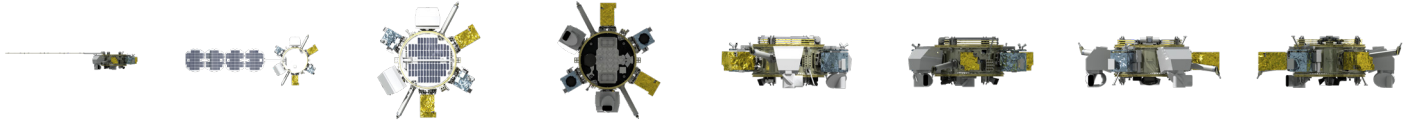| SPECIFICATIONS	
ORBIT	Optimized for GEO, adaptable for LEO and MEO missions
TARGETED MISSION DURATION	One to three years, single string
DRY MASS (NO P/LS)	430-470 kg, (orbit dependent)
DIMENSIONS (NO P/LS)	157.5 cm dia x 61 cm ht. (62" dia. x 24" ht.)
FUEL CAPACITY*	310 kg *optimal BOL pressure uses 301 kg
PAYLOAD MASS	> 1,920 kg (> 320 kg per port). Please see Page 3 for more information on payload mass
TOTAL POWER (BOL)	1,200 W via four-panel solar array
PAYLOAD PEAK POWER	Tailorable based on mission profile
BATTERY	96 A-hr Li-ion
DOWNLINK RATE	256 kbps/1.6 Mbps via SGLS; other downlink frequencies available upon request
UPLINK RATE	2.0 kbps via AFSC; other uplink frequencies available upon request
PAYLOAD DATA STORAGE	36 Gbytes non-TMR, non-volatile

LAUNCH VEHICLE (LV) COMPATIBILITY	
REFERENCE LV CONFIGURATION	EELV Secondary Payload Adapter (ESPA)
PAYLOAD ATTACH FITTING	15" diameter port (qty. six ports)
OTHER LV COMPATIBILITIES	All EELV ESPA Compatible Launch Vehicles

REFERENCE ORBIT COMPATIBILITY	
APOGEE ALTITUDE	35,786 km $\pm$ 300 km
PERIGEE ALTITUDE	35,786 km $\pm$ 300 km
INCLINATION	0 deg $\pm$ 2 deg
OTHER ORBIT COMPATIBILITIES	All Low Earth Orbits; Low Inclination to Sun-Synchronous. Earth-Trailing Orbits, Geosynchronous Equatorial Orbits (GEO), Cis-Lunar Orbits, Earth-Sun and Earth Moon Libration Points

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SPECIFICATIONS

|	
DESIGN MISSION LIFETIME AND RELIABILITY RATING	1.5 years (3 years goal) Ps=0.8
STRUCTURE TYPE DESCRIPTION	Aluminum Forged Ring; Aluminum Honeycomb forward and aft decks and internal bulkhead
ELECTRICAL POWER SUBSYSTEM	**Direct Energy Transfer System** Peak Payload Power (EOL): 850 W Orbit Average Payload Power (EOL): 800 W Allowable Payload Standby Power : 120 W safe mode Bus Voltage, Nominal Range (V): 24 V to 33.6 V Battery-Capacity: 24 Ahr (96 Ahr total, 4x quantity)
ATTITUDE CONTROL ARCHITECTURE TYPE	3-axis stabilized, zero momentum **Pointing Accuracy** Roll 149.4 arcsec Pitch 142.4 arcsec Yaw 144 arcsec (3-sigma) @Star Tracker Interface, Normal RWA operations Pointing Stability: 4.6 arcsec/sec **Maximum Maneuver Rates** Mission Specific, nominal range from 0.25-0.75 deg/sec
COMMUNICATION SYSTEMS	Receive Frequency Band: L-Band Receiver Bandwidth: $\pm$ 100 kHz for doppler Transmit Frequency Band: S-Band **Telemetry Transmit Rate** Low rate: 8 kbps SCO via omni-directional antenna system Medium rate: 256 kbps direct-carrier BPSK via omni-directional antenna system High rate: 1.6 Mbps direct-carrier BPSK via high-gain antenna **Command Receive Rate** 2 kbps FSK/AM ternary SGLS uplink via omni-directional antenna system 1 Mbps PRN ranging available for turnaround Transmitter Power: 5 W
COMMAND & DATA HANDLING	Single Integrated Avionics Unit (IAU) hosting all spacecraft C&DH and power control functions, including spacecraft component interfaces and instrument payload state of health **Data Handling Capacity** 115 kbps UART for Payload Command, Telemetry, Data Data Storage Capacity: 24,000Mb
THERMAL CONTROL	Cold-biased passive thermal control design with surface treatments and MLI blanketing as required. Active thermal control provided by software-controlled heater circuits and thermostatically controlled heater circuits.
PROPULSION SYSTEM	Monopropellant blowdown system with twelve (12x) 0.2 lbf thrusters and four (4x) 5 lbf thrusters Total Impulse Capability 360 m/s (1489 kg dry mass)

