

SPACECRAFT PROPULSION

WITH THRUST AND PRECISION INTO SPACE





ARIANEGROUP

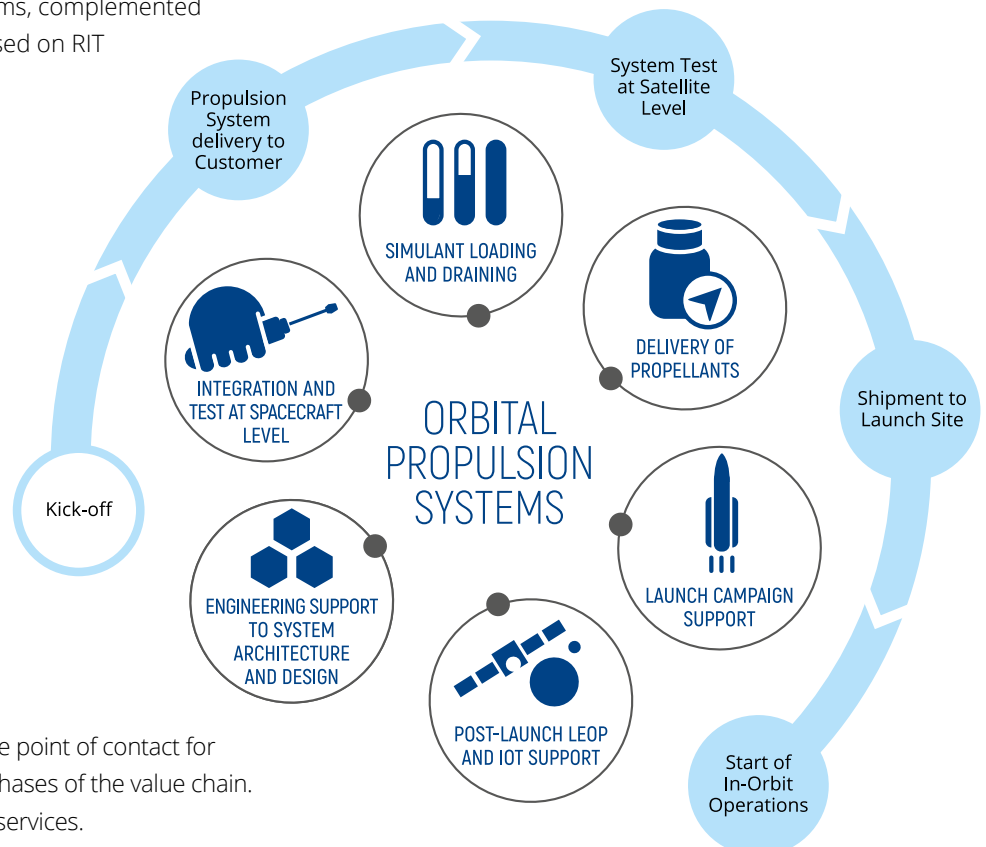
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THRUST AND PRECISION INTO SPACE

ArianeGroup is a market leader in spacecraft propulsion systems and equipment. For over 50 years, customers worldwide have been benefiting from a competitive portfolio of high quality products and services.

We cover the complete range of products and services related to orbital propulsion, from chemical monopropellant systems for smaller satellites to chemical bipropellant systems for larger platforms, complemented by the electric propulsion portfolio based on RIT (radiofrequency ion technology).



At ArianeGroup, customers have a single point of contact for the complete propulsion system at all phases of the value chain. From system design up to after-launch services.

All key equipment of ArianeGroup propulsion systems (thrusters, propellant tanks, and fluidic equipment) is produced in house.

ALL ABOUT PRECISION

With our orbital propulsion thrusters and engines, our customers can be sure that their mission requirements related to propulsion will be fulfilled with pin-point precision.



Our biggest orbital propulsion thruster, the 400N apogee engine, has placed hundreds of satellites in their final orbits

400
NEWTON



400N
Bipropellant
Apogee Engine

200
NEWTON



200N
Bipropellant
Thruster

10
NEWTON

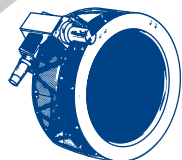


10N
Bipropellant
Thruster

1
NEWTON



1N
Monopropellant
Thruster



RIT 2X
Radio Frequency Ion
Thruster

70-215
MILLI-
NEWTON



RIT μ X
Radio Frequency Ion
Thruster

50-500
MICRO-
NEWTON

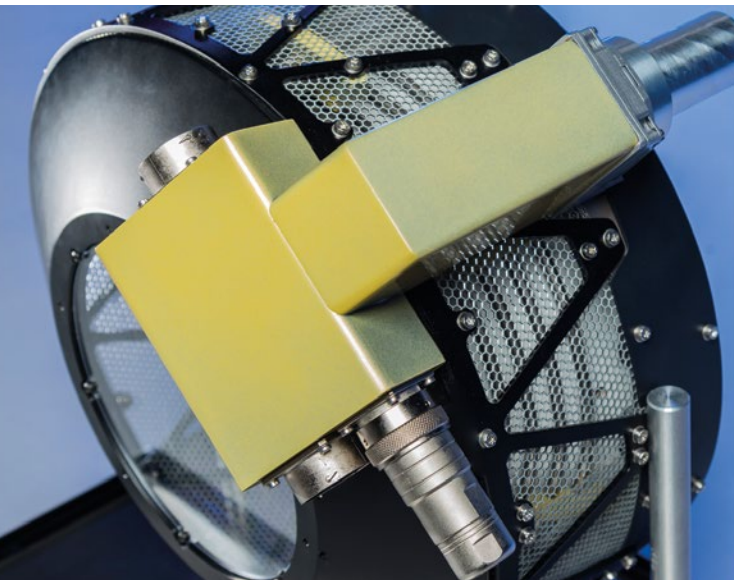
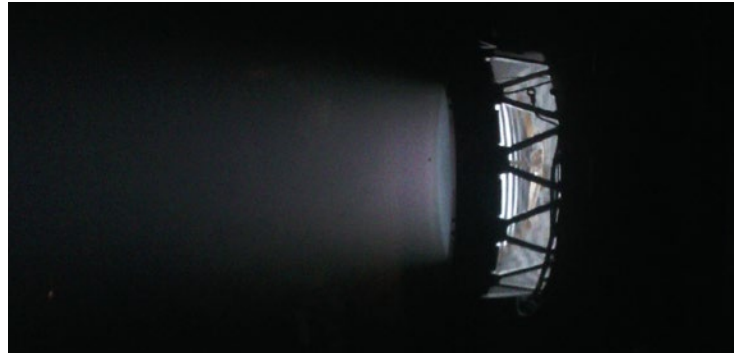
With micro precision
the RIT μ X thruster
brings space missions
to the exact orbit

ELECTRIC PROPULSION SYSTEMS AND COMPONENTS

RADIOFREQUENCY ION PROPULSION FOR ORBIT RAISING, STATION KEEPING AND DEEP SPACE MISSIONS.

