



AEROJET

A GenCorp Company

Redmond Operations

Total Propulsion Solutions

AEROJET

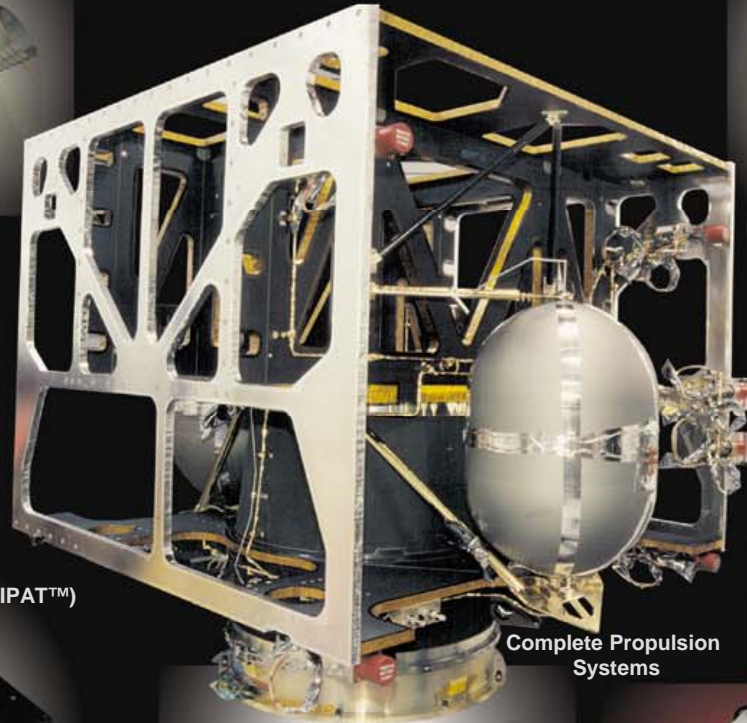
Man Rated
Space Propulsion



Bipropellant
Control Thrusters



High Performance Apogee Thruster (HIPAT™)



Complete Propulsion
Systems



Rocket Engine Modules



Monopropellant Hydrazine Thrusters



Ion Thrusters



Arcjets



Power Processing Units



“Green” Monopropellant Thrusters



Hall Effect Thrusters



Pulsed Plasma Thrusters

Redmond Operations



- LOCATED IN REDMOND, WA
- 80 ACRE SITE
- FOURTEEN BUILDINGS
- 180,000 SQUARE FEET

Engineering Capability



Mechanical Design

- Liquid/Solid Propulsion Systems and Components
- Structures, Pressure Vessels and Plumbing

Electrical Design

- Analog and Power Conversion Electronics
- Digital-Embedded Processors, Controls and Test Equipment

Manufacturing Engineering-Concurrent with Design

Structural Analysis

- System Dynamics and Static Analysis
- Non-Linear Structural Analysis
- Fracture Mechanics

Thermal Analysis

- Radiation, Conduction, Convection
- Passive and Active Control Systems

Performance Analysis

- Orbital Mechanics and Trajectory Analysis
- Multi-Body Dynamic Simulation
- System Fluid Dynamics for Surge and Water Hammer, Press. Drop Balancing Optimization
- Computational Fluid Dynamics
- Plume Analysis

Magnetic Circuit Analysis

- Magnetic Field Analysis and Design

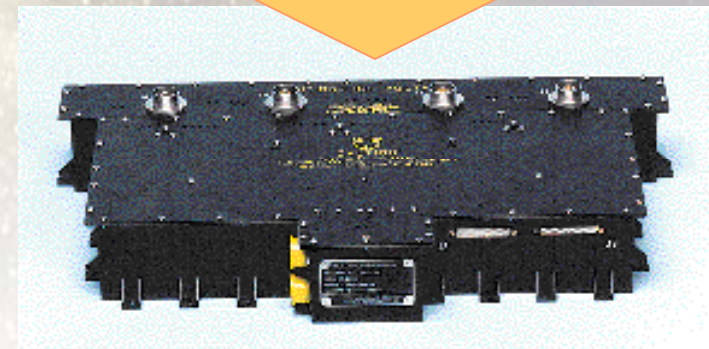
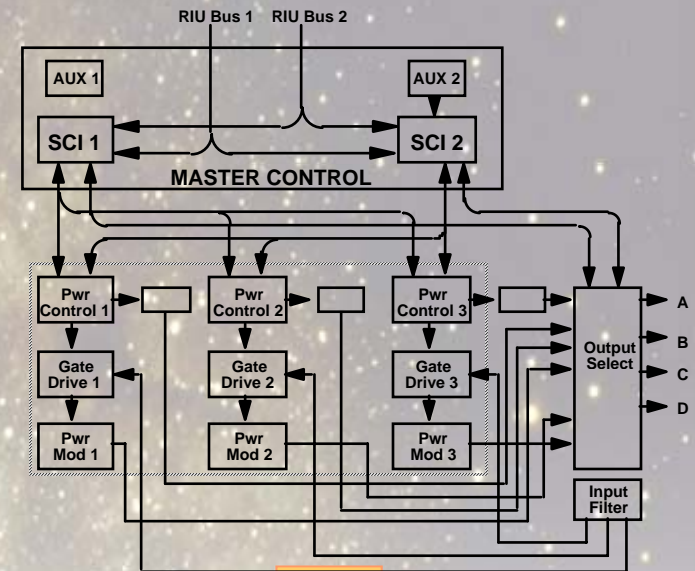
Circuit Simulation and Timing Analysis Materials and Processes

- Process Control, Metallurgical Analysis and Mechanical Processing Testing

Component Engineering

- Electrical and Mechanical Components
- Specifications and Performance Analysis
- Supplier/Component Selection, Qualification, Problem Resolution and Risk Mitigation
- Valve Design

Safety and Reliability Analysis



2kW Space System Power Control System

Supported Software

AEROJET

Mechanical Design

- Unigraphics NX and I-DEAS, Pro-E
- Electronic Transfer of Model Geometry from Design to Machining

Electrical Design

- ORCAD, Unigraphics NX, IDEAS, PADS 2000

Structural Analysis

- ANSYS, ABAQUS, Nastran and NISA for Finite Element Analysis
- ANSYS, NISA DISPLAY and IDEAS for Pre / Post Processing
- NASGRO Crack Analysis

Thermal Analysis

- SINDA / Thermal Desktop
- IDEAS TMG
- NISA DISPLAY and IDEAS for Pre / Post Processing

Performance Analysis

- FORTRAN, C++, MathCAD, Maple, Tecplot, and Custom Codes
- Fluent / Gambit for CFD Analysis
- LETS and AFT / Impulse for Fluid Flow
- Simpler and Simulink for Systems Analysis

Magnetic Analysis

- Magnet

Circuit Simulation and Timing Analysis

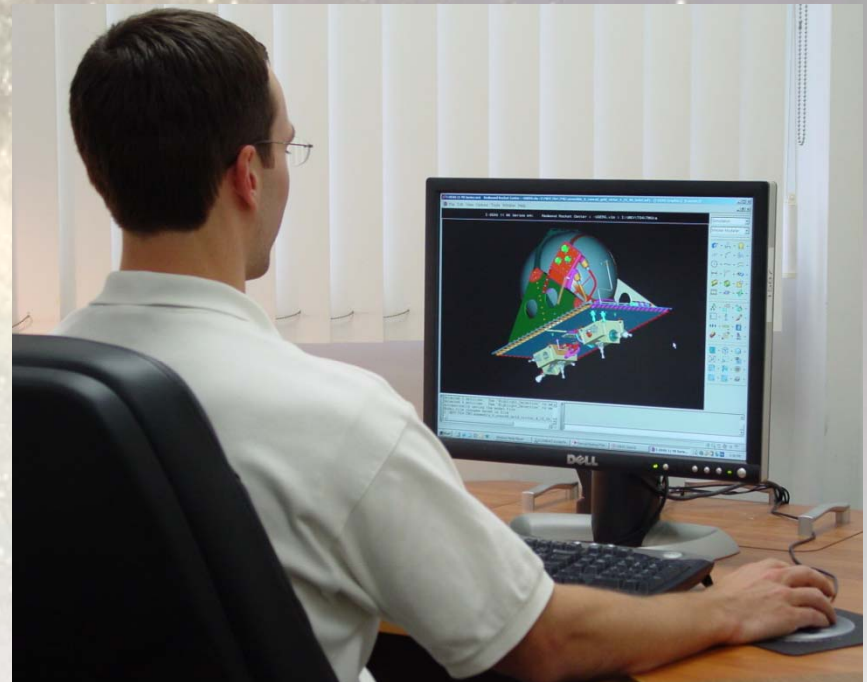
- P-SPICE, ACTEL Designer

Manufacturing Engineering

- Unigraphics NX and IDEAS

All Engineering, Including Project Office

- MS Office Suite
- Microsoft Outlook



Test Capability

AEROJET

Vibration Test Facility

- Sine Sweeps, Random Vibration, Mechanical Shock
- Response Measurements

Hotfire Facilities

- Hydrazine, HAN, MMH/NTO and Other Propellants
- 10 State-of-the-Art Vacuum Firing Chambers
 - Steam Ejector, Mechanical and Cryo-Pumps
 - Acceptance Testing
 - Thermal Model Verification
- Fuel Storage and Testing

Environmental Test Facilities

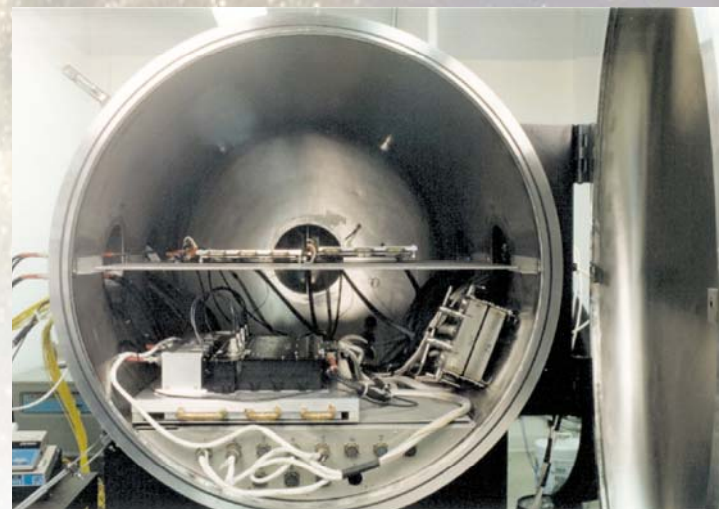
- Thermal Vacuum, Thermal Shock and Temperature Cycling
- Long Term Hydrazine Compatibility Testing

Electronics

- Automated End Item Test Equipment Utilizing Software Control
- Circuit Card Electrical Test Equipment Design and Fabrication
- High Voltage Corona Testing
- EMI / ESD Testing

Materials and Processing Testing

- Chemical Analysis
- Metallographic Sectioning, Tensile and Shear Tests, Other



C80009-61A.ppt

Altitude Test Facility

Building 63 - Front View

AEROJET



Altitude Test Facility

Building 63 - Capabilities Summary

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Altitude Testing

- Ten vacuum test chambers
- Hydrazine rocket engines 0.02 lbf - 100 lbf (duty cycle dependent)
- Bipropellant and dual mode engines up to 200 lbf
 - 3-Stage steam ejector system
- Arcjets up to 50 kilowatts
- Xenon Hall Effect Thrusters up to 4.5 kilowatts
- Multiple vacuum pump configurations possible
- High vacuum ($<1 \times 10^{-6}$ torr)
 - Four chambers with cryogenic pumps
- All chambers have a self-contained, fully equipped, closed hydrazine propellant feed system. Modifications can be accommodated to meet new requirements.

Sea Level Testing

- Two protected, fortified test cells
- Multiple and alternative fuel compatible (liquid, solids, bipropellant)
- Two 4' x4' x4' temperature conditioning chambers for conditioned testing

Manufacturing Capability

AEROJET

Machine Shop

- CNC Milling & Turning
- EDM
- Grinding
- Conventional Machining
- Full Service Dimensional Inspection Lab

Mechanical and Electronic Assembly Areas

- Class 1,000, 10,000 and 100,000 Clean Rooms and Assembly Areas
- Automatic Orbital Welding
- Electron Beam Welding
- Manual and Automatic GTA Welding
- Tube Bending
- Precision Part Cleaning
- Water and Gas Flow Testing
- Radiographic and UT Testing
- High Pressure Leak and Test Vault
- Valve Assembly and Encapsulation
- Manual and Wave Soldering
- Wire/Cable Harness Design and Manufacturing

Certification

- AS9100
- ISO 9001: 2000
- ISO 14001



Manufacturing Capability

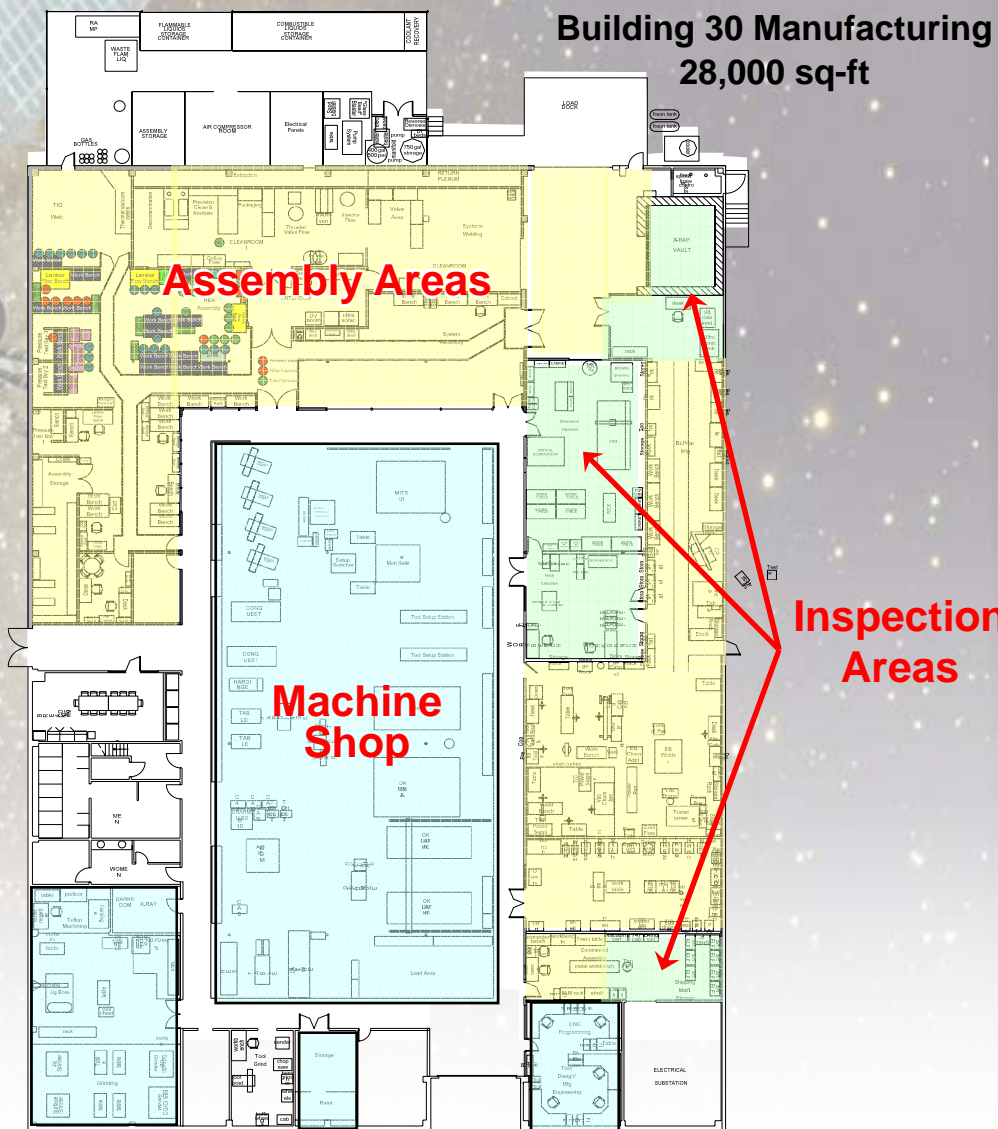
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Manufacturing Floor Space

- 84,000 of 180,000 total square feet

Integration and Launch Services

- Fueling Carts and Personnel Available to Fuel at Customers' Locations



Chemistry Capability

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Chemical Manufacturing

- Catalyst Fabrication
- Gold and Rhodium Plating
- Chemical Milling and Etching
- Metal Cleaning and Passivation
- Heat Treating
- Teflon Processing

Chemical Analysis

- Full Mil Spec Assay of Hydrazine, MMH and MON-3 Oxidizer
- DI Water According to JSC C-20
- Solvent Purity Analysis
- Trace Metal Content by ICP-OES
- Gas Constituent Analysis by FTIR
- pH and Titration Analysis

Product Development

- Ignition Delay Testing (Pino)
- Propellant Environment Simulation
- High Temperature Catalyst Development
- Material Compatibility Testing
- Thermal Cycling

Environmental Chemistry Support

- Age Sensitive Materials Testing
- Trace Contaminant Testing and Remediation



A glowing blue sign with a large white letter 'O' in the center. The sign is mounted on a metal frame and is illuminated from above, creating a bright blue glow. The word 'Products' is overlaid in a large, white, serif font across the bottom of the sign. The background is dark, and there are some faint lights and reflections visible.

O Products

Monopropellant

AEROJET

MR-103C

MR-103D

MR-103G

MR-103M

MR-111C

MR-111E

MR-50S

MR-50T

MR-106E - 28 Vdc

MR-106E - 70 Vdc

MR-106L

MR-120

MR-107B

MR-107J

MR-107K

MR-107L

MR-107M

MR-107N

MR-107P

MR-107S

MR-107T

MR-107V

MR-104A/C

MR-104D

MR-80B

MRM-103D

MRM-106B

MRM-106C

MRM-106D

MRM-106E

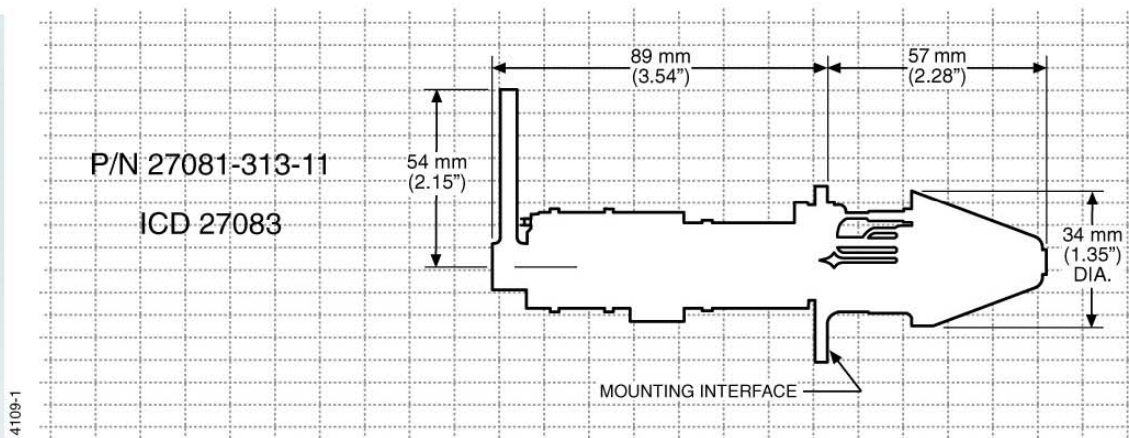
MRM-106F

MRM-122

**Space Shuttle
Gas Generator**

**“Green” Propellants
& Systems**

MR-103C 1 N (0.2-lbf) ROCKET ENGINE ASSEMBLY



Design Characteristics

- PropellantHydrazine
- Catalyst S405
- Thrust/Steady State 1.02 – 0.22 N (0.230 – 0.05 lbf)
- Feed Pressure 27.6 – 6.2 bar (400 – 90 psia)
- Chamber Pressure 23.4 – 5.9 bar (340 – 85 psia)
- Expansion Ratio 100:1
- Flow Rate 0.5 – 0.09 g/sec (0.001 – 0.0002 lbf-sec)
- Valve Dual Seat
- Valve Power 8.25 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power 1.54 Watts Max @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr 3.93 Watts Max @ 28 Vdc & 21°C
- Mass 0.33 kg (0.73 lbf)
 - Engine 0.13 kg (0.28 lbf)
 - Valve 0.20 kg (0.45 lbf)

Performance

- Specific Impulse 224 – 209 sec (lbf-sec/lbf)
- Total Impulse 121,817 N-sec (27,387 lbf-sec)
- Total Pulses 410,000
- Minimum Impulse Bit 0.022 N-sec @ 6.9 bar & 15 ms ON
 (0.005 lbf-sec @ 100 psia & 15 ms ON)
- Steady State Firing 30,000 sec – Single Firing
 60 hrs – Cumulative

Status

- Flight Proven

Reference

- SC00-2000-XI-1

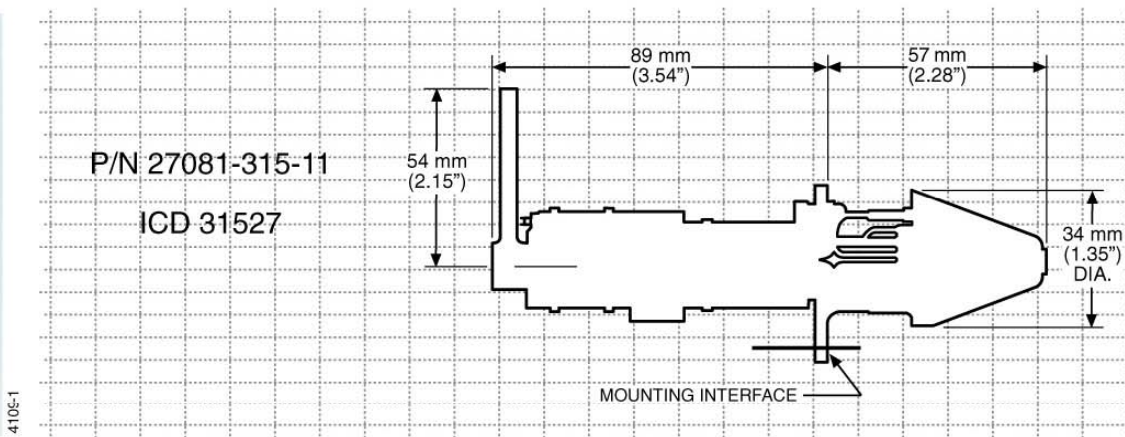
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MR-103D 1N (0.2-lbf) ROCKET ENGINE ASSEMBLY



Design Characteristics

- PropellantHydrazine
- Catalyst S405
- Thrust/Steady State 1.02 – 0.22 N (0.230 – 0.05 lbf)
- Feed Pressure 27.6 – 6.2 bar (400 – 90 psia)
- Chamber Pressure 23.4 – 5.9 bar (340 – 85 psia)
- Expansion Ratio 100:1
- Flow Rate 0.5 – 0.09 g/sec (0.001 – 0.0002 lbf-sec)
- Valve Dual Seat
- Valve Power 8.25 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power 1.54 Watts Max @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr 3.93 Watts Max @ 28 Vdc & 21°C
- Mass 0.33 kg (0.73 lbf)
 - Engine 0.13 kg (0.28 lbf)
 - Valve 0.20 kg (0.45 lbf)

Performance

- Specific Impulse 224 – 209 sec (lbf-sec/lbf)
- Total Impulse 186,000 N-sec (41,828 lbf-sec)
- Total Pulses 275,028
- Minimum Impulse Bit027 N-sec @ 6.9 bar & 15 ms ON
 (0.006 lbf-sec @ 100 psia & 15 ms ON)
- Steady State Firing 5,000 sec – Single Firing
 111.4 hrs – Cumulative

Status

- Flight Proven

Reference

- SC00-2000-XI-1

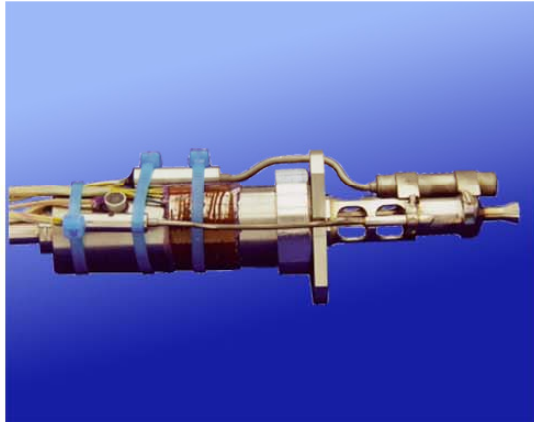
Rev. Date: 4/24/06

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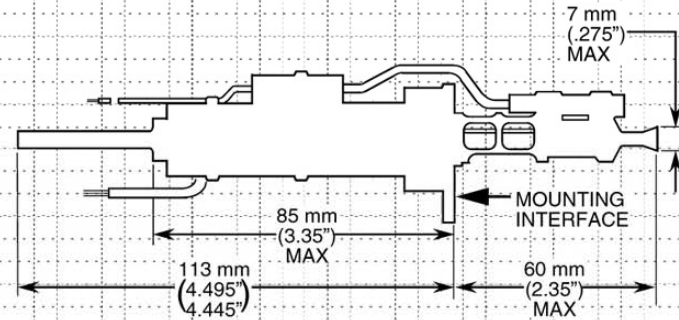


MR-103G 1N (0.2-lbf) ROCKET ENGINE ASSEMBLY



P/N 34308-303

ICD 34309



Design Characteristics

- Propellant..... Hydrazine
- Catalyst..... S405
- Thrust/Steady State 1.13 – 0.19N (0.253 – 0.043 lbf)
- Specific Impulse..... 224 – 202 sec (lbf-sec/lbm)
- Feed Pressure..... 28.3 – 4.8 bar (420 – 70 psia)
- Chamber Pressure..... 23.8 – 4.5 bar (345 – 65 psia)
- Expansion Ratio..... 100:1
- Flow Rate..... 0.5 – 0.09 g/sec (0.0011 – 0.0002 lbfm/sec)
- Valve..... Dual Seat
- Valve Power..... 8.25 Watts Max@28 Vdc & 21°C
- Cat. Bed Heater Pwr..... 6.32 Watts Max@28 Vdc & 21°C
- Mass 0.33 kg (0.73 lbfm)
 - Engine..... 0.127 kg (0.28 lbfm)
 - Valve..... 0.204 kg (0.45 lbfm)

Performance

- Total Impulse..... 97,078 N-sec
..... (21,825 lbf-sec)
- Total Pulses..... 835,017
- Minimum Impulse Bit..... 0.0133 N-sec@0.015sec ON & 6.9 bar
..... (0.003 lbf-sec@0.015sec) (ON & 100psi)
- Steady State Firing Single firing..... 300 sec 1,000 sec
..... Cumulative..... 23.8 hrs — 40.6 hrs

Status

- Flight Proven

Reference

- AIAA-2005-3952

Rev. Date: 5/15/06

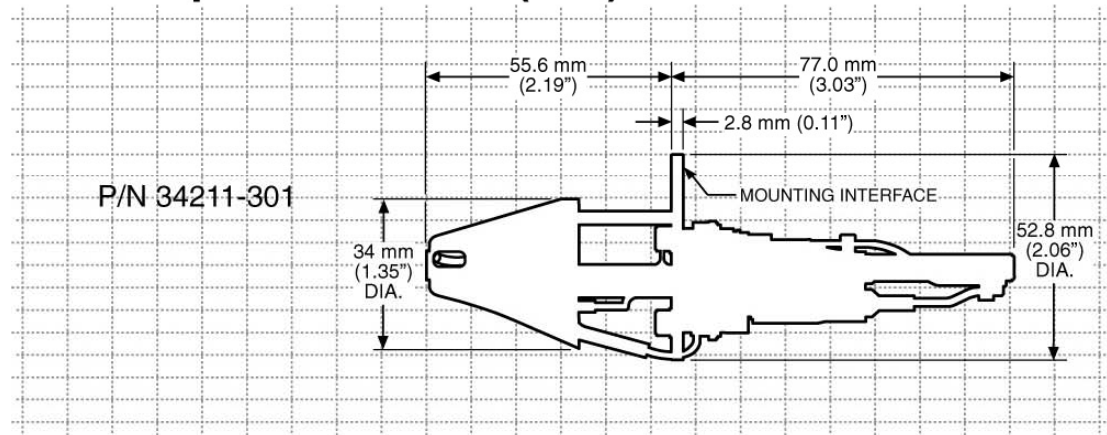
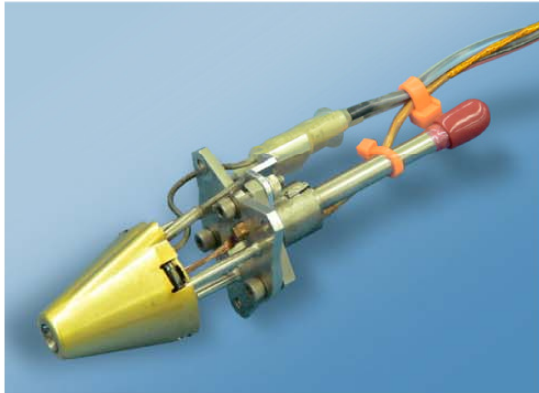
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MR-103M 1N (0.2-lbf) ROCKET ENGINE ASSEMBLY

Minimum Impulse Thruster (MIT)



