A Standard Micro Propulsion System for CubeSats

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There is a Need for a Standard Propulsion System

20 Unique Designs / 40 Systems Under Contract To-Date

Flight Proven in LEO on Nano ACE

First Interplanetary CubeSat Propulsion MarCO-A & -B

VACCO has Learned by Doing:

One LEO Mission Successfully Completed (TRL 9).

Two Missions to Mars Successfully Completed (TRL 9).

Twenty Systems Delivered and Awaiting Launch (TRL 8).

Valuable Lessons Learned in:

Design, Manufacture, Assembly, Test & In-Space Operations.

Systems Have Been Custom Designs:

Designed to Detailed Specifications.

Wide Variety of Shapes and Sizes.

Significant Development Risk, Cost and Schedule.

There is a Clear Need for a Standardized Solution.

Design Criteria for a Standard Propulsion System

Cold Gas Systems are Most Numerous and Have the Greatest Need for Standardization

A Basic Layout was Selected:

10 cm x 10 cm Cross Section.

Four Thrusters Located on Exposed Facet.

Fill Port Located on Exposed Facet.

Power/Data Connector Located on Side Adjacent to Exposed Facet.

No Customer Specification Required, System Ordered by Part Number:

Common Manifold, Controller and Firmware.

25mN Thrusters Standard (Can be throttled by Command).

Thrust Directions can be Specified within Limits.

Standard Options for Total Impulse (Selected by Dash Number).

Non-Recurring Engineering Charges will be Driven by Statement of Work:

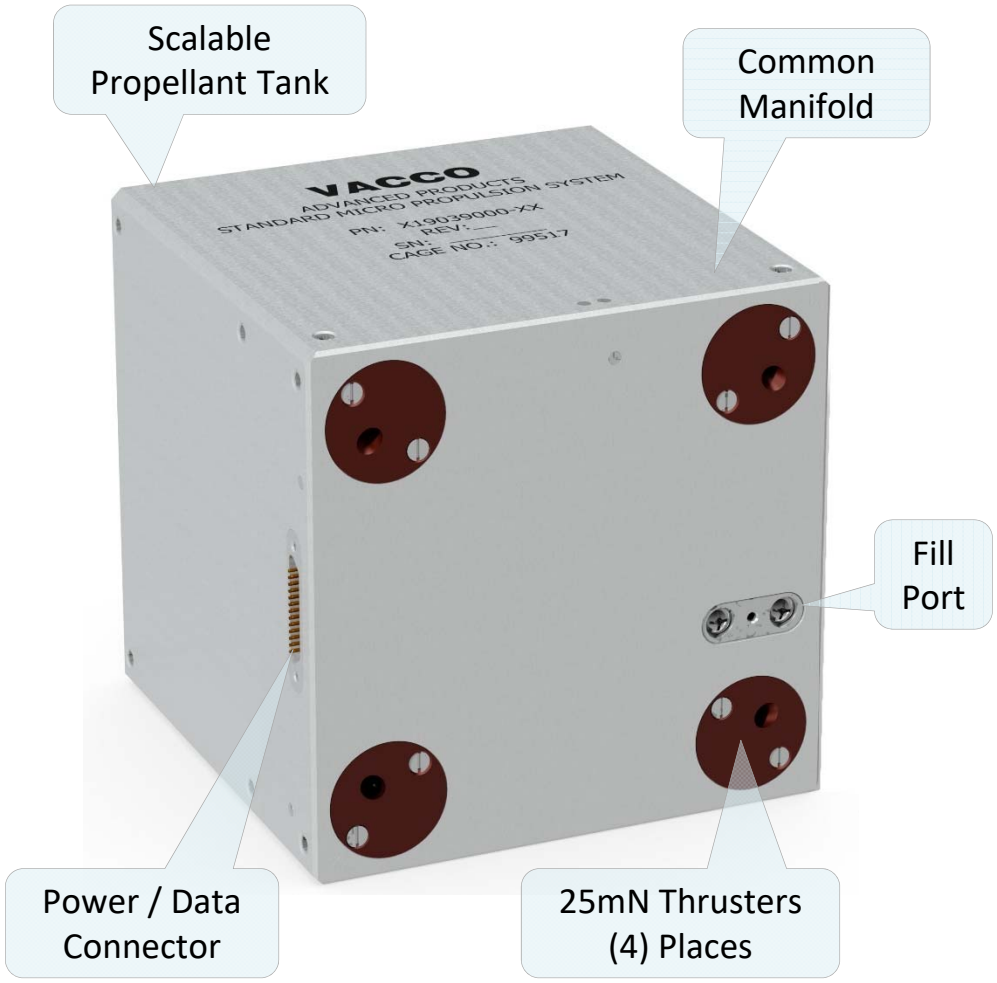
Standard End Item Data Package included.