Overview

Our electric space propulsion expertise is based on the space proven Radiofrequency Ion Technology (RIT). Within this field, we produce complete propulsion systems, modules, thrusters and related components.



Working Principle and Advantages of RIT Technology

In a Radiofrequency Ion Thruster, the atoms in the propellant – the inert gas xenon – are ionised by means of a high-frequency electromagnetic field, forming a plasma. In a plasma, both positively charged xenon ions and electrons can exist separately. The positively charged xenon ions are then accelerated utilizing electrical fields and so ejected to provide thrust. In order to prevent an imbalance in the satellite's net charge due to the stream of positively charged ions being expelled, a neutralizer is used to release electrons so as to keep the system in balance.

- › High performance at low complexity
- › Highest specific impulse offers substantial mass saving
- › Narrow beam divergence
- › Robust design concept with a large domain of operational stability
- › Large throttle range and adaptable to available electric power
- › Highest growth potential with increasing electric power



RIT μ X

A VERSATILE MINIATURIZED ELECTRIC PROPULSION THRUSTER OPTIMIZED FOR HIGH PRECISION ORBITAL MANEUVERS

RIT μ X is the smallest Radiofrequency Ion Thruster of the electric propulsion thruster portfolio of ArianeGroup. An electric propulsion system based on RIT μ X answers to advanced and challenging mission requirements thanks to special characteristics demonstrated during extensive tests: Complex thrust profiles, high dynamics and high resolution, thrust linearity, very low noise and very long thruster lifetime.



RIT 10 EVO

THE OPTIMUM THRUSTER FOR NORTH SOUTH STATION KEEPING FOR GEO SATELLITES SYSTEMS AND SMALLER LEO SATELLITES

RIT 10 EVO is the Radiofrequency Ion Thruster with medium thrust level based on the RIT 10 which has flown successfully and flawlessly over 10 years.



RIT 2X SERIES

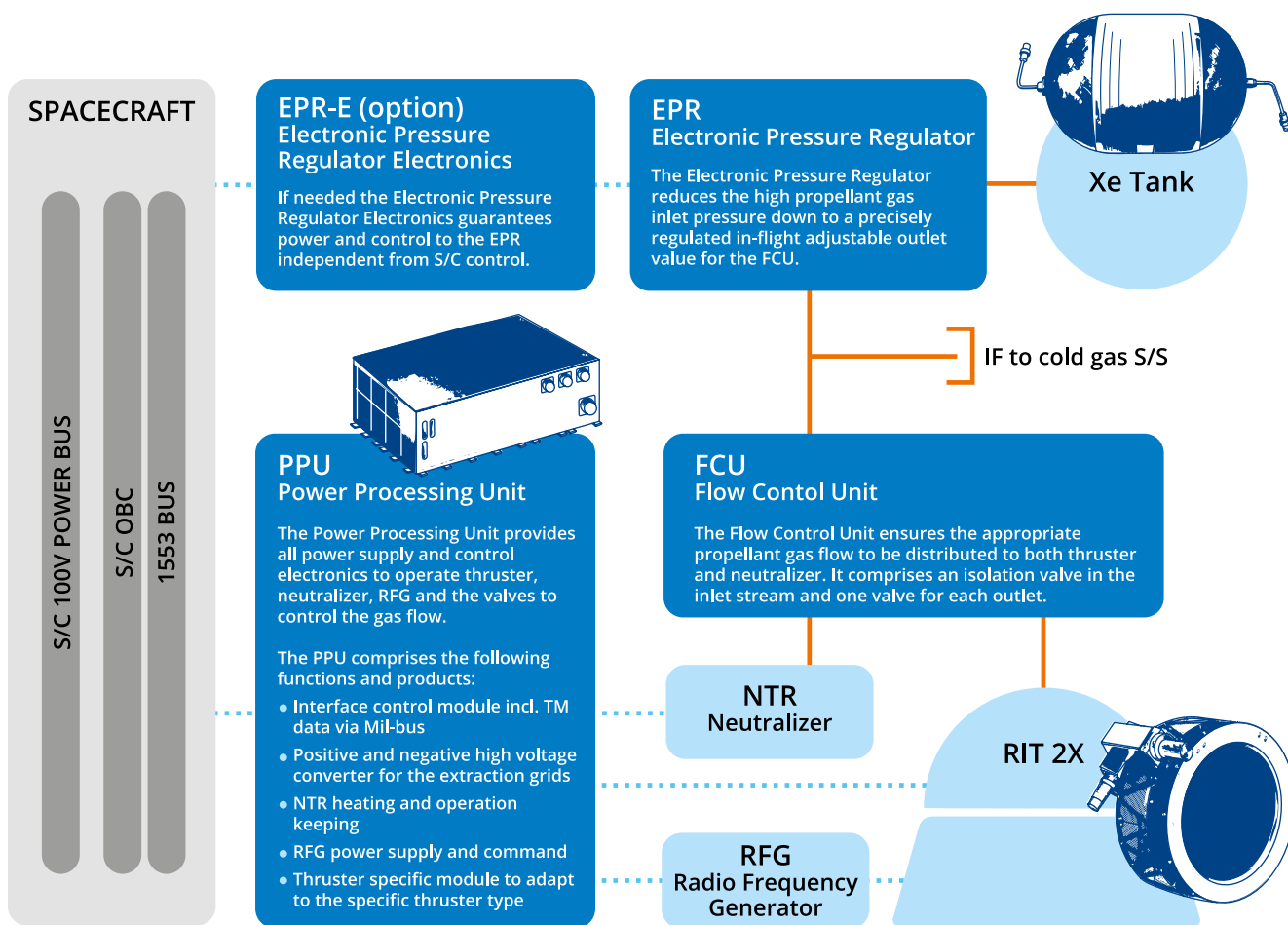
THE BEST MASS SAVING SOLUTION FOR AN ALL-ELECTRIC SATELLITE

The RIT 2X series consists of the largest Radiofrequency Ion Thrusters of the electric propulsion portfolio of ArianeGroup. An electric propulsion system based on a RIT 2X thruster has various advantages like the highest possible thrust efficiency which results in excellent specific impulse over wide thrust ranges and very efficient use of electrical energy.