Design Characteristics

- PropellantHydrazine
- Catalyst S405
- Thrust/Steady State 0.99 – 0.28 N (0.22 – 0.06 lbf)
- Feed Pressure 27.6 – 6.9 bar (400 – 100 psia)
- Chamber Pressure 20.7 – 5.9 bar (300 – 85 psia)
- Expansion Ratio 100:1
- Flow Rate 0.45 – 0.14 g/sec (0.001 – 0.0003 lbf-sec)
- Valve Single Seat
- Valve Power 7.1 Watts @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr 3.8 Watts @ 28 Vdc & 21°C
- Mass 160 gm (0.35 lbf)
 - Engine 135 gm (0.30 lbf)
 - Valve 25 gm (0.05 lbf)

Performance

- Specific Impulse 221 – 206 sec (lbf-sec/lbf)
- Total Impulse 121,817 N-sec (27,387 lbf-sec)
- Total Pulses 515,344
- Minimum Impulse Bit ~670E-6 N-sec @ 1.6 ms ON
 (~150E-6 lbf-sec @ 1.6 ms ON)
- Steady State Firing 30,000 sec – Single Firing
 60 hrs – Cumulative

Status

- Qualified

Reference

- JANNAF-2005 – “The Minimum Impulse Thruster”

Rev. Date: 5/23/06
 2006-018
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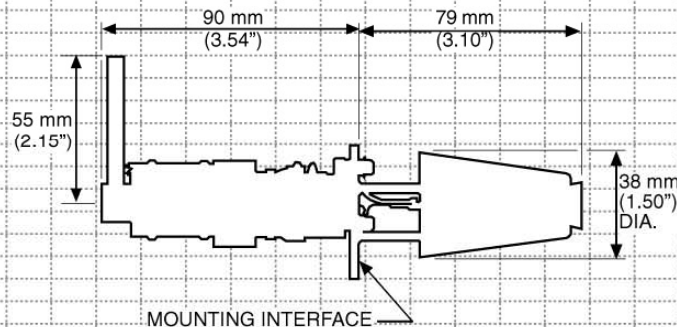
MR-111C 4 N (1.0-lbf) ROCKET ENGINE ASSEMBLY



4448-3

P/N 27720-308-11

ICD 31528



Design Characteristics

- Propellant Hydrazine
- Catalyst S405
- Thrust/Steady State 5.3 – 1.3 N (1.2 – 0.3 lbf)
- Feed Pressure 27.6 – 5.5 bar (450 – 50 psia)
- Chamber Pressure 12.1 – 3.4 bar (200 – 35 psia)
- Expansion Ratio 74:1
- Flow Rate 2.4 – 0.6 g/sec (0.0053 – 0.0014 lbm-sec)
- Valve Dual Seat
- Valve Power 8.25 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power 1.54 Watts Max @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr 3.85 Watts Max @ 28 Vdc & 21°C
- Mass 0.33 kg (0.73 lbm)
 - Engine 0.13 kg (0.28 lbm)
 - Valve 0.20 kg (0.45 lbm)

Performance

- Specific Impulse 229 – 215 sec (lbf-sec/lbm)
- Total Impulse 260,000 N-sec (58,500 lbf-sec)
- Total Pulses 420,000
- Minimum Impulse Bit 0.08 N-sec @ 6.9 bar & 15 ms ON
 (0.0171 lbf-sec @ 100 psia & 15 ms ON)
- Steady State Firing 5,000 sec min – Single Firing

Status

- Flight Proven

Status

- AIAA-1999-2469

Rev. Date: 4/26/06

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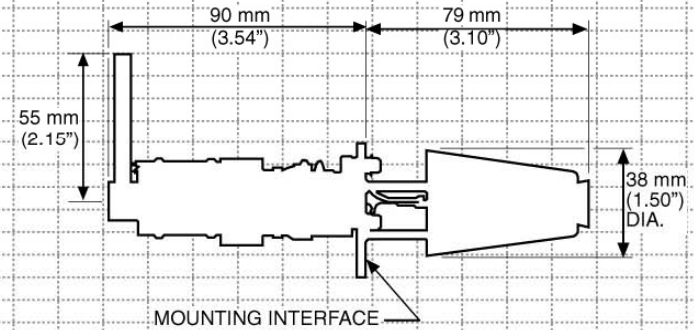
MR-111E 2N (0.5-lbf) ROCKET ENGINE ASSEMBLY



4418-3

P/N 27740-304-1

ICD 31528



Design Characteristics

- Propellant Hydrazine
- Catalyst S405
- Thrust/Steady State 2.2 – 0.5N (0.5 – 0.11 lbf)
- Feed Pressure 25.5 – 4.1 bar (370 – 60 psia)
- Chamber Pressure 14.1 – 3.1 bar (204 – 45 psia)
- Expansion Ratio 200:1
- Flow Rate 1.2 – 0.3 g/sec (0.0022 – 0.0005 lbm-sec)
- Valve Dual Seat
- Valve Power 8.25 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power 1.54 Watts Max @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr 3.85 Watts Max @ 28 Vdc & 21°C
- Mass 0.33 kg (0.73 lbm)
 - Engine 0.13 kg (0.28 lbm)
 - Valve 0.20 kg (0.45 lbm)

Performance

- Specific Impulse 224 – 213 sec (lbf-sec/lbm)
- Total Impulse 260,000 N-sec (58,500 lbf-sec)
- Total Pulses 420,000
- Minimum Impulse Bit 0.02 N-sec @ 6.9 bar & 15 ms ON
 (0.006 lbf-sec @ 100 psia & 15 ms ON)
- Steady State Firing 15.5 hr – Single Firing
 26.7 hr – Cumulative

Status

- Flight Proven

Rev. Date: 4/26/06

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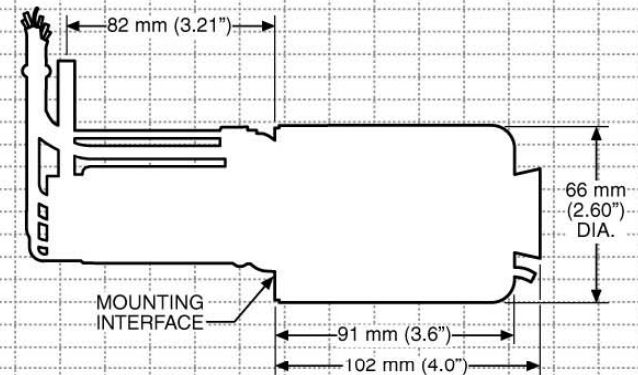
MR-50S 22N (5.0-lbf) ROCKET ENGINE ASSEMBLY



3877-1

P/N 31175-302-11

ICD 32626



Design Characteristics

- Propellant Hydrazine
- Catalyst S405
- Thrust/Steady State 32.0 – 5.8 N (7.2 – 1.3 lbf)
- Feed Pressure 27.6 – 3.4 bar (400 – 50 psia)
- Chamber Pressure 9.3 – 1.9 bar (135 – 28 psia)
- Expansion Ratio 40:1
- Flow Rate 14.2 – 3.0 g/sec (0.0313 – 0.0066 lbf/sec)
- Valve Dual Seat
- Valve Power 25.3 Watts Max @ 28 Vdc & 21°C
- Valve Heater Pwr 1.54 Watts Max @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr 3.95 Watts Max @ 28 Vdc & 21°C
- Mass 0.68 kg (1.50 lbf)
 - Engine 0.41 kg (0.90 lbf)
 - Valve 0.27 kg (0.60 lbf)

Performance

- Specific Impulse 229-208 sec (lbf-sec/lbf)
- Total Impulse 459,000 N-sec (103,271 lbf-sec)
- Total Pulses 609
- Minimum Impulse Bit 0.32 N-sec @ 3.4 bar & 30 ms ON
 (0.071 lbf-sec @ 50 psia & 30 ms ON)
- Steady State Firing 14,400 sec – Single Firing
 24,840 sec – Cumulative

Status

- Flight Proven

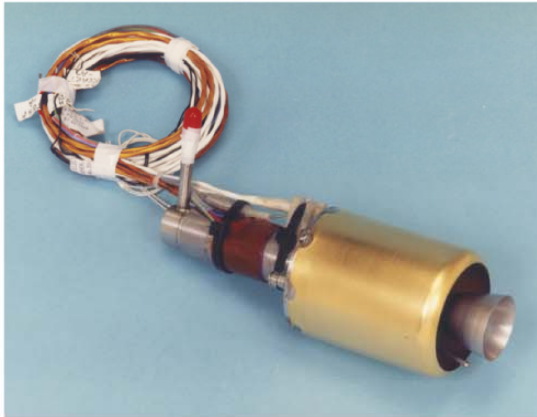
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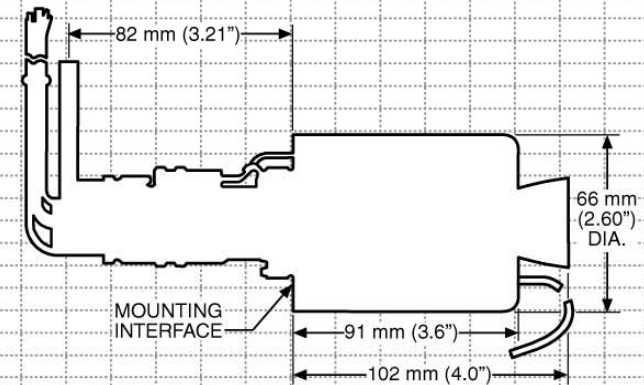
MR-50T 22N (5.0-lbf) ROCKET ENGINE ASSEMBLY



3877-1

P/N 32980-301

ICD 32981



Design Characteristics

- Propellant Hydrazine
- Catalyst S405
- Thrust/Steady State 19.5 – 8.5 N (4.39 – 1.92 lbf)
- Feed Pressure 24.1 – 6.9 bar (350 – 100 psia)
- Chamber Pressure 5.8 – 2.6 bar (84 – 37 psia)
- Expansion Ratio 40:1
- Flow Rate 8.6 – 3.9 g/sec (0.019 – 0.0087 lbf/sec)
- Valve Dual Seat
- Valve Power 25.3 Watts Max @ 28 Vdc & 21°C
- Valve Heater Pwr 1.96 Watts Max @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr 3.27 Watts Max @ 28 Vdc & 21°C
- Mass 0.68 kg (1.50 lbf)
 - Engine 0.41 kg (0.90 lbf)
 - Valve 0.27 kg (0.60 lbf)

Performance

- Specific Impulse 225-215 sec (lbf-sec/lbf)
- Total Impulse 224,000 N-sec (50,422 lbf-sec)
- Total Pulses 26,000
- Minimum Impulse Bit 0.73 N-sec @ 6.9 bar & 80 ms ON
 (0.165 lbf-sec @ 100 psia & 80 ms ON)
- Steady State Firing 600 sec

Status

- Flight Proven

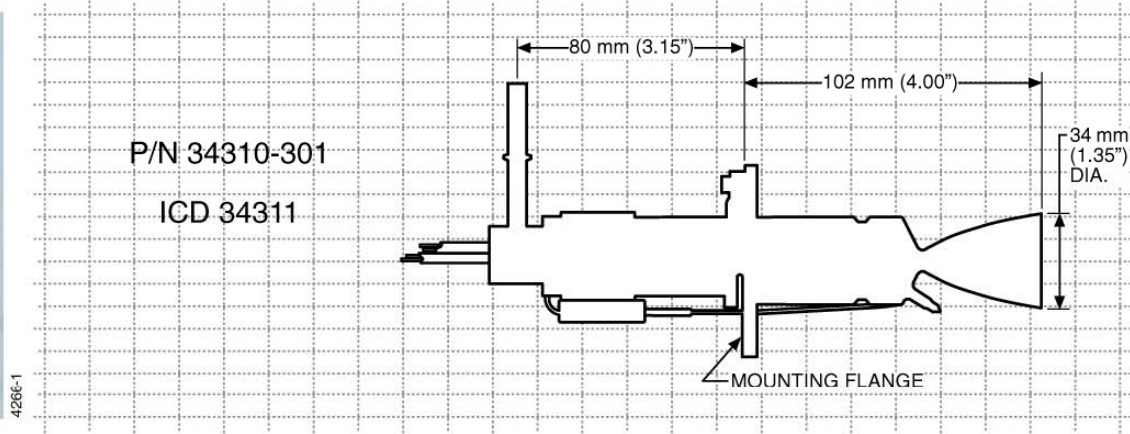
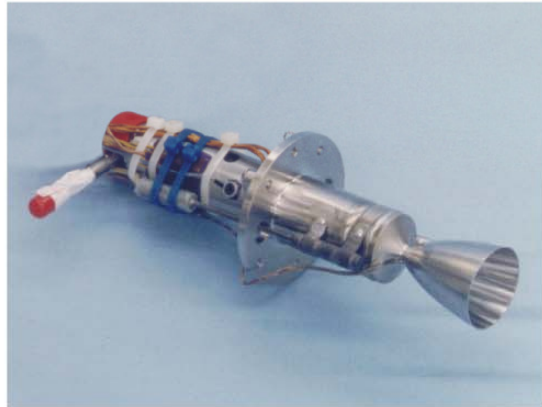
Rev. Date: 4/24/06

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MR-106E 22N (5.0-lbf) ROCKET ENGINE ASSEMBLY - 28 Vdc



P/N 34310-301

ICD 34311

4266-1

Design Characteristics

- Propellant Hydrazine
- Catalyst LCH-227/202
- Thrust/Steady State 30.7 – 11.6 N (6.9 – 2.6 lbf)
- Feed Pressure 24.1 – 6.9 bar (350 – 100 psia)
- Chamber Pressure 12.4 – 4.5 bar (180 – 65 psia)
- Expansion Ratio 60:1
- Flow Rate 13.1 – 5.0 g/sec (0.0289 – 0.011 lbfm/sec)
- Valve Dual Seat
- Cat. Bed Heater Pwr 6.53 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power 3.27 Watts @ 28 Vdc & 21°C
- Valve Power 25.3 Watts Max @ 28 Vdc & 21°C
- Mass 0.635 kg (1.4 lbfm) Max

Performance

- Specific Impulse 235 – 229 sec (lbf-sec/lbfm)
- | | REA 'A' | REA 'B' | Mars* |
|---------------------------------|---|-----------------------------------|--------------------------|
| ■ Total Impulse | 36,000 N-sec
(26,958 lbf-sec) | 125,000 N-sec
(28,044 lbf-sec) | 90,587 N-sec
(20,366) |
| ■ Total Pulses | 12,405 | 186 | 66,631 |
| ■ Minimum Impulse Bit | 0.46 N-sec @ 12.8 bar & 16 ms ON
(0.103 lbf-sec @ 185 psia & 16 ms ON) | | |
| ■ Steady State Firing | 2,000 sec – Single Firing
4,670 sec – Cumulative | | |

Status

- Flight Proven

**Mars Odyssey Test Program –
December, 2000*

Reference

- AIAA-2001-3632
- AIAA-1999-2469

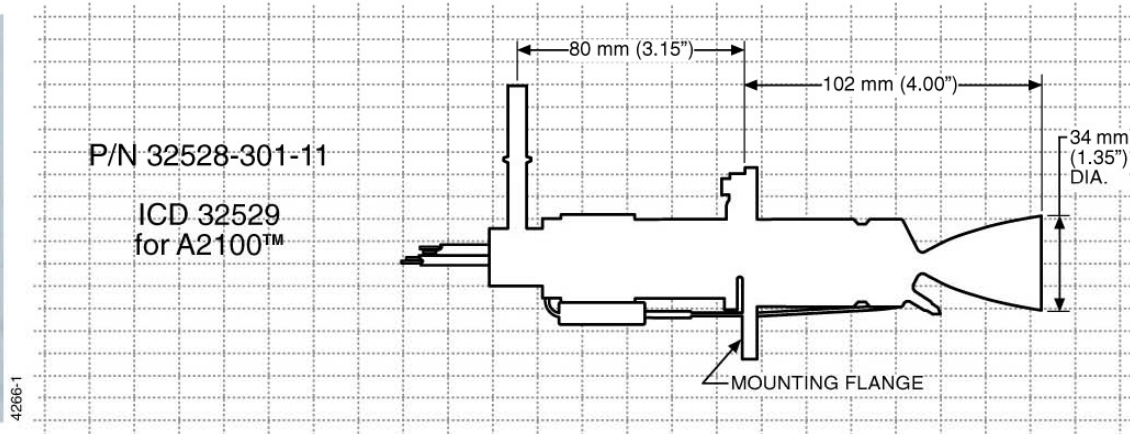
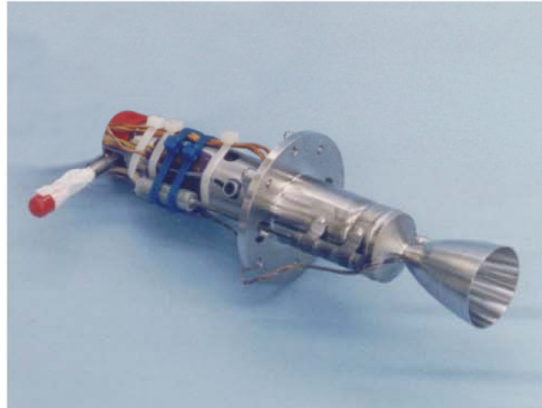
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MR-106E 22N (5.0-lbf) ROCKET ENGINE ASSEMBLY - 70 Vdc



Design Characteristics

- Propellant Hydrazine
- Catalyst LCH-227/202
- Thrust/Steady State 30.7 – 11.6 N (6.9 – 2.6 lbf)
- Feed Pressure 24.1 – 6.9 bar (350 – 100 psia)
- Chamber Pressure 12.4 – 4.5 bar (180 – 65 psia)
- Expansion Ratio 60:1
- Flow Rate 13.1 – 5.0 g/sec (0.0289 – 0.011 lbm/sec)
- Valve Dual Seat
- Valve Power 39.52 Watts Max @ 70 Vdc & 21°C
- Valve Heater Power 3.27 Watts @ 70 Vdc & 21°C
- Cat. Bed Heater Pwr 6.36 Watts Max @ 70 Vdc & 21°C
- Mass 0.52 kg (1.14 lbm)
 - Engine 0.23 kg (0.50 lbm)
 - Valve 0.29 kg (0.64 lbm)

Performance

- Specific Impulse 235 – 229 sec (lbf-sec/lbm)
- Total Impulse

	REA 'A'	REA 'B'	Mars*
120,000 N-sec	125,000 N-sec	90,587 N-sec	
(26,958 lbf-sec)	(28,044 lbf-sec)	(20,366)	
- Total Pulses 12,405 186 66,631
- Minimum Impulse Bit 0.46 N-sec @ 12.8 bar & 16 ms ON
 (0.103 lbf-sec @ 185 psia & 16 ms ON)
- Steady State Firing 2,000 sec – Single Firing
 4,670 sec – Cumulative

Status

- Flight Proven

**Mars Odyssey Test Program –
December, 2000*

Reference

- AIAA-2001-3632
- AIAA-1999-2469

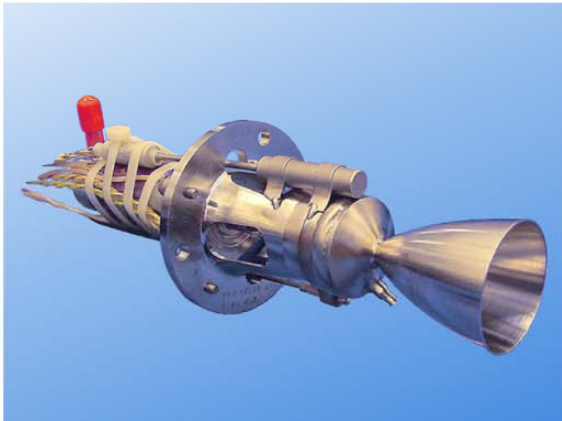
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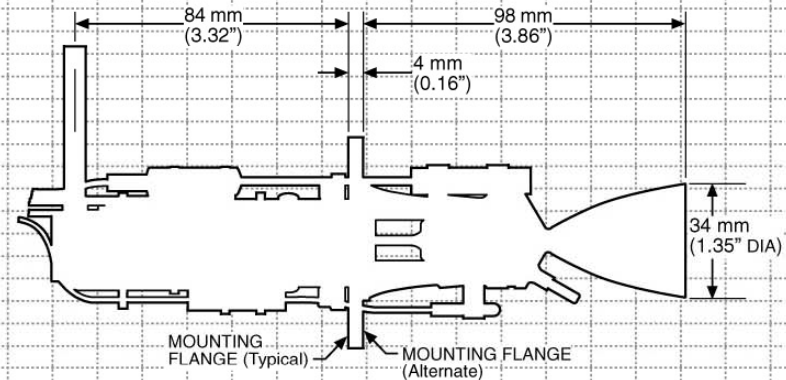
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MR-106L 22N (5.0-lbf) ENGINE ASSEMBLY - 28 Vdc



P/N 35258-301
 35258-302
 35942-301
 ICD 35308



Design Characteristics

- PropellantHydrazine
- Catalyst S405/LCH-202
- Thrust/Steady State 34 – 10N (7.7 – 2.3 lbf)
- Feed Pressure 27.6 – 5.9 bar (400 – 85 psia)
- Chamber Pressure 13.4 – 4.1 bar (195 – 60 psia)
- Expansion Ratio 60:1
- Flow Rate 14.7 – 4.5 g/sec (0.032 – 0.010 lbf-sec)
- Valve Dual Seat
- Cat. Bed Heater Pwr 13.2 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power 4.0 Watts @ 28 Vdc & 21°C
- Valve Power 24.5 Watts Max @ 28 Vdc & 21°C
- Mass 0.590 kg (1.3 lbf) Nom

Performance

- Specific Impulse 235 – 229 sec (lbf-sec/lbf)
- Total Impulse 561,388 N-sec
 (126,205 lbf-sec)
- Total Pulses 120,511
- Minimum Impulse Bit 0.15 N-sec @ 5.9 bar & 16 ms ON
 (0.034 lbf-sec @ 85 psia & 16 ms ON)
- Steady State Firing 4,000 sec

Status

- Qualified: Integrated on 3 Spacecraft

Reference

- AIAA-2005-3954

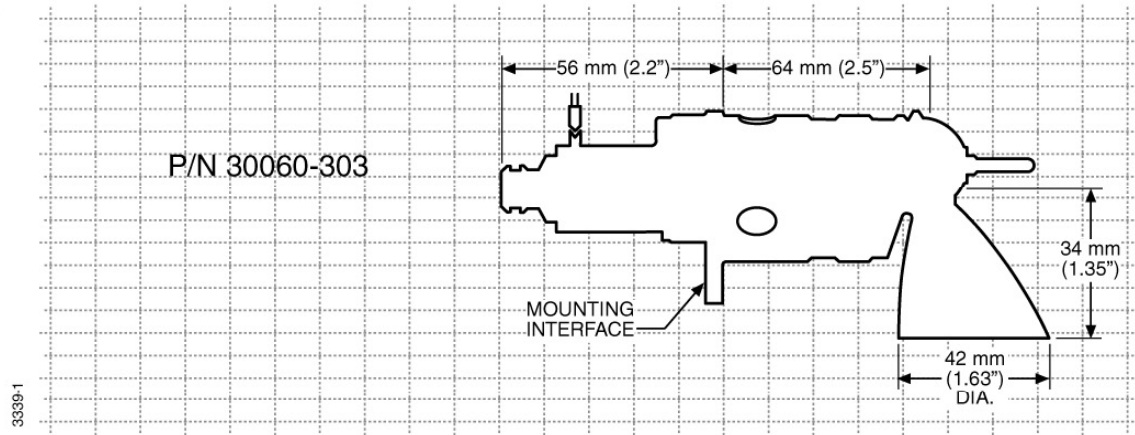
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MR-120 90N (20-lbf) ROCKET ENGINE ASSEMBLY



Design Characteristics

- Propellant Hydrazine
- Catalyst LCH-207/202
- Thrust/Steady State 111.2 – 40.0N (25 – 9 lbf)
- Feed Pressure 24.5 – 7.2 bar (355 – 105 psia)
- Chamber Pressure 12.4 – 4.5 bar (180 – 65 psia)
- Expansion Ratio 15:1
- Flow Rate 49.9 – 19.5 g/sec (0.11 – 0.043 lbfm/sec)
- Valve Single Seat
- Valve Power 43 Watts Max @ 32 Vdc & 5°C
- Mass 0.41 kg (0.90 lbfm)
 - Engine 0.29 kg (0.63 lbfm)
 - Valve 0.12 kg (0.27 lbfm)

Performance

- Specific Impulse 229-222 sec (lbf-sec/lbfm)
- Total Impulse 36,900 N-sec (8,289 lbf-sec)
- Total Pulses 1,911
- Minimum Impulse Bit 0.98 N-sec @ 22.4 bar & 11 ms ON
 (0.22 lbf-sec @ 325 psia & 11 ms ON)
- Steady State Firing 150 sec

Status

- Flight Ready

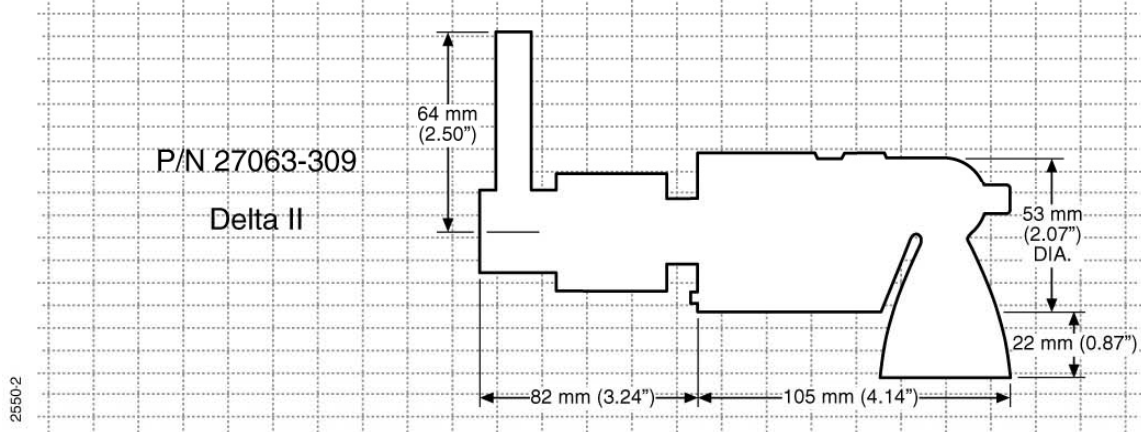
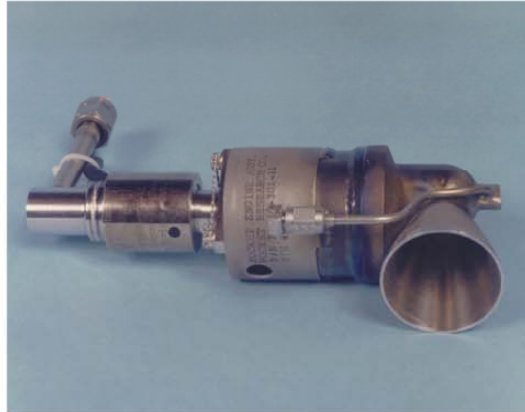
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MR-107B 180N (40-lbf) ROCKET ENGINE ASSEMBLY



Design Characteristics

- Propellant Hydrazine
- Catalyst S405/LCH-202
- Thrust/Steady State 178 – 49N (40 – 11 lbf)
- Feed Pressure 31.0 – 6.9 bar (450 – 100 psia)
- Chamber Pressure 15.4 – 4.2 bar (223 – 61 psia)
- Expansion Ratio 20:1
- Flow Rate 77.1 – 24.5 g/sec (0.17 – 0.054 lbf/sec)
- Valve Single Seat
- Valve Power 50 Watts Max @ 28 Vdc & 24°C
- Mass 0.88 kg (1.95 lbf)
 - Engine 0.61 kg (1.35 lbf)
 - Valve 0.27 kg (0.60 lbf)

Performance

- Specific Impulse 235-203 sec (lbf-sec/lbf)
- Total Impulse 19,000 N-sec (4,278 lbf-sec)
- Total Pulses 3,890
- Minimum Impulse Bit 3.2 N-sec @ 31.0 bar & 20 ms ON
 (0.7 lbf-sec @ 450 psia & 20 ms ON)
- Steady State Firing 97 sec

Status

- Flight Proven

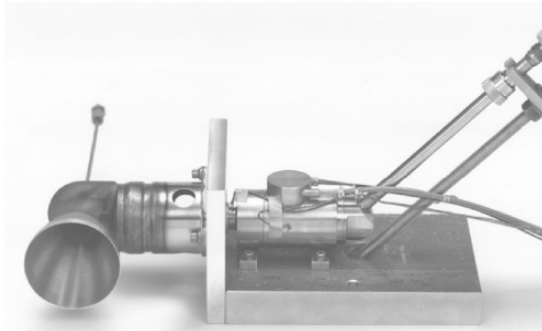
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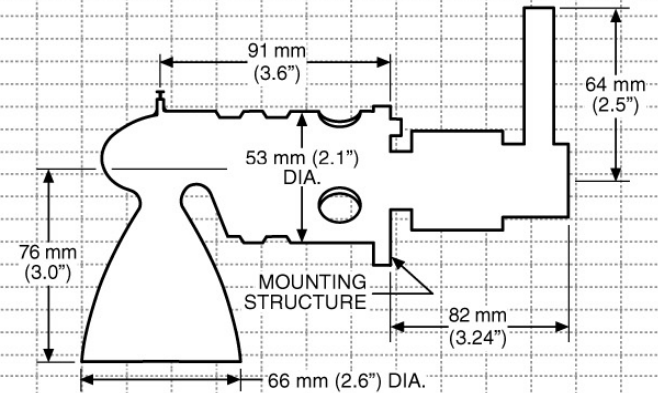


