

# HYDROS™ -M

'Green' High-Performance Propulsion for MicroSats



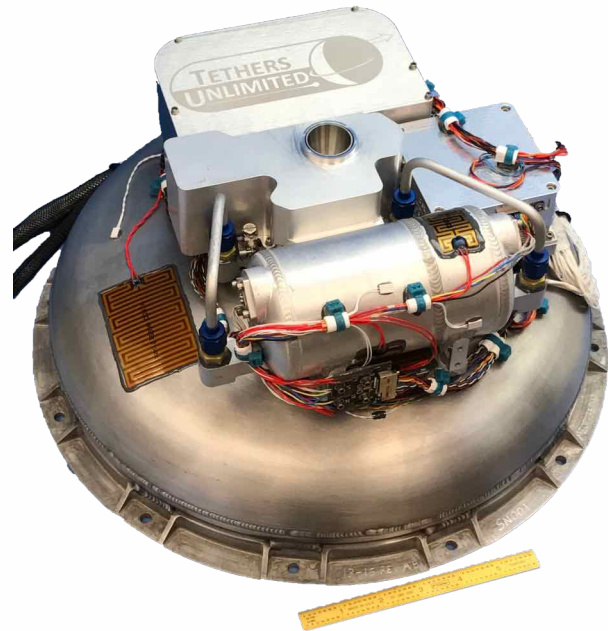
Transformative Technologies  
for Space, Sea, Earth, & Air

HYDROS-M provides: high impulse, high thrust, flexible propulsion, and delivers 'bolt-on' orbit agility for MicroSats. HYDROS-M is powