

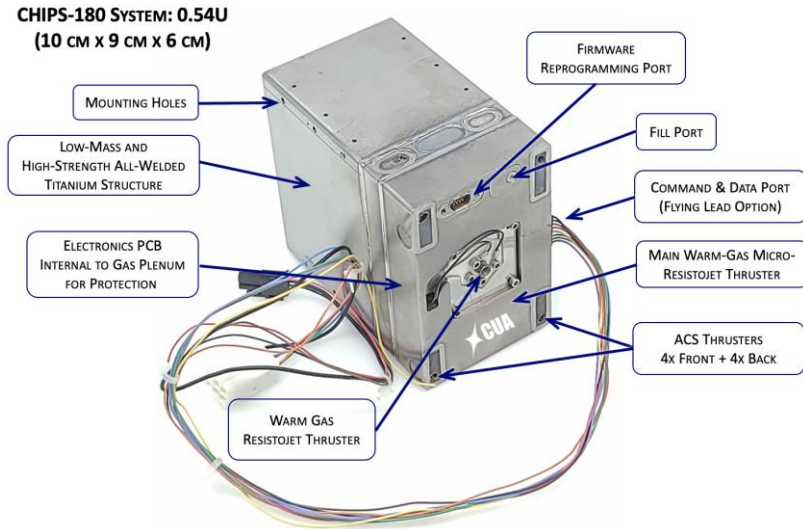


# Cubesat High Impulse Propulsion System (CHIPS)

## System Overview

June 2023

The CU Aerospace (CUA) 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 (superheater) technology with proven valving cycled to >120 million actuations 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 low system temperature rise (~1°C) over 10-minute operating cycles.



The illustrated CHIPS-180 is an ultra-compact 0.54U fully-throttleable system (10 cm x 9 cm x 6 cm package size) having 180 N-s of total impulse with self-pressurizing R134a propellant. System set-points, system status, and firing telemetry are all accessible and configurable through a customizable interface port. CHIPS technology can be customized in size to meet customer-specific mission requirements. CHIPS can also be packaged as a cold-gas-only system requiring reduced power, but with a total impulse penalty of approximately 25-30%. The CHIPS package can incorporate up to 8 ACS thrusters for 6 degree-of-freedom (6DOF) operation.

## Performance Specifications

Parameter	CHIPS-180	CHIPS-500	CHIPS-1000	Units
Thruster System Package Volume	540 (6 x 9 x 10)	1,300 (13 x 10 x 10)	2,500 (12.5 x 20 x 10)	cm <sup>3</sup>
Propellant Mass	277	770	1,513	g
System Wet Mass	1,027	1,835	3,130	g
Power Draw (when thrusting)	20	25	30	W
Mass Flow Rate	23 [34]	45	45	mg/s
Thrust	15 [15]	25 [18]	31 [21]	mN
Specific Impulse	67 [45]	69 [46]	70 [46]	s
Total Impulse	176 [118]	505 [350]	1,030 [715]	N-s
Volumetric Impulse	326 [218]	387 [270]	410 [285]	N-s/liter
Maximum Continuous Thrust Time	10	10	10	min
Minimum Impulse Bit	< 0.1	< 0.1	< 0.1	mN-s

*Note: values in square brackets [xx] represent performance when run in cold gas mode.*

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

Information contained in this document should not be used for design purposes, but for informational purposes only. CU Aerospace reserves the right to update the specification sheet without notice.

