Performance Matrices for CUA Propulsion Systems
(30 March 2021)

Well-Developed Systems:

Parameter / Propulsion System	CHIPS (1U)	PUC (1U)	MVP (1U)	Units
Thruster System Package Volume	865	865	926	cm^3
Available Tank Volume	627	667	309	cm^3
Propulsion Technology	Micro-resistojet	Micro-plasma discharge	Micro-resistojet	–
Propellant	R134a (R236fa opt.)	SO_2	Polymer Fiber (Delrin)	–
Power Draw when Firing (Avg. Duty Cycled)	25 (15.6)	15 (10)	39 (13.5)	W
Specific impulse	76	70	66	sec
Mass Flow Rate	40	6.5	7.0	mg/s
Thrust	31	5	4.5	mN
Total impulse	478	593	280	N-s
Vol. Impulse (total impulse / system volume)	553	653	302	N-s/liter
Propellant Mass	617	815	433	g
Dry Mass	758	641	622	g
Propulsion System Wet Mass	1,375	1,500	1,055	g
Delta-V capability (**for 4 kg s/c Wet Mass**)	125	167	74	m/s
ACS Capability	Yes	No	No	m/s
Maximum continuous thrust time (rest time)	10 (6)	20 (10)	3 (7)	min
TRL	5-6	6	6	–

Evolving Systems (*Estimated Developed Performance*):

Parameter / Propulsion System	MPUC (1.5U)	MPUC (2U)	FPPT (1.0U)	FPPT (1.7U)	Units
Thruster System Package Volume	1,500	2,000	1,000	1,719	cm^3
Available Tank Volume	770	1,220	150	405	cm^3
Propulsion Technology	Monopropellant		Pulsed Plasma Thruster		–
Propellant	H_2O_2-Ethanol		PTFE Fiber		–
Nominal Power Draw	3		48		W
Capacitor Bank Energy	N/A		16	32	J
Specific impulse	180		1,000 – 1,700	3,500	sec
Mass Flow Rate	100		0.017 – 0.036	0.010	mg/s
Thrust	160		0.28 – 0.35	0.33	mN
Total impulse	1,550	2,460	3,240 – 5,500	29,200	N-s
Vol. Impulse (total impulse / system volume)	1,030	1,230	3,240 – 5,500	17,000	N-s/liter
Propellant Mass	862	1,366	330	850	g
Dry Mass	1,600	1,850	1,210	1,975	g
Propulsion System Wet Mass	2,462	3,116	1,540	2,825	g
Delta-V capability (**Propulsion Wet Mass + 10 kg**)	159	259	330 – 560	2,355	m/s
TRL	4 (est. 6 by May 2022)		5 (est. 6 by June 2021)		–

CUA | 3001 Newmark Drive | Champaign, IL 61822
T: (217) 239-1703 | info@cua.space | www.CUA.space

CubeSat High Impulse Propulsion System
(CHIPS)
October 2019

The CU Aerospace (CUA) / VACCO CubeSat High Impulse Propulsion System (CHIPS) offers a miniaturized and well-integrated small-satellite propulsion solution, including both a main thruster and three-axis attitude control system (ACS). CHIPS achieves a high total-impulse-to-volume ratio by leveraging CUA's high-efficiency resistojet technology, VACCO Industries' compact frictionless valve technology, and self-pressurizing, non-toxic, and inert propellants. Waste heat from the electronics and resistojet is efficiently and regeneratively recovered to evaporate propellant, resulting in a system temperature rise of only ~1°C per 10 minutes of operation.

The baseline CHIPS is a 1U, fully-throttleable system. System set-points, system status, and firing telemetry are all accessible and configurable through an RS-422 serial interface. CUA offers an optional battery module to simplify integration with existing low-power CubeSat buses. CHIPS may be customized to meet customer-specific mission requirements.

CHIPS 1U R134a Performance:

	Warm at 25 W	Cold
Specific impulse† [s]	76	52
Thrust [mN]	31	31
Max total impulse‡ [N-s]	478	299
Δv 4 kg [m/s]	125	85

CHIPS 1U R236fa Performance:

	Warm at 25 W	Cold
Specific impulse† [s]	60	38
Thrust [mN]	23	23
Max total impulse‡ [N-s]	433	271
Δv 4 kg [m/s]	123	78

CHIPS ACS Performance:

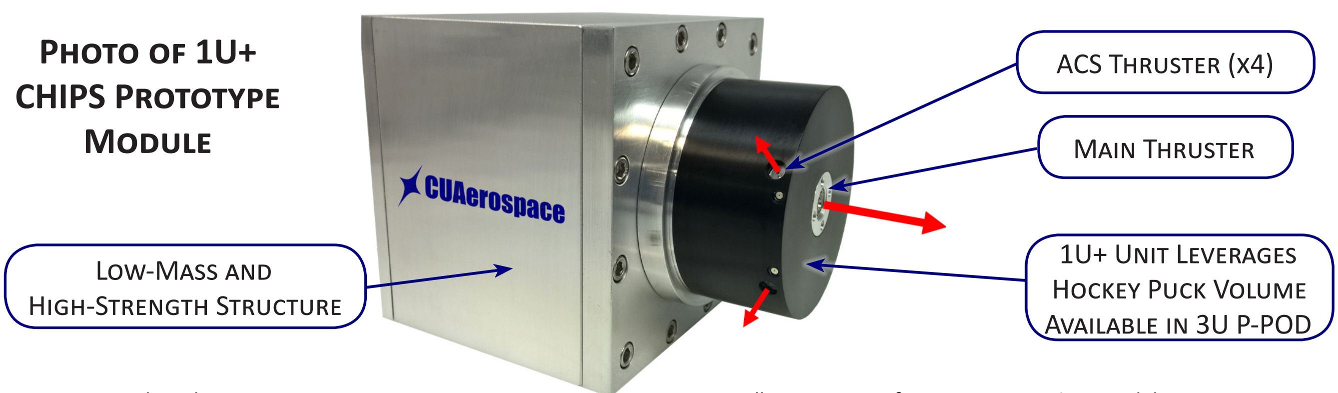
Unit Size	0.6U	1U*	1.5U
Max specific impulse† [s]	47		
Pointing accuracy‡ [°]	1.2		
Min impulse bit† [mN-s]	0.2		
Control authority	Roll, Pitch, Yaw, -Z		