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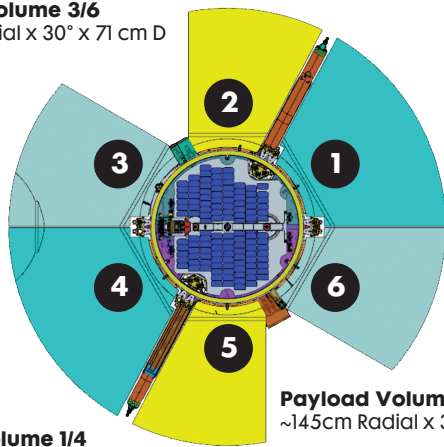## MOUNTING LOCATIONS AND VOLUMES (INTERIOR AND EXTERIOR)

Payload Port dependent. Ports 1 & 6 or 3 & 4 can be combined into a single volume

R = 7.5 cm

R = 7.5 cm
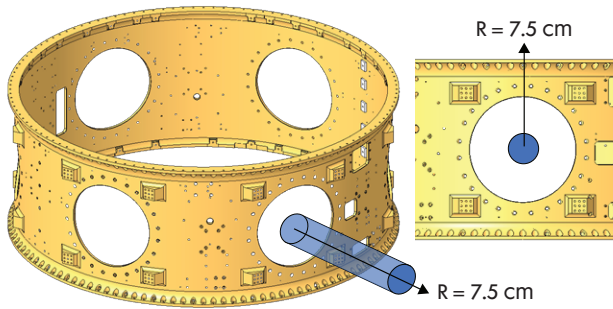
Payload Volume 3/6
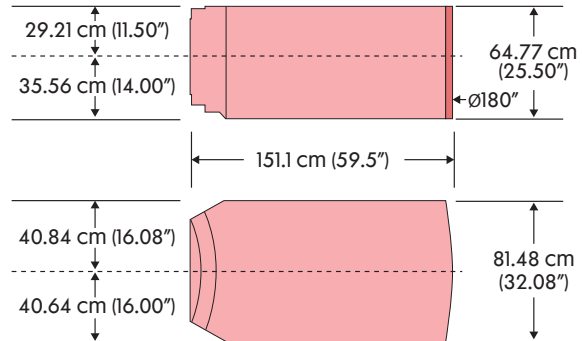~145cm Radial x 30° x 71 cm D

Payload Volume 1/4
~145cm Radial x 60° x 71 cm D

Payload Volume 2/5
~145cm Radial x 30° x 71 cm D

ESPAStar Generic Compliant Payload Volume 1 (View 1)

29.21 cm (11.50")
35.56 cm (14.00")
64.77 cm (25.50")
Ø180"
151.1 cm (59.5")

40.84 cm (16.08")
40.64 cm (16.00")
81.48 cm (32.08")

ESPAStar Generic Compliant Payload Volume 1 (View 2)

A. 27.9 cm (11.00")
B. 21.6 cm (8.5")
C. 31.98 cm (12.59")
D. 27.9 cm (11.0")
E. 21.6 cm (8.5")

2X Ø 184.2 cm (72.5")
2X Ø 166.6 cm (65.6")
45°

F. 16.8 cm (6.6")
G. 20.3 cm (8.0")
30°
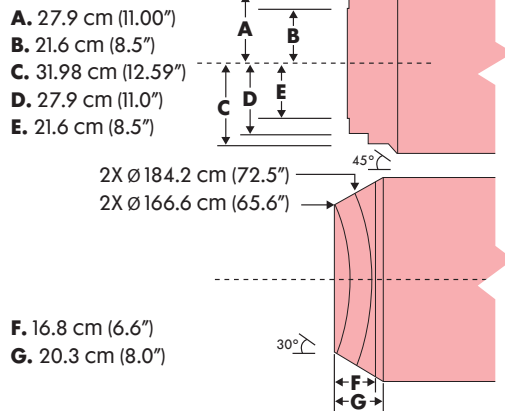
INTERFACE [1]	ESPAStar-D QTY	NOTE
Differential RS-422		
Asynchronous	2	UART, 8-bits, no parity, on stop bit
Synchronous	1	
SpaceWire	1	
Discrete Bi-Level		
Bi-Level Input (TLM)	5	Input to bus; Payload TLM
Bi-Level Output (CMD)	5	Output from bus; Payload CMD
MIL-STD-1553 [2]	1	Non-standard, dual redundant
High Speed Data 3:21 SERDES	1	Non-standard, 3:21 deserializer
Analog Telemetry	7	Analog voltage telemetry ±10V
Temperature Sense	10 [3]	AD590, PRT, 10K Thermistor

(1) All input/output directionality is with respect to the Platform / (2) The MIL-STD-1553 connection must be planned for by no later than Program CDR / (3) The ESPAStar-D Platform can support 10 AD590s per port, and up to 4 PRTs shared by entire manifest, but it does not accommodate 10k Thermistors