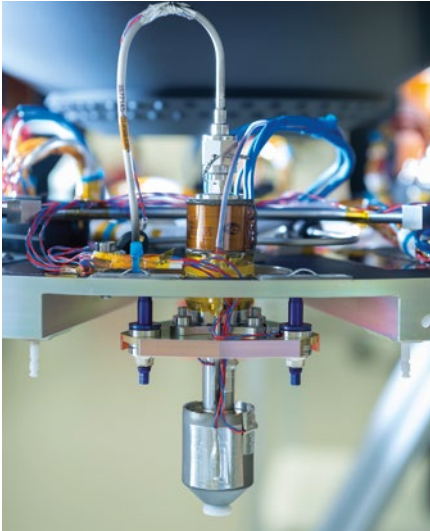
RIT 2X FIRING

FLOW DIAGRAM



..... Electric interface

———— Fluidic interface



CHEMICAL PROPULSION

ArianeGroup's chemical propulsion portfolio brings all kinds of commercial, exploration and human-rated missions into the precise orbit.

ArianeGroup develops, produces, and tests chemical monopropellant and bipropellant components and systems for different type of missions.

From small LEO platforms up to sophisticated exploration missions, ArianeGroup can support customers worldwide with the right propulsion for any space destination.



Monopropellant 1N



Monopropellant 400N



Bipropellant 10N



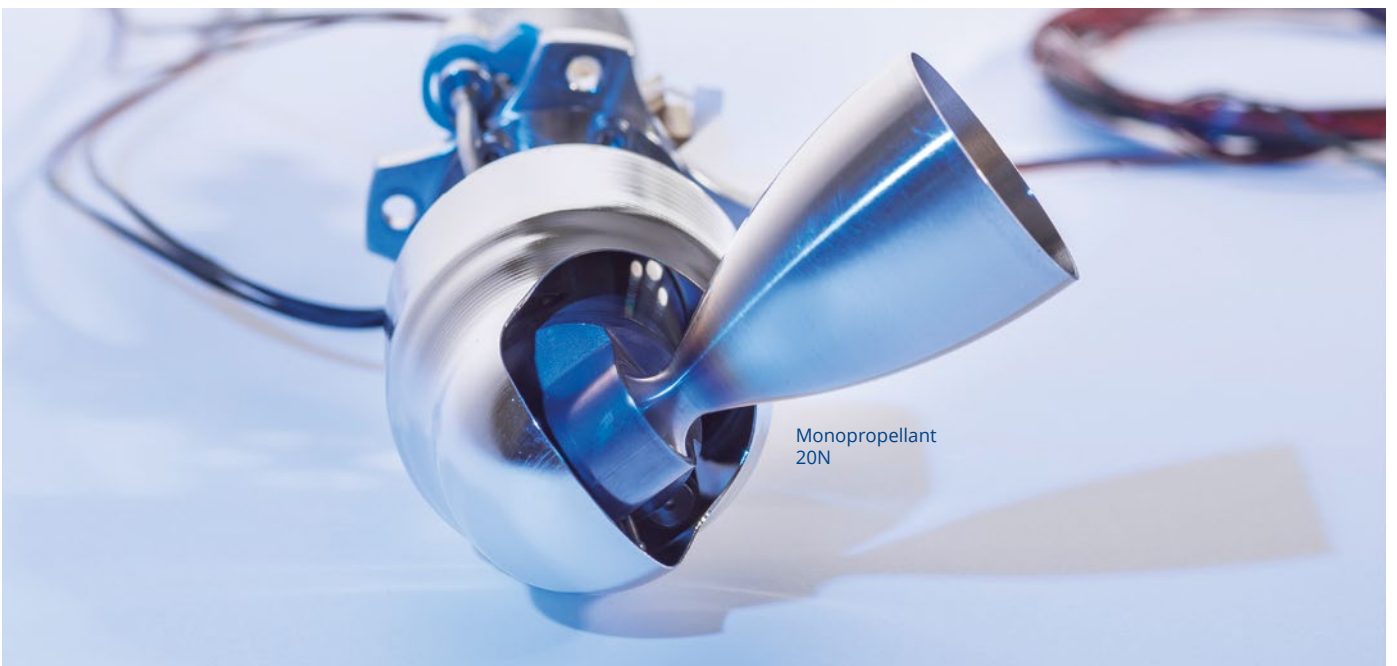
Bipropellant 200N



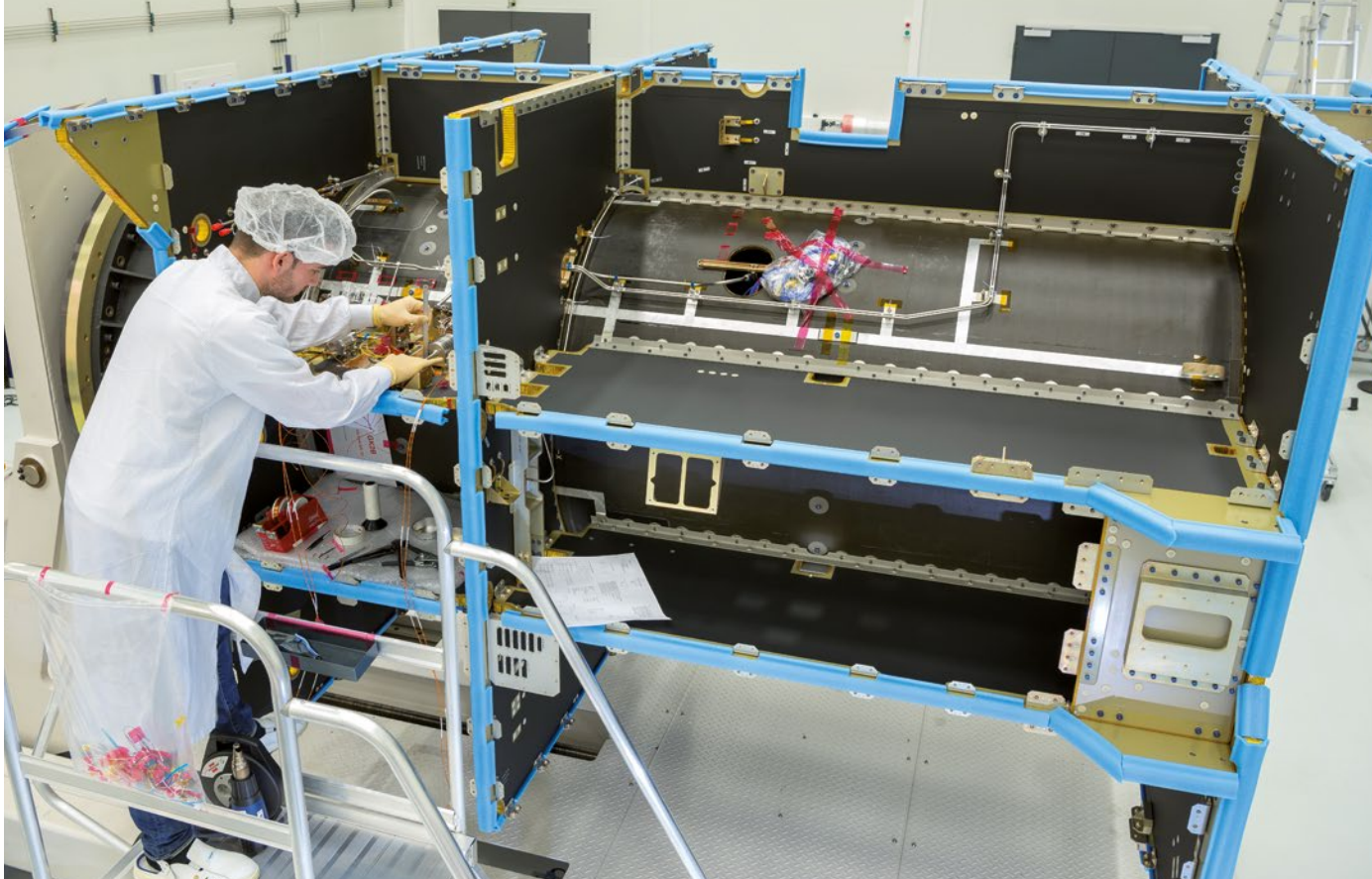
Bipropellant 400N

CHEMICAL PROPULSION COMPLETE RANGE OF THRUST

	MONOPROPELLANT THRUSTERS			BIPROPELLANT THRUSTERS			
	1N	20N	400N	10N	200N	400N Model S400-12	400N Model S400-15
THRUST RANGE	0.320 - 1.1 N	7.9 - 24.6 N	120 - 420N	6.0 - 12.5 N	180N - 285 N	420 N	425 N
SPECIFIC IMPULSE	220 s	230 s	220 s	292 s	270 s	318 s	321 s
MASS FLOW RANGE	0.142 - 0.447 g/s	3.2 - 10.4 g/s	58 - 190 g/s	2.30 - 4.20 g/s	60 - 100 g/s	110 - 142 g/s	
PROPELLANT	Hydrazine (N ₂ H ₄), High Purity Grade			Fuel: MMH Oxidiser: N ₂ O ₄ , MON-1, MON-3			



Monopropellant 20N



INTEGRATION OF A CHEMICAL BIROPELLANT SYSTEM

COMPLETE SYSTEMS

ArianeGroup's expertise in the design, manufacturing, assembly, integration, and test of complete propulsion systems has contributed to hundreds of successful space missions worldwide. For over 50 years, we have been supplying propulsion systems in support of hundreds of major international satellites and spacecraft. We provide standard propulsion systems and we design and develop customized systems to the specific needs of our customers.

In addition to propulsion systems based on conventional hydrazine, ArianeGroup develops propulsion systems with alternative propellants that comply best to technical, safety and environmental requirements.



Chemical propulsion system for lander application

INTEGRATION OF A CHEMICAL MONOPELLANT SYSTEM



SPACECRAFT PROPULSION



PROPELLANT TANKS FOR MONOPROPELLANT AND BI-PROPELLANT SYSTEMS

A qualified and experienced team for propellant tank development and production

ArianeGroup develops and produces propellant tanks for chemical monopropellant and bipropellant systems in its tank center.

The spectrum of different tank types includes surface tension tanks, bladder tanks, propellant tanks for spin-stabilized spacecraft, aluminum-alloy diaphragm tank and tanks with liquid center of gravity control.

With different geometries, from spherical shell to cassini shape and with volume capacities ranging from 58 liters up to 2,100 liters, ArianeGroup responds to a wide range of satellite platform requirements. Most tanks are made of titanium to ensure high load at low weight.

ArianeGroup has created standard designs to optimize the product line, and also makes its engineering experience available for individual customer requirements.

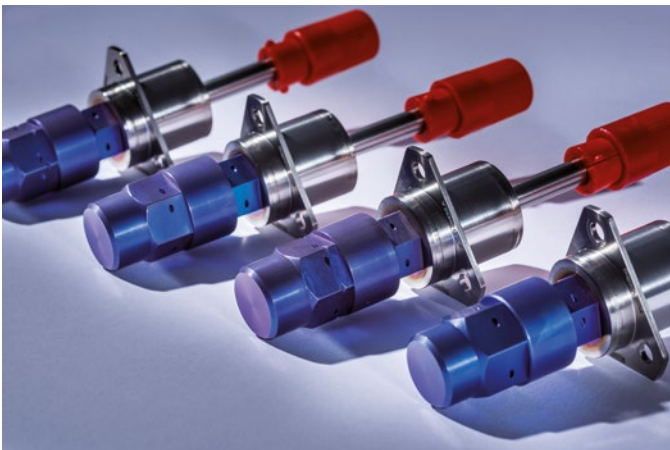
NON-DESTRUCTIVE INSPECTION



FLUIDIC EQUIPMENT

Valves for the fill, drain, isolation, control and regulation of propellants and pressurants.