*Baseline 1U CHIPS form factor †Demonstrated ‡Estimated

Space Propulsion

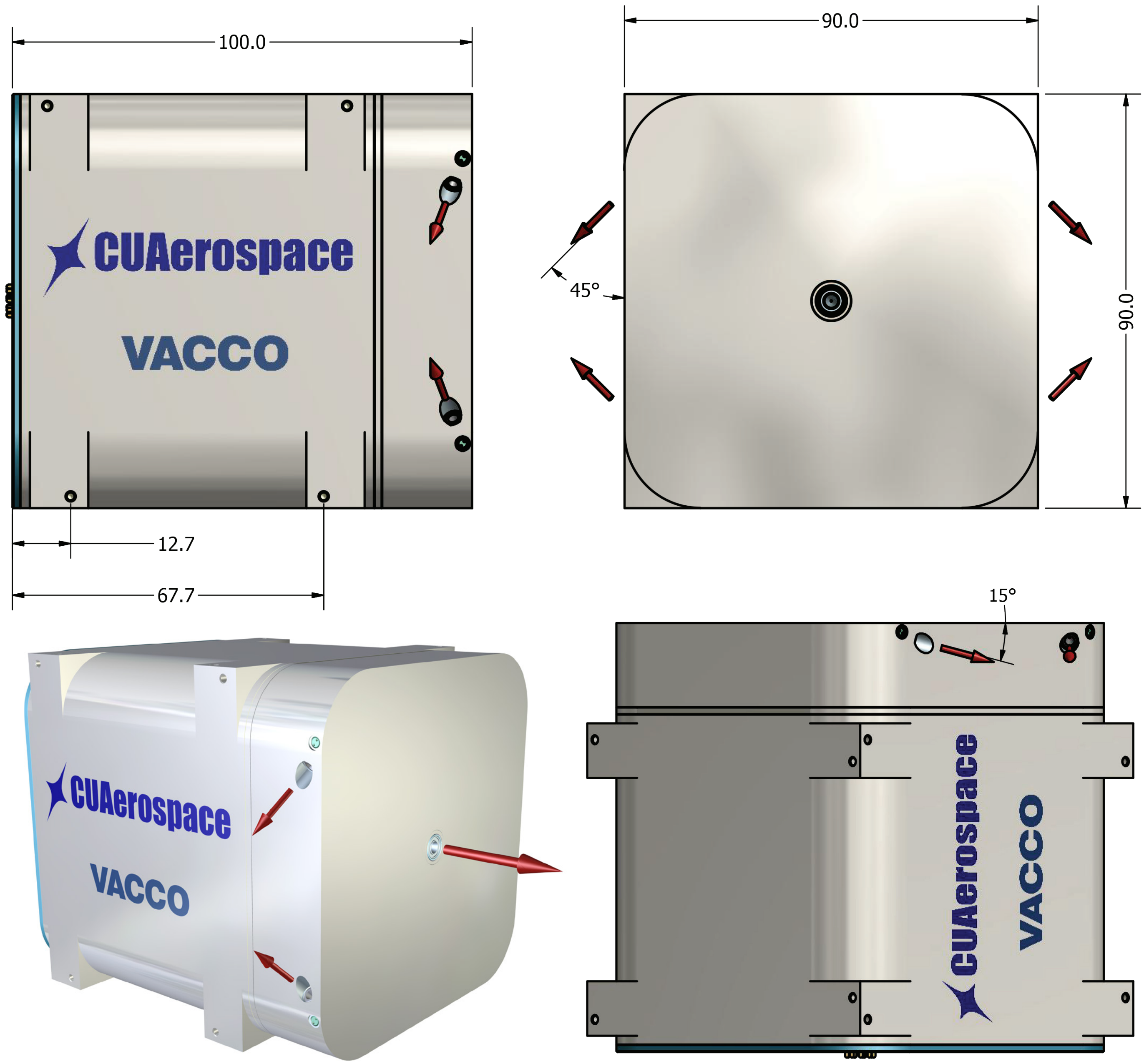
Features:

Photo of 1U+ CHIPS Prototype Module



- Two operational modes:
  - Warm gas: high specific impulse
  - Cold gas: minimum or small impulse
- Overall control authority: roll, pitch, yaw, +/- z
- On-orbit update of system parameters, including:
  - Thrust duration
  - Plenum pressure (i.e. thrust)
  - Superheater power level (i.e. specific impulse)
  - Temperature & fault set-points
- Telemetry and status packets for system monitoring
- Dedicated propellant heater for continous operation below 0°C ambient temperature
- Propellant vaporizer for ensuring 100% vapor delivery
- Voltage and current sensors for closed-loop power regulation, monitoring, troubleshooting, and protection.
- Reliable, frictionless VACCO valve technology:
  - Valves tested to 200,000+ cold gas firings
  - System is two-failure-tolerant against leakage
- Life span: 2+ years from propellant load
- High-density & self-pressurizing propellants (R134a and R236fa):
  - Non-flammable, chemically stable, high critical temperature, low freezing point, & low vapor pressure
  - Commonly used refrigerant / propellant
- Optional battery module

Baseline Design for 1U CHIPS



0.6U System: Subtract 40 mm from length
1.5U System: Add 50 mm to length

Dimensions of the baseline 1U CHIPS unit are for illustrative purposes only. CHIPS is highly adaptable to a wide range of customer-specific geometries. Inquire to see how CUA can adapt CHIPS to meet your mission requirements.

CHIPS is engineered and manufactured through a partnership between CUA and VACCO Industries.