MR-107J 220N (50-lbf) ROCKET ENGINE ASSEMBLY



P/N 30120-301

3528



Design Characteristics

- PropellantHydrazine
- Catalyst LCH-207/LCH-202
- Thrust/Steady State 258 – 116 N (58.0 – 26.0 lbf)
- Feed Pressure 34 – 12 bar (500 – 175 psia)
- Chamber Pressure 9.7 – 4.5 bar (140 – 65 psia)
- Expansion Ratio 21.5:1
- Flow Rate 113 – 54 g/sec (0.25 – 0.12 lbf/sec)
- Valve Dual Seat
- Valve Power 170 Watts @ 28 Vdc & 21°C
- Mass 1.46 kg (3.22 lbf)
 - Engine 0.64 kg (1.42 lbf)
 - Valve 0.82 kg (1.80 lbf)

Performance

- Specific Impulse 234 – 224 sec (lbf-sec/lbf)
- Total Impulse 81,200 N-sec (18,257 lbf-sec)
- Total Pulses 3,704
- Minimum Impulse Bit 11 N-sec @ 13.8 bar & 100 ms ON
 (2.5 lbf-sec @ 200 psia & 100 ms ON)
- Steady State Firing 450 sec – Cumulative

Status

- Flight Proven

Rev. Date: 4/26/06

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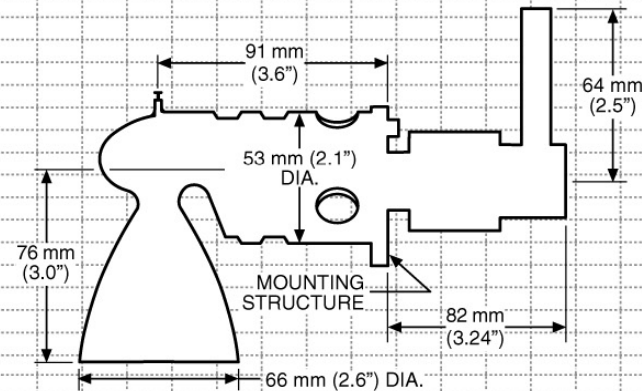
MR-107K 220N (50-lbf) ROCKET ENGINE ASSEMBLY



P/N 31315-301-11

ICD 31316

3722-1



Design Characteristics

- Propellant Hydrazine
- Catalyst LCH-207/LCH-202
- Thrust/Steady State 222 – 80N (50 – 18 lbf)
- Feed Pressure 31.0 – 6.9 bar (450 – 100 psia)
- Chamber Pressure 8.27 – 2.6 bar (120 – 38 psia)
- Expansion Ratio 21.5:1
- Flow Rate 98.4 – 36.7 g/sec (0.217 – 0.081 lbm/sec)
- Valve Single Seat
- Valve Power 37.0 Watts @ 28 Vdc & 21°C
- Valve Heater Pwr 2.0 Watts @ 28 Vdc & 21°C
- Mass 0.91 kg (2.00 lbm)
 - Engine 0.63 kg (1.40 lbm)
 - Valve 0.27 kg (0.60 lbm)

Performance

- Specific Impulse 230 – 222 sec (lbf-sec/lbm)
- Total Impulse 426,000 N-sec (95,853 lbf-sec)
- Total Pulses 26,624
- Minimum Impulse Bit 0.62 N-sec @ 6.9 bar & 6 ms ON
 (0.14 lbf-sec @ 100 psia & 6 ms ON)
- Steady State Firing 2,137 sec – Single Firing
 2,684 sec – Cumulative

Status

- Flight Proven

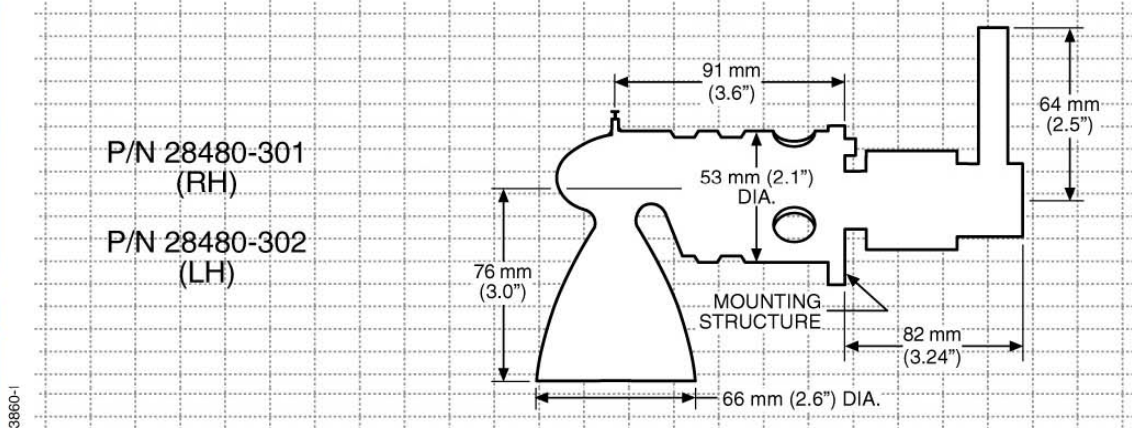
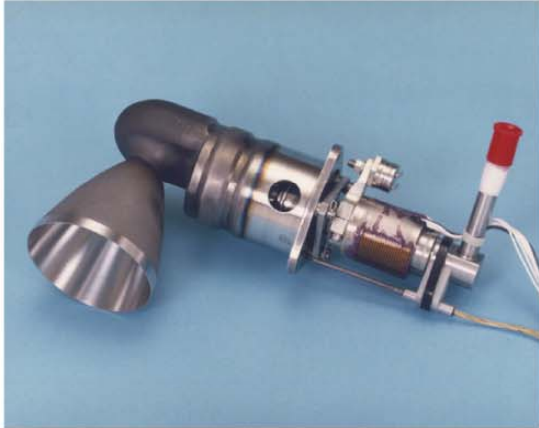
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MR-107L 130N (30-lbf) ROCKET ENGINE ASSEMBLY



P/N 28480-301
(RH)

P/N 28480-302
(LH)

Design Characteristics

- PropellantHydrazine
- Catalyst LCH-207/LCH-202
- Thrust/Steady State 142–67 N (32.0–15.0 lbf)
- Feed Pressure 32.8 – 10.3 bar (475 – 150 psia)
- Chamber Pressure 5.4 – 2.6 bar (78 – 37 psia)
- Expansion Ratio 21.5:1
- Flow Rate 64 – 30 g/sec (0.14–0.067 lbf/sec)
- Valve Single Seat
- Valve Power 36.3 Watts @ 28 Vdc & 24°C
- Valve Heater Pwr 8 Watts Nominal @ 28 Vdc & 21°C
- Valve Thermostat Controls Valve Heater
- Mass 0.91 kg (2.02 lbf)
 - Engine 0.64 kg (1.42 lbf)
 - Valve 0.27 kg (0.60 lbf)

Performance

- Specific Impulse 228 – 224 sec (lbf-sec/lbf)
- Total Impulse 332,000 N-sec (74,715 lbf-sec)
- Total Pulses 5,344
- Minimum Impulse Bit 1.16 N-sec @ 10.3 bar & 20 ms ON
 (0.26 lbf-sec @ 150 psia & 20 ms ON)
- Steady State Firing 2,137 sec – Single Firing
 2,684 sec – Cumulative

Status

- Flight Proven

Rev. Date: 4/26/06

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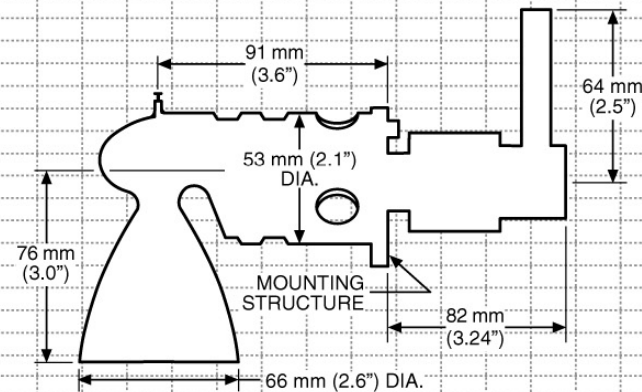
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MR-107M 220N (50-lbf) ROCKET ENGINE ASSEMBLY



P/N 31560-301-11
ICD 31316

3722-1



Design Characteristics

- PropellantHydrazine
- Catalyst LCH-207/LCH-202
- Thrust/Steady State 231.3–57.8 N (52–13 lbf)
- Feed Pressure 29.7–5.9 bar (430–85 psia)
- Chamber Pressure 8.8–2.2 bar (127–32 psia)
- Expansion Ratio 21.5:1
- Flow Rate 102.5–26.5 g/sec (0.226–0.0585 lbf/sec)
- Valve Single Seat w/Internal Diodes
- Valve Power 37.0 Watts @ 28 Vdc & 21°C
- Mass 0.90 kg (2.00 lbf)
 - Engine 0.64 kg (1.40 lbf)
 - Valve 0.27 kg (0.60 lbf)

Performance

- Specific Impulse 230–222 sec (lbf-sec/lbf)
- Total Impulse 426,000 N-sec (95,853 lbf-sec)
- Total Pulses 26,624
- Minimum Impulse Bit 0.623 N-sec @ 6.9 bar & 6 ms ON
 (0.14 lbf-sec @ 100 psia & 6 ms ON)
- Steady State Firing 2,137 sec–Single Firing
 2,684 sec–Cumulative

Status

- Flight Proven

Reference

- AIAA-1994-3378

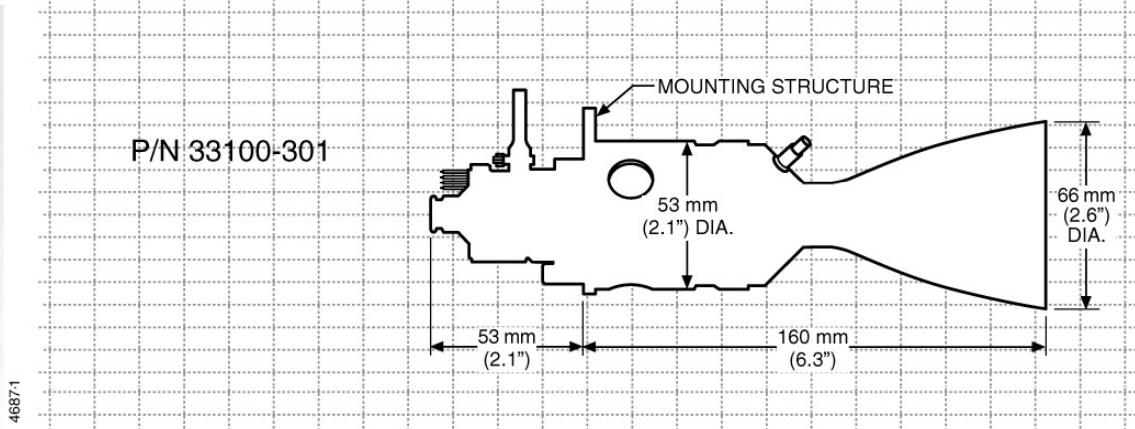
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MR-107N 270N (60-lbf) ROCKET ENGINE ASSEMBLY



Design Characteristics

- PropellantHydrazine
- Catalyst LCH-227/LCH-202
- Thrust/Steady State 296–109 N (66.6–24.6 lbf)
- Feed Pressure 29.0 – 8.2 bar (420 – 119 psia)
- Chamber Pressure 11.2 – 4.2 bar (162 – 61 psia)
- Expansion Ratio 20.7:1
- Flow Rate 131 – 49 g/sec (0.290–0.108 lbm/sec)
- Valve Moog Single Seat
- Valve Power 46 Watts @ 28 Vdc & 24°C
- Valve Heater Power 3 Watts @ 28 Vdc & 21°C
- Mass 0.74 kg (1.64 lbm)
 - Engine 0.54 kg (1.20 lbm)
 - Valve 0.20 kg (1.44 lbm)

Performance

- Specific Impulse 232 – 229 sec (lbf-sec/lbm)
- Total Impulse 68,500 N-sec (15,397 lbf-sec)
- Total Pulses 1,485
- Minimum Impulse Bit 1.46 N-sec @ 9.3 bar & 20 ms ON
 (0.328 lbf-sec @ 135 psia & 20 ms ON)
- Steady State Firing 40 sec – Single Firing
 299 sec – Cumulative

Status

- Flight Proven

Reference

- AIAA-2001-3261

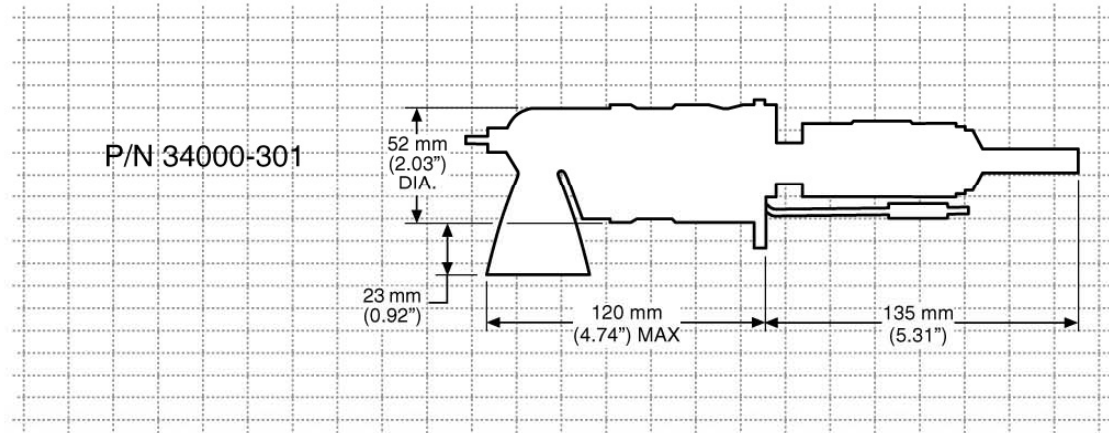
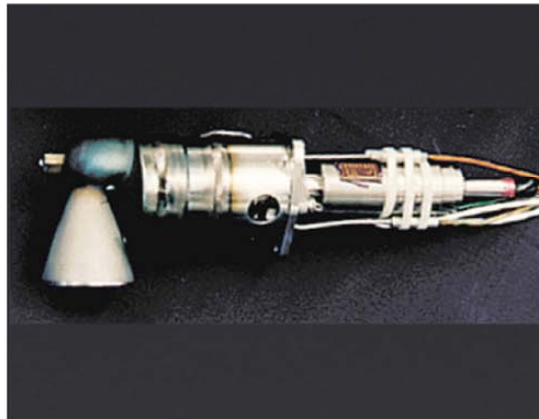
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MR-107P 90N (20-lbf) ROCKET ENGINE ASSEMBLY



Design Characteristics

- PropellantHydrazine
- Catalyst LCH-207/LCH-202
- Thrust/Steady State 98–34.2N (22–7.7 lbf)
- Feed Pressure 24.1 – 6.9 bar (350 – 100 psia)
- Chamber Pressure 8.5 – 3.0 bar (123 – 44 psia)
- Expansion Ratio 20:1
- Flow Rate 44.1 – 15.4 g/sec (0.0973–0.034 lbm/sec)
- Valve Dual Seat
- Valve Power 115 Watts @ 34 Vdc & 24°C
- Mass 1.10 kg (2.43 lbm)
 - Engine 0.65 kg (1.43 lbm)
 - Valve 0.45 kg (1.00 lbm)

Performance

- Specific Impulse 226–221 sec (lbf-sec/lbm)
- Total Impulse 426,000 N-sec (95,853 lbf-sec)
- Total Pulses 26,624
- Minimum Impulse Bit 1.78 N-sec @ 6.9 bar & 40 ms ON
 (0.40 lbf-sec @ 100 psia & 40 ms ON)
- Steady State Firing 2,137 sec

Status

- Flight Ready

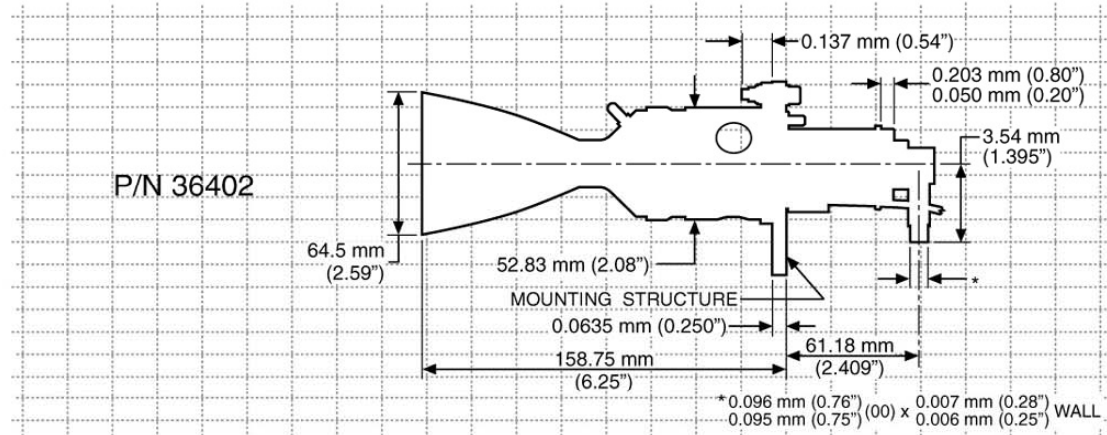
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MR-107S 275N (60-lbf) ROCKET ENGINE ASSEMBLY



Design Characteristics

- Propellant Hydrazine
- Catalyst S-405 / LCH-202
- Thrust/Steady State 360–85 N (81 – 19 lbf)
- Feed Pressure 35 – 7 bar (500 – 100 psia)
- Chamber Pressure 14 – 4 bar (197 – 45 psia)
- Expansion Ratio 21.5:1
- Flow Rate 154.7 – 36.3 g/sec (0.341–0.08 lbm/sec)
- Valve Single Seat
- Valve Power <34.8 Watts @ 28 Vdc & 20°C
- Mass 1.01 kg (2.23 lbm)
 - Engine 0.67 kg (1.48 lbm)
 - Valve 0.34 kg (0.75 lbm)

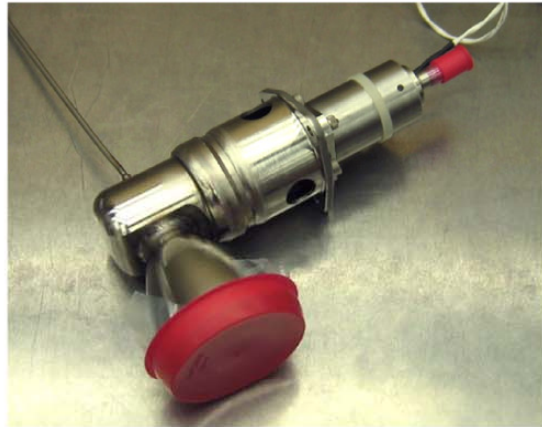
Performance – Reference MR-107S/T Testing in 2007

- Specific Impulse 225 – 236 sec (lbf-sec/lbm)
- Total Impulse 337,620 N-sec (75,900 lbf-sec)
- Total Pulses 30,300
- Steady State Firing 41 sec @ 360N (81-lbf)
 - 100 sec @ 236N (53-lbf)
 - 30 sec @ 285N (64-lbf)

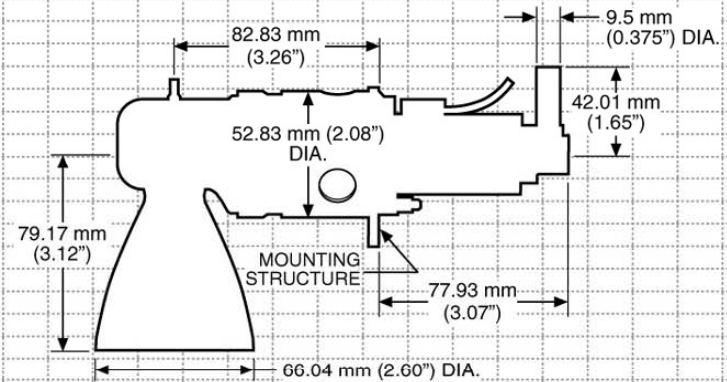
Status

- Qualified

MR-107T 110N (25-lbf) ROCKET ENGINE ASSEMBLY



P/N 36399



Design Characteristics

- PropellantHydrazine
- Catalyst S-405 / LCH-202
- Thrust/Steady State 125–54 N (28–12 lbf)
- Feed Pressure 37–7 bar (500–100 psia)
- Chamber Pressure 4.7–1.8 bar (69–26 psia)
- Expansion Ratio 21.5:1
- Flow Rate 55.8–22.7 g/sec (0.123–0.05 lbfm/sec)
- Valve Single Seat
- Valve Power <34.8 Watts @ 28 Vdc & 20°C
- Mass 1.01 kg (2.23 lbfm)
 - Engine 0.67 kg (1.48 lbfm)
 - Valve 0.34 kg (0.75 lbfm)

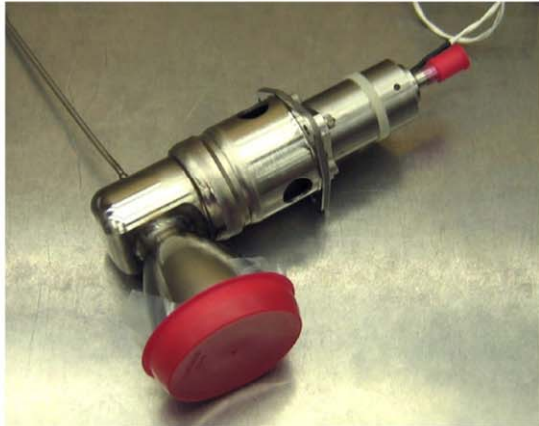
Performance – Reference MR-107S/T Testing in 2007

- Specific Impulse 222–228 sec (lbf-sec/lbfm)
- Total Impulse 92,967 N-sec (20,900 lbf-sec)
- Total Pulses 14,300
- Steady State Firing 100 sec @ 125N (28-lbf)
 - 100 sec @ 54N (12-lbf)

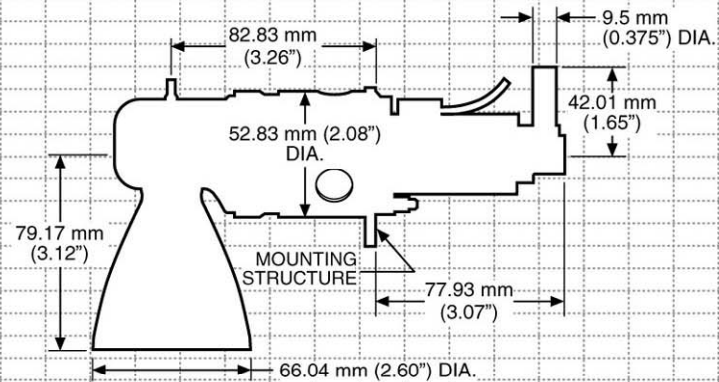
Status

- Qualified

MR-107V 220N (49.5-lbf) ROCKET ENGINE ASSEMBLY



P/N 36516-301



Design Characteristics

- PropellantHydrazine
- Catalyst S-405 / LCH-202
- Thrust/Steady State 220 – 67 N (49.5 – 15 lbf)
- Feed Pressure 26 – 5.5 bar (377 – 80 psia)
- Chamber Pressure 8.4 – 2.6 bar (122 – 38 psia)
- Expansion Ratio 21.5:1
- Flow Rate 98 – 31 g/sec (0.216–0.07 lbm/sec)
- Valve Single Seat
- Valve Power <34.8 Watts @ 28 Vdc & 20°C
- Mass 1.01 kg (2.23 lbm)
 - Engine 0.67 kg (1.48 lbm)
 - Valve 0.34 kg (0.75 lbm)

Performance – Reference MR-107S/T Testing in 2007

- Specific Impulse 229 – 223 sec (lbf-sec/lbm)
- Total Impulse 337,175 N-sec (75,800 lbf-sec)
- Total Pulses 30,275
- Steady State Firing 100 sec @ 111 N (25-lbf)

Status

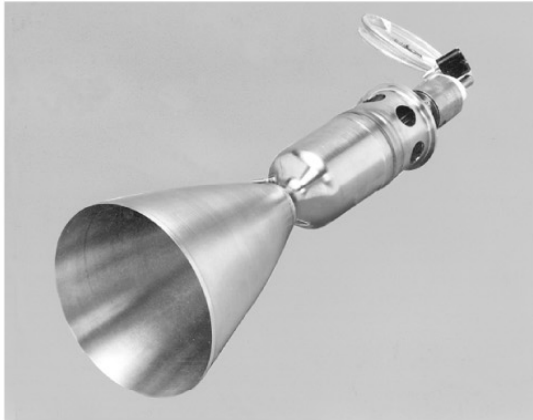
- Qualification Testing in 2007

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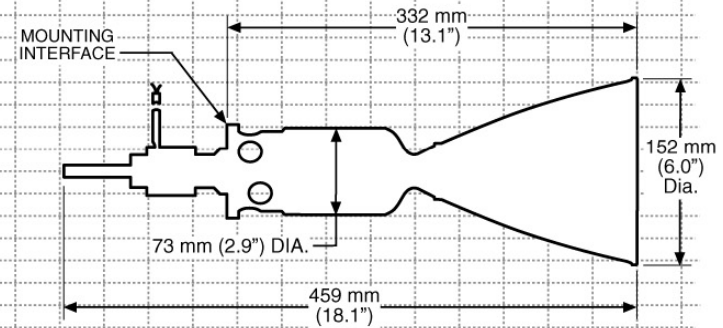
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MR-104A/C 440N (100-lbf) ROCKET ENGINE ASSEMBLY



P/N 28875-305
ICD PS-2598867



Design Characteristics

- Propellant Hydrazine
- Catalyst S405 / LCH-202
- Thrust/Steady State 572.5 – 204.6 N (128.7 – 46 lbf)
- Feed Pressure 28.9 – 6.9 bar (420 – 100 psia)
- Chamber Pressure 10.7 – 3.9 bar (155 – 56 psia)
- Expansion Ratio 53:1
- Flow Rate 240.4 – 90.72 g/sec (0.53 – 0.20 lbm-sec)
- Valve Single Seat
- Valve Power 30 Watts @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr 13.1 Watts @ 28 Vdc & 21°C
- Mass 1.86 kg (4.11 lbm)
- Engine 1.44 kg (3.17 lbm)
- Valve 0.43 kg (0.94 lbm)

Performance

- Specific Impulse 239 – 223 sec (lbf-sec/lbm)
- Total Impulse 693,900 N-sec (156,000 lbf-sec)
- Total Pulses 1,742
- Minimum Impulse Bit 8.23 N-sec @ 24.13 bar & 22 ms ON
 (1.85 lbf-sec @ 350 psia & 22 ms ON)
- Steady State Firing 2,000 sec – Single Firing
 2,654 sec – Cumulative

Status

- Flight Proven

Rev. Date: 5/17/06

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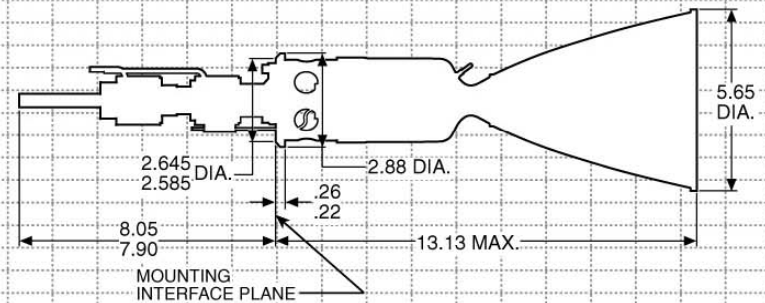
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MR-104D 100 lbf (440N) ROCKET ENGINE ASSEMBLY



P/N 34012-301



Design Characteristics

- PropellantHydrazine
- Catalyst S405/LCH-202
- Thrust/Steady State 506.2 – 201.0N (113.8 – 45.2 lbf)
- Feed Pressure 24.8 – 6.9 bar (360 – 100 psia)
- Chamber Pressure 9.4 – 3.8 bar (137 – 55 psia)
- Expansion Ratio 53:1
- Flow Rate 217.9 – 90.8 g/sec (0.48 – 0.20 lbm-sec)
- Valve Dual Seat
- Valve Power 60 Watts @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr 14.4 Watts/el @ 28 Vdc & 21°C
- Weight 2.22 kg (4.9 lbm)
 - Engine 1.50 kg (3.3 lbm)
 - Valve 0.72 kg (1.6 lbm)

Performance

- Specific Impulse 237 – 223 sec (lbf-sec/lbm)
- Total Impulse 693,900 N-sec (156,000 lbf-sec)
- Total Pulses 1,742
- Minimum Impulse Bit 8.23 N-sec @ 24 bar & 22 ms ON
 (1.85 lbf-sec @ 350 psia & 22 ms ON)
- Steady State Firing 2,137 sec – Single Firing
 2,654 sec – Cumulative