# System Features

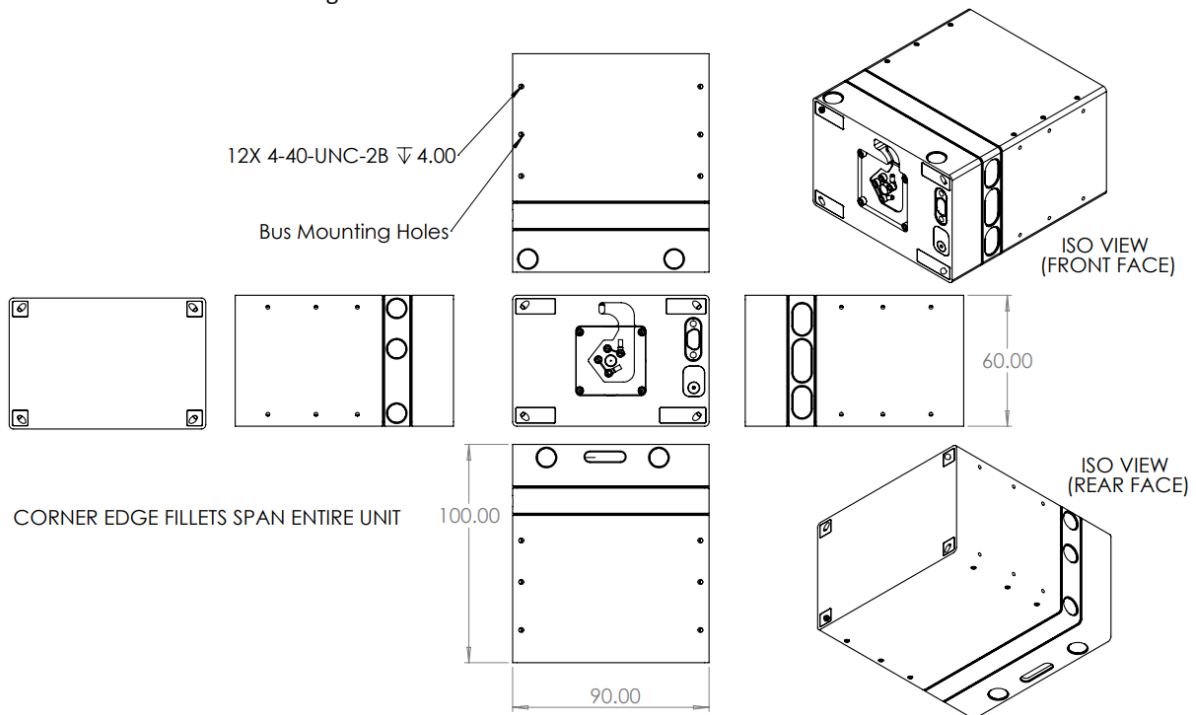
## Operation:

- Two operational modes:
  - Warm gas mode for higher specific impulse, large total impulse maneuvers.
  - Cold gas mode for minimum or small total impulse maneuvers.
- Overall control authority: roll, pitch, yaw,  $\pm X/Y/Z$ 
  - 6 Degree of Freedom (6DOF) achievable with 8 ACS thrusters
- Highly configurable controller for on-orbit update of system parameters, including:
  - Thrust duration
  - Plenum pressure (thrust)
  - Superheater power level (specific impulse)
  - Temperature set-points
  - Fault set-points
- Telemetry and system status packets for health monitoring
- Dedicated propellant heaters for continuous operation below 0°C ambient temperature
- Propellant temperature sensor for closed-loop propellant temperature regulation
- Propellant vaporizer ensuring 100% vapor delivered from liquid storage
- Pressure sensor for closed-loop propellant mass flow control and thrust throttling

- Voltage and current sensors for closed-loop power regulation, monitoring, troubleshooting, and over-current protection.
- Life span: 3+ years from propellant load.

## Mechanical:

- Low mass, high strength all-welded Ti-6Al-4V (Grade 5) propellant tank
- Reliable valve technology:
  - Valves tested to >120,000,000+ cold gas firings retaining low leak rate  $\leq 1 \times 10^{-4}$  scc/sec for GHe
  - System is two-fault-tolerant against leakage
- Volume optimized:
  - All mechanical and electrical subsystems highly integrated into tank structure
  - Miniaturized system only 0.54U
  - Custom tank sizes available
  - Self-contained electronics control board enclosed in gas plenum
- High-density, self-pressurizing R134a baseline (R236fa alternate) propellant
  - Green, non-toxic, non-flammable and inert
  - Chemically stable, high critical temperature, low freezing point, and low vapor pressure



## 0.54U CHIPS WITH 1 PRIMARY & 8 ACS THRUSTERS

Dimensions 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.

CU Aerospace, L.L.C. | 3001 Newmark Dr. | Champaign, IL 61822

T: (217) 239-1701 | info@cuaerospace.com | www.cuaerospace.com

Information contained in this document should not be used for design purposes, but for informational purposes only.

CU Aerospace reserves the right to update the specification sheet without notice.