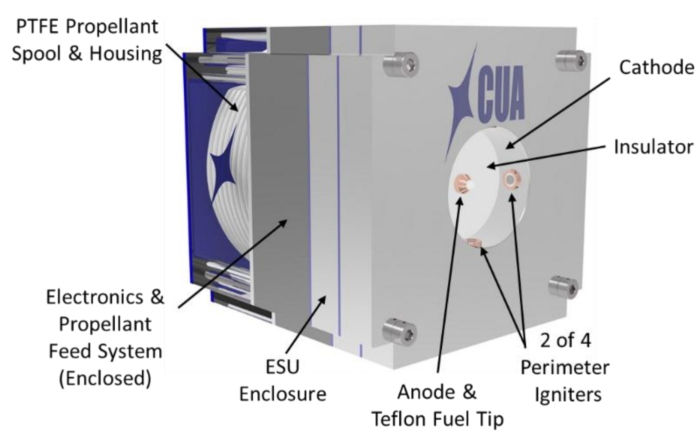
FIBER-FED PULSED PLASMA THRUSTER (FPPT) SYSTEM
SOLID INERT POLYMER PROPELLANT
JULY 2020

The CU Aerospace (CUA) Fiber-fed Pulsed Plasma Thruster (FPPT) system is a pulsed plasma thruster that uses PTFE fiber as propellant. This approach enables CUA to provide competitive ΔV to CubeSat and small satellite customers at a substantially lower cost and risk profile than traditional liquid or gaseous propulsion systems that use valves and pressure vessels. In a 1.1U form factor, FPPT provides a peak total impulse of 5,500 N-s, a peak continuous thrust of 0.38 mN at 48 W to the power processing unit (PPU), or a peak maximum specific impulse of 2,400 seconds. The design incorporates 16 J capacitor bank energy storage unit (ESU) modules to trade propellant volume for performance. Presently, FPPT is in the later stages of development on a NASA Phase II SBIR program.

System Information		
System lifetime	> 10^8 pulses	
System temperature range [°C]	– 40 to +75	
Nominal mass flow rate [mg/s]	0.017 – 0.036	0.011 – 0.022
Nominal Power to PPU [W]	48	
Propulsion system volume	1.0U	1.7U
Nominal Pulse Energy [J]	16	32
Specific Impulse [s]	1,000 – 1,700	1,600 – 2,400
Nominal Thrust [mN]	0.28 – 0.35	0.27 – 0.34
Minimum Impulse Bit [μN-s]	100	200
Total impulse [N-s]	3,240 – 5,500	13,450 – 20,180
Propellant Mass [kg]	0.33	0.86
Total propulsion wet mass [kg]	1.54	2.83
ΔV (FPPT wet mass + 10 kg s/c) [m/s]	330 – 560	1,405 – 2,110
TRL	5 (est. 6 by Nov. 2020)	

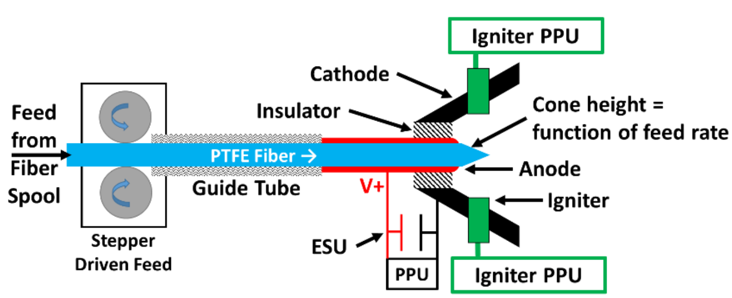
TYPICAL OPERATION AND INTERFACE

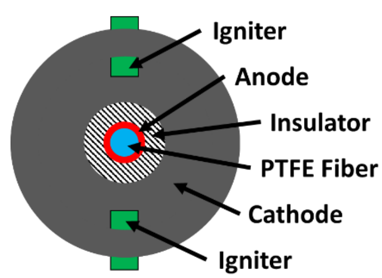
FPPT starts immediately without warmup and mechanically feeds PTFE propellant fiber from a non-rotating spool through the anode where it is subjected to a pulsed discharge and electromagnetically accelerated to provide thrust. Varied power, thrust, mass flow rate, and resultant specific impulse levels are user-selectable by adjusting propellant feed rate, pulse rate, and optionally adjustable bank voltage.

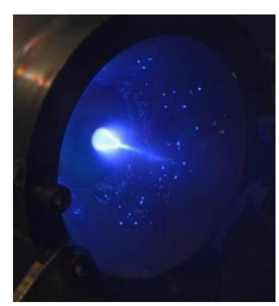


Developmental 1.1U FPPT system interface:

- Unregulated bus battery voltage to PPU
- I^2C communication protocol (other options available on request) for all thruster control and feedback
- Mounting interface designed for typical CubeSat structure via external enclosure adaptable to customer requirements





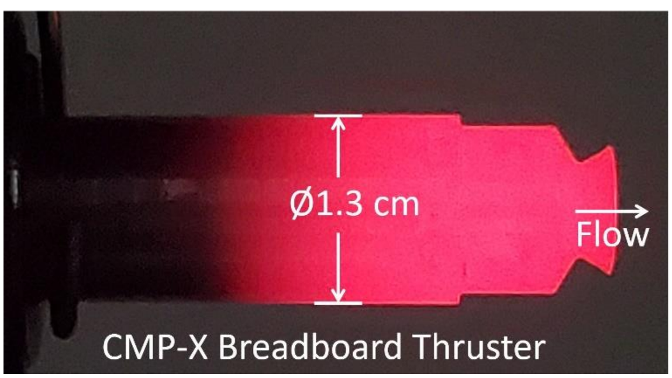


CUA | 3001 NEWMARK DRIVE | CHAMPAIGN, IL 61822
T: (217) 239-1701 | INFO@CUA.SPACE | WWW.CUA.SPACE

Monopropellant Propulsion Unit for Cubesats (MPUC) System
Low Flame Temperature Green Monopropellant
July 2021

The CU Aerospace (CUA) Monopropellant Propulsion Unit for Cubesats (MPUC) system, is a compact monopropellant thruster using a high performance, non-detonable, low-toxicity ("green") chemical monopropellant [CUA Monopropellant, formulation 10 (CMP-X)] MPUC has benign storage characteristics, uses an in-house CUA Catalyst, formulation 9, (CC-9) catalyst bed, and uses non-refractory construction materials thanks to a ~950°C flame temp. Propellant is driven by gaseous helium pressurant, providing constant fuel flow and thrust over the system lifetime. The system is readily adapted for a two-phase pressurant (self-pressurizing liquid) that can both provide constant primary fuel flow and also feed a four-nozzle cold gas ACS. High "volumetric impulse" (N-s/liter) performance levels of >1000 N-s/liter for the anticipated system and ~180 s specific impulse for the optimized thruster head will provide significant orbital maneuverability (a 6U 12 kg satellite with a 2U-sized MPUC system would see a total ΔV > 210 m/s) and also enable end of mission de-orbiting. The average power requirement is projected to be a moderate ~3 W based on previously-developed hardware. CMP-X thrusters have demonstrated 180 s specific impulse at 174 mN thrust during thrust stand testing and continuous firing times > 10 min.