Status

- Flight Ready

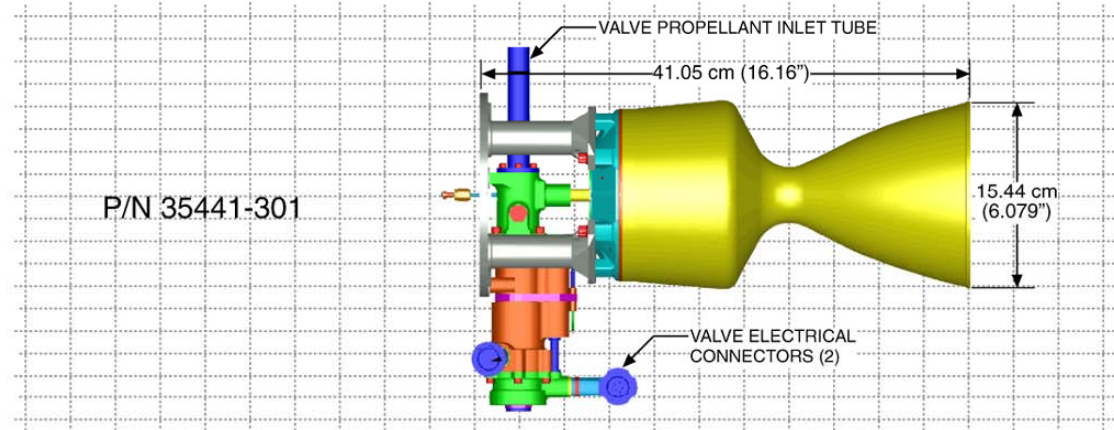
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MR-80B 3,100N (700-lbf) THROTTLING ROCKET ENGINE ASSEMBLY



Design Characteristics

- Propellant Hydrazine
- Catalyst S405
- VacuumThrust/Steady State 3780 – 31N (850 – 7 lbf)
- Feed Pressure 41.7 Bar (605 psia)
- Chamber Pressure 20.4 – 0.14 Bar (296 – 2 psia)
- Expansion Ratio 16.7:1
- Cat. Bed Heater Pwr 6.3 Watts/Element Max @ 30 Vdc
- Valve Heater Power 9.45 Watts/Element @ 30 Vdc
- Valve Cavitating Throttle
- Valve Power 168 Watts Max @ 28 Vdc
- Weight 8.51 kg (18.76 lbm)
 - Engine 6.92 kg (15.26 lbm)
 - Valve 1.59 kg (3.50 lbm)

Performance

- Vacuum Specific Impulse 225- 200 sec (lbf-sec/lbm)
- | | Dev. #1 | Dev. #2 | Dev. #3R | Qual. |
|-----------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| ■ Starts | 8 | 8 | 12 | 8 |
| ■ Total Throughput | 292.1 kg
(644 lbm) | 183.7 kg
(405 lbm) | 451.3 kg
(995 lbm) | 308.4 kg
(680 lbm) |
| ■ Total Firing Time | 334 sec | 418 sec | 806 sec | 560 sec |
| ■ Longest Single Firing | 76 sec | 117 sec | 137 sec | 214 sec |

Status

- Flight Qualified

Reference

- JP&P-1992: Volume 8, No. 2, P. 320-331
- 2007-AIAA-5481

Date: 5/19/08

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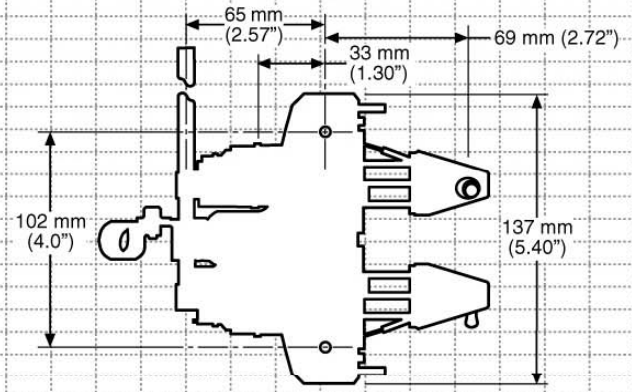
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MRM-103D 1 N (0.2-lbf) ROCKET ENGINE ASSEMBLY



P/N 232830-301 (LH)
 P/N 32830-302 (RH)
 2 Engine REM



Design Characteristics

- Propellant Hydrazine
- Catalyst S405
- Thrust/Steady State 1.02 – 0.22 N (0.230 – 0.050 lbf)
- Feed Pressure 27.6 – 6.2 bar (400 – 90 psia)
- Chamber Pressure 23.4 – 5.9 bar (340 – 85 psia)
- Expansion Ratio 100:1
- Flow Rate 0.45 – 0.09 g/sec (0.001 – 0.0002 lbf-sec)
- Valve Dual Seat
- Valve Power (per Valve)
 8.25 Watts Max @ 28 Vdc & 20°C
- Mass 1.27 kg (2.8 lbf)
- Bed Heaters and Temp. Sensors
- REM Plate Htrs (Thermostat Controlled) & Temp. Sensor
- MLI Blanket
- Electrical Interface: 1016 – 1118 mm (40 – 44") Leadwires

Performance

- Specific Impulse 224 – 209 sec (lbf-sec/lbf)
- Total Impulse 125,700 N-sec (28,263 lbf-sec)*
- Total Pulses 210,238*
- Minimum Impulse Bit 0.03 N-sec @ 6.9 bar & 15 ms ON
 (0.006 lbf-sec @ 100 psia & 15 ms ON)
- Steady State Firing 0.8 hr* – Single Firing
 176.9 hr* sec – Cumulative

Status

- Flight Proven

**As qualified for the MRM-103D
 Basic MR-103D qualified to slightly higher levels.*

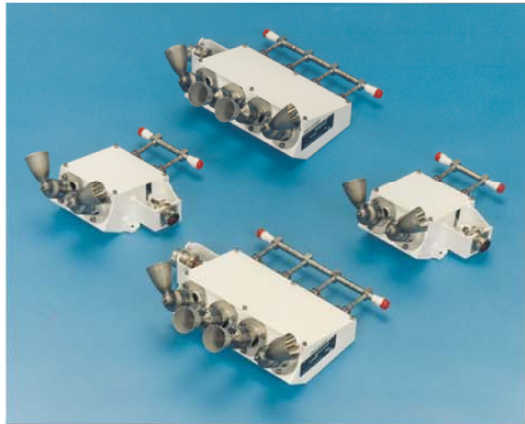
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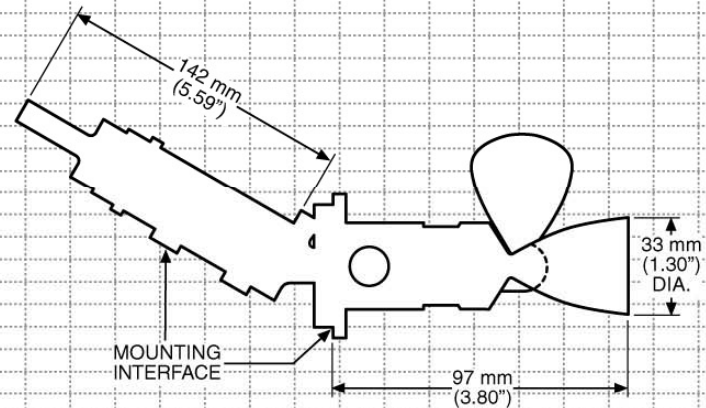
MRM-106B 27N (6.0-lbf) ROCKET ENGINE ASSEMBLY



3391-2

P/N 30400
4 Engine REM

P/N 30410
2 Engine REM



Design Characteristics

- Propellant Hydrazine
- Catalyst LCH-227/202
- Thrust/Steady State 27 – 9N (6.0 – 2.0 lbf)
- Feed Pressure 31 – 6.2 bar (450 – 90 psia)
- Chamber Pressure 10.9 – 3.8 bar (158 – 55 psia)
- Expansion Ratio 61:1
- Flow Rate 11.8 – 4.1 g/sec (0.026 – 0.009 lbf-sec)
- Valve Dual Seat
- Valve Power 27 Watts Max @ 28 Vdc & 21°C
- Mass Axial: 0.46 kg (1.009 lbfm) Lateral: 0.47 kg (1.033 lbfm)
 Engine “ 0.19 kg (0.423 lbfm) “ 0.20 kg (0.447 lbfm)
 Valve “ 0.27 kg (0.586 lbfm) “ 0.27 kg (0.586 lbfm)
- No Catalyst Bed Heaters or Valve Heaters
- 26 Pin Electrical Connectors on 4 Engine REM
- 18 Pin Electrical Connectors on 2 Engine REM

Performance

- Specific Impulse 232 – 218 sec (lbf-sec/lbfm)
- Total Impulse 125,000 N-sec (28,044 lbf-sec)
- Total Pulses 12,405
- Minimum Impulse Bit 1.16 N-sec @ 31 bar & 15 ms ON
 (0.26 lbf-sec @ 450 psia & 15 ms ON)
- Steady State Firing 2,000 sec – Single Firing
 4,670 sec – Cumulative

Status

- Flight Proven

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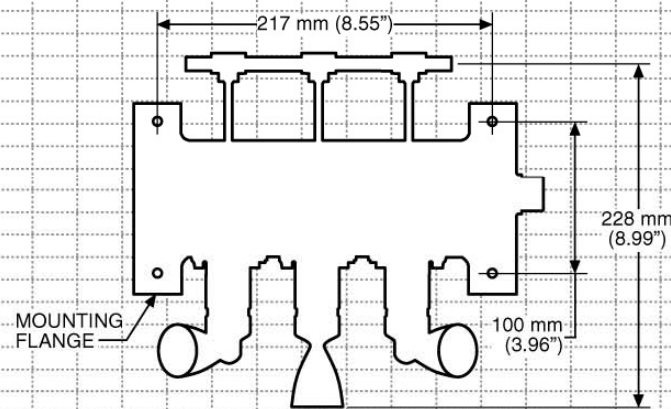


MRM-106C 40N (9.0-lbf) ROCKET ENGINE MODULE



4934-1

P/N 33010-301
3 Engine REM



Design Characteristics

- Propellant Monopropellant Hydrazine
- Catalyst LCH-207/202
- Thrust/Steady State 40 N (9.0 lbf)
- Feed Pressure 31 bar (450 psia)
- Chamber Pressure 16 bar (237 psia)
- Expansion Ratio 61:1
- Flow Rate 17.7 g/sec (0.039 lbfm/sec)
- Valve Single Seat
- Valve Power 15 Watts Max @ 28 Vdc & 20°C
- Mass Axial: 0.12 kg (0.259 lbfm) Lateral: 0.36 kg (0.801 lbfm)
 Engine " 0.15 kg (0.319 lbfm) " 0.16 kg (0.361 lbfm)
 Valve " 0.20 kg (0.440 lbfm) " 0.20 kg (0.440 lbfm)
- No Catalyst Bed Heaters or Valve Heaters
- 22 Pin Electrical Connectors

Performance

- Specific Impulse 231 sec (lbf-sec/lbfm)
- Total Impulse 136,000 N-sec (30,618 lbf-sec)
- Total Pulses 1,570
- Minimum Impulse Bit 2.62 N-sec @ 31 bar & 60 ms ON
 (0.59 lbf-sec @ 450 psia & 60 ms ON)
- Steady State Firing 1,000 sec – Single Firing
 2,991 sec – Cumulative

Status

- Flight Proven

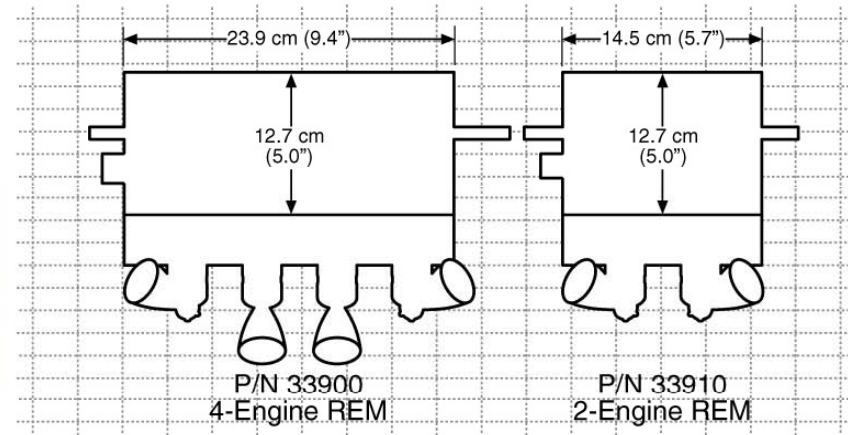
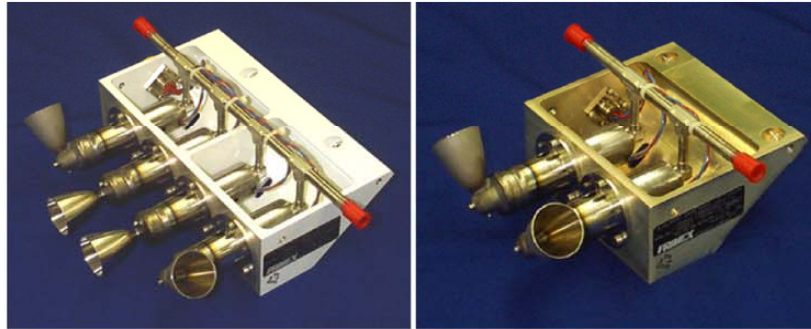
Rev. Date: 5/23/06

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MRM-106D 27/40N (6.0/9.0-lbf) ROCKET ENGINE MODULE



Design Characteristics

- Propellant Monopropellant Hydrazine
- Catalyst LCH-207/ 202
- Thrust/Steady State
 per Axial Rocket: 27 – 17 N (6.0 – 3.8 lbf)
 per Lateral Rocket: 40 – 21 N (9.0 – 4.7 lbf)
- Feed Pressure 31 – 13.8 bar (450 – 200 psia)
- Chamber Pressure . . . Axial: 11.0 – 6.9 bar (160 – 100 psia)
 Lateral: 17.2 – 8.6 bar (250 – 125 psia)
- Expansion Ratio 61:1
- Flow Rate
 Axial: 11.8 – 7.51 g/sec (0.026 – 0.017 lbm/sec)
 Lateral: 17.7 – 9.52 g/sec (0.039 – 0.021 lbm/sec)
- Valve Single Seat, Non-Sliding Fit
- Valve Power 20.1 Watts Nominal @ 28 Vdc & 21°C
- Mass 4-Engine REM: 2.7 kg (5.96 lbm)
 2-Engine REM: 1.5 kg (3.34 lbm)

- No Catalyst Bed Heaters or Valve Heaters
- 10 Pin Electrical Connectors on 4-Engine REM
- 6 Pin Electrical Connectors on 2-Engine REM

Performance

- Specific Impulse 234 – 227 sec (lbf-sec/lbm)
- Total Impulse (Axial & Lateral) 91,200N-sec (20,500 lbf-sec)
- Total Pulses >7,629 (Lateral) >1,500 (Axial)
- Minimum Impulse Bit 0.63N-sec @ 31 bar & 20 ms ON
 (0.142 lbf-sec @ 450 psia & 20 ms ON)
- Steady State Firing 1,000 sec – Single Firing

Status

- Flight Proven

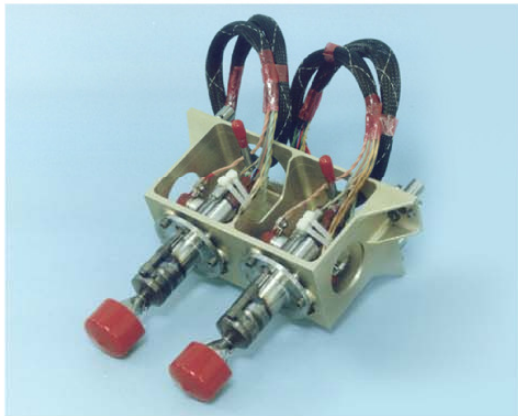
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MRM-106E 22N (5.0-lbf) ROCKET ENGINE MODULE (REM)

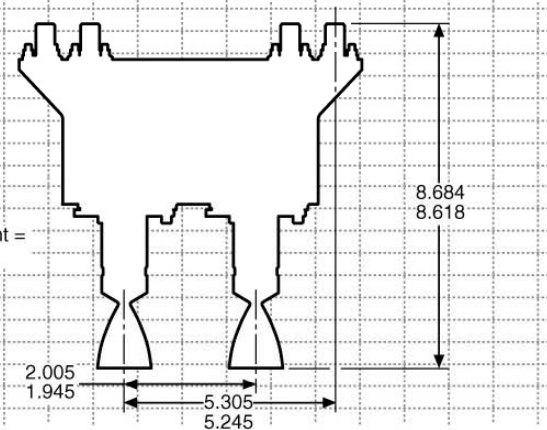


5188-3

P/N 33862-301

2 Engine REM

REA height =
4.29 MAX



Design Characteristics

- Propellant Hydrazine
- Catalyst LCH-227/202
- Thrust/Steady State 30.7 – 11.6 N (6.9 – 2.6 lbf)
- Feed Pressure 24.1 – 6.9 bar (350 – 100 psia)
- Chamber Pressure 12.4 – 4.5 bar (180 – 65 psia)
- Expansion Ratio 60:1
- Flow Rate 12.1 – 5.0 g/sec (0.0289 – 0.011 lbm/sec)
- Valve Power 25.3 Watts Max @ 28 Vdc & 21°C
- Mass 4.1 kg (1.86 lbm) Max

Performance

- Specific Impulse 235 – 229 sec (lbf-sec/lbm)
- Total Impulse

	REA 'A'	REA 'B'	Mars*
120,000 N-sec	120,000 N-sec	125,000 N-sec	90,587 N-sec
(26,958 lbf-sec)	(26,958 lbf-sec)	(28,044 lbf-sec)	(20,366 lbf-sec)
- Total Pulses 12,405 186 66,631
- Minimum Impulse Bit 0.46 N-sec @ 12.8 bar & 16 ms ON
 (0.103 lbf-sec @ 185 psia & 16 ms ON)
- Steady State Firing 2,000 sec – Single Firing
 4,670 sec – Cumulative

Status

- Flight Proven

*Mars Odyssey Test Program
December 2000

Rev. Date: 5/17/06

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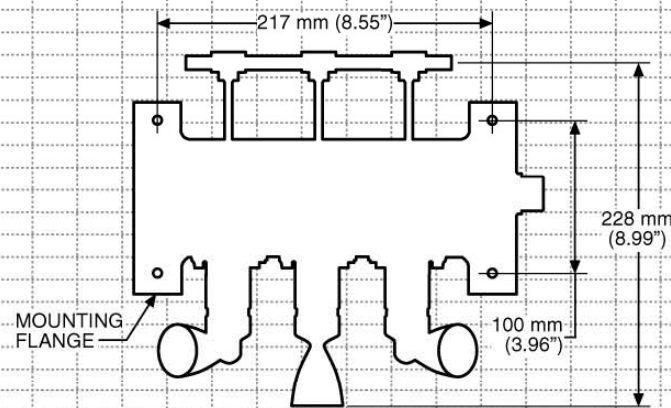
MRM-106F 40N (9.0-lbf) ROCKET ENGINE MODULE



4934-1

P/N 33010-303

3 Engine REM



Design Characteristics

- Propellant Monopropellant Hydrazine
- Catalyst LCH-207/202
- Thrust/Steady State (per Rocket) 40 N (9.0 lbf)
- Feed Pressure 31 bar (450 psia)
- Chamber Pressure 16 bar (237 psia)
- Expansion Ratio 61:1
- Flow Rate 17.7 g/sec (0.039 lbfm/sec)
- Valve Single Seat, Non-Sliding Fit
- Valve Power 20.1 Watts Nominal @ 28 Vdc & 21°C
- Mass <2.23 kg (4.9 lbfm) per REM
- No Catalyst Bed Heaters or Valve Heaters
- 22 Pin Electrical Connector

Performance

- Specific Impulse 231 sec (lbf-sec/lbfm)
- Total Impulse 136,000 N-sec (30,618 lbf-sec)
- Total Pulses 1,570
- Minimum Impulse Bit 2.62 N-sec @ 31 bar & 20 ms ON
 (0.59 lbf-sec @ 450 psia & 60 ms ON)
- Steady State Firing 1,000 sec – Single Firing
 2,991 sec – Cumulative

Status

- Flight Proven

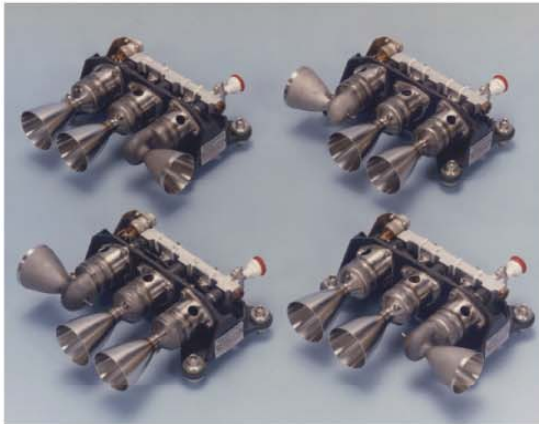
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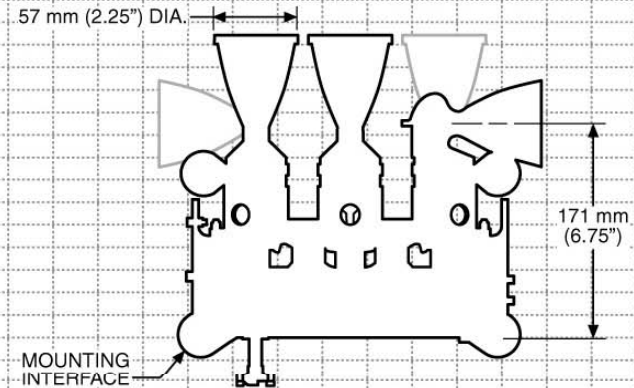
MRM-122 130N (30-lbf) ROCKET ENGINE MODULE



33163

P/N 30110
3 Engine REM
(TITAN II)

P/N 30700
3 Engine REM
(Commercial TITAN)



Design Characteristics

- Propellant Hydrazine
- Catalyst LCH
- Thrust/Steady State 142 – 51N (32 – 11.5 lbf)
- Feed Pressure 29.6 – 6.9 bar (430 – 100 psia)
- Chamber Pressure 5.4 – 2.0 bar (79 – 29 psia)
- Expansion Ratio 20.7:1 (Axial), 21.5:1 (Roll)
- Flow Rate 63.5 – 24.0 g/sec (0.14 – 0.053 lbf/sec)
- Valve Single Seat
- Valve Power 43 Watts Max @ 32 Vdc & 4°C
- Mass Axial: 0.66 kg (1.46 lbf) Lateral: 0.76 kg (1.68 lbf)
- Engine “ 0.54 kg (1.20 lbf) “ 0.64 kg (1.42 lbf)
- Valve “ 0.12 kg (0.26 lbf) “ 0.12 kg (0.26 lbf)
- No Catalyst Bed Heaters or Valve Heaters
- 19 Pin Electrical Connectors on REM

Performance

- Specific Impulse 228 – 217 sec (lbf-sec/lbf)
- Total Impulse 332,000 N-sec (74,715 lbf-sec)
- Total Pulses 7,005
- Minimum Impulse Bit 1.20N-sec @ 9.3 bar & 20 ms ON
- (0.27 lbf-sec @ 135 psia & 20 ms ON)
- Steady State Firing 2,137 sec – Single Firing
- 2,684 sec – Cumulative

Status

- Flight Proven

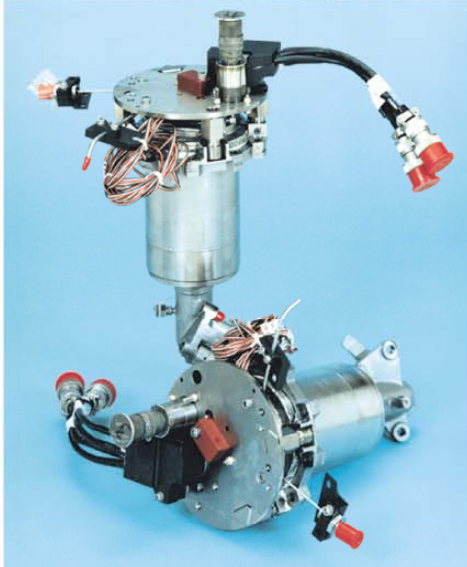
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SPACE SHUTTLE APU GAS GENERATOR



P/N 27745-306	BOOSTER	GAS GENERATOR
P/N 28910-302	ORBITER	GAS GENERATOR

Design Characteristics

- Propellant Monopropellant Grade Hydrazine
- Catalyst S405 / 14-18 Mesh
- Thrust – Pulsing Gas Flow Equivalent to 220N (50-lbf) Thruster
- Feed Pressure 103.4 bar (1500 psia)
- Flow Rate 120 – 134 g/sec (0.265 – 0.296 lbm/sec)
- Propellant Valve Part of APU
- Mass of Gas Generator 4.90 kg (10.8 lbm) Max

Performance

- Delivered Power 11 kW (idle) to 93 kW
- Qualified to 99 hrs/6,600 kg (14,500 lbm) N₂H₄, 167 Starts

Status

- Flight Qualified: 3 x 113 Manned Flights (Orbiter), 4 x 113 (Booster)

Rev. Date: 4/24/06

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“Green” Propellants and Systems

AEROJET



**Hydroxyl Ammonium Nitrate (HAN)
Thruster**

- **Aerojet Redmond Operations Is Developing and Qualifying “Green” Propellants for Next Generation Use**
- **“Green” Propellants**
 - Hydroxyl Ammonium Nitrate (HAN) Blends
 - CINCH (Competitive Impulse Non-Carcinogenic Hydrocarbons)
 - High Temperature Blends for Improved Performance
- **System Planning and Design**
 - System Integration
 - Compatibility and Long Term Storage Evaluations
- **Status – In Development**
- **Reference – AIAA-2003-4643**

Catalyst Manufacturing

AEROJET

S-405 Spontaneous Hydrazine Decomposition Catalyst

- Used on Space Shuttle, NASA Exploration Missions, Commercial Launch Vehicles and Satellites
- Industry Standard for Over 40yrs
- Process Technology Licensed from Shell Chemical Co.