Standard Acceptance Test Procedure.

Data Items, Meetings and Reports not included.

One Year Delivery Initially with a Goal of Three Months Eventually.

Standard Cold Gas Micro Propulsion System X19039000



Six Similar Systems Currently in Production

Intelligent, Self-Contained System:

(4) 25mN Cold Gas Thrusters for ACS & Delta-V.

All-Welded Aluminum Alloy Construction.

Normally-Closed Frictionless Valves.

Electronic, Closed-Loop Pressure Regulation.

Built-In, Shielded Control Electronics.

9V to 12.6V Unregulated Input Voltage.

RS422 Data Bus Interface.

Flight-Proven Firmware with Health Monitoring.

Integral Pressure & Temperature Sensors.

Minimum Impulse Bit: <2.5mN-Sec.

Range Safety Features:

Non-Toxic R236fa Propellant:

- Benign Fire Extinguisher Material.
- Max Pressure <0.69MPa (<100 psi).

Leak-Before-Burst Propellant Tank

(3) Seals Against Propellant Leakage.

Standard Controller Features

Verified 18 krad Total Dose Radiation Tolerance.

Watchdog Timer and No FLASH Memory Writing.

Safe to Remove Power at Any Time During Any Operation.

Closed-loop PID Electronic Pressure Regulation.

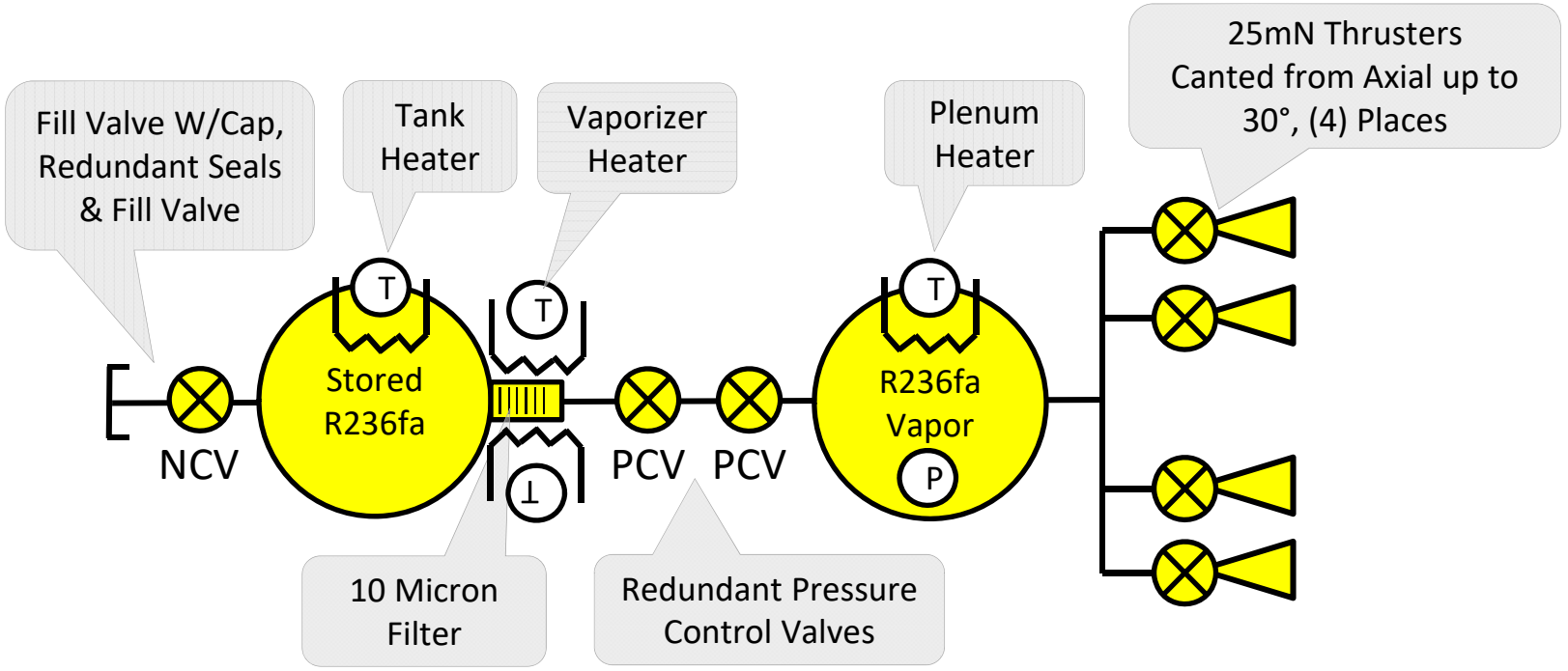
Advanced Valve Drivers w/Step-Down After 20ms.

Over 30 Controller Commands:

Heater voltage/power	Plenum pressure setpoint	PID constants	Save thrusting sequence
Maximum system power	Valve maximum voltage	Redundant PCV driver	Valve hold current
Manual heater override	Telemetry transmit rate	Plenum pressure timeout	Temperature set points

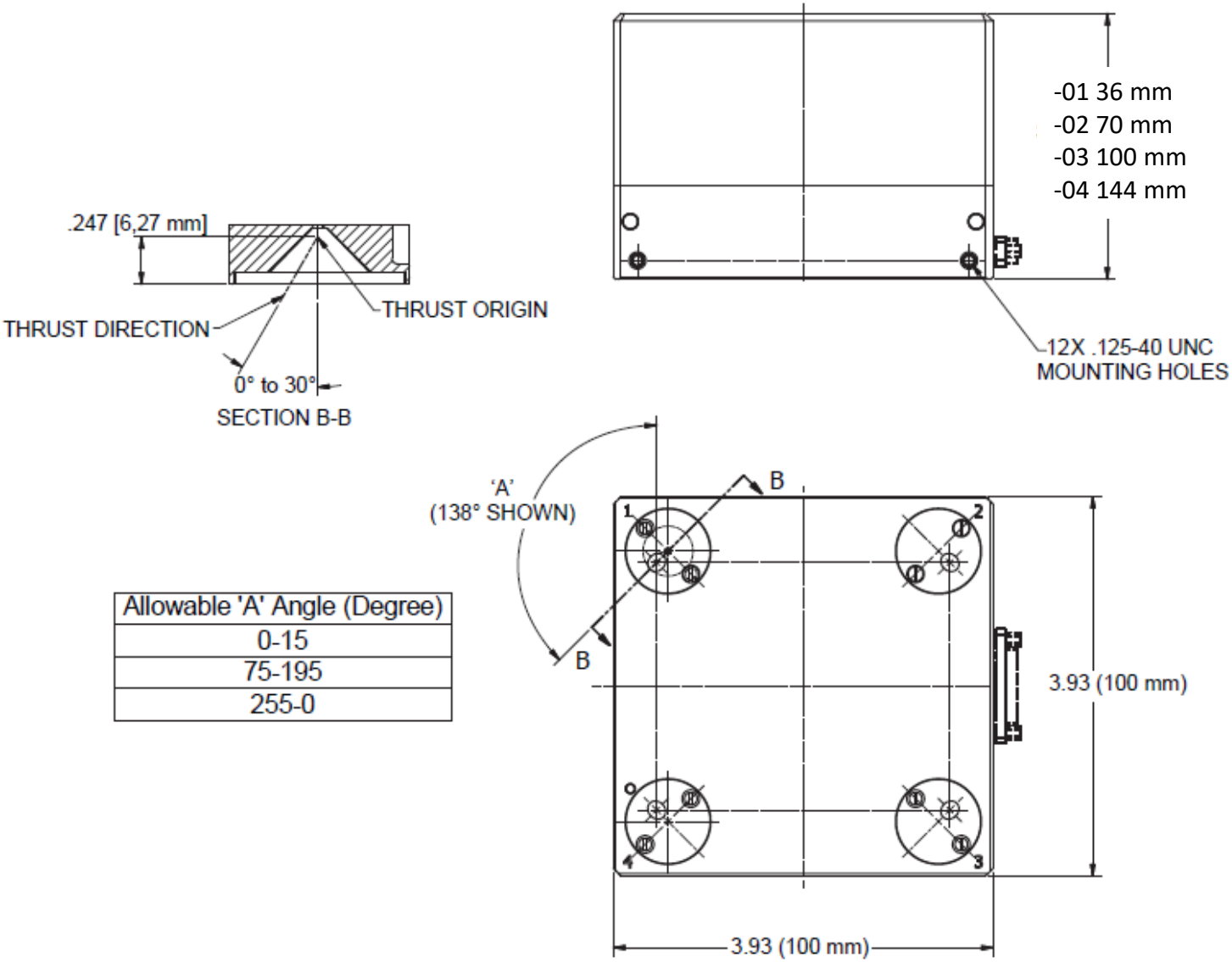
Health Monitoring Data Continuously Output at 10 Hz.

Standard Cold Gas MiPS Schematic and Performance



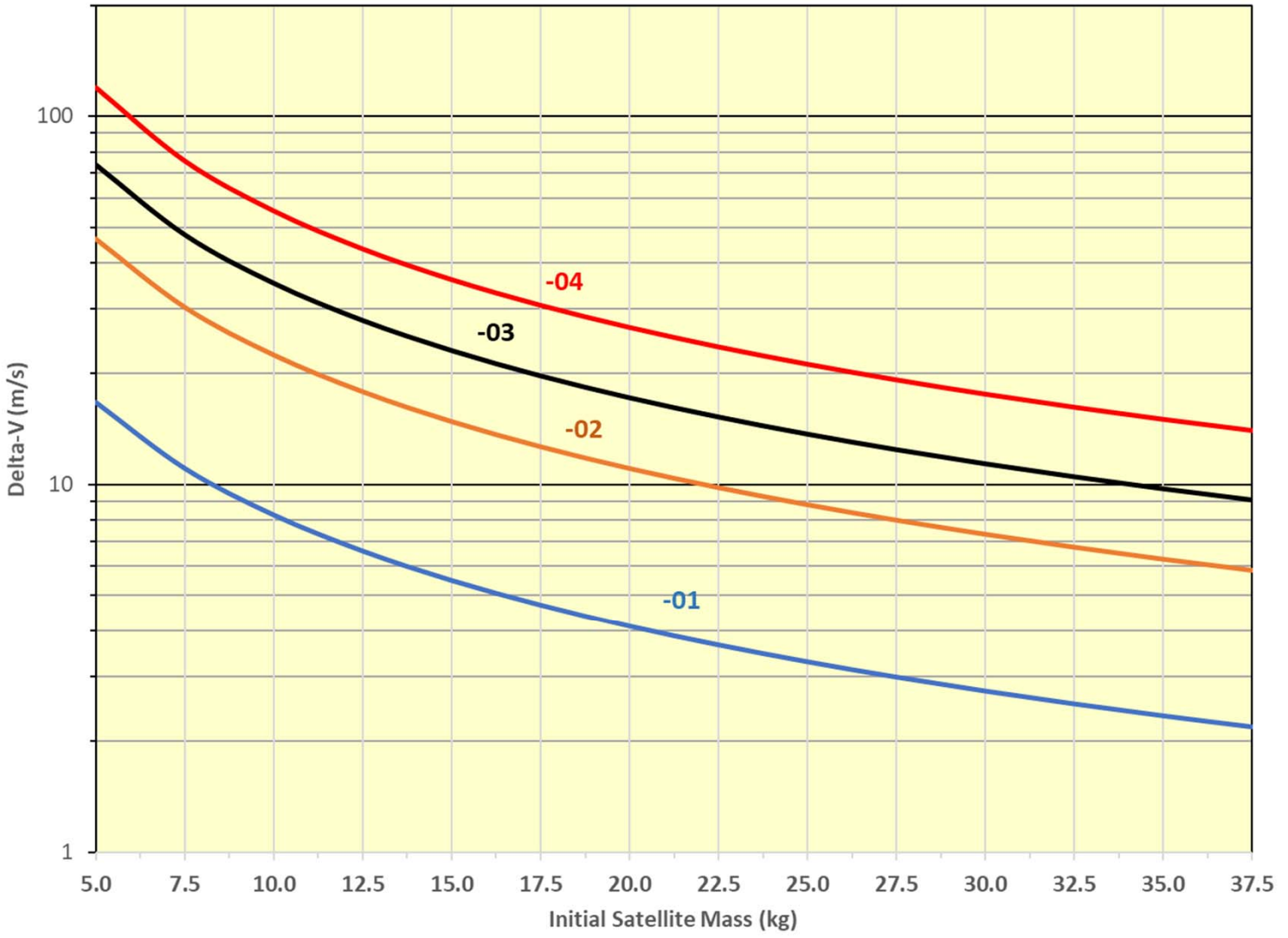
	System Height (mm)	R236fa Propellant Volume (cc)	R236fa Propellant Liquid Mass (g)	MiPS Dry Mass (grams)	Total Impulse (N-Sec)
X19039000-01	36	170	209	639	82
X19039000-02	70	453	557	799	219
X19039000-03	100	697	857	956	336
X19039000-04	144	1,068	1,314	1,144	515

Standard MiPS Envelope



Allowable 'A' Angle (Degree)
0-15
75-195
255-0

Delta-V for Standard Sizes



Standard Propulsion System Summary

VACCO has Created a Standard Propulsion System for CubeSats Based on Flight Experience:

Lower Cost and Shorter Leadtime.

High-Performance Cold Gas System.

Four 25mN Thrusters Provide Pitch, Yaw, Roll and Delta-V.

Built-In, Shielded Controller.

Flexible 9V to 12.6V Input Power.

RS422 Control Interface.

Flight-Proven Firmware with Health Monitoring.

Standard Options for Limited Customization:

Four Sizes for a Range of Total Impulse.

Thrust Direction Can Be Specified Within Limits

Can be Application-Engineered at Additional Cost.

Incorporated Experience Gained Over 40 Systems:

Design, Manufacture, Assembly, Test & In-Space Operations.