Parameter / Propulsion System	MPUC (1.5U)	MPUC (2U)
Thruster System Package Volume [cm^3]	1,500	2,000
Available Tank Volume [cm^3]	770	1,220
Propulsion Technology	Monopropellant	
Propellant	H_2O_2-Ethanol	
Nominal Power Draw [W]	3	
Specific impulse [s]	180	
Mass Flow Rate [mg/s]	100	
Thrust [mN]	160	
Total impulse [N-s]	1,550	2,460
Vol. Impulse (total impulse / system volume) [N-s / liter]	1,030	1,230
Propellant Mass [g]	862	1,366
Dry Mass [g]	1,600	1,850
Propulsion System Wet Mass [g]	2,462	3,116
Delta-V capability (**Propulsion Wet Mass + 10 kg**) [s]	159	259
TRL	4 (est. 6 by May 2022)	



CMP-X Breadboard Thruster

An MPUC system equipped with CMT technology is an exceptionally compact, moderate thrust, lightweight system with very high volumetric impulse. This system offers affordable access to CubeSat propulsion and is easily scalable to larger sizes depending on mission requirements to meet needs of differing users in DOD, industry, and academia.


CC-9 in tray


CC-9 w/ 50% H_2O_2


MnO_2 w/ CMP-X


CC-9 w/ CMP-X

CUA | 3001 Newmark Drive | Champaign, IL 61822
T: (217) 239-1701 | info@cua.space | www.CUA.space

The CUA Monofilament Vaporization Propulsion (MVP) system is an electrothermal thruster that uses a space-rated plastic as propellant. This approach enables CUA to deliver competitive delta-V to CubeSat customers at a substantially lower cost and dramatically lower risk profile than traditional liquid or gaseous propulsion systems having pressure vessels. In a 1.15U form factor, MVP provides a total impulse of 334 N-s with a peak continuous thrust of 4.5 mN. A flight-like MVP passed environmental and subsystem qualification testing on a NASA Phase II SBIR program.

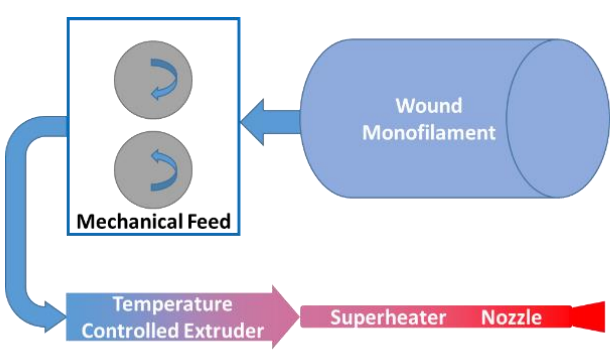
System Information	
Propulsion system volume	1.15U
System lifetime	Not propellant limited
Spacecraft temperature range	Not propellant limited
Propellant	POM, gaseous MW = 30
Propellant Mass	516 g
Total propulsion wet mass	1.14 kg
Nominal mass flow rate	7.0 mg/s
Total thrust time	22 hr
Specific Impulse	66 s
Primary Thrust	4.5 mN
Total impulse	334 N-s
Spacecraft ΔV, M(initial) = 4 kg	89 m/s
Propulsion power when firing	45 W
Propulsion power (avg. duty cycled)	13.5 W
TRL	6

TYPICAL OPERATION AND INTERFACE

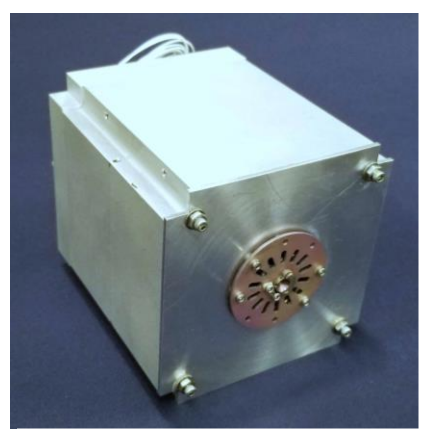
MVP draws from 3D printing technology to feed propellant. A preheat is required before firing (~3 minutes), but once warmed the "ready" state is maintained with minimal power draw and thermal loading. When firing, the system uses approximately 45 W (duty cycled average is only 13.5 W). Propellant fiber is mechanically drawn from a fixed spool into the extruder where it evaporates. Propellant metering is precise, but evaporation time results in "softer" starts and stops. As a consequence, minimum impulse bit is inherently much larger than gaseous propulsion systems with fast-actuating valves; this represents the largest trade-off for the reduced system cost, complexity, and risk.

Developmental 1.15U MVP system interface:

- Unregulated battery voltage line (for resistojet and preheat, will be **stepped down**)
- Regulated 12 V line (<2 W when firing)
- I^2C communication protocol (other options available on request)
- Mounting interface designed for typical CubeSat structure via external enclosure adaptable to customer requirements



MVP Schematic



MVP 1.15U Flight-Like System

Propulsion Unit for CubeSats

PUC-184-SO2

Product Overview

July 2020

The CU Aerospace / VACCO Propulsion Unit for CubeSats (PUC) is a complete high-performance and compact small-satellite propulsion solution. The all-welded titanium PUC comes fully integrated with all necessary propulsion subsystems, including controller, power processing unit, micro-cavity discharge thruster, propellant valves, heaters, sensors, and software. PUC is software-configurable to operate over a wide range of power, thrust, and impulse levels. System set-points, system status, and firing telemetry are all accessible and configurable through an RS422 serial interface.