PAYLOAD MASS AND CENTER-OF-MASS ALLOWABLE DESIGN ENVELOPE

CENTER-OF-MASS LOCATION (CM (IN)	MASS FOR FOUR-POINT MOUNT (KG (LB)	MASS FOR -HP EIGHT-POINT MOUNT (KG (LB)
0 (0)	370 (815)	740 (1631)
51 (20)	370 (815)	740 (1631)
76 (30)	158 (348)	316 (696)
102 (40)	90 (198)	180 (396)
>102 (>40)	0 (0)	0 (0)

PAYLOAD ELECTRICAL POWER CAPABILITIES

24V-34V POWERED SWITCHES WITH FOLLOWING RATINGS:

- 1.2A Fire Only
- 5.0A Fire Only
- 5.0 Arm/Fire

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Nominal ESPAStar-D Schedule

	Year 1 (J F M A M J J A S O N D)	Year 2 (J F M A M J J A S O N D)	Year 3 (J F M A M J J A S O N D)	Year 4 (J F M A M J J A S O N D)
Long Lead Procurement	▬▬▬▬▬▬			
PHASE 1: Milestones	◆◆◆ ◆	◆ ◆		
	ATP SRR PDR	CDR Platform Comp		
	Kickoff			
Subsystem Design	▬▬▬▬▬			
Structure Build/Test	▬▬▬▬▬▬▬	▬▬▬		
PHASE 2: Milestones		◆ ◆	◆ ◆	
		PADR PIRR	PER PSR	
Test Payload Emulators on Flatsat		▬		
Install & Test All Payloads		▬▬	▬	
Environmental Testing		▬▬	▬	
PHASE 3: Milestones			LBCT-TRR ◆◆ LRR/FRR	
			Pre-Fuel RVW MRR	
Pack/Ship SV to Launch Site & Setup			▬	
Launch Site I&T			▬▬	
ILC			◆	
Pack & Ship MGSE/EGSE Back to Factory			▬▬	
PHASE 4: Milestones			◆	◆
			OAR/Customer Handover	MSN OPS Support Comp.
Conduct On-Orbit Checkout			Rehearsal #1 R#2 Dress	
Support Mission Operations			Mission Dependent Duration	▬▬▬

PAYLOAD THERMAL ACCOMMODATIONS

- Available P/L thermal capacity from Core SC (Orbit Avg.): 7.5W per payload port
- P/L Interface Temperature Range: -30 C to +50 C
- Available P/L Thermal Field of View: 1pi steradian from payload port

SCIENCE DATA STORAGE

- 2 GB via Spacewire or SERDES only

FACILITIES OVERVIEW AND USE PLAN

CONTRACT BASELINE DELIVERY SCHEDULE, ARO THROUGH LAUNCH AND ON-ORBIT CHECKOUT

OTHER SPECIAL FEATURES AND CAPABILITIES

- ESPAStar-D updgrades:
  - Dynatubes (fuel sharing with payloads)
  - Aux Prop Tank (replacing a Payload for 200 kg propellant)
  - Software Defined Radio for TT&C
  - Increased battery capacity
  - Evolved Avionics System, providing additional I/O for payloads and more onboard processing
  - Camera

EPSASTAR-D HISTORIC MISSIONS

VEHICLE	STATUS
ESPAStar-D-1	Launched 2022
ESPAStar-D-2	Launched 2022
ESPAStar-D-3	Launched 2021
ESPAStar-D-4	Launched 2022
ESPAStar-D-5	In Production or Delivered
ESPAStar-D-6	In Production or Delivered
ESPAStar-D-7	In Production or Delivered
ESPAStar-D-8	In Production or Delivered
ESPAStar-D-9	In Production or Delivered
ESPAStar-D-10	Launched 2023
ESPAStar-D-11	In Production or Delivered
ESPAStar-D-12	In Production or Delivered
ESPAStar-D-13	In Production or Delivered
ESPAStar-D-14	In Production or Delivered

GILBERT FACTORY AND TEST FACILITIES
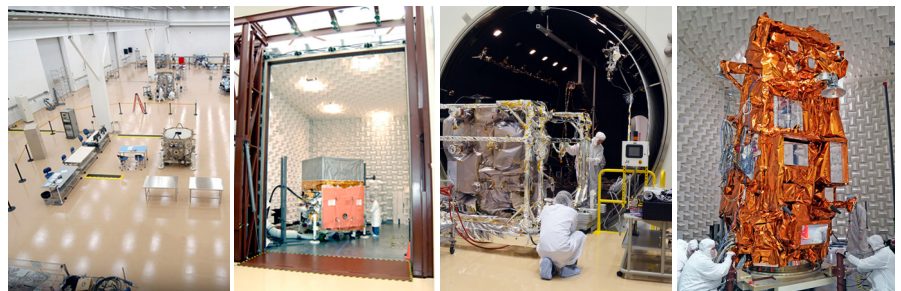
AI&T Low-Bay

EMI/EMC Test Chamber

Thermal Vacuum Test Chamber

Acoustics Chamber

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