LCH Aerojet Family of Catalysts for:

- Hydrazine
- Hydrazine Propellant Blends
- HAN-based Propellants
- MMH Propellant Blends
- H₂/O₂
- HC/O₂
- N₂O

Catalyst Testing

- H₂ Chemisorption
- Physical Surface Area - BET
- Crush Strength
- Ignition Response (Pino)
- Size Range (Sieve)

Catalyst Development

- Selection and Processing of Catalyst Supports
- Active Phase Identification and Loading
- Hypergolic Coatings for Low Temperature Start



Bipropellant

AEROJET

R-6D 22 N

MTT 22 N

R-1E 110 N

R-4D 490 N

**HiPAT™ High
Performance 445 N**

**HiPAT™ High Performance
Dual Mode 445 N**

R-42 890 N

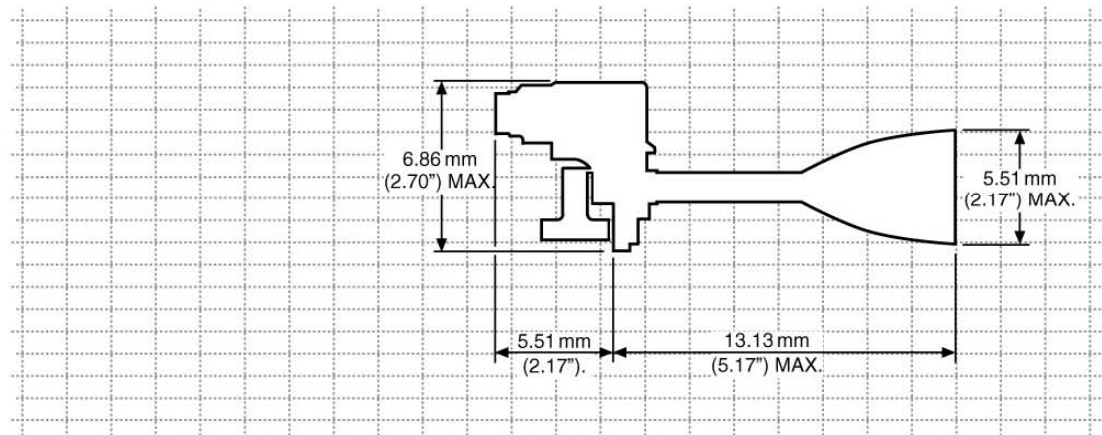
R-42DM 890 N

AMBR 623 N

R-40 3,870 N

R-40B 4,000 N

R-6D 5-lbf (22N) BIPROPELLANT ROCKET ENGINE



Design Characteristics

- Propellant MMH/NTO(MON-3)
- Thrust/Steady State 22 N (5 lbf)
- Inlet Feed Pressure Range
. 27.96 – 6.9 bar (400 – 100 psia)
- Chamber Pressure 6.7 bar @ 22N (97 psia @ 5 lbf)
- Expansion Ratio 100:1
- Flow Rate 7.71 g/sec (0.017 lbfm/sec)
- Valve Single Seat Torque Motor
. Dual Seat Solenoid
- Valve Power 5 Watts @ 28 Vdc (Moog Torque Motor)
- Mass 0.454 kg (1.0 lbfm)

Performance

- Specific Impulse 294 sec (lbf-sec/lbfm)
- Total Impulse >1,334,400 N-sec (300,000 lbf-sec)
- Total Pulses 336,331
- Minimum Impulse Bit 0.0089 N-sec (0.002 lbf-sec)
- Steady State Firing 0.005 sec to Unlimited

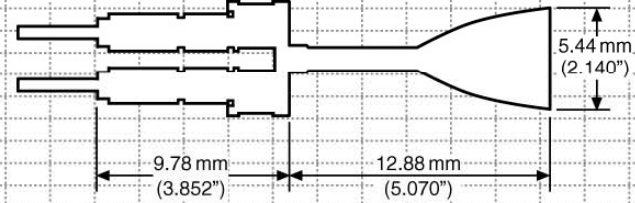
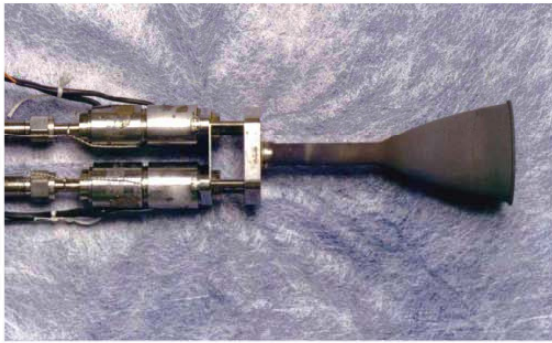
Status

- Flight Qualified

Reference:

- AIAA-1989-2734

MTT 5-lbf (22N) BIPROPELLANT ROCKET ENGINE



Design Characteristics

- Propellant MMH/NTO(MON-3)
- Thrust/Steady State 22 N (5 lbf)
- Inlet Feed Pressure Range
. 27.6 – 10.3 bar (400 – 150 psia)
- Chamber Pressure 6.7 bar @ 22 N (97 psia @ 5 lbf)
- Expansion Ratio 100:1
- Flow Rate 7.94 g/sec (0.0175 lbfm/sec)
- Valve Dual Seat Solenoid
- Valve Power 60 Watts @ 28 Vdc
- Weight 0.454 kg (1.0 lbfm)

Performance

- Specific Impulse 285 sec (lbf-sec/lbfm)
- Total Impulse >1,334,400 N-sec (300,000 lbf-sec)
- Total Pulses 300,000
- Minimum Impulse Bit 0.044 N-sec (0.01 lbf-sec)
- Steady State Firing Unlimited

Status

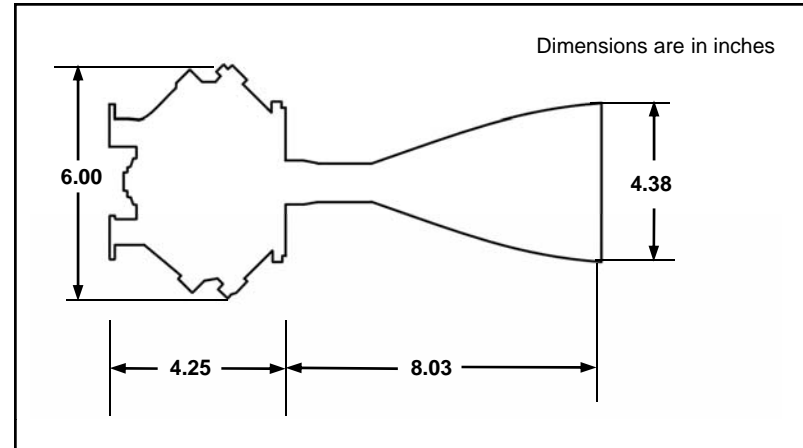
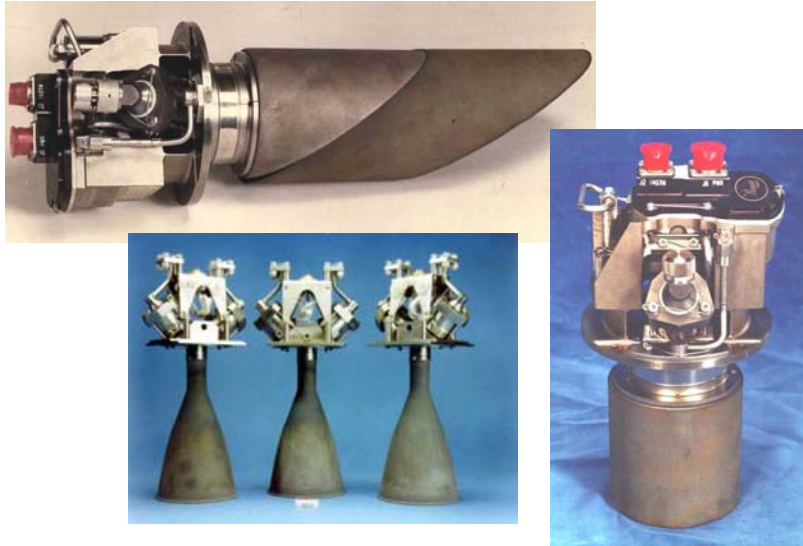
- In Development

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2006-018
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R-1E 110N (25 lbf) BIPROPELLANT ROCKET ENGINE



Design Characteristics

- Propellant MMH/NTO(MON-3)
- Thrust/Steady State 111 N (25 lbf)
- Inlet Pressure Range 27.6-6.9 bar (400-100 psia)
- Chamber Pressure* 7.3 bar (106 psia)
- Expansion Ratio 100:1
- Flowrate* 40.4 g/sec (0.089 lbm/sec)
- Valve Aerojet Solenoid, Single Coil, Single Seat
- Valve Power 36 Watts @ 28 Vdc
- Mass 2 kg (4.4 lbm)

* At rated thrust

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Performance

- Specific Impulse* 280 sec (lbf-sec/lbm)
- Total Impulse 11,120,000 N-sec (2,500,000 lbf-sec)
- Total Pulses 330,000
- Minimum Impulse Bit 0.89 N-sec (0.2 lbf-sec)
- Steady State Firing (sec) No Limitations

Status

- Flight Proven

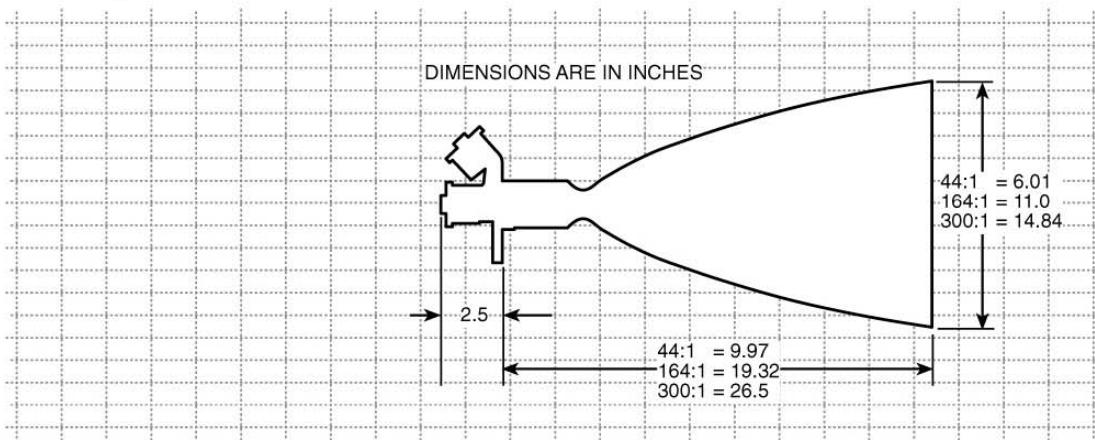
Reference

- AIAA - 1990 - 1837

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R-4D 490N (110-lbf) BIPROPELLANT ROCKET ENGINE



Design Characteristics

- Propellant MMH/NTO(MON-3)
- Thrust/Steady State 490N (110-lbf)
- Inlet Pressure Range 29.3–4.1Bar (425–60 psia)
- Chamber Pressure* 7.45 Bar (108 psia)
- Expansion Ratio 44:1, 164:1, 300:1
- Flow Rate* 158 g/sec (0.348 lbfm/sec) (300:1)
- Valve Aerojet Solenoid, Single Coil, Single Seat
- Valve Power Various (46 Watts @ 28 Vdc Typical)
- Mass 44:1, 3.40 kg (7.5 lbfm)
 164:1, 3.76 kg (8.3 lbfm)
 300:1, 4.31 kg (9.5 lbfm)
- Engine 44:1, 2.49 kg (5.5 lbfm)
 164:1, 2.86 kg (6.3 lbfm)
 300:1, 3.40 kg (7.5 lbfm)
- Valve 0.9 kg (2.0 lbfm)

*at Rated Thrust

Performance

- Specific Impulse* 44:1 = 300 sec (lbf-sec/lbfm)
 164:1 = 311 sec (lbf-sec/lbfm)
 300:1 = 315.5 sec (lbf-sec/lbfm)
- Total Impulse Demonstrated
 20,016,000 N-sec (4,500,000 lbf-sec)
- Total Pulses 20,781
- Minimum Impulse Bit 15.6 N-sec (3.5 lbf-sec)
- Demonstrated Steady State Firing 12,000 sec

Status

- Flight Proven

References

- AIAA - 2004 - 3694
- AIAA - 1980 - 1294
- AIAA - 1979 - 1331

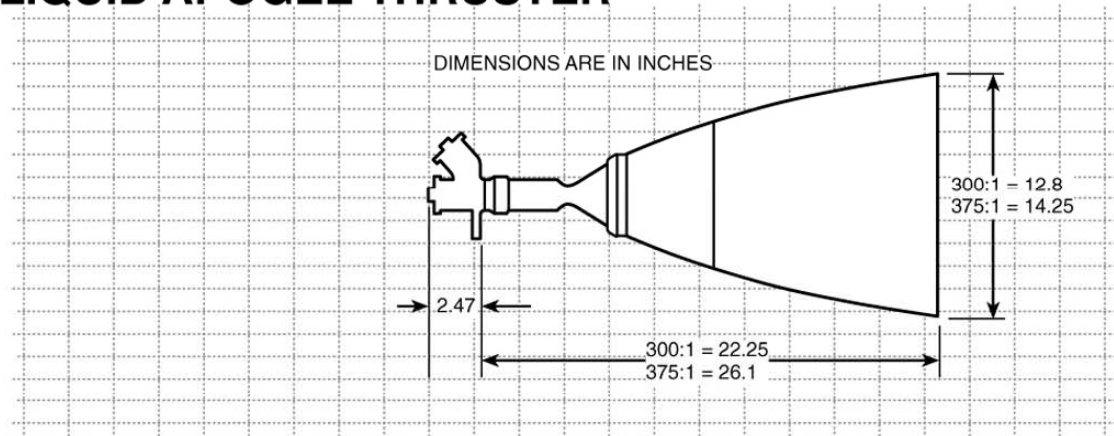
Rev. Date: 5/24/05

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HiPAT™ 445 N (100-lbf) HIGH PERFORMANCE LIQUID APOGEE THRUSTER



Design Characteristics

- Propellant MMH/NTO(MON-3)
- Thrust/Steady State 445 N (100-lbf)
- Inlet Pressure Range 27.6 – 6.9 bar (400 – 100 psia)
- Chamber Pressure* 9.4 bar (137 psia)
- Expansion Ratio 300:1, 375:1
- Flow Rate* 141 g/sec (0.31 lbfm/sec)
- Valve Aerojet Solenoid, Dual Coil, Single Seat
- Valve Power Various (46 Watts @ 28 Vdc Typical)
- Mass 300:1, 5.2 kg (11.5 lbfm)
 375:1, 5.44 kg (12 lbfm)

*At rated thrust

Performance

- Specific Impulse* 300:1 = 320 sec (lbf-sec/lbfm)
 375:1 = 323 sec (lbf-sec/lbfm)
- Total Impulse Demonstrated
 20,016,500 N-sec (4,635,000 lbf-sec)
- Total Pulses 500
- Minimum Impulse Bit 35.6 N-sec (8 lbf-sec)
- Demonstrated Steady State Firing 3600 sec

Status

- Flight Proven

References

- AIAA - 2001 - 3253
- AIAA - 2000 - 3161

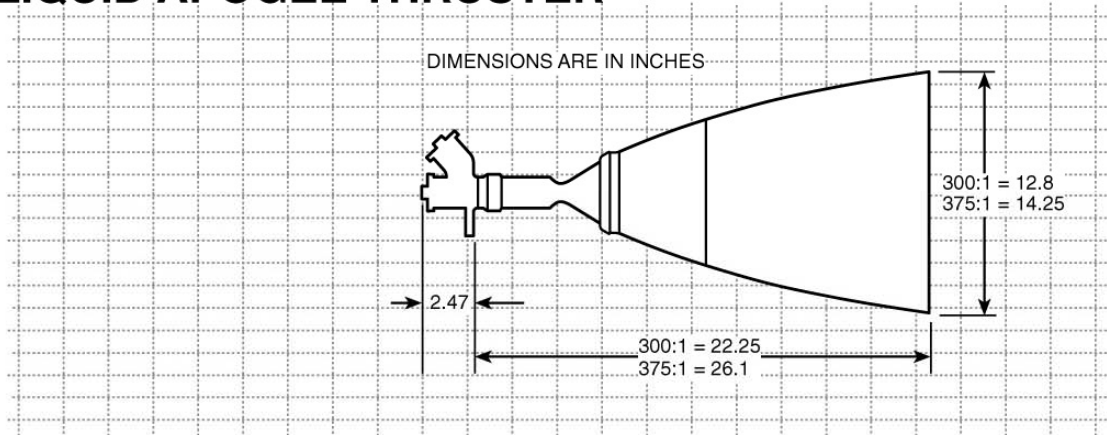
Rev. Date: 5/24/05

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HiPAT™ 445 N (100-lbf) DUAL MODE HIGH PERFORMANCE LIQUID APOGEE THRUSTER



Design Characteristics

- Propellant Hydrazine/NTO(MON-3)
- Thrust/Steady State 445 N (100-lbf)
- Inlet Pressure Range 21.4–15.2 bar (310–220 psia)
- Chamber Pressure* 9.4 bar (137 psia)
- Expansion Ratio 300:1, 375:1
- Oxidizer/Fuel Ratio 0.85
- Flow Rate* 141 g/sec (0.31 lbf/sec)
- Valve Aerojet Solenoid, Dual Coil, Single Seat
- Valve Power Various (46 Watts @ 28 Vdc Typical)
- Mass 300:1, 5.2 kg (11.5 lbf)
 375:1, 5.44 kg (12 lbf)

*At rated thrust

Performance

- Specific Impulse* 300:1 = 326 sec (lbf-sec/lbf)
 375:1 = 329 sec (lbf-sec/lbf)
- Total Impulse Demonstrated In Excess of 9.55×10^6 N-sec
 (2.15×10^6 N-sec)
- Total Pulses 672
- Total Thermal Cycles 345
- Minimum Impulse Bit 35.6 N-sec (8 lbf-sec)
- Demonstrated Steady State Firing 1800 sec

Status

- Qualified

Reference

- AIAA - 2003 - 4775

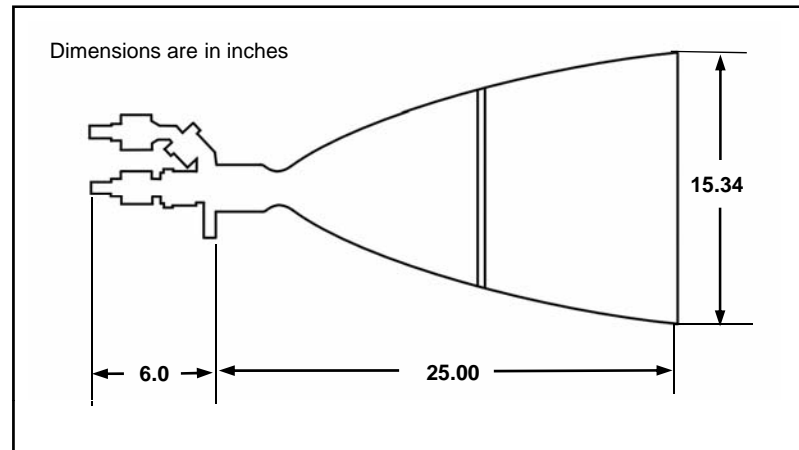
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R-42 890N (200 lbf) BIPROPELLANT ROCKET ENGINE



Design Characteristics

- Propellant MMH/NTO(MON-3)
- Thrust/Steady State..... 890 N (200 lbf)
- Inlet Pressure Range 29.3-6.9 bar (425-100 psia)
- Chamber Pressure*..... 7.1 bar (103 psia)
- Expansion Ratio 160:1
- Flowrate*..... 300 g/sec (0.66 lbf/sec)
- Valve Aerojet Solenoid, Single Coil, Single Seat
- Valve Power 46 Watts @ 28 Vdc
- Mass..... .4.53 kg (10.0 lbf)

**At rated thrust*

Performance

- Specific Impulse* 303 sec (lbf-sec/lbf)
- Total Impulse 24,271,000 N-sec (5,456,700 lbf-sec)
- Total Pulses 134
- Minimum Impulse Bit 44.48 N-sec (10.0 lbf-sec)
- Steady State Firing Cumulative 27,000 sec
- Steady State Firing (Single Firing) 3,940 sec

Reference

- AIAA - 1990 - 2055

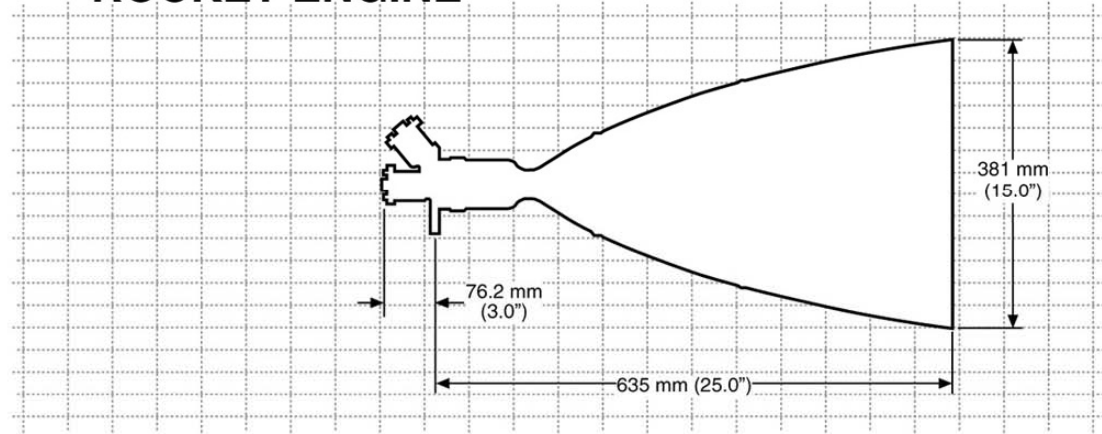
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AEROJET

R-42DM 890 N (200 lbf) DUAL MODE HIGH PERFORMANCE ROCKET ENGINE



Design Characteristics

- Propellant Hydrazine / NTO(MON-3)
- Thrust/Steady State 890 N (200 lbf)
- Inlet Pressure Range 25.5 – 13.8 bar (370 – 200 psia)
- Chamber Pressure* 9.6 bar (140 psia)
- Expansion Ratio 200:1
- Oxidizer / Fuel Ratio 0.8 – 1.2 (1.0 nominal)
- Flow Rate* 277 g/sec (0.61 lbf/sec)
- Valve Aerojet Single or Dual Seat
- Valve Power Various (45 Watts @ 28 Vdc Typical)
- Mass with single seat valves 7.3 kg (16 lbf)

*at rated thrust

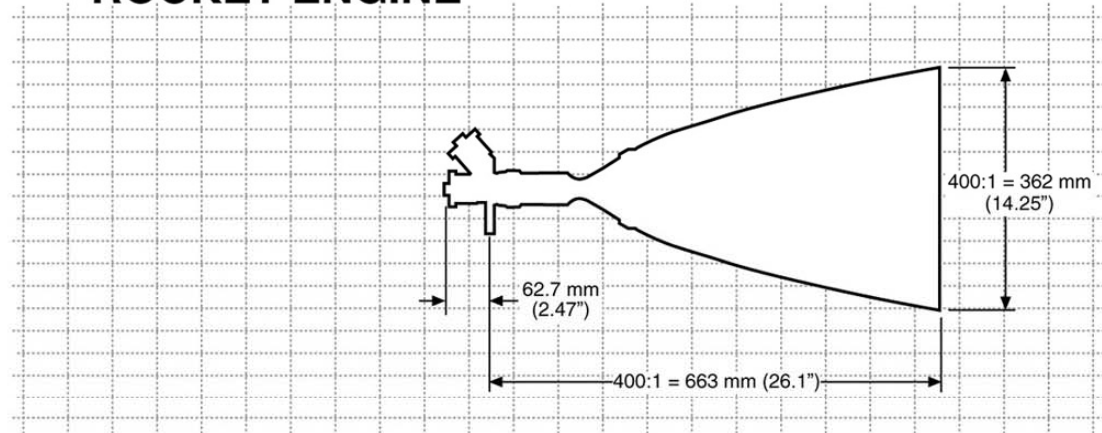
Performance

- Specific Impulse 327 sec (lbf-sec/lbf)
- Total Impulse $>20.0 \times 10^6$ N-sec (4.5×10^6 lbf-sec)
- Total Pulses >100
- Total Thermal Cycles >50
- Steady State Firing 1000 sec

Status

- FY2008 IR&D, TRL 6
- Ready for final flight design and analysis, and formal qualification (program specific)

AMBR 623 N (140 lbf) DUAL MODE HIGH PERFORMANCE ROCKET ENGINE



Design Characteristics

- Propellant Hydrazine / NTO(MON-3)
- Thrust/Steady State 623N (140 lbf)
- Inlet Pressure Range 22.4 – 12.1 bar (325 – 125 psia)
- Chamber Pressure* 13.8 bar (200 psia)
- Expansion Ratio 400:1
- Oxidizer / Fuel Ratio 1.0 – 1.3 (1.1 nominal)
- Flow Rate* 204 g/sec (0.45 lbfm/sec)
- Valve Aerojet Single or Dual Seat
- Valve Power Various (45 Watts @ 28 Vdc Typical)
- Mass with single seat valves 5.4 kg (12 lbfm)

*at rated thrust

Performance

- Specific Impulse 333 sec (lbf-sec/lbfm)
- Total Impulse 5,586,000 N-sec (1,255,800 lbf-sec)
- Total Pulses >100
- Total Thermal Cycles >50
- Steady State Firing 2700 sec

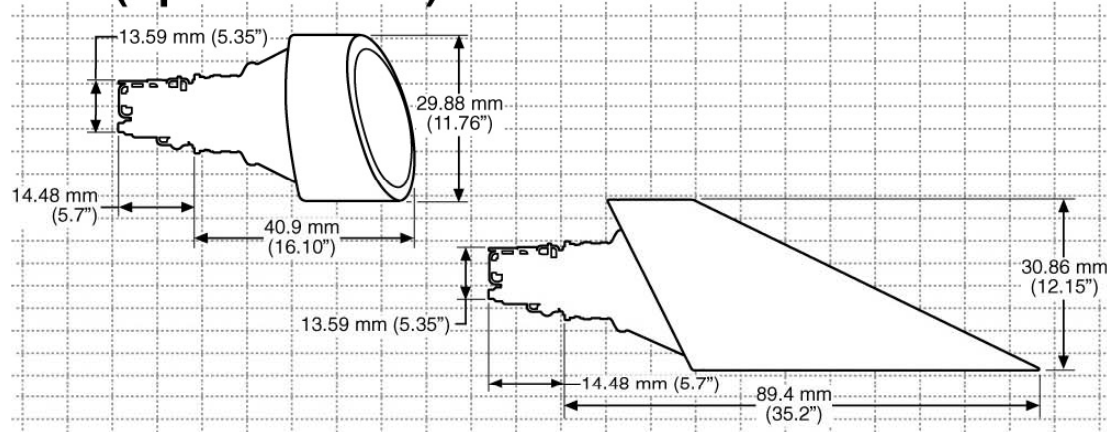
Status

- FY2008-9 NASA funded, TRL 6
- Ready for final flight design and analysis, and formal qualification (program specific)

Reference:

- AIAA-2009-5125

R-40 3,870N (870-lbf) BIPROPELLANT ROCKET ENGINE (Space Shuttle)



Design Characteristics

- Propellant MMH/NTO (MON-3)
- Thrust/Steady State 3870N (870 lbf)
- Inlet Pressure Range 27.6 – 10.3 bar (400 – 150 psia)
- Chamber Pressure* 9.9 bar (145 psia)
- Expansion Ratio** 22:1
- Flow Rate* 1.40 kg/sec (3.07 lbf-sec)
- Valve Aerojet
- Valve Power 70 Watts @ 28 Vdc
- Mass** 6.8 kg (15.0 lbf)

*At rated thrust

**Design, but varies by configuration

Performance

- Specific Impulse* 281 sec (lbf-sec/lbm)
- Total Impulse 92,073,600 N-sec (20,700,000 lbf-sec)
- Total Pulses 50,000
- Minimum Impulse Bit 111 N-sec (25.0 lbf-sec)
- Steady State Firing 23,000 sec

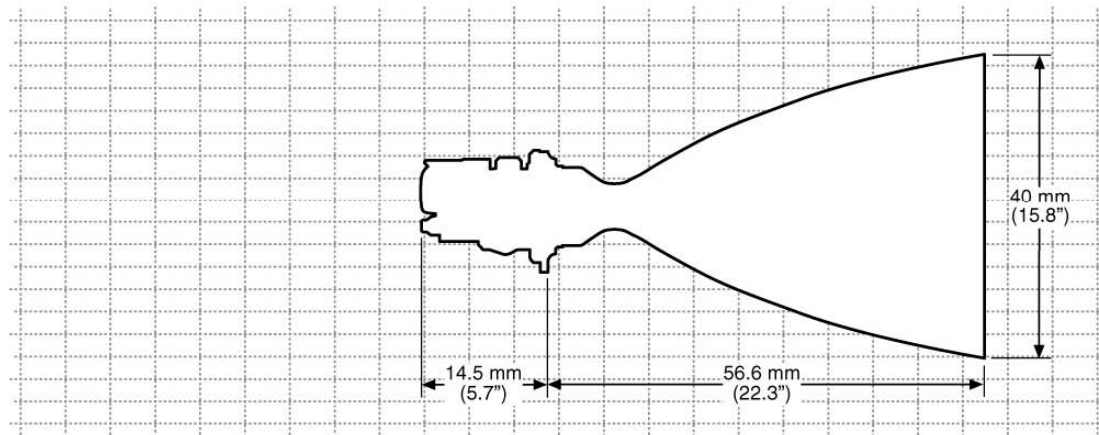
Status

- Flight Proven

Reference

- AIAA-1985-1222
- AIAA-1980-1131
- AIAA-1980-1130
- AIAA-1979-1144
- AIAA-1978-1006
- AIAA-1975-1300
- AIAA-1974-1109
- AIAA-1970-0618

R-40B 4,000N (900-lbf) BIPROPELLANT ROCKET ENGINE



Design Characteristics

- Propellant MMH/NTO (MON-3)
- Thrust/Steady State 4,000 N (900 lbf)
- Inlet Pressure Range 27.6 – 10.3 bar (400 – 150 psia)
- Chamber Pressure* 10.34 bar (150 psia)
- Expansion Ratio 60:1
- Flow Rate* 1.40 kg/sec (3.07 lbfm-sec)
- Valve Aerojet
- Valve Power 70 Watts @ 28 Vdc
- Mass 6.8 kg (15.0 lbfm)

**At rated thrust*

Performance

- Specific Impulse* 293 sec (lbf-sec/lbfm)
- Total Impulse 92,073,600 N-sec (20,700,000 lbf-sec)
- Total Pulses 50,000
- Minimum Impulse Bit 111 N-sec (25.0 lbf-sec)
- Steady State Firing 23,000 sec

Reference

- IAF-1987-0283

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Electric Propulsion

AEROJET

BPT-2000

Dual Mode BPT-4000

MR-501B

MR-502A

**MR-502 &
MR-502A PCU**

MR-510

MR-509

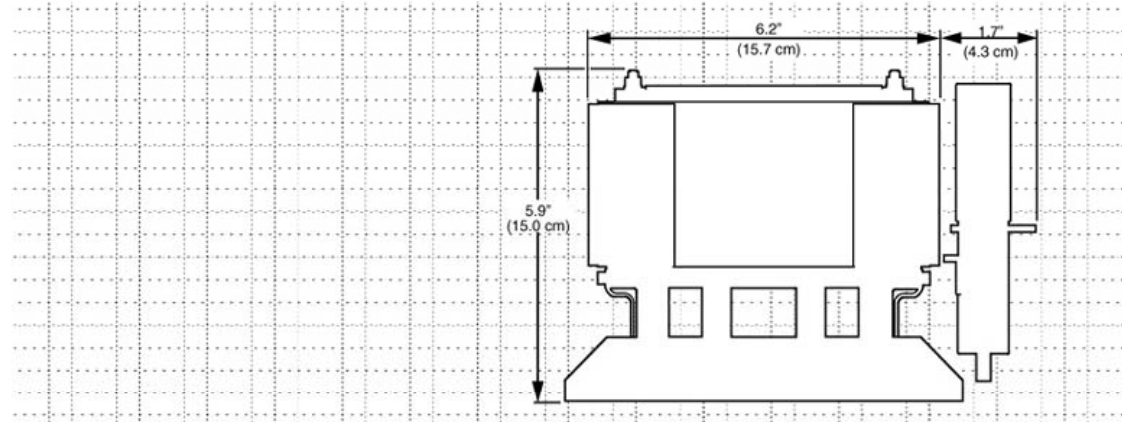
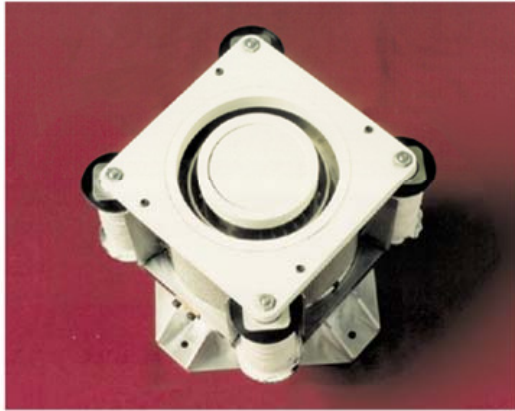
MR-512