The baseline 0.25U system fits within a compact 350 cm^3 volume (0.25U + “hockey puck”), providing outstanding performance for minimal CubeSat volume and mass fraction. The PUC’s 89 mm x 89 mm cross-section intentionally falls well under the CubeSat 100 mm x 100 mm specification, so as to not interfere with other CubeSat subsystems such as solar panels and magnetic torquers. For increased performance, or to meet customer specific mission requirements, the tank width may be customized. The tank may additionally be expanded from 0.25U to any desired length, providing significant potential for increased propellant capacity, i.e. delta-V capability, compared with the baseline 0.25U design.

The PUC achieves its high total impulse, low-volume capability by employing CU Aerospace Micro-Cavity Discharge (MCD) propellant heating technology, high-density and self-pressurizing liquid propellants, and an optimized low-mass-flow nozzle. PUC MCD thrusters demonstrate negligible component wear during 0.25U life cycle testing, providing constant lifetime operations. The robust MCD components permit extensive warm firing beyond the 0.25U operational life, allowing for pre-flight testing and/or increases to the PUC’s propellant tankage without impacting MCD performance or reliability.

Performance Specifications (0.25U System)

Parameter	Warm Fire Only	Cold Fire Only	Unit	Notes
Thrust	4.5	5.5	mN	Nominal
Total impulse	184	124	N-s	
Delta-V capability (4 kg CubeSat)	48	32	m/s	
Delta-V capability (3 kg CubeSat)	64	43	m/s	
Specific impulse	70	47	sec	Nominal
Maximum continuous thrust time	20	54	min	
Minimum impulse bit	---	1.0	mN-s	

CU Aerospace, L.L.C. | 3001 Newmark Dr. | Champaign, IL 61822
T: (217) 239-1701 | info@cuaerospace.com | www.cuaerospace.com

System Features

Operation:

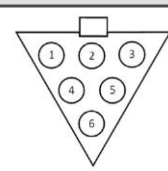
- Two operational modes:
  - Warm gas mode for high specific impulse, large total impulse manuvers.
  - Cold gas mode for minimum or small total impulse manuvers.
- Highly configurable controller for on-orbit update of system parameters, including:
  - Thrust duration
  - Plenum pressure (thrust)
  - MCD power level (specific impulse)
  - Temperature set-points
  - Fault set-points
- System status packets for health monitoring
- Regular telemetry packets during operation
- Dedicated propellant heater for continous operation below +5°C ambient temperature.
- Propellant temperature sensor for closed-loop propellant temperature regulation.
- Propellant vaporizer ensuring 100% vapor delivered from liquid storage.
- Pressure sensor (0.01 to 1.2 atm) for closed-loop propellant mass flow control and thrust throttling.
- Voltage and current sensors for closed-loop MCD power regulation, monitoring, troubleshooting, and over-current protection.
- Life span: 2 years from propellant load.

Mechanical:

- Low mass, high strength all-welded Ti-6Al-4V propellant tank.
- Reliable, frictionless VACCO valve technology:
  - Valves tested to 75,000+ cold gas firings.
  - System one-failure-tolerant against leakage.
- Volume optimized:
  - All mechanical and electrical subsystems highly integrated into tank structure.
  - Baseline unit only 0.25U.
  - Custom tank sizes available.
- Propellant fill port and firmware update header located in “hockey puck” for ease of accessibility following integration into CubeSat structure.
- Mounting: 4x 2-56 UNC-2B threaded holes

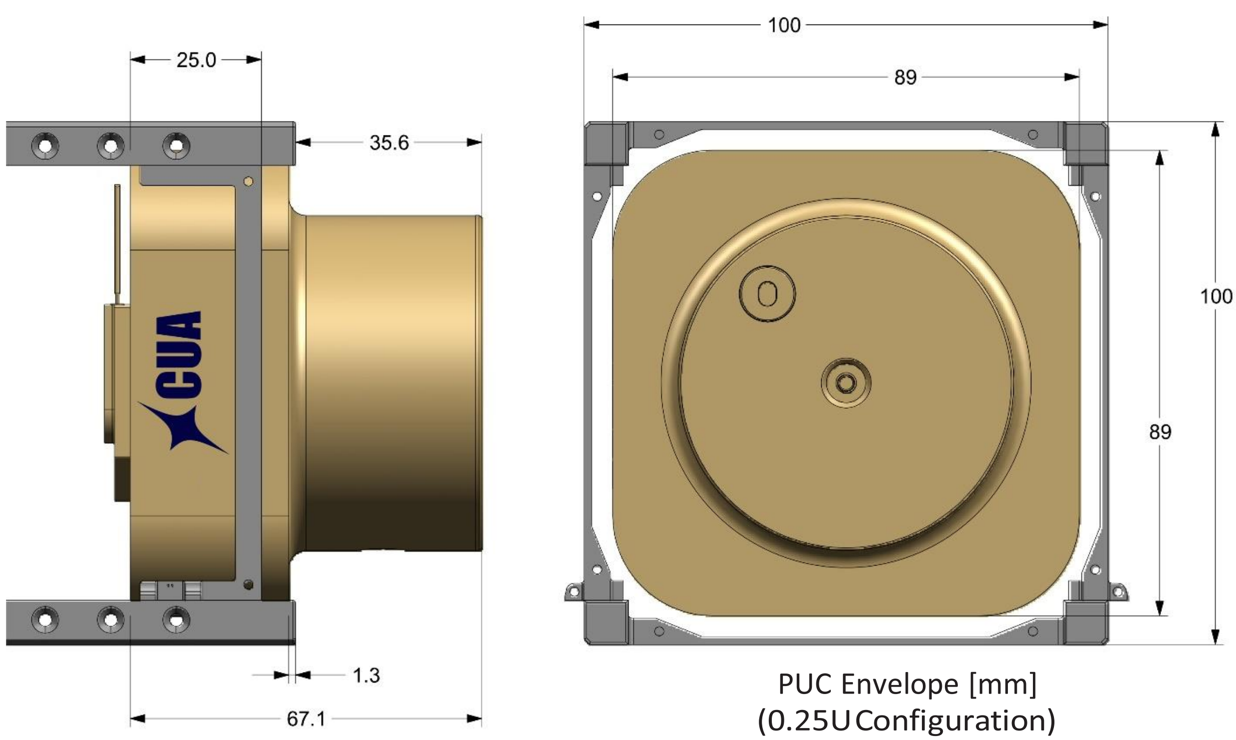
Electrical Specifications

Parameter	Minimum	Nominal	Maximum	Unit	Notes	
Operating voltage	9	11.1	12.6	V	Unregulated	
Max transient voltage			14	V		
Max in-rush current			14.5	A	> 7 amps for less than 50 µs	
DC isolation resistance	0.99	1	1.01	MΩ		
Power						
Warm Fire	12	15	18	W	User programmable	
Cold Fire	5.9	8	9.8	W	Input voltage dependent	
Standby		0.01	0.05	W		
Communication standard	RS422 (115.2 kbps)					
Electrical Wiring (Flying Leads)						
26 AWG PTFE (24” min.)	Blue	Green	Orange	Yellow	Red (x2)	Black (x2)
Purpose	RS422_Y	RS422_Z	RS422_A	RS422_B	9-12.6 V	GND
Firmware Update Header						
Pin #	1	2	3			
Purpose	3.3V	TDO	TDI			
Pin #	4	5	6			
Purpose	TMS	TCK	GND			

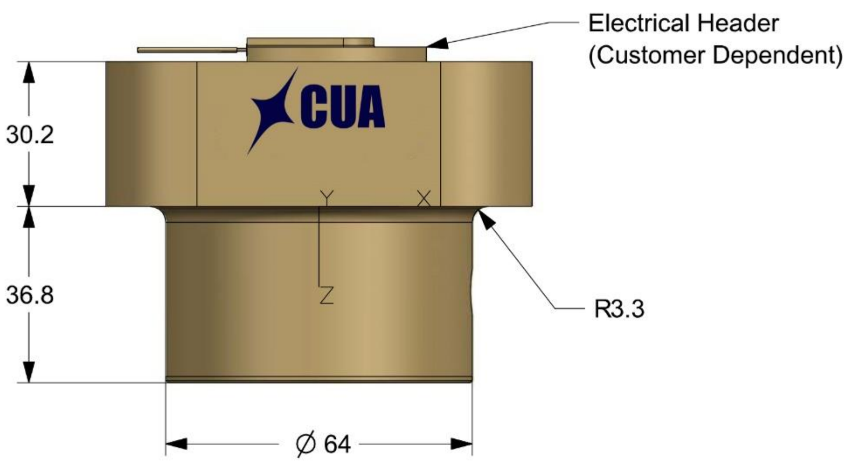


Mechanical Specifications (0.25U System)

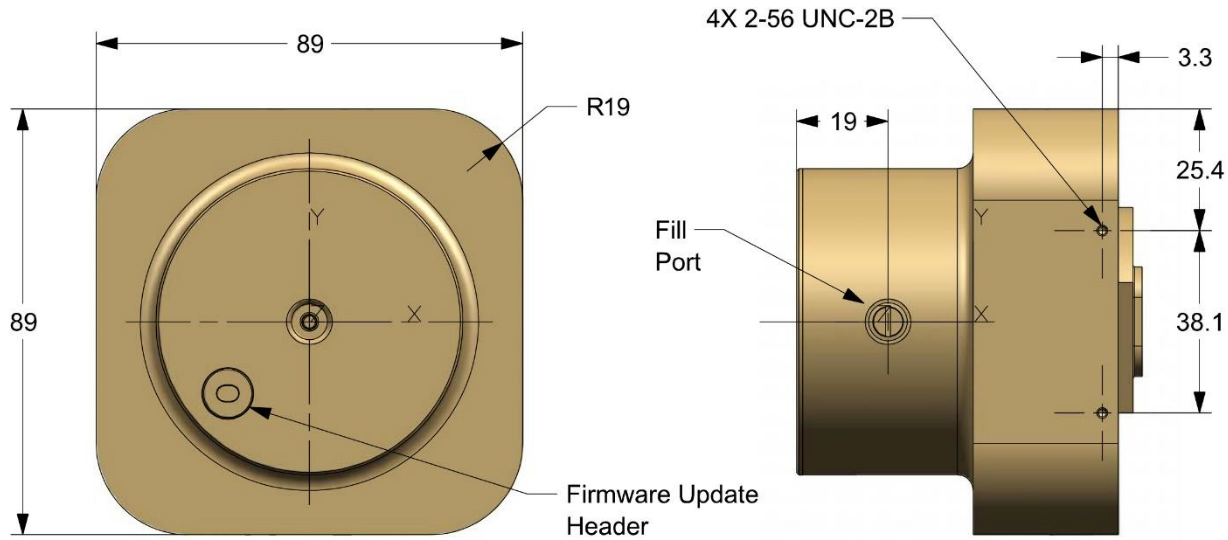
Parameter	Minimum	Nominal	Maximum	Unit	Notes
Dimensions	89 mm x 89 mm x 67 mm (0.25U + "hockey puck")				
Wet mass		718		g	nominal
Dry mass		450		g	nominal
Temperature ranges					
Operating	-13		+50	°C	
Storage w/o propellant	+5		+50	°C	recommended preflight storage
Storage w/ propellant	+5		+30	°C	recommended preflight storage
Survivability	-34		+71	°C	flight
Pressure ranges (propellant tank)					
Operating pressure	20	48	122	psia	
Proof pressure	317			psia	
Burst pressure	528			psia	
Vibe acceptance level	14			G_{RMS}	
Leak rates					
Isolation valve (NC)		5	19	g/yr	1 g/yr = 0.04 scch
Proportional valve (NC)		5	19	g/yr	1 g/yr = 0.04 scch
Mass flow regulation (throttle capability)					
Cold fire	20	100	200	%	of nominal
Warm fire	80	100	120	%	of nominal