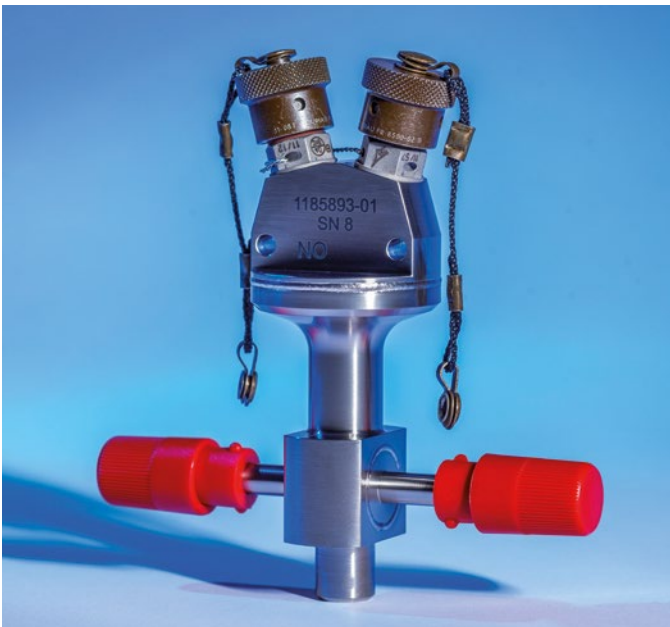
To ensure the highest possible quality, reliability, and performance of our spacecraft propulsion systems and thrusters, we design, develop and produce our own valves for the control of propellants and pressurants.



FILL & DRAIN VALVE

Characteristics

- Two-failure tolerant
- Three inhibits against external leakage
- Helium/Xenon high pressure valves with MEOP 310 bar
- Hydrazine low pressure valves with MEOP 37 bar



PYROVALVE

Characteristics

- Normally closed and normally opened valve
- ESA standard redundant pyro initiators
- All-welded titanium design
- MEOP: 310 bar
- Fluid compatibility: helium, argon, xenon, nitrogen, MON, MMH, hydrazine, deionized water, IPA



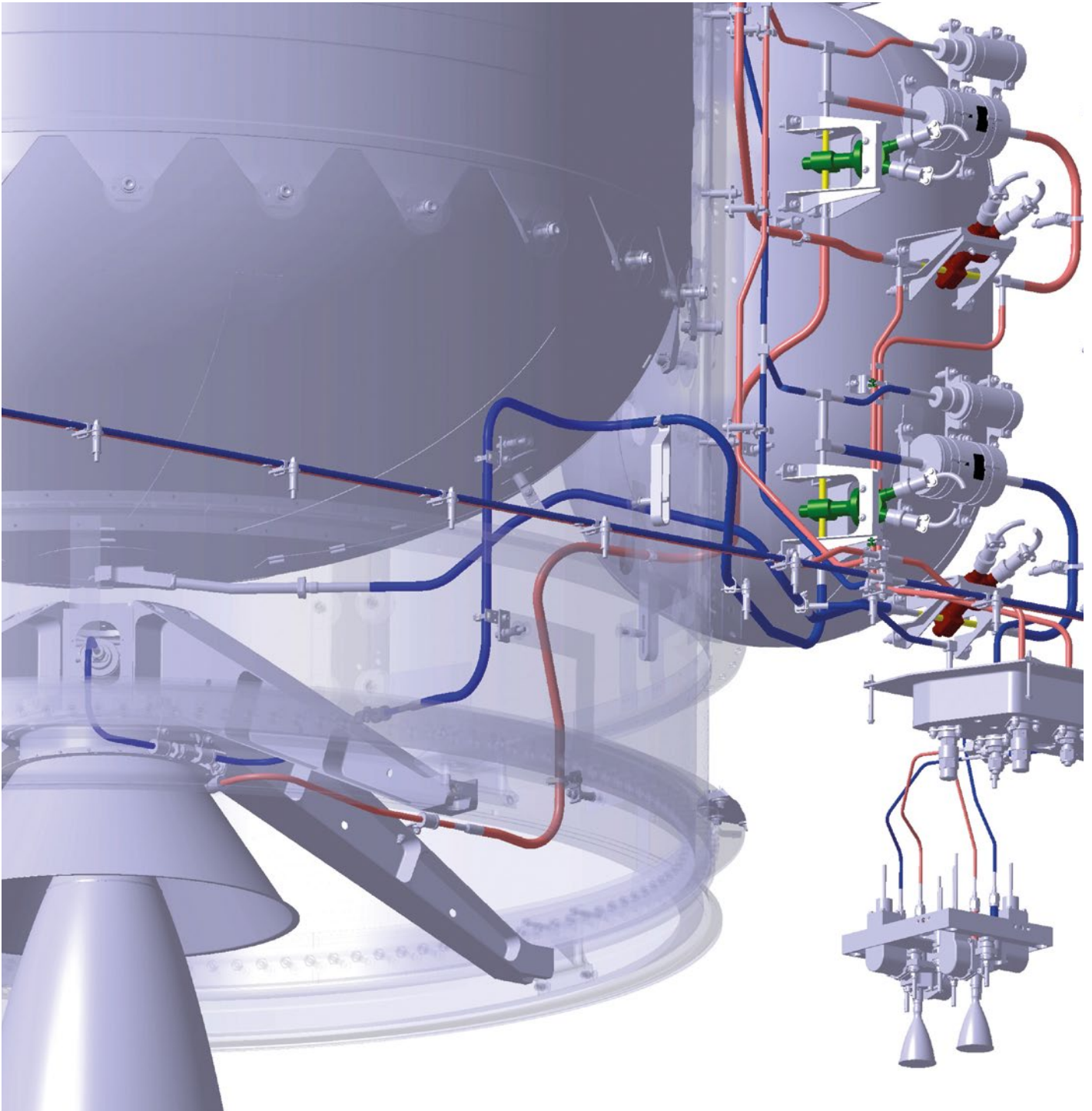
INTEGRATION OF PROPELLANT ISOLATION ASSEMBLY



SHAPE MEMORY ALLOY VALVE

Characteristics

- Normally closed valve
- Non pyrotechnical NiTi actuator
- Simple electrical activation (ESCC 4009 heater)
- All-welded titanium design
- MEOP: 345 bar
- Fluid compatibility: helium, argon, xenon, nitrogen, MON, MMH, hydrazine, deionized water, IPA
- Lifetime 22.5 years on orbit / 10 on ground



CHEMICAL ORBITAL PROPULSION MODULE

UNIFIED PROPULSION SYSTEM

CHEMICAL ORBITAL PROPULSION MODULE

CHEMICAL ORBITAL PROPULSION MODULE FOR TRANSFER ORBIT, ATTITUDE MANEUVER DURING TRANSFER ORBIT, STATION KEEPING AND DEORBITING.