PRS-101

**Gridded Ion
Engines**

**6.9 kW Ion
Propulsion
System**

BPT-2000 Hall Effect Thruster



Design Characteristics

- Propellant Xenon
- Mass (Thruster & Cathode) <5.2 kg
- Envelope Dimensions 15 x 17 x 22 cm
- Nominal Input Power 2200 Watt
- Operational Power Range 1200 – 2700 Watt
- Nominal Voltage 350 Volt
- Operational Voltage Range 250 – 400 Volt

Status

- Flight Prototype Unit Fabricated and Tested

Performance at 2.2 kW

- Thrust 123 mN
- Specific Impulse* 1765 sec
- Efficiency* 48%
- Life (Continuous)** >6000 hr
- Total Impulse >2.6 x 10⁶ N-sec
- Nominal Flowrate 7.1 mg/sec
- On/Off Cycles 6000 cycles

* Corrected for facility pressure effects

** Based on accel life tests and analysis

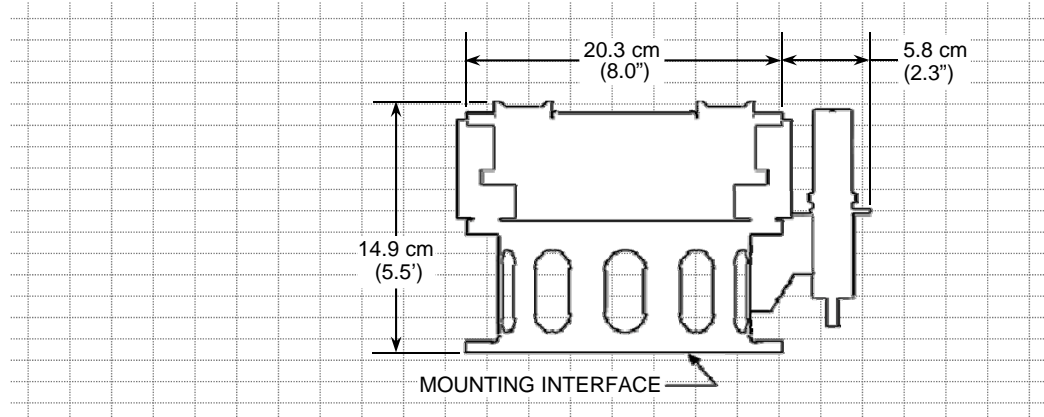
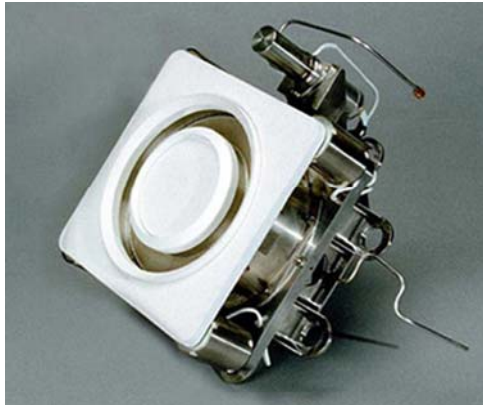
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DUAL MODE BPT-4000 HALL THRUSTER



Design Characteristics

- Propellant Xenon
- Mass (Thruster & Cathode) <12.3 kg
- Envelope 14 x 25 x 28 cm
- Input Power 1000 to 4500 Watt
- Input Voltage 200 or 400 Volt

Status (as of Feb. 2006)

- Qualification Complete
- >6,700 hours Demonstrated, Additional Life Testing Planned
- >6,300 Cycles Demonstrated, Additional Life Testing Planned

Performance

	2.0 kW	3.0 kW	4.5 kW
■ Thrust (300 Volts)	132 mN	195 mN	290 mN
■ Thrust(400 Volts)	117 mN	170 mN	254 mN
■ Specific Impulse (300 V)	1676 sec	1700 sec	1790 sec
■ Specific Impulse (400 V)	1858 sec	1920 sec	2020 sec
■ Life Capability	>10,000 hr		
■ Total Impulse	>5.5 x 10 ⁶ N-sec		
■ On/Off Cycles	6,700 Cycles		

Reference

- AIAA-2005-3682

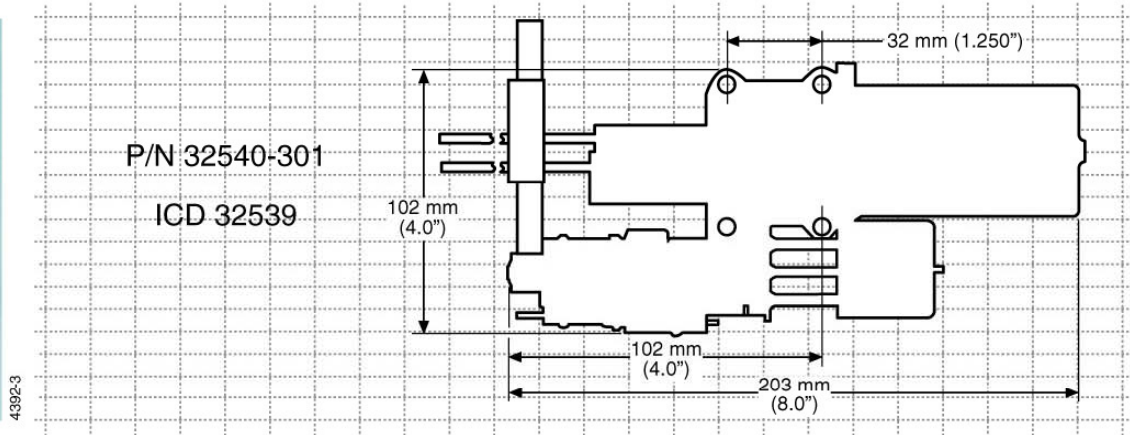
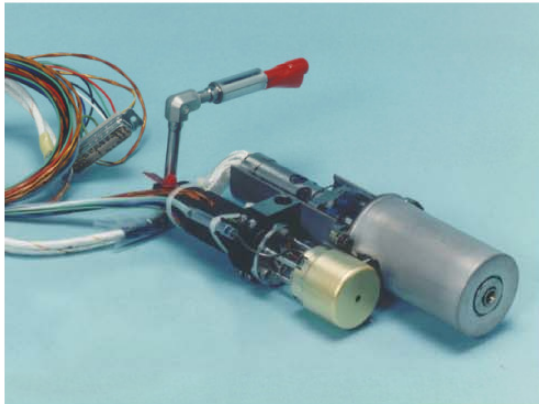
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MR-501B ELECTROTHERMAL HYDRAZINE THRUSTER (EHT)



Design Characteristics

- PropellantHydrazine
- Catalyst S405
- Thrust/Steady State 0.369–0.182 N (0.083–0.041 lbf)
- Feed Pressure 24.1 – 6.9 bar (350 – 100 psia)
- Flow Rate
 0.1225–0.045 g/sec (0.00027–0.0001 lbm/sec)
- ValveDual Seat
- Valve Power 8.25 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power 8.00 Watts Max @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr4.00 Watts Max @ 28 Vdc & 21°C
- Augmentation Heater Pwr 493 – 467 Watts
- Augmentation Heater Voltage 24.4 Vdc
- Mass 0.889 kg (1.96 lbm)

Performance

- Mission Specific Impulse at 24.4 Vdc*
 303–294 sec (lbf-sec/lbm)
- Total Impulse 326,928 N-sec (73,500 lbf-sec)
- Demonstrated Total Off-Pulses** 500,000
- Minimum Off-Pulse Bit at Max Feed Pressure
 0.0022 N-sec (0.0005 lbf-sec)
- Steady State Firing 1.7 hrs – Single Firing
 389 hrs – Cumulative

Status

- Flight Proven

Reference

- AIAA-1983-1255

* Performance dependent on feed pressure blowdown

** Designed primarily for steady state operation but has demonstrated off-pulse capability

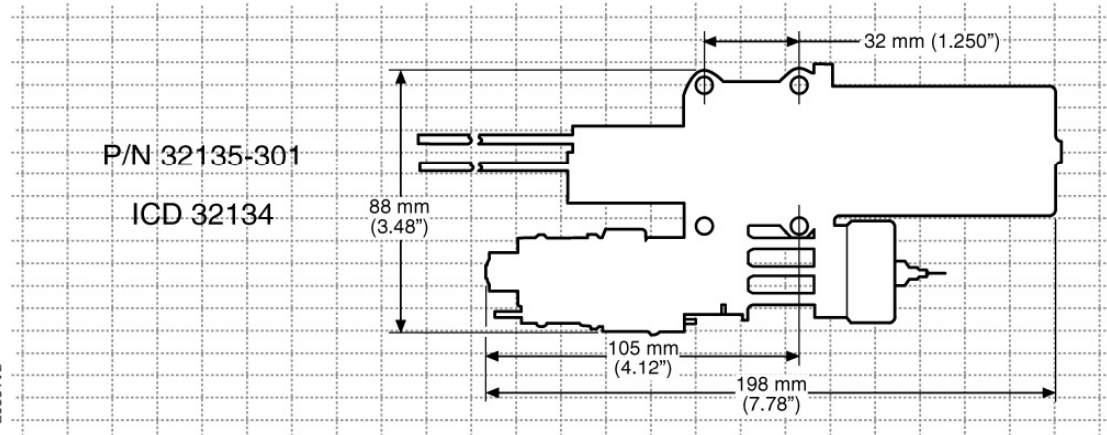
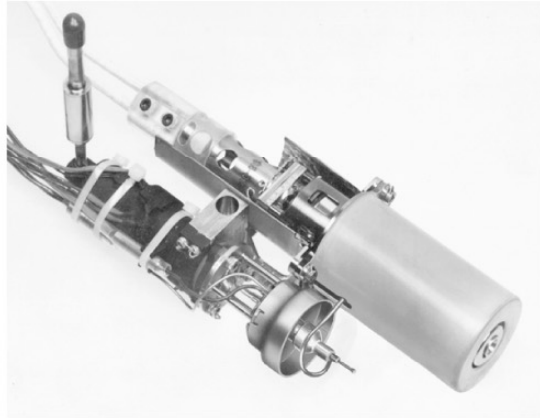
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MR-502A IMPROVED ELECTROTHERMAL HYDRAZINE THRUSTER (IMPEHT)



Design Characteristics

- Propellant Hydrazine
- Catalyst S405
- Thrust/Steady State 0.80 – 0.36 N (0.18 – 0.08 lbf)
- Feed Pressure 26.5 – 6.2 bar (385 – 90 psia)
- Flow Rate 0.28 – 0.12 g/sec (0.0061 – 0.00026 lbm/sec)
- Valve Dual Seat
- Valve Power 8.25 Watts Max @ 28 Vdc & 21°C
- Valve Heater Power 1.54 Watts Max @ 28 Vdc & 21°C
- Cat. Bed Heater Pwr 3.93 Watts Max @ 28 Vdc & 21°C
- Augmentation Heater Pwr 885 – 610 Watts
- Augmentation Htr Voltage 29.5 – 24.5 Vdc Letdown
- Mass 0.87 kg (1.92 lbm)

Performance

- Mission Specific Impulse*
 - Steady-State Blowdown 303 – 294 sec (lbf-sec/lbm)
- Total Impulse 524,864 N-sec (118,000 lbf-sec)
- Total Pulses MR-502A not designed for pulsing
- Steady State Firing 2.0 hrs – Single Firing
 - 370 hrs – Cumulative

Status

- Flight Proven

Reference

- AIAA-1987-0996

*Performance dependent on feed pressure blowdown

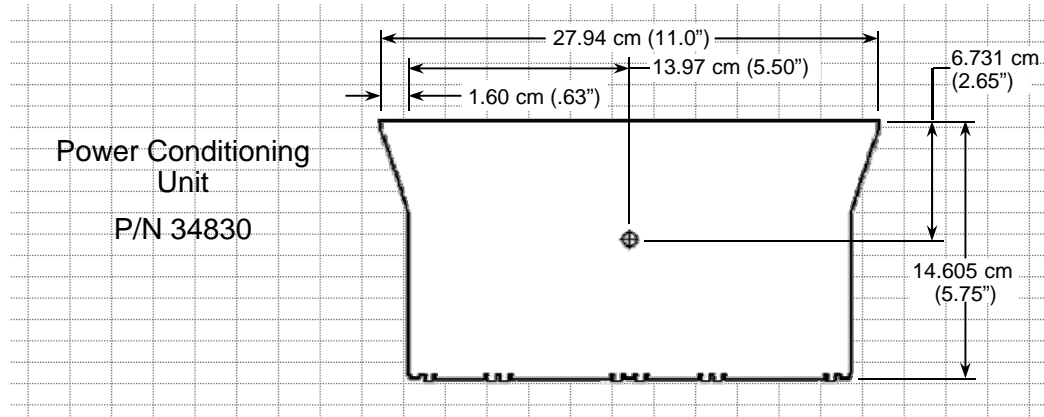
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MR-502 & MR-502A IMPEHT POWER CONDITIONING UNIT



Design Characteristics

- Mass 2 kg
- Envelope 27.94 x 9.42 x 14.61 cm
- Input Voltage 15-29.9 vdc
- Inrush Current 32 Amp Max
- Efficiency >97%

Interface

- Enable/Disable Command Latch Relay Drive
- On/Off Command 0V – Off, 14V – On

Demonstrated Performance

- Limits inrush current to the 30 Amps during augmentation heater warm-up
- Two identical independent channels that can be operated either redundantly or simultaneously
- When used simultaneously, the IMPEHT pair should be started one after the other

Status

- Flight Proven

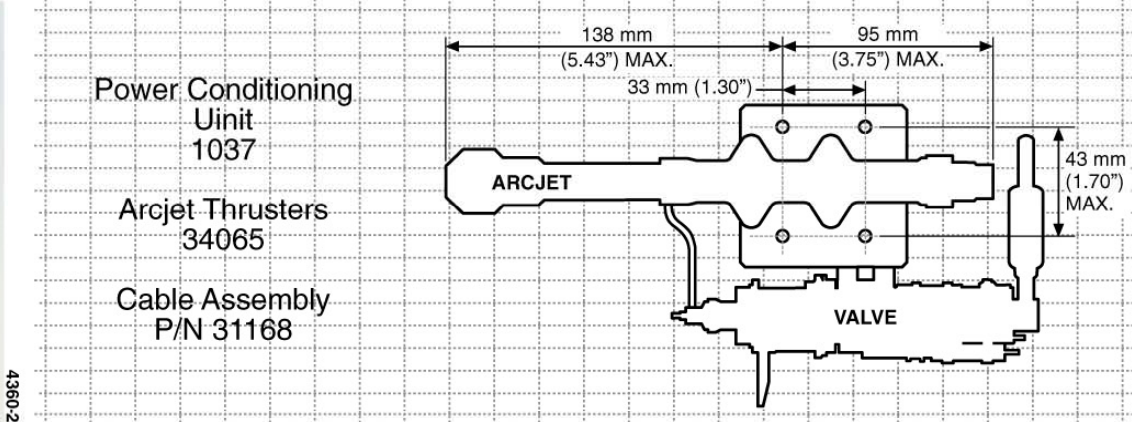
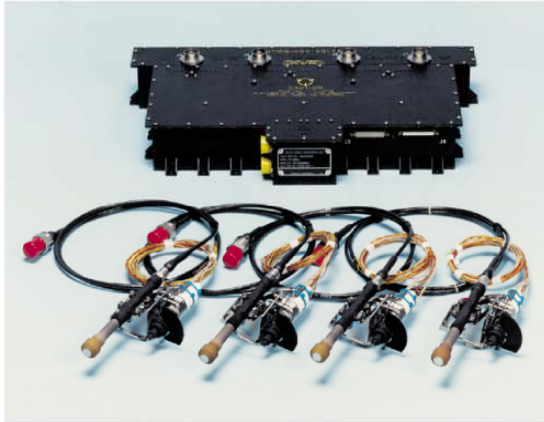
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MR-510 ARCJET THRUSTER & CABLE ASSEMBLY



Design Characteristics

- Propellant Hydrazine
- Feed Pressure (Nominal) 18.6–13.8 bar (270–200 psia)
- Thrust/Steady State 258–222 mN (58-50 mlf)
- Mass
 - Arcjet Thruster
 - +3175 mm/125" cable 1.58 kg (3.49 lbf)
- Envelopes
 - Arcjet 237 x 125 x 91 mm (9.3 x 4.9 x 3.6 in.)
- Valve Dual Seat
- Valve Power 8.2 Watts Max @ 28 Vdc & 21°C
- Power Cable - PCU Arcjet <4650 mm/183"

– For Power Conditioning Unit Information, see separate Data Sheet

Demonstrated Performance

at 2000 Watts input power to the arcjet

- Thrust 258 – 222 mN (58 – 50 mlf)
- Specific Impulse >585 – 615 sec
- Total Impulse 1,450,000 N-sec. (326,000 lbf-sec)
- Firing Time
 - Total (1 hr On, 1/2 hr Off) >1730 Cycles
 - Longest Single Burn During Qualifications 20 hrs
- Starts >1960
- Telemetry Signals Available
 - Gas Generator Temperature
 - Valve Temperature
 - Arc Voltage and Current through Power Conditioning Unit Telemetry

Status

- Flight Proven

Reference

- AIAA-2001-3901
- AIAA-1999-2272
- IEPC-1997-082

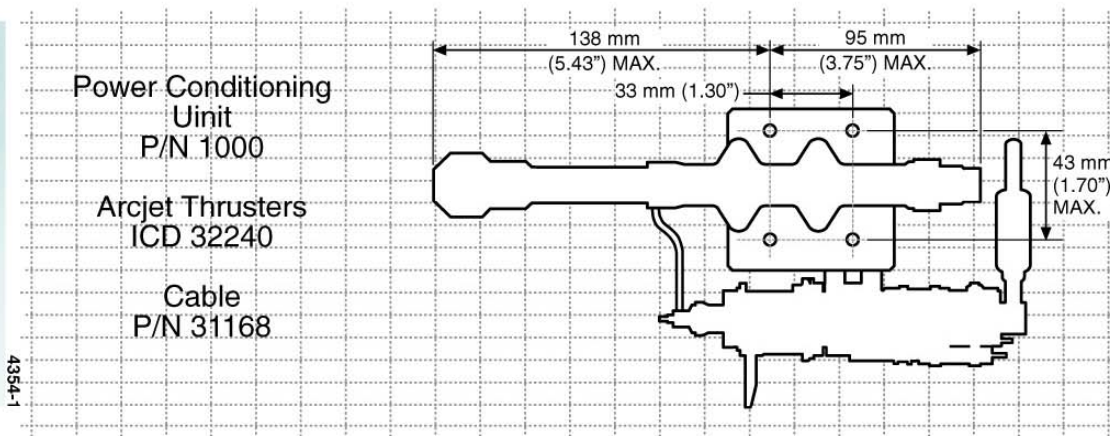
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MR-509 LOW POWER ARCJET SYSTEM



Power Conditioning Unit
P/N 1000

Arcjet Thrusters
ICD 32240

Cable
P/N 31168

4354-1

Design Characteristics

- Propellant Hydrazine
- Feed Pressure (Nominal) 17.6–14.1 bar (255–205 psia)
- Thrust/Steady State 254–213 mN (57-47 mlbf)
- Mass
 - Arcjet Thruster
 - +2000 mm/79" cable 1.38 kg (3.04 lbm)
 - Power Conditioning Unit (PCU) 4.13 kg (9.1 lbm)
- Envelopes
 - Arcjet 237 x 125 x 91 mm (9.3 x 4.9 x 3.6 in.)
 - PCU 236 x 185 x 83 mm (9.3 x 7.3 x 3.3 in.)
- Valve Dual Seat
- Valve Power 8.25 Watts Max @ 28 Vdc & 21°C
- PCU Input Power (per Arcjet) 1800 Watts
- Input Voltage 65–96 Vdc
- PCU Efficiency, Avg >91%
- Power Cable - PCU Arcjet <2000 mm/79"

Demonstrated Performance

at 1670 Watts input power to the arcjet

- Thrust 254–213 mN (57–47 mlbf)
- Specific Impulse (Blowdown Mission Avg.) >502 sec
- Total Impulse 866,500 N-sec. (194,500 lbf-sec)
- Demonstrated Firing Time
 - Total (1 hr On, 1/2 hr Off) >1050 Cycles
 - Longest Single Burn During Qualifications 65 hrs
- Starts >1170
- Telemetry Signals Available
 - Arcjet Current
 - Arcjet Voltage
 - PCU Status Flags
 - Gas Generator Temperature
 - Valve Temperature
 - PCU Temperature

Status

- Flight Proven

Reference

- IEPC-1997-081

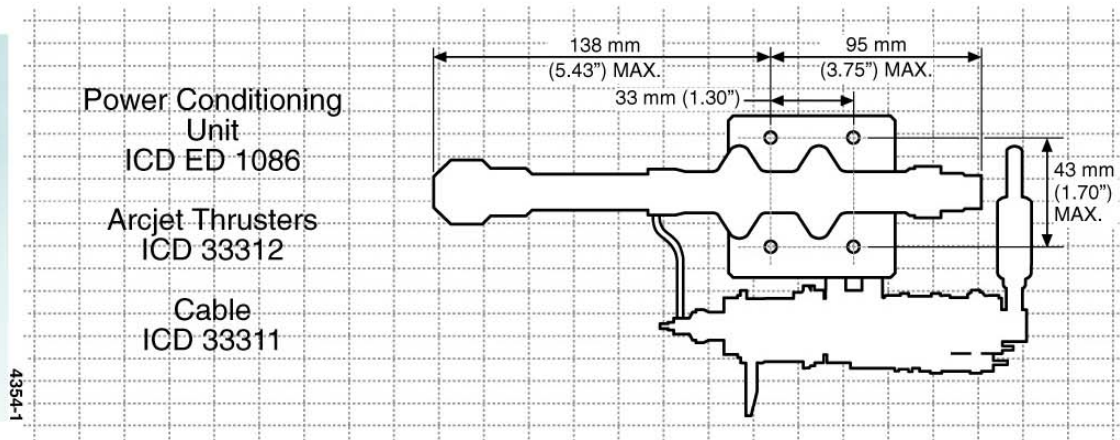
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MR-512 LOW POWER BUS ARCJET SYSTEM



Design Characteristics

- Propellant Hydrazine
- Feed Pressure (Nominal) 17.6–13.8 bar (255–200 psia)
- Thrust/Steady State 254–213 mN (57-47 mlbf)
- Mass
 - Arcjet Thruster
 - +2000 mm/79" cable 1.38 kg (3.04 lbm)
 - Power Processing Unit (PPU) 6.2 kg (13.7 lbm)
- Envelopes
 - Arcjet 237 x 125 x 91 mm (9.3 x 4.9 x 3.6 in.)
 - PPU 310 x 220 x 95 mm (12.2 x 8.7 x 3.7 in.)
- Valve Dual Seat
- Valve Power 8.25 Watts Max @ 28 Vdc & 20°C
- PCU Input Power (per Arcjet) 1780 Watts
- Input Voltage 33–51.5 Vdc
- PPU Efficiency, Avg >91%
- Power Cable - PCU Arcjet <2000 mm/79"

Demonstrated Performance

at 1670 Watts input power to the arcjet

- Thrust 254 – 213 mN (57 - 47 mlbf)
- Specific Impulse (Blowdown Mission Avg.) >502 sec
- Total Impulse 866,500 N-sec (194,500 lbf-sec)
- Firing Time
 - Total (1 hr On, 1/2 hr Off) >1050 Cycles
 - Single Burn 65 hrs
- Starts >1170
- Telemetry Signals Available
 - Arcjet Current
 - Arcjet Voltage
 - PCU Status Flags
 - Gas Generator Temperature
 - Valve Temperature
 - PCU Temperature

Status

- Flight Proven

Reference

- AIAA-1998-3631

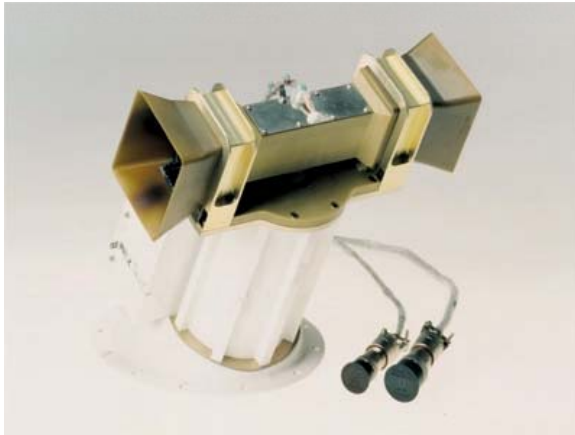
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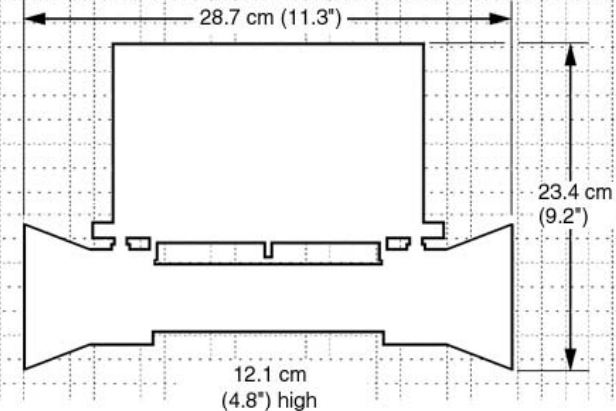
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PRS-101 Pulsed Plasma Thruster System



P/N 1071-1
EO-1 Configuration



Design Characteristics

- Propellant Teflon® (Solid Bar)
- Max Thrust Level1 1.24 mN @ 100 Watts
- Power Level
. Up to 100 Watts @ 28 vdc Unregulated
- Compact Solid State Propulsion System
- Ultra Low Minimum Impulse Bit for Precision Control
- Enables All-thruster ACS (No Momentum Wheels)
- Mass (w/o propellant) 4.74 kg
- Includes Integral Power Processing Electronics
- Power Efficiency >80%

Performance

- Specific Impulse Up to 1350 sec
- Thrust to Power Ratio 12.4 μ N/Watt
- Demonstrated Capability. 3,000 N-sec/thruster
- Predicted Capability (backed by selective testing)
. 15,600 N-sec/system (thruster pair)

Status

- Flight Proven

Reference

- AIAA-2003-5016 ■ AIAA-2001-3637
- AIAA-2002-3973 ■ AIAA-1999-3376

Rev. Date: 4/14/06

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Gridded Ion Engine Technology

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NEXT 6.9 kWe Ion Thruster and Propellant Management System (with NASA GRC)

NEXIS 20 kWe Ion Thruster (with JPL)

HiPEP 25 kWe Ion Thruster (with NASA GRC)

Low Power Ion Thruster 0.5 kWe Ion Propulsion System (with NASA GRC)

NSTAR-class 2.5 kWe Ion Thruster

Power Processing

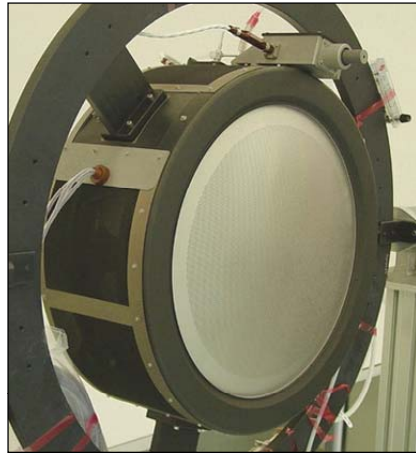
Digital Controllers

Xenon Propellant Management Systems



NEXT 6.9 kW Ion Propulsion System

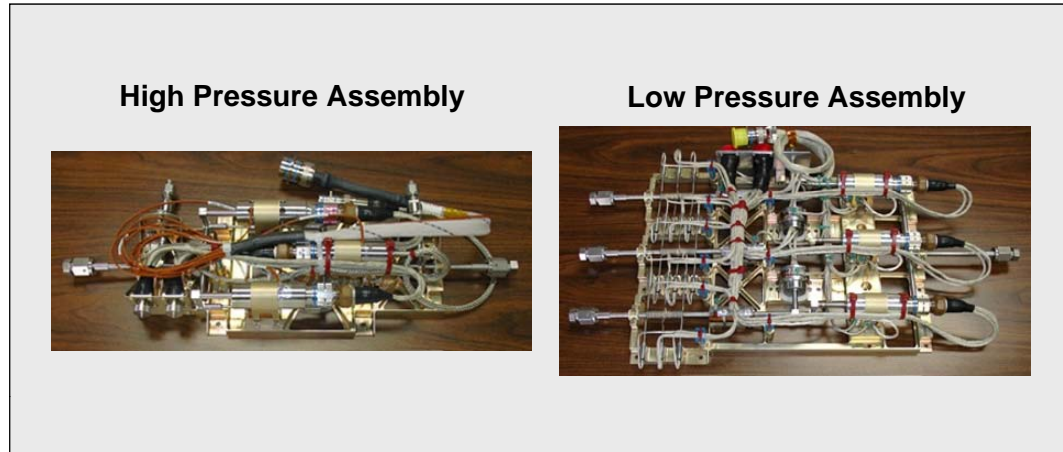
Thruster, Propellant Management System, Digital Control Interface Unit