PUC Envelope [mm]
(0.25U Configuration)



Center of Gravity Est. (Geometry as shown)		
	Dry [mm]	Wet [mm]
X	1.2	0.6
Y	0.9	0.5
Z	-1.6	-4.8



Propellant Specifications

Parameter	Value	Unit	Notes
Propellant	SO_2		High Purity Liquid Sulfur Dioxide
Propellant mass (0.25U System)	268	g	Nominal
Critical temperature	156.9	°C	
Freezing point	-75.6	°C	
Vapor pressure	48	psia	At 20°C

Sulfur dioxide (SO_2) characteristics:

- High mass density
- Self-pressurizing
- Non-flammable
- Chemically stable
- High critical temperature
- Low freezing point
- Low vapor pressure
- Commonly used refrigerant prior to the development of freons

PUC is engineered and manufactured through a partnership between CU Aerospace and VACCO Industries.

CU Aerospace, L.L.C. | 3001 Newmark Dr. | Champaign, IL 61822
T: (217) 239-1701 | info@cuaerospace.com | www.cuaerospace.com

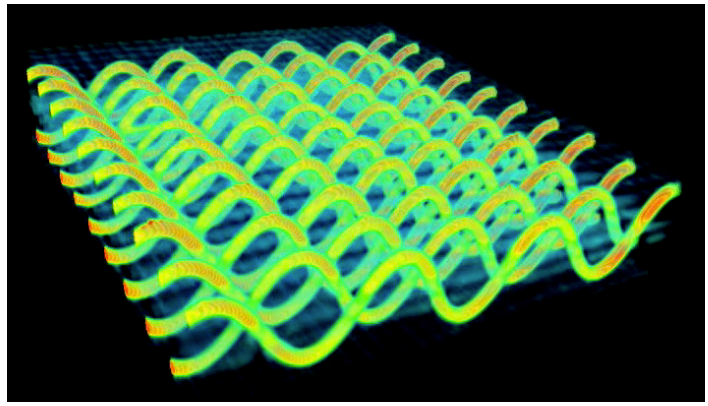
VascTech Sacrificial Polymer

October 2019

Microvascular Materials

VascTech (Vaporization of sacrificial components Technology) is a unique process developed at the University of Illinois at Urbana-Champaign (UIUC) to imbue composites with three-dimensional vasculature. This enabling technology is being commercialized by CU Aerospace (CUA) and has been expanded from high strength fibers to include filament for fused deposition printers and 3D sacrificial templates. CUA is currently examining several applications for microvascular composites such as thermal management, self-healing, re-configurable antenna, but the possibilities are endless.

VascTech Microchannels:



Fabrication entails incorporating VascTech polymers into an epoxy matrix and curing at elevated temperature. After curing, the composite is trimmed to expose the sacrificial polymer, which is subsequently vaporized by heating the sample to ~200°C under vacuum yielding empty channels and a vascular network. By circulating fluids with unique physical properties, there is the capability to create a new generation of biphasic composite materials in which the solid phase provides strength and form while the fluid phase provides interchangeable functionality.

Products:

CUA is currently selling developmental quantities of VascTech polymers including:

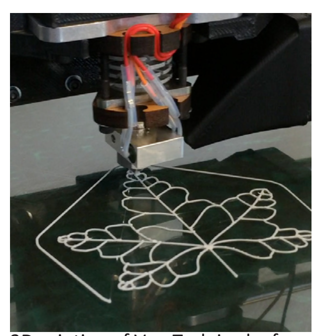
- High strength fibers (typically with diameters of 300 to 500 microns)
- Extruded sheets (15, 20, or 32 mils thickness and 7 inch width)
- Filaments for 3D printers (1.75 or 3 mm diameter)
- 3D sacrificial templates

Note that VascTech works best with an epoxy matrix that gels at lower temperature but can then be post-cured up to 180°C. VascTech has also shown to be compatible with a silicone matrix to produce microvascular networks in a flexible matrix.

In addition to selling the VascTech polymer, CUA can provide consulting, modeling, and manufacturing support as needed for this enabling technology. Contact us for pricing and additional information.

High-strength VascTech fibers

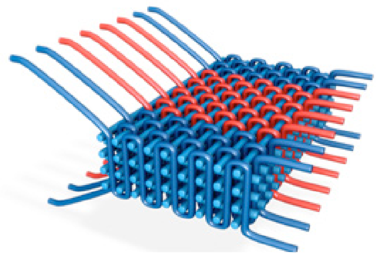
Extruded VascTech sheets

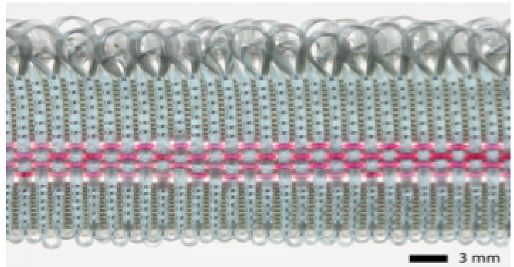


3D printing of VascTech ivy leaf geometry

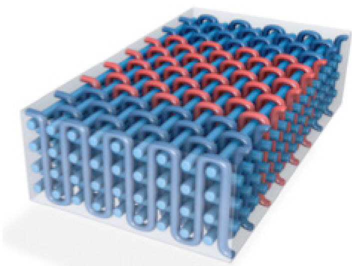
CUA | 3001 Newmark Drive | Champaign, IL 61822

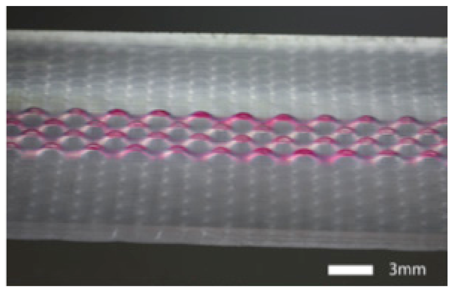
T: (217) 239-1701 | info@cua.space | www.vasctech.us



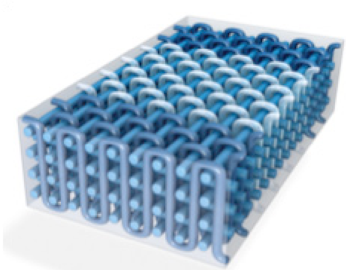


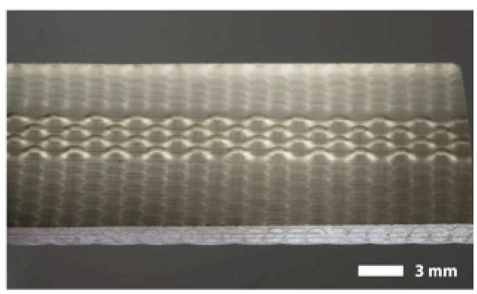
1. Catalyst infused polylactic acid (PLA) sacrificial fibers woven into preform.