Main Subsystems and Components:

Propulsion System

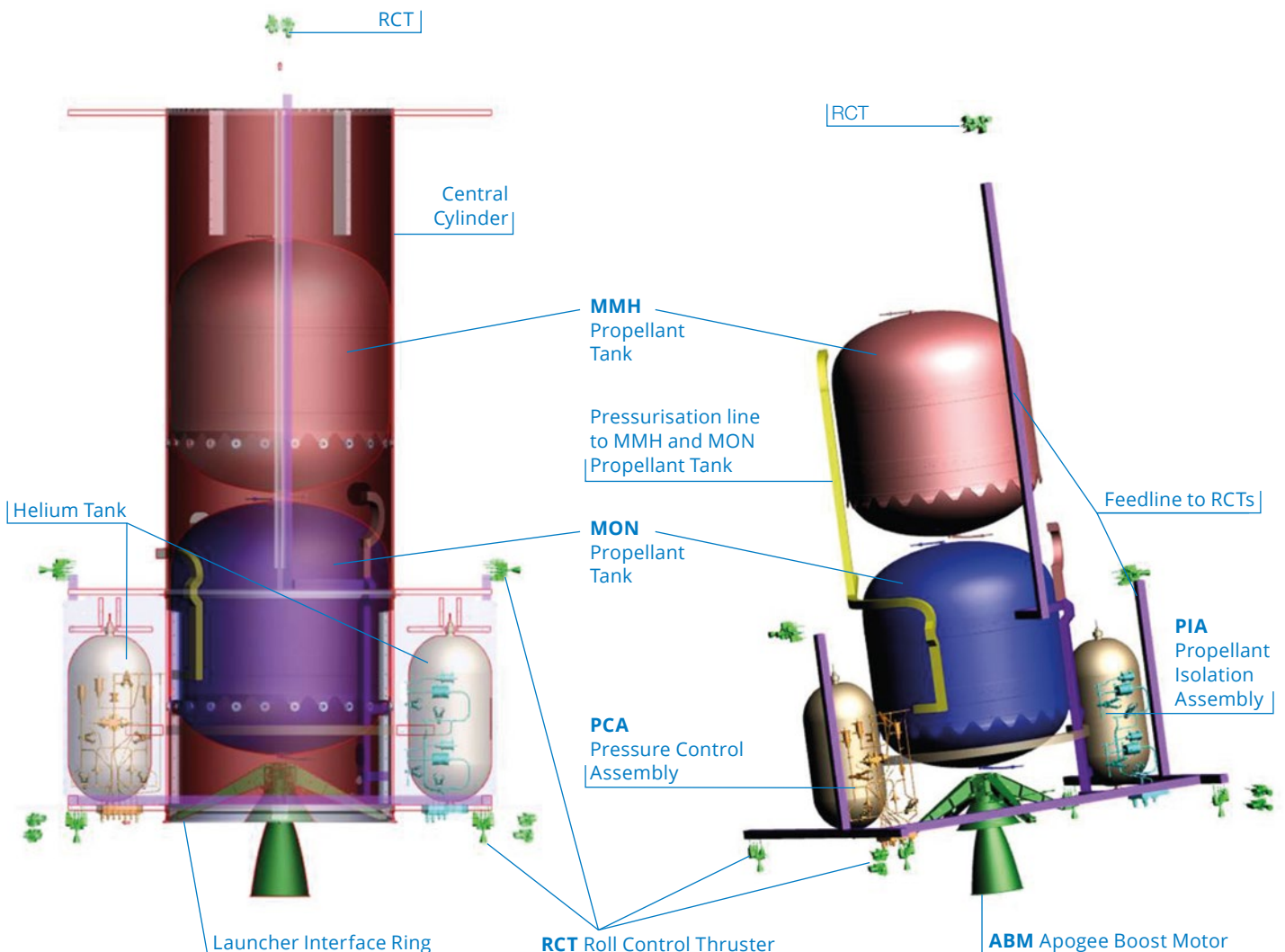
- › Fuel Tank (700L – 1450L)
- › Oxidizer Tank (700L – 1450L)
- › 10N Thrusters – RCT
- › Advanced Apogee Boost Motor
- › Pressure Control Assembly – PCA
- › Propellant Isolation Assembly – PIA
- › Helium Tank (51L – 90L)
- › Pyrovalves
- › Fill and Drain Valves
- › Pressure Regulator
- › Pressure Transducer

Central Cylinder with Launcher Interface Ring

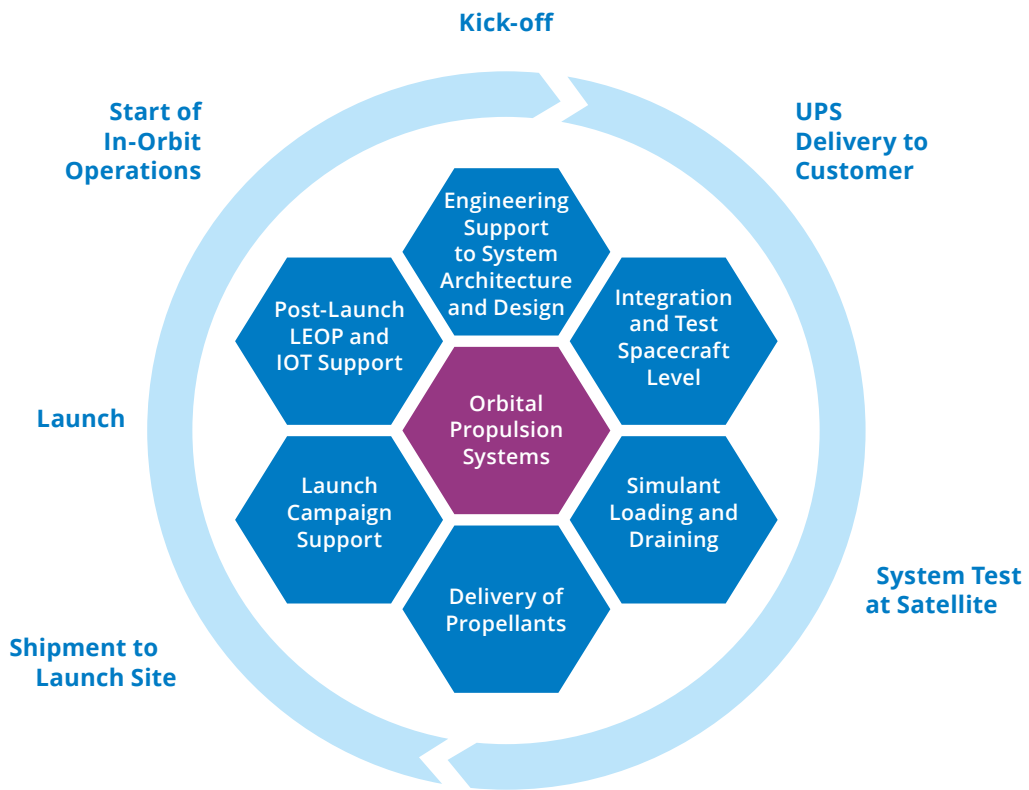
Propulsion Thermal Control

Key Features

- › Reduced interface management
- › Modular design
- › Advantageous symmetry
- › Fully integrated subassembly
- › Multiple space proven equipment
- › Provision of complete services around propulsion
- › 15-year lifetime nominal

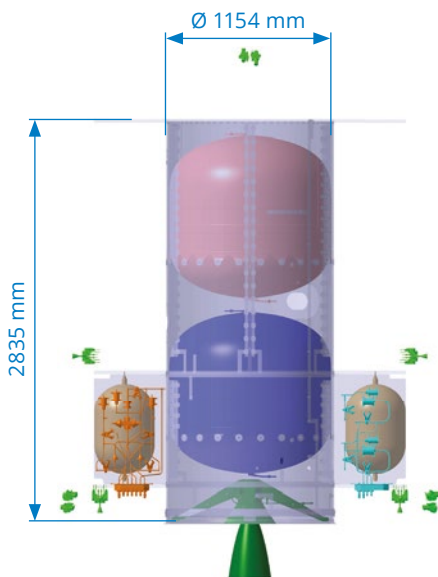


ArianeGroup provides the complete range of services around the Unified Propulsion System (UPS), from engineering support for system architecture, design and verification up to propellant loading and Launch Early Operations Phase (LEOP).



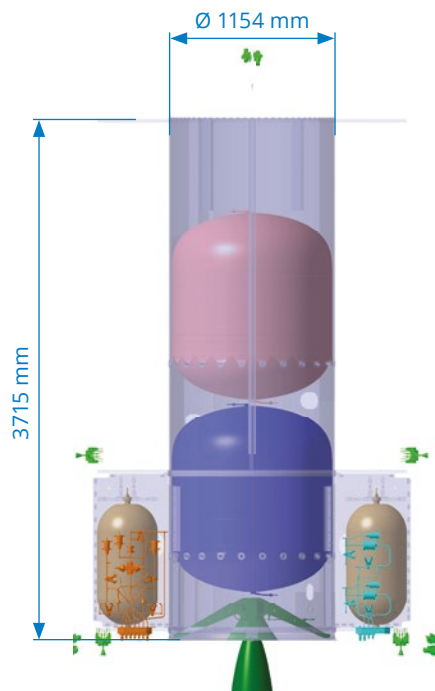
Bi-propellant UPS B2

Propellant Loading Mass up to 1895 kg



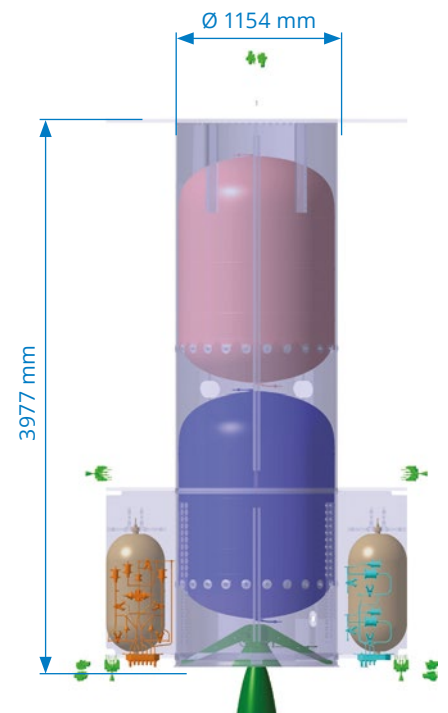
Bi-propellant UPS B3

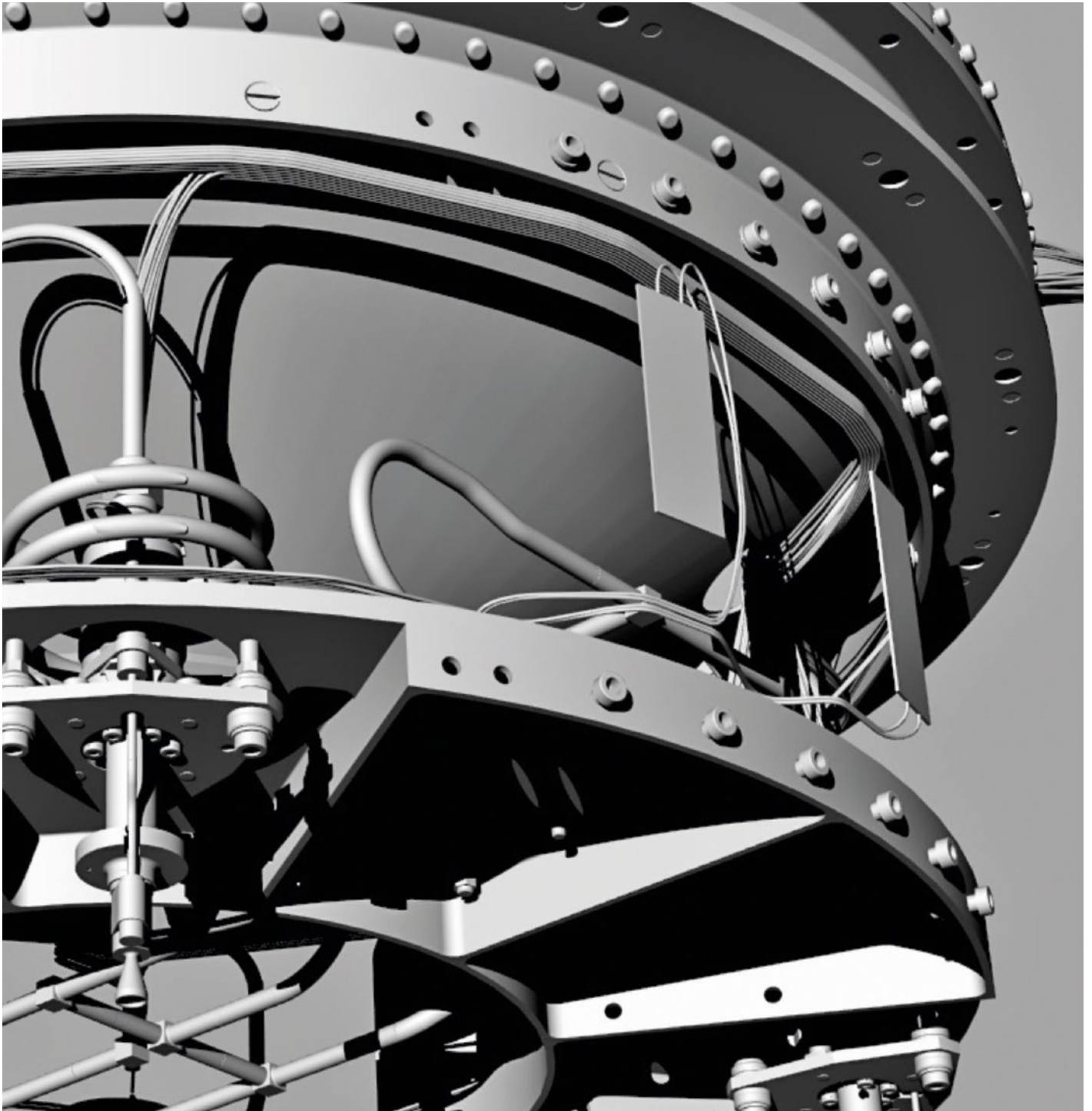
Propellant Loading Mass up to 2441 kg



Bi-propellant UPS C3

Propellant Loading Mass up to 3194 kg





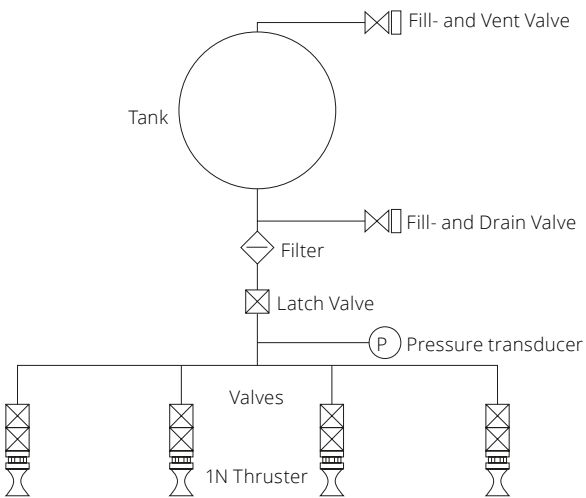
MONO PROPELLANT SYSTEM PM25

SPACE PROPULSION

PM25 DATASHEET

Main features

- › simple and reliable single branch monopropellant propulsion system
- › plug-in design
- › all-metallic propellant tank with propellant management device for bubble free propellant
- › redundant cat bed heater
- › design life up to 12 years
- › pre-integrated and tested ready for integration into the spacecraft
- › three barrier design with dual seat flow control and fill- and drain valves



PM25	
Dry Mass	26.7 kg +/- 5%
Module Overall Height	917 mm
Module Diameter (w/o FDV and electrical Connectors)	660 mm
Max. Leakage	6.1 E-05 scc/s
1N Thruster	
Thrust Range (Steady State Firing)	1.0 +/- 0.1 N at 22 bar ≥ 0.25 N at EOL (5.5 bar)
Supply Pressure Range	5.5 - 24 bar
Steady State Firing Specific Impulse Range	> 2100 m/s (215s) at 22 bar > 1962 m/s (200s) at 5.5 bar
(Minimum) Impulse Bit	0.043 Ns (50 ms ON-Time) at 22 bar 0.014 Ns (50 ms ON-Time) at 6.6 bar
Total Hydrazine Throughput	69.8 kg
Total Operation Time	65.6 h
Longest Steady State Burn	43200 s (12 h)
Total Impulse	140504 Ns
Total Number of Pulses	99862
Propellant Tank	
MEOP	24.6 bar
Tank Net Volume	104 litres
Max. Propellant Capacity	80 kg
Expulsion Efficiency	99.14%

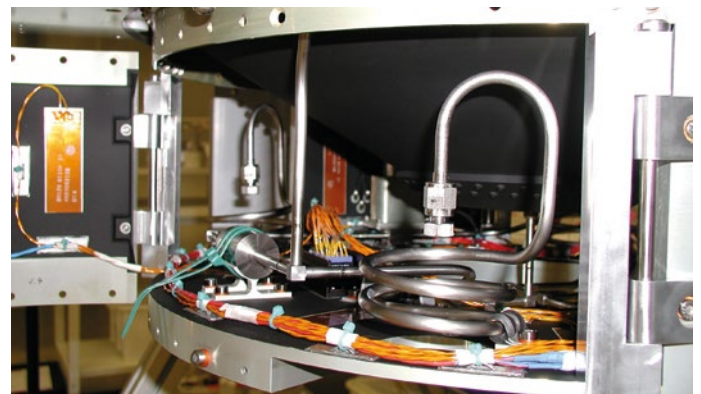
Technical Description

- › The Propulsion Module baseline consists of:

- one (1) Tank
- four (4) Thrusters
- one (1) Latching Valve (LV)
- one (1) Pressure Transducer (PT)
- one (1) Filter
- one (1) Propellant Fill & Drain Valve
- one (1) Pressurant Fill & Vent Valve
- Structure S/S
- Thermal Control S/S
- Harness S/S



- › All-welded design which minimizes mass and ensures leak-tightness, to the exception of screwed connection used for thrusters latch valve and flow control valves for easier integration and flexibility
- › The nominal operational time of up to 12 years.
- › Use of hydrazine as propellant and gaseous helium or nitrogen as pressurant
- › Operating in blow down mode with a ratio of 4 : 1
- › The thrusters provide under BOL conditions a nominal thrust of 1.0 N.
- › Fill- and Drain valves with 3 barriers against propellant leakage
- › Easy accessibility of Fill- and Drain valves for launch site fueling operations
- › Autonomous thermal concept providing multi-layer insulation, heaters and thermistors
- › Cold Start Capability of 1N Thruster allowing to use the propulsion subsystem also for safe mode operation
- › Electrical connection to spacecraft by flexible connector harness or board
- › The PM25 Design Concept is also suitable for ADN propellant as a Green Propulsion Application



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