Thruster Assembly

Design Characteristics

- Propellant Xenon
- Thruster Mass..... <13.3 kg
- Thruster Envelope Dimensions 58 dia. x 44 cm
Active optics area..... 36 cm dia.
- Thruster Input Power 600 to 6900 Watt
- Propellant Management System Mass
High Pressure Assembly < 2.2 kg
Low Pressure Assembly.....< 4.1 kg
- PMS Volume< 11,775 c.c.
PMS does not require plenum tanks
- DCIU interface with Power Processing.....RS-485



Propellant Management System

Performance

- Thrust 235 mN
- Specific Impulse..... >4100 sec
- Efficiency @ full power >70%
- Propellant Throughput..... >270 kg
- On/Off Cycles>3650 cycles
- End of Life Xenon Residuals < 1% BOL

Status

- Thruster at Prototype Model Design
- Propellant Mgmt System at Engineering Model Design
- Digital Control Interface at laboratory design level

Reference

- AIAA-2005-3885
- AIAA-2004-4111

Rev. Date: 6/14/06

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(425) 885-5000 FAX (425) 882-5747

Approved for public release and export

AEROJET

Space Electronics

AEROJET

Heritage Chart

MR-510 PCU

4.5 kWatt Hall Thruster PCU

Space Electronics Heritage

AEROJET

**TELSTAR 4 / SERIES 7000
1.8 kW POWER CONDITIONER**



• QUALIFIED 1992

**A2100
4.4 kW POWER CONDITIONER**



• QUALIFIED 1996

**DRTS
1.8 kW POWER CONDITIONER**



• QUALIFIED 1998

**ATTD
30 kW POWER CONDITIONER**



• QUALIFIED 1993

A2100 POWER RELAY BOX



• QUALIFIED 1997

**NRL EPDM
1.5 kW POWER CONDITIONER**



• QUALIFIED 1997

**EHT/IMPEHT
CONTROLLER**



**EO-1
HIGH VOLTAGE
POWER CONDITIONER**

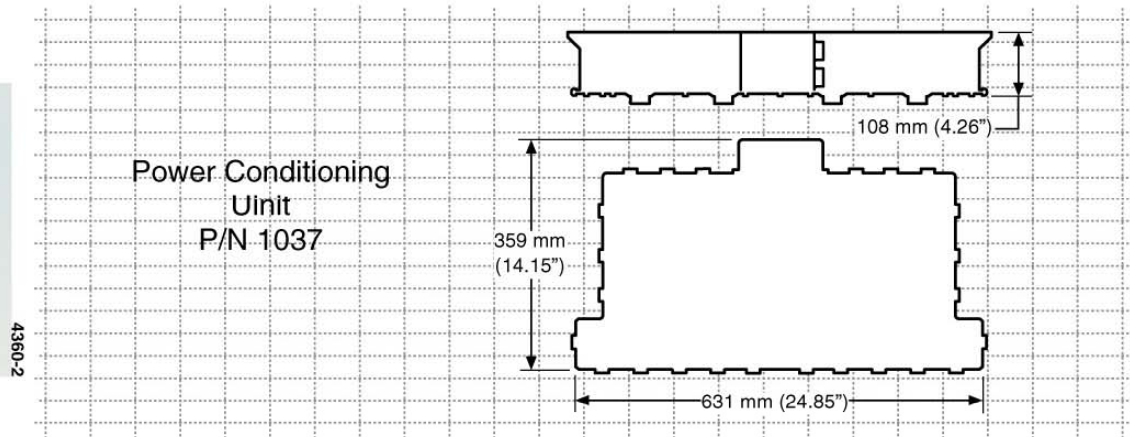


**HALL THRUSTER
PROPULSION SYSTEM
4.5 kW POWER PROCESSING UNIT**



• IN QUALIFICATION

MR-510 ARCJET POWER CONDITIONING UNIT (PCU)



Design Characteristics

- PCU – has three internal power converters, any two of which can operate simultaneously.
- Output can be switched between four different Arcjets
- Includes “Bubble Protection Mode” to mitigate gas induced shutdowns
- Mass 15.8 kg (34.8 lbm)
- Envelope 632 x 361 x 109 mm (24.9 x 14.2 x 4.3 in.)
- Input Voltage 69 ± 1 Vdc
- Efficiency, Avg $>90.7\%$
- Heat Rejection (two Arcjets operating @ 2000 Watts)
. <410 Watts @ 23°C
- Output per Channel (up to two Channels)
. 1500, 1670, 1830 or 2000 Watts
- Input Power, when operating two Arcjets @ 2000 Watts
. 4340 Watts

Demonstrated Performance

- Telemetry Signals Available
 - Arcjet Current
 - Arcjet Voltage
 - PCU Status Flags
 - PCU Temperature

Status

- Flight Proven

Reference

- AIAA-1998-3630

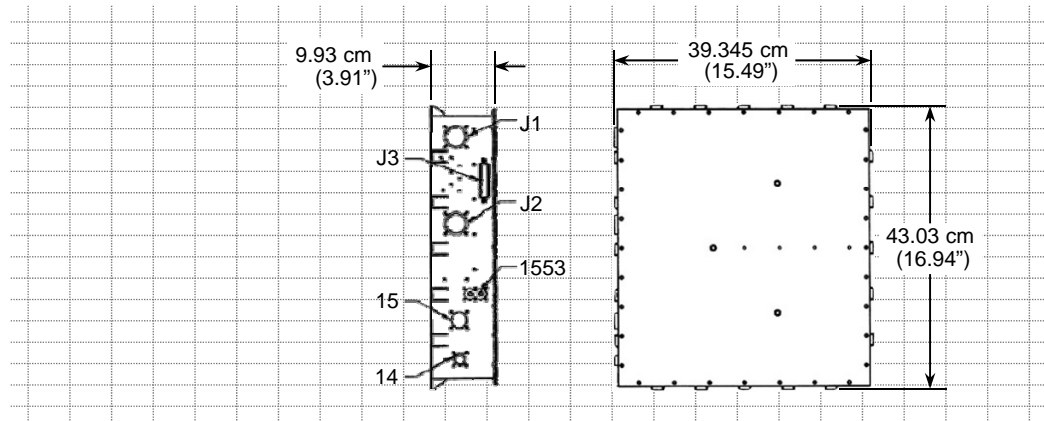
Rev. Date: 5/03/06

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AEROJET

4.5 kW HALL THRUSTER POWER PROCESSOR UNIT



Design Characteristics

- Mass 12.5 kg
- Envelope 43 x 40 x 11 cm
- Input Voltage 70 +/- 2 VDC
- Efficiency (Avg) >92%
- MIL-STD-1553 Command & Telemetry Interface:
 - 30 Telemetry Channels
- Commandable Power Settings:
 - Discharge Power 2.0 - 4.5 kW
 - Discharge Voltage 150 - 400 V

Demonstrated Performance

- Closed Loop Control of Xenon Flow Controller and Discharge Current
- Holding Valve Drivers
- S-Level, Radiation Hardened Components
- Optimized for Manufacturability
 - Only Four Circuit Cards

Status

- Qualified

Reference

- AIAA-2005-3682

Rev. Date: 5/23/06

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Propulsion Systems

AEROJET

Geosynchronous Satellites

- B-Sat 2
- INDOSTAR (Cakrawarta-1)

MEO Satellites

- GPS IIF

LEO Satellites

- EO-1
- IKONOS
- MSTI

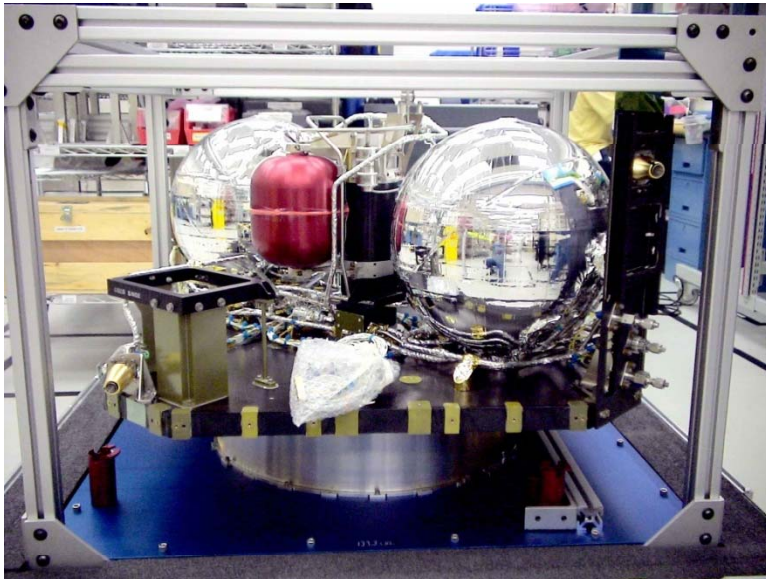
Interplanetary and Scientific Satellites

- CONTOUR
- Coriolis
- ACE
- STEREO
- Pluto/New Horizons
- THEMIS

Launch Vehicles

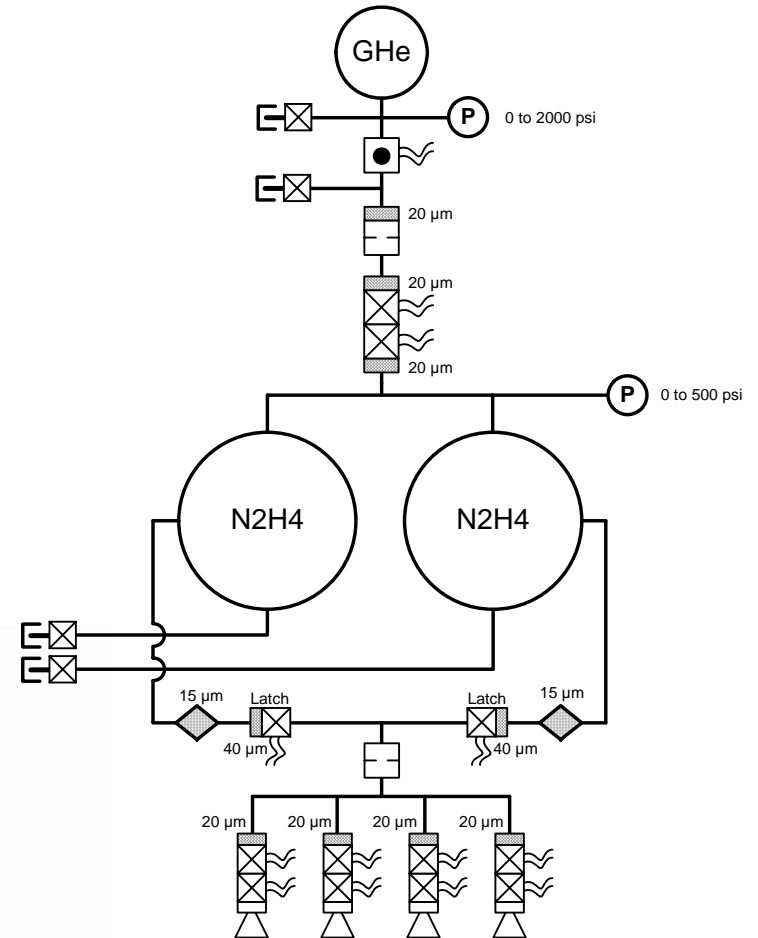
- Athena
- Pegasus HAPS
- Atlas Roll Control Module

THEMIS (Time History of Events and Macroscale Interactions During Substorms)



- NASA MIDEX Mission, Scheduled for Launch in October of 2006
- Number of Systems: 5
- Propellant Load: 109 lbm (49.5 kg) Hydrazine
- 400-50 psia (27.6-3.5 bar) Blowdown Operation with Single Repressurization Event from 1700 psia (117 Bar) Pressurant Subsystem
- 4 MR-111C 1-lbf (4.5 N) Thrusters
- Used for Delta-V and Orbit Maintenance
- Aerojet Designed and Integrated System on Customer-Supplied Structure

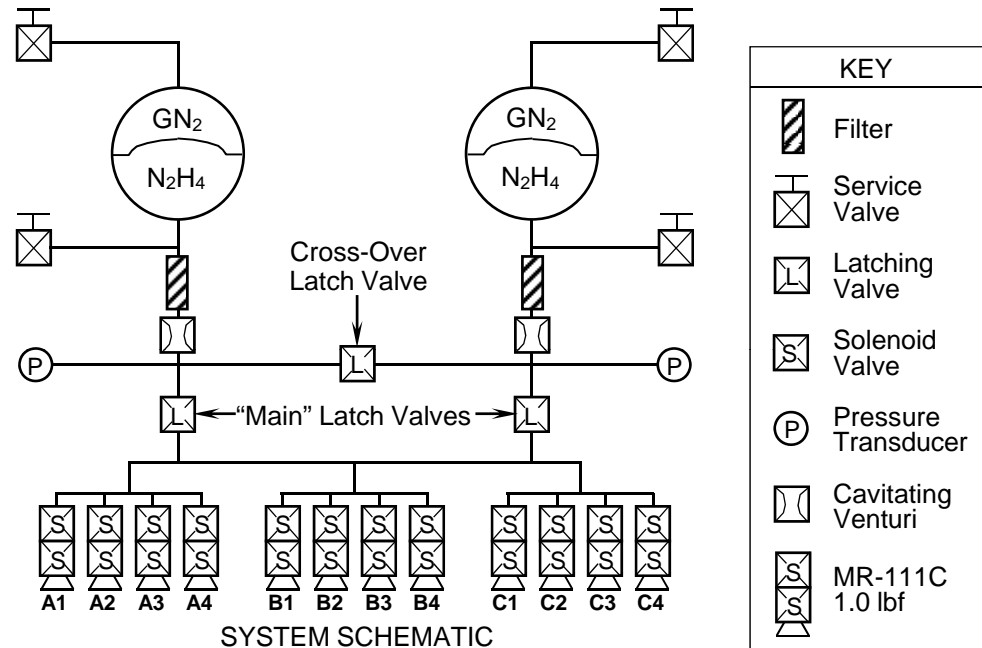
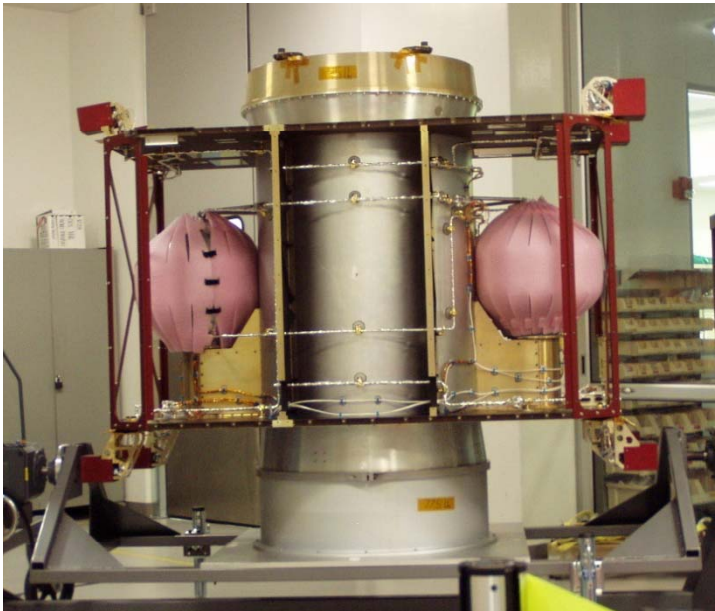
Reference: AIAA-2006-5217



System Schematic

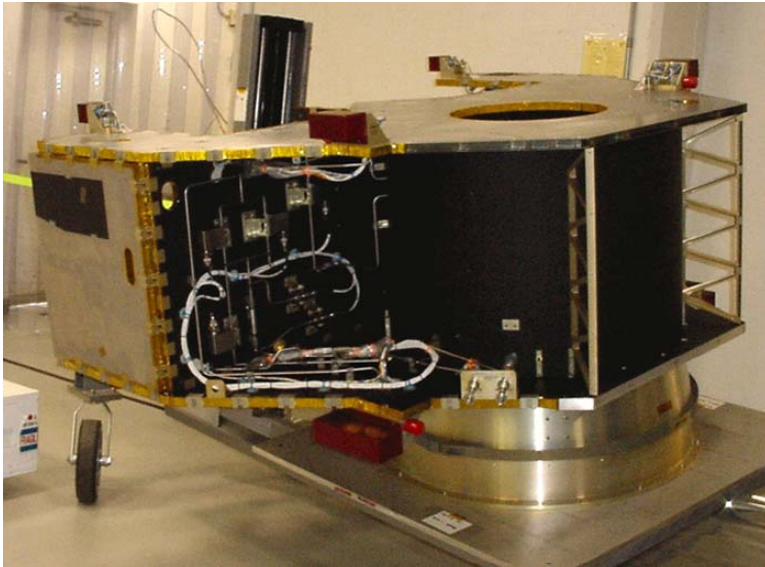
Solar-Terrestrial Relations Observatory (STEREO)

AEROJET



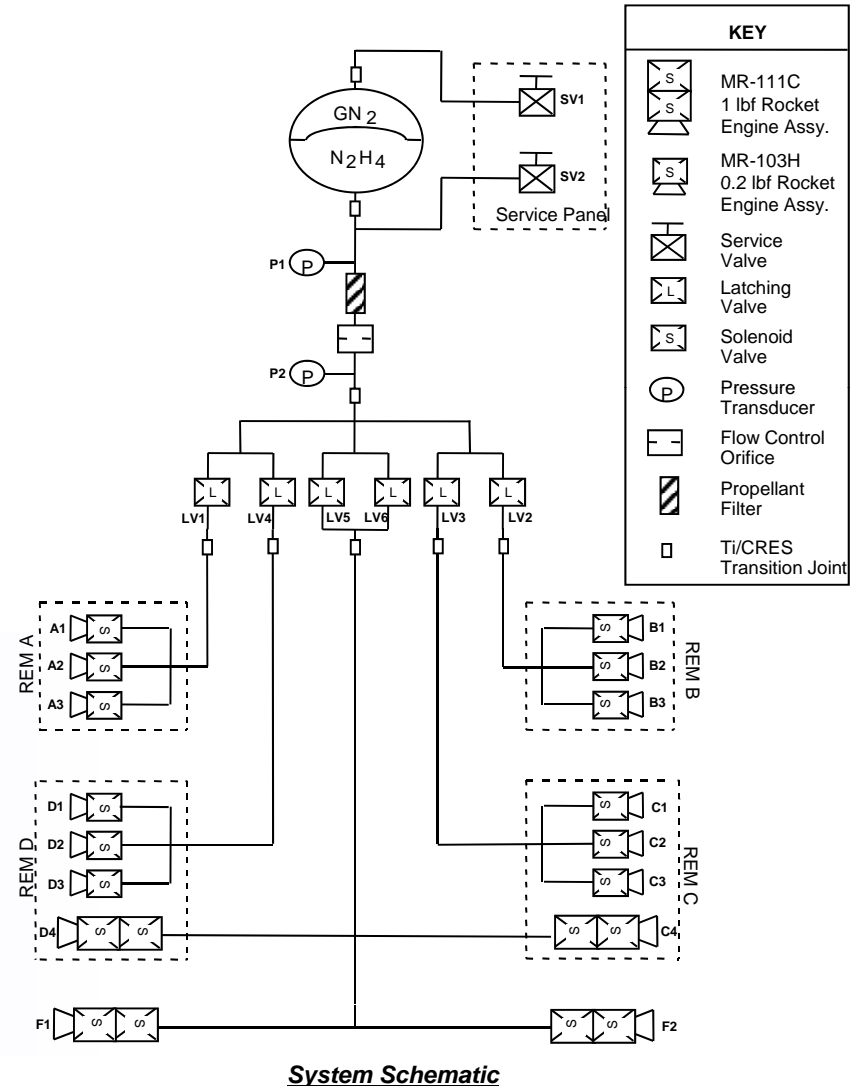
- **NASA Earth-Sun Science Mission**
- **Planned Launch: July 2006**
- **Systems Delivered to JHU/APL: 2**
- **Propellant Load: 135 lbm (61 kg) Hydrazine Each**
- **320-110 psia (22.1-7.6 bar) Blowdown Operation**
- **12 MR-111C 1.0-lbf (4 N) Thrusters**
- **Designed for Attitude Control and Course Correction**
- **Aerojet Designed and Integrated System on Customer-Supplied Structure**

Pluto/New Horizons

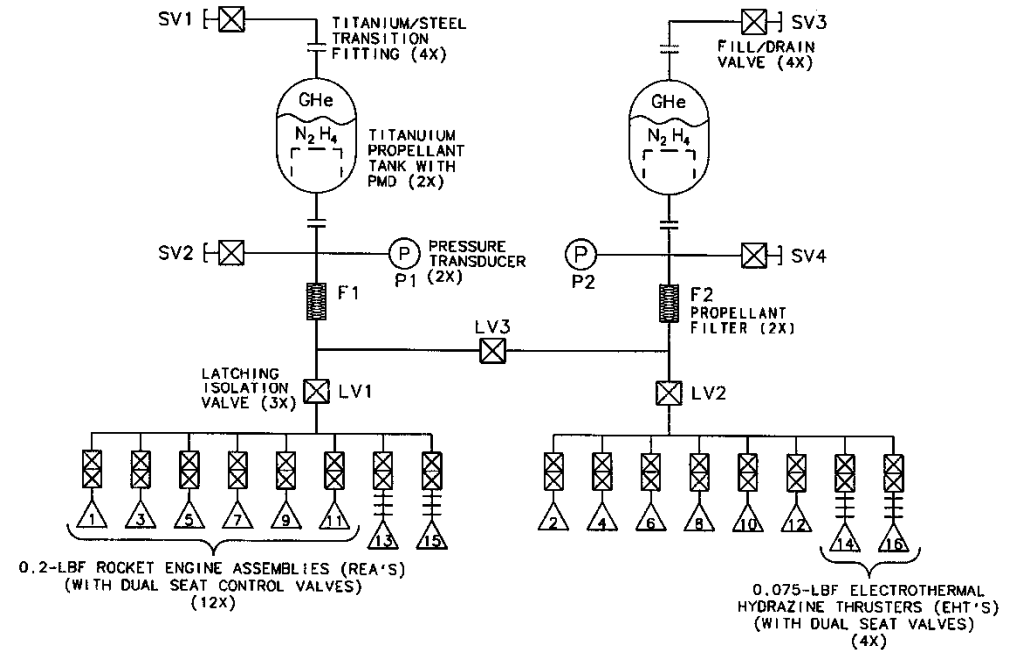
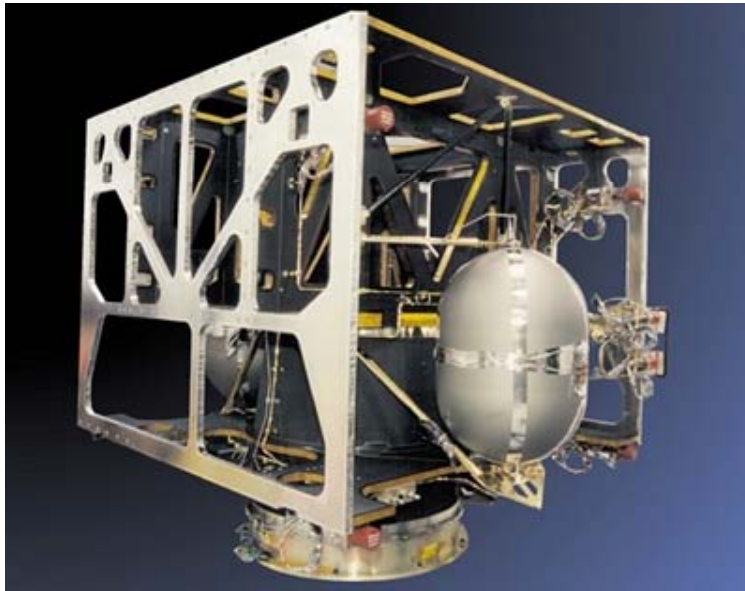


- NASA New Horizons Mission
- Launched: January 19, 2006
- Systems Delivered to JHU/APL: 1
- Propellant Load: 143 lbm (65 kg) Hydrazine
- 420-75 psia (28.9-5.2 bar) Blowdown Operation
- 12 MR-103H 0.2-lbf (1N) Thrusters
- 4 MR-111C 1-lbf (5N) Thrusters
- Designed for Attitude Control and Course Correction
- Aerojet Designed and Integrated System on Customer-Supplied Structure

Reference: IAC-2004-S.1.09



BSAT-2

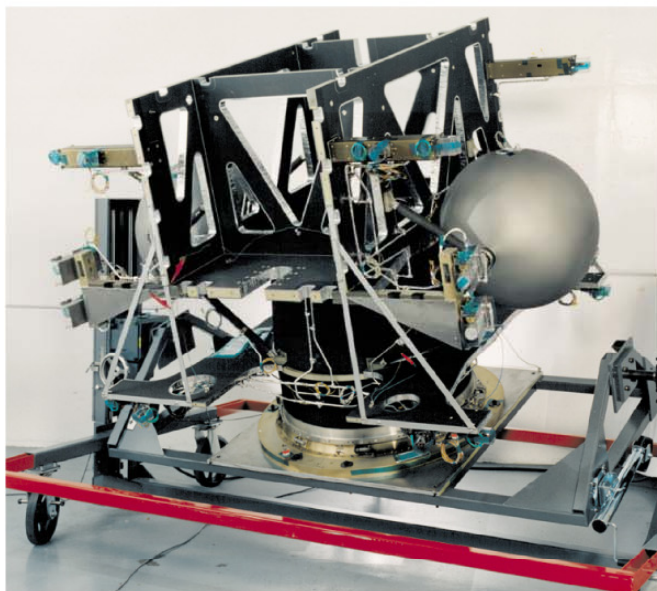


- **Systems Delivered: 3**
- **Propellant Load: 464 lbm (210 kg) Hydrazine Total in 2 Tanks**
- **400-100 psia (27.5-6.9 bar) Blowdown Operation**
- **12 MR-103G 0.2-lbf (1 N) Thrusters**
- **4 MR-501B Electrothermal Hydrazine Thrusters (EHTs)**
- **Used for Orbit Raising and Attitude Control (GEO Spacecraft)**
- **Aerojet Integrated System on Customer-Supplied Structure**

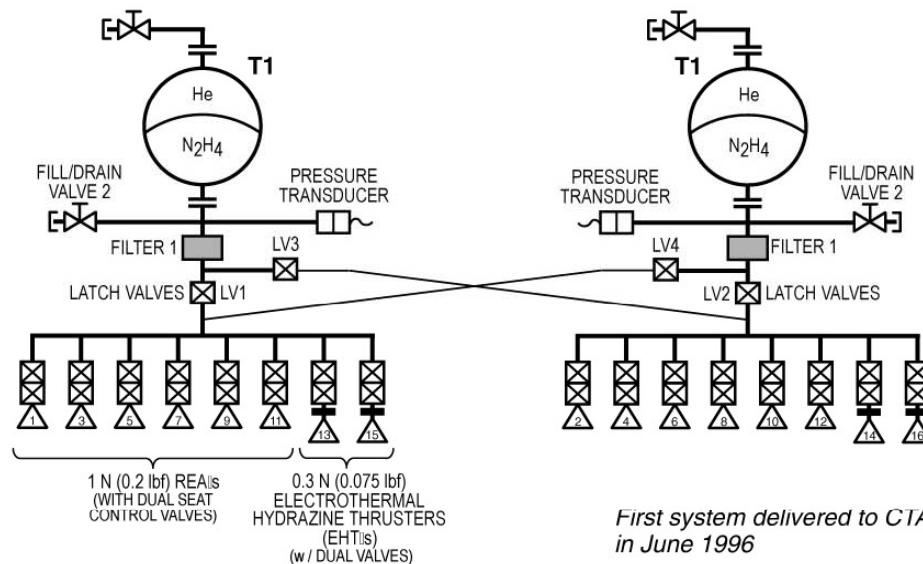
AEROJET

INDOSTAR PROPULSION SYSTEM

Design Summary



Propulsion Schematic



First system delivered to CIA in June 1996

Performance Parameters

- Propellant Mass 227 kg (500 lbm)
- Total Impulse 632,000 N-sec (141,923 lbf-sec)
- Pressurant Mass 0.5 kg (1.2 lbm)
- Pressure BOL/EOL 21 / 8 bar (305 / 118 psia)–est.
- Blowdown Ratio 2.6/1

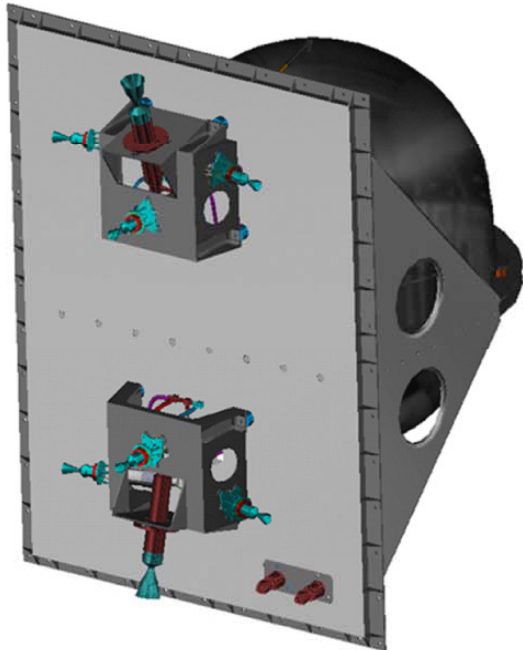
Status

- Flight Proven – Launched 11/12/97

Component Description

ITEM	QTY	MANUFACTURER
■ Tank	2	PSI
■ 1 N (0.2 lbf) REA (M5-103G)	12	AEROJET
■ EHT (MR-501B)	4	AEROJET
■ Fill / Drain Valve	4	OEA
■ Pressure Transducer	2	PAINE
■ Filter	2	VACCO
■ Latch Valve	4	MOOG

GPS IIF MODERNIZATION PROGRAM Propulsion System Design Summary

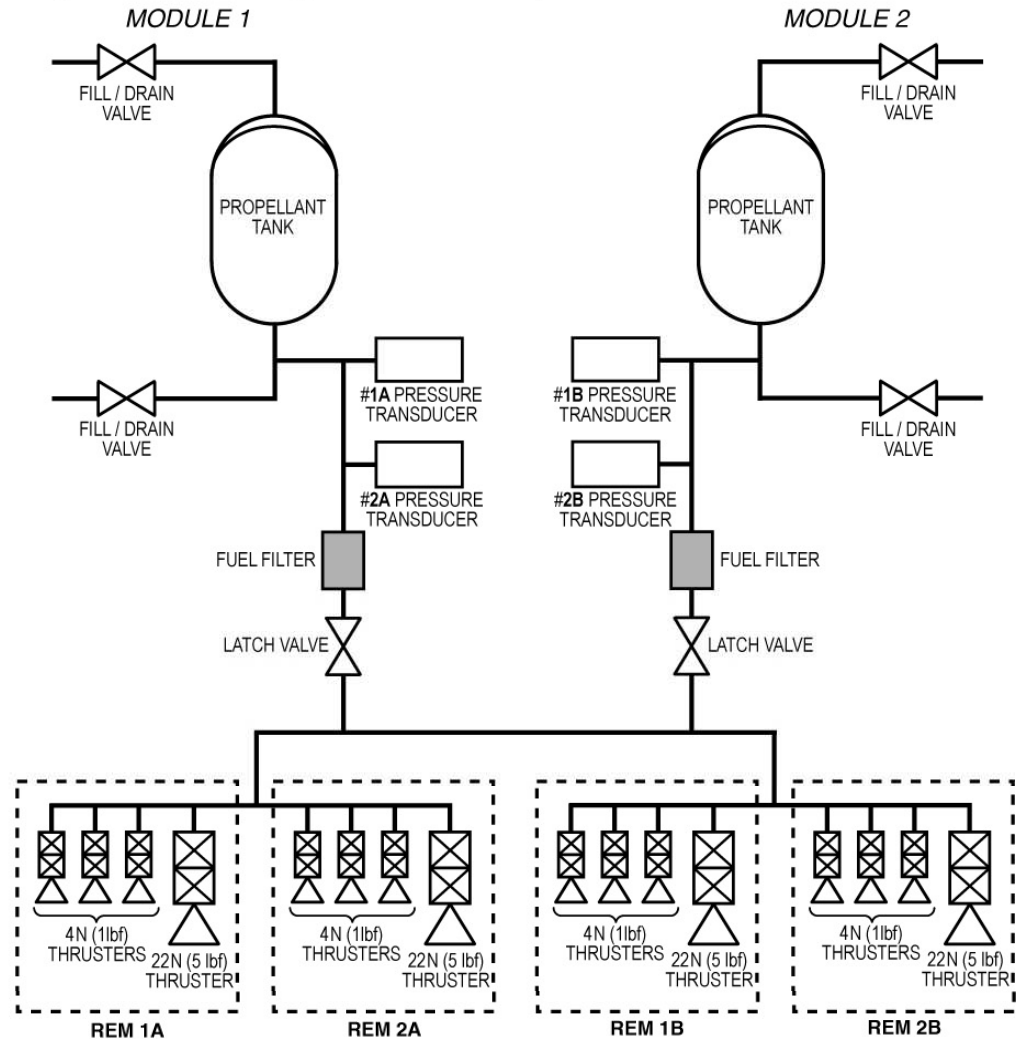


Performance Parameters

- Propellant Mass 118 – 145 kg (260 – 320 lbm)
- Total Impulse 249,000 N-S (56,000 lbf-sec)
- Pressurant Mass 1.8 kg (4 lbm)
- Pressure BOL/EOL
. 27.5 / 6.5 – 11.4 bar (400 / 95 – 165 psia)
- Blowdown Ratio 4:1

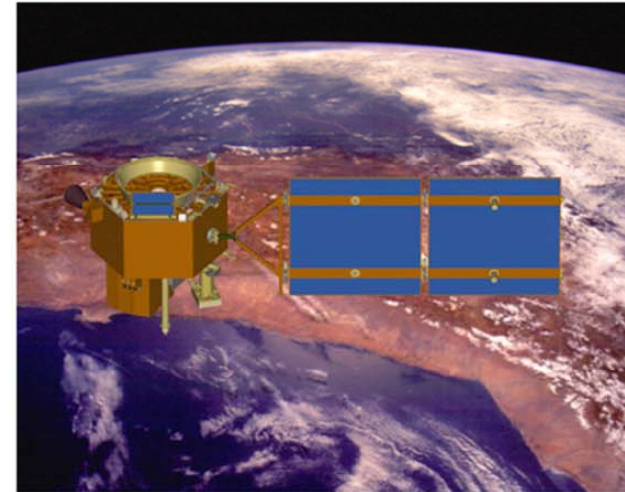
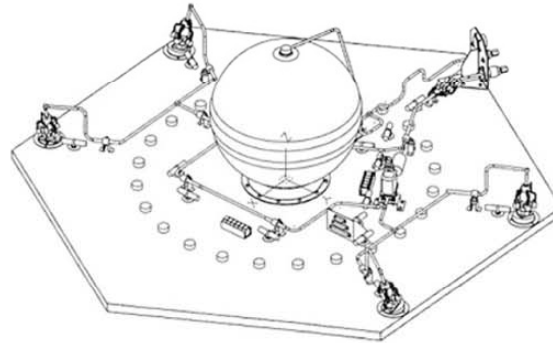
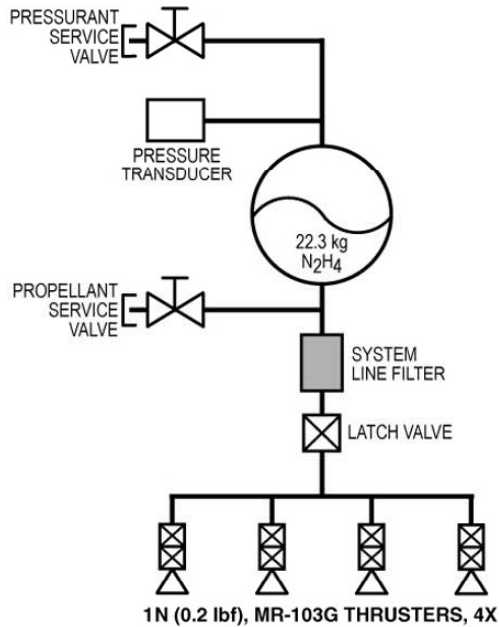
Reference

- AIAA-1999-2469



EO-1 PROPULSION SYSTEM

PROPULSION SCHEMATIC



Performance Parameters

- Propellant Mass 22.3 kg (49 lbm)
- Total Impulse (per REA)
 46,000 N-sec (10,428 lbf-sec) @ 21°C
- Pressure BOL/EOL
 18.8 / 5.2 bar (273 / 76 psia) @ 21°C
- Blowdown Ratio 36:1

Component Description

ITEM	QTY	MANUFACTURER
■ Tank	1	PSI
■ 1N (0.2 lbf) REA (MR103G)	4	AEROJET
■ Fill / Drain Valve Fuel	1	MOOG
■ Fill / Drain Valve GN ₂	1	MOOG
■ Latch Valve	1	MOOG
■ Pressure Transducer	1	PAINE
■ Filter		WINTEC, LLC

Status

- Flight Proven

Reference

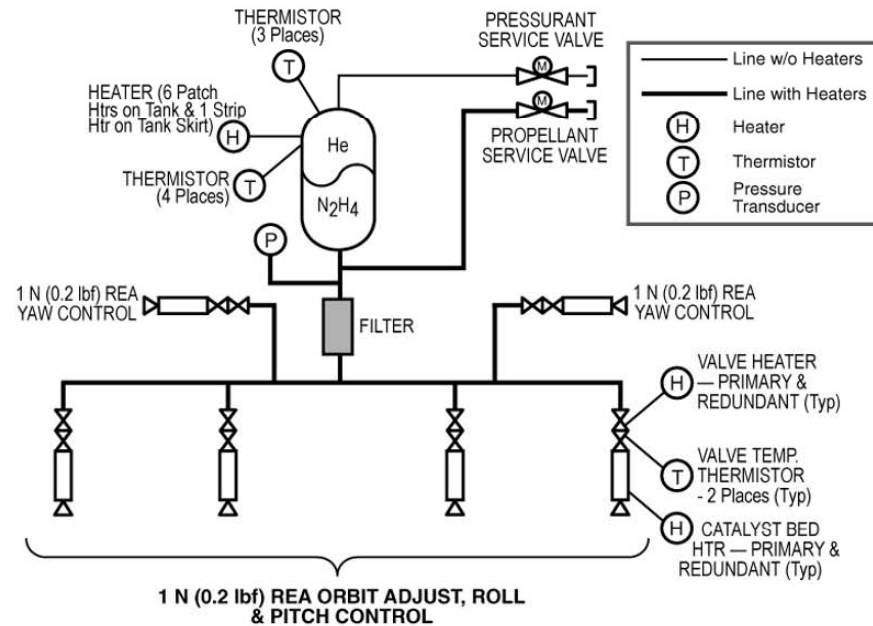
- AIAA-2001-3637

IKONOS (CRSS) PROPULSION MODULE Design Summary



4791-2

Propulsion Schematic



Performance Parameters

- Propellant Mass 37.6 kg (83 lbm)
- Total Impulse 73,000 N-sec (16,500 lbf-sec)
- Pressure BOL/EOL 21 / 5 bar (307 / 72 psia)
- Blowdown Ratio 4.3 / 1

Component Description

ITEM	QTY	MANUFACTURER
■ Tank	1	PSI
■ 1N (0.2 lbf) REA (MR-103G)	6	AEROJET
■ Fill / Drain Valve	2	CFE
■ Propellant Filter	1	CFE
■ Pressure Transducer	1	OMEGADYNE

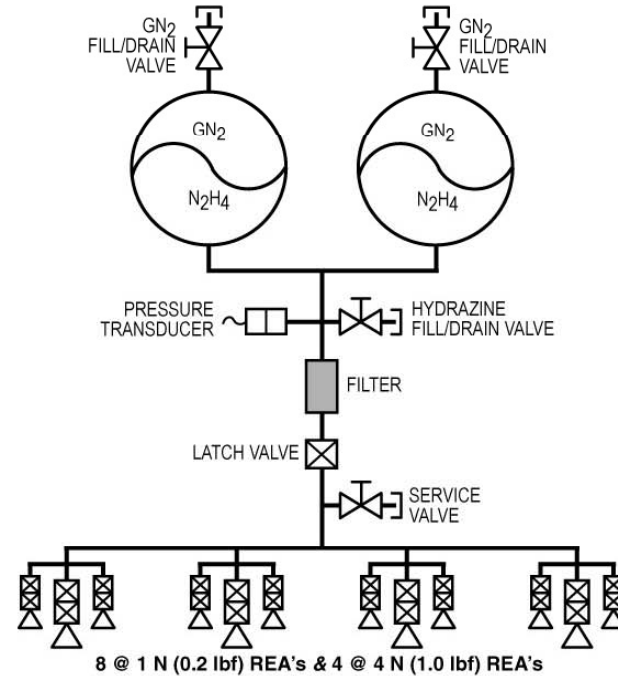
MSTI-3 PROPULSION MODULE

Design Summary



4260-2

Propulsion Schematic



Performance Parameters

- Propellant Mass 22 kg (49 lbm)
- Total Impulse 42,000 N-sec (9,500 lbf-sec)
- Pressurant Mass 0.22 kg (0.49 lbm)
- Pressure BOL/EOL 22.7 / 6.2 bar (329 / 90 psia)
- Blowdown Ratio 3.7 / 1
- System Mass BOL/EOL 39.5 / 17.2 kg (87 / 38 lbm)

Status

- Flight Proven – MSTI-2, Launched 5/8/94
- MSTI-2, Launched 5/16/96

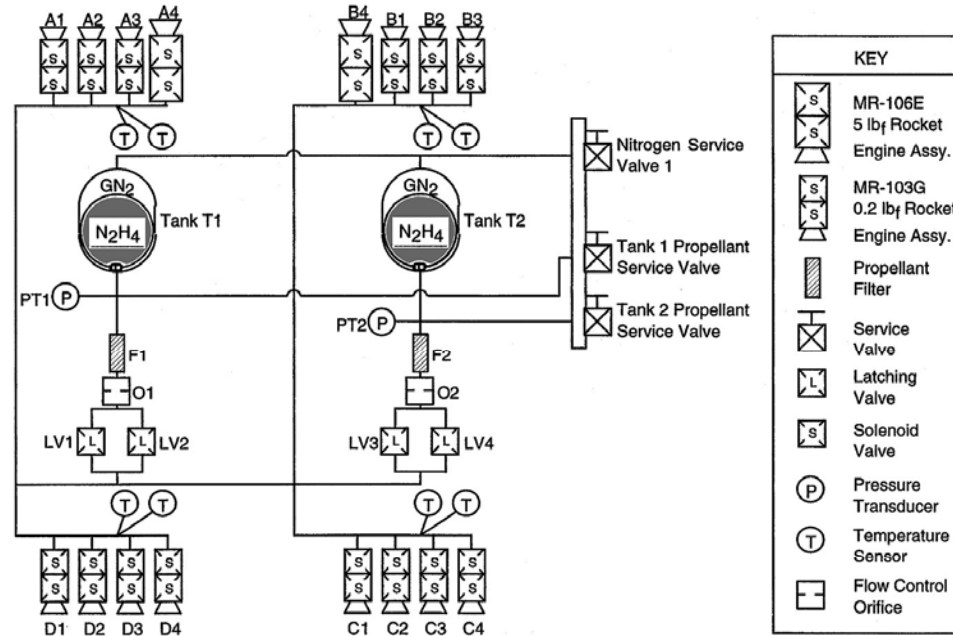
Component Description

ITEM	QTY	MANUFACTURER
■ Tank	2	PSI
■ 1N (0.2 lbf) REA (MR-103C)	8	AEROJET
■ 4N (1.0 lbf) REA (MR-111C)	4	AEROJET
■ Fill / Drain Valve	4	VACCO
■ Latch Valve	1	VALCOR
■ Pressure Transducer	1	PAINE
■ Filter	1	VACCO

Comet Nucleus Tour (CONTOUR)



CONTOUR LPS Schematic



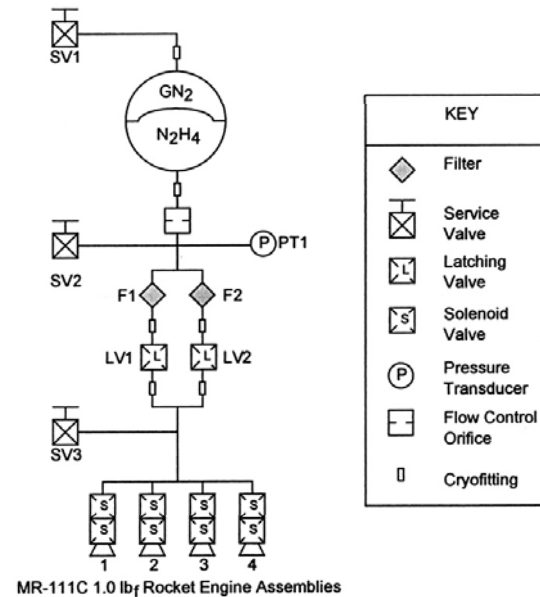
- **Systems Delivered: 1**
- **Propellant Load: 165 lbm (90 kg) Hydrazine**
- **350-125 psia (24.1-8.6 bar) Blowdown Operation**
- **14 MR-103G 0.2-lbf (1 N) Thrusters**
- **2 MR-106E 5-lbf (22 N) Thrusters**
- **Used for Attitude Control (Interplanetary Spacecraft)**
- **Aerojet Integrated System on Customer-Supplied Structure**

AEROJET

Coriolis



Coriolis HPS Schematic

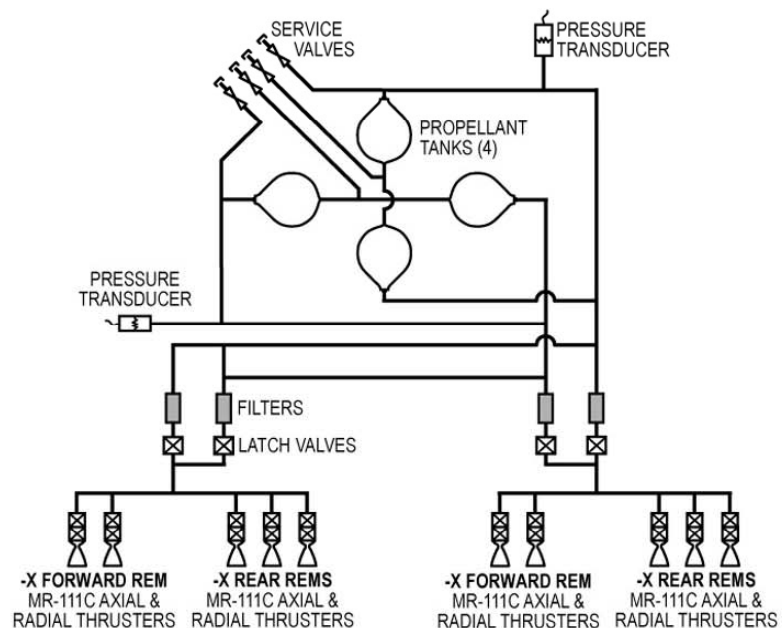


- **Systems Delivered: 1**
- **Propellant Load: 200 lbm (91 kg) Hydrazine**
- **400-75 psia (27.5-5.2 bar) Blowdown Operation**
- **4 MR-111C 1-lbf (4 N) Thrusters**
- **Used for Orbit Raising (LEO Spacecraft)**
- **Aerojet Integrated System and Secondary Structure on Customer-Supplied Primary Structure**

ACE PROPULSION SYSTEM Design Summary



Propulsion Schematic



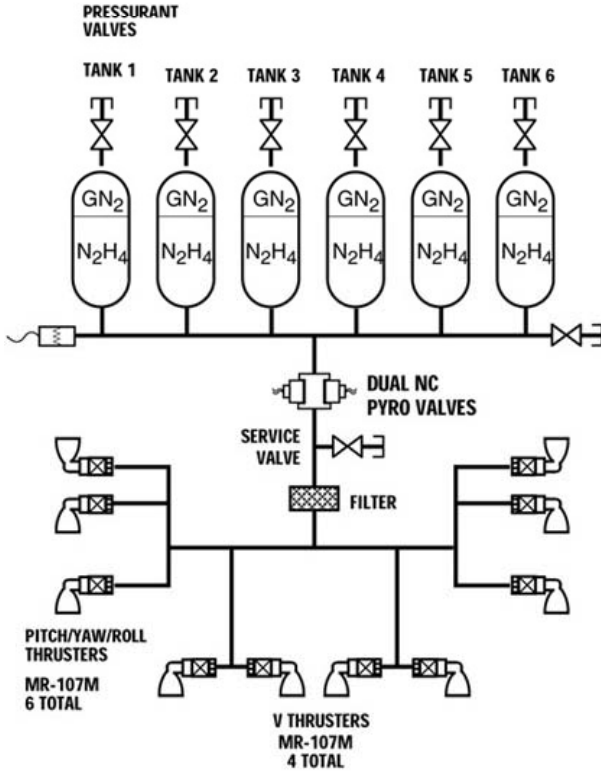
Primary Performance Parameters

- Propellant Mass 90 kg (42 lbm)
- Total Impulse 409,900 N-sec (92,158 lbf-sec) (@21°C)
- Pressurant Mass 0.59 kg (1.3 lbm)
- Pressure BOL/EOL 21.1 / 5.5 bar (307 / 80 psia) (@21°C)
- Blowdown Ratio 3.8:1
- System Mass BOL/EOL 229 – 40 kg (505 / 89 lbm)

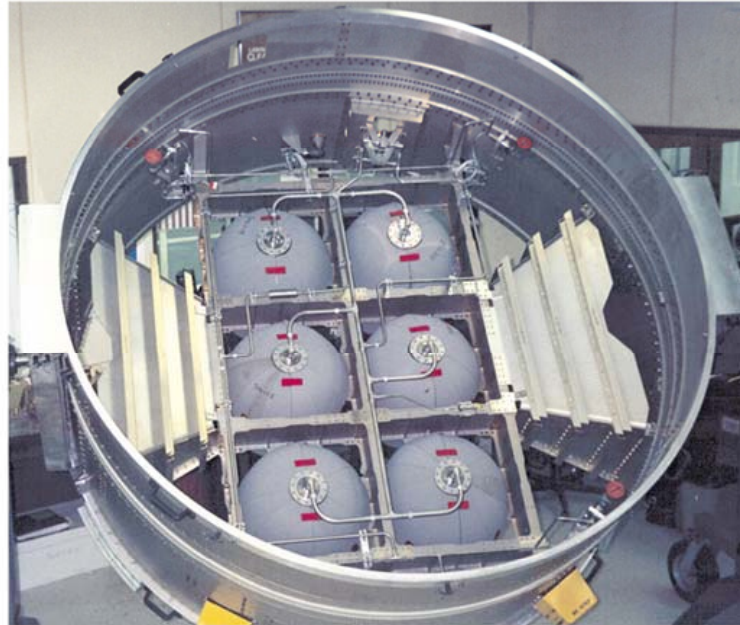
Component Description

ITEM	QTY	MANUFACTURER
■ Tank	4	PSI
■ 4N (1.0 lbf) REA (MR-111C)	10	AEROJET
■ Fill / Drain Valve	4	OEA
■ Isolation Valve	4	MOOG
■ Pressure Transducer	2	PAINE
■ Filter	4	VACCO

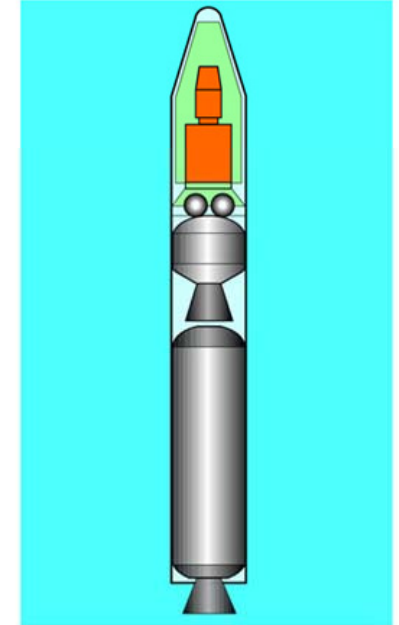
Athena Attitude Control System



SCHEMATIC



ATHENA ACS



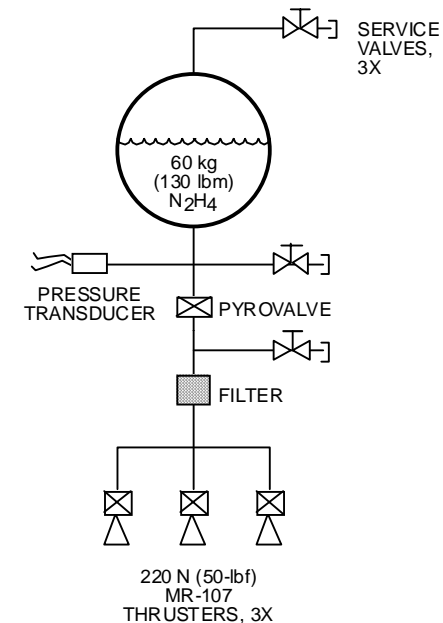
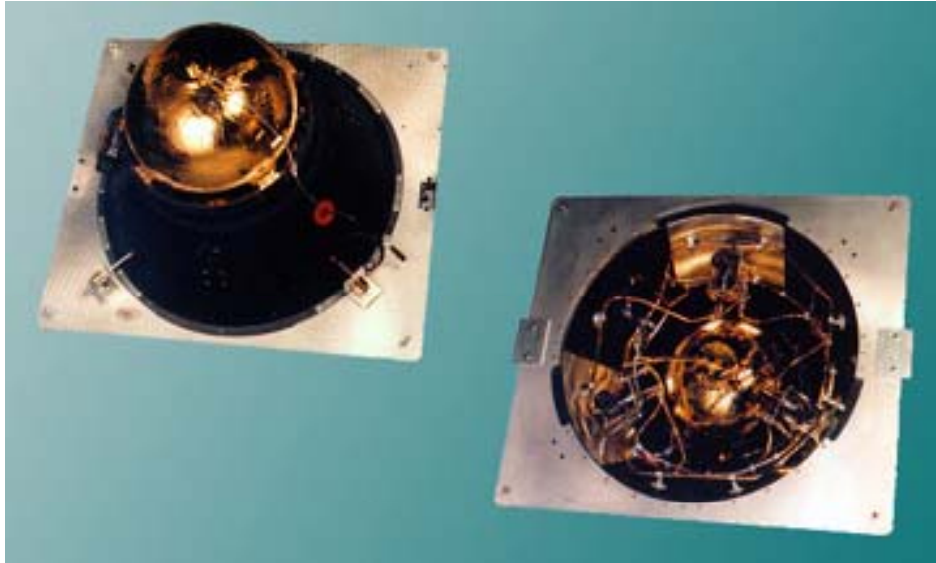
ATHENA 1

- ACS CONSISTS OF TEN (10) 220 N (50-lbf) THRUSTERS, VALVING, TANKS AND INSTRUMENTATION OPERATING IN A BLOWDOWN MODE
- ACS CAN CARRY 2, 4 OR 6 TANKS WITH A MAXIMUM OF 354 kg (780-lbs) OF N₂H₄

C11255-79D



Pegasus Hydrazine Auxiliary Propulsion System (HAPS)

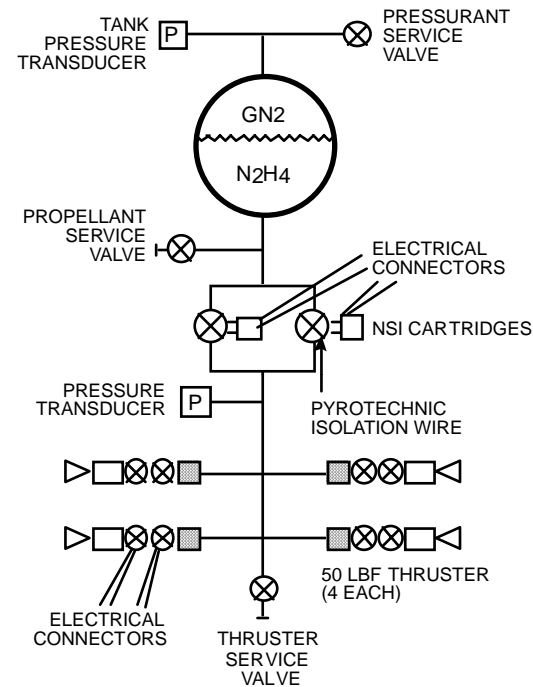
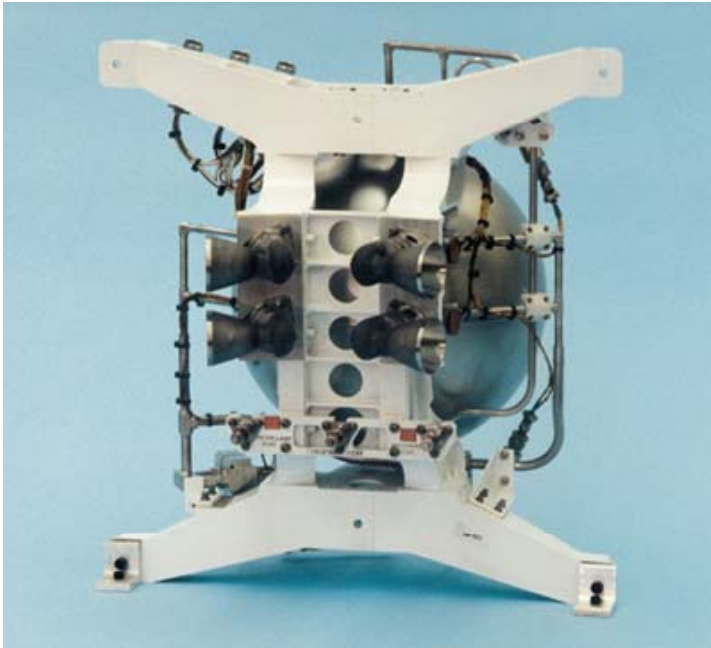


Propulsion Schematic

- **Systems Delivered: 9**
- **Propellant Load: 130 lbm (60 kg) Hydrazine**
- **450-90 psia (30.9-6.2 bar) Blowdown Operation with Aerojet-Designed Low Cost AF-E-332 Bladder Tank**
- **3 MR-107K 50-lbf (220 N) Thrusters**
- **Used for Final Orbit Trim (4th Stage) for Pegasus XL**
- **Aerojet Integrated System on Customer-Supplied Structure**

AEROJET

Atlas II Roll Control Module (ARCM)



Propulsion Schematic

- **Systems Delivered: 64**
- **Propellant Load: 35 lbm (16 kg) Hydrazine**
- **498-175 psia (34.3-12.1 bar) Blowdown Operation**
- **4 MR-107J 50-lbf (220 N) Thrusters**
- **Used for Vehicle Roll Control**
- **Fully Modular System Built by Aerojet, Integrated onto Launch Vehicle**

AEROJET

Contact Information

AEROJET

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