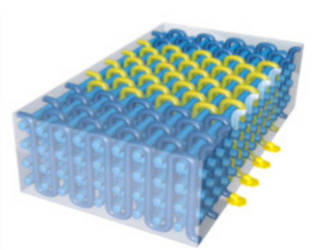


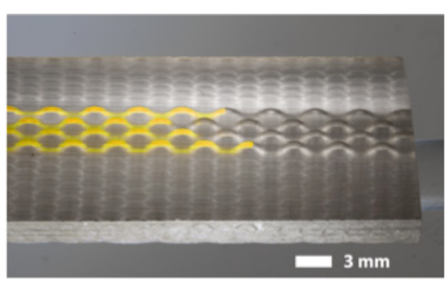
2. Infused with epoxy via Vacuum Asisted Resin Transfer Molding (VARTM).





3. PLA evacuation by heating at 200 deg. C for 12 hours under vacuum.





Actual fluid flow.

4. Vascular architectures enable dynamic, multipurpose, and reprogrammable functionality.

DISTRIBUTED AND SCALABLE IMU (DSIMU)

OCTOBER 2019

The CU Aerospace (CUA) Distributed and Scalable IMU provides a decentralized and resilient inertial measurement system for spacecraft through the use of multiple, distributed MEMS inertial sensors and software that provides for calibration and high-performance sensor fusion. The adaptable DSIMU system steps beyond the traditional co-located triaxial accelerometer and gyroscope arrangement, expanding spacecraft configuration flexibility, enhancing resilience through redundancy and providing the ability to build a gyroscope-free IMU. Tailored sensor placement can provide enhanced capabilities on-orbit such as newly observable states, jitter detection and source determination, as well as noise reduction and bandwidth extension through advanced sensor fusion. The DSIMU is presently in development through a NASA Phase I STTR.

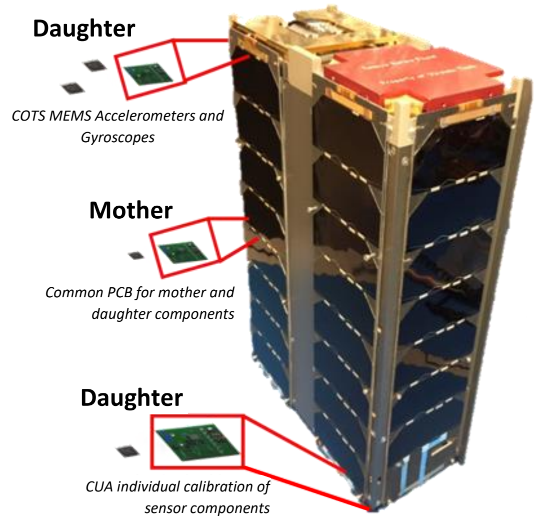
Package Options
DSIMU Baseline Package w/ 4 Sensors
DSIMU RadHard Electronics Package w/ 4 Sensors
DSIMU Expanded Package w/ 10 Sensors
DSIMU RadHard Expanded Package w/ 10 Sensors
Calibration Package
Software License (no hardware)

FEATURES

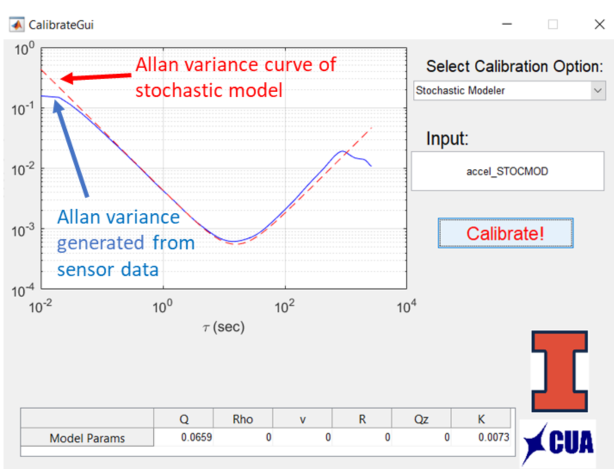
The CUA DSIMU package consists of a mother board that connects to daughter boards via DF13 connectors. Each board can contain all three axes of accelerometer and gyroscope measurements. In the current DSIMU prototype, up to six daughter boards can be connected to the mother board. Packages will include a radiation hardened option.

Additional features include:

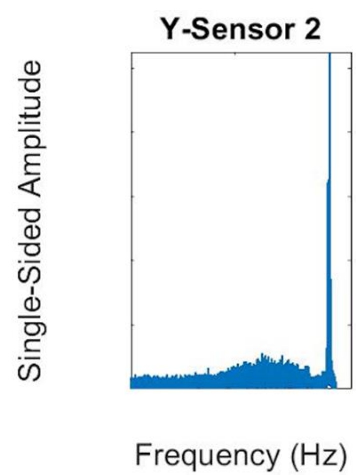
- A software license that provides the CUA calibration GUI.
- The option for individually calibrated MEMS sensors for optimal sensor fusion.
- SDK includes built-in functions for gyroscope-free IMU configurations and jitter identification and isolation.



Our initial board concept includes mother and daughter boards that can be distributed throughout a spacecraft.



Software license includes GUI for customer calibration and alignment.



Unique frequency domain patterns generated by a distributed set of accelerometers and gyroscopes can be used for jitter identification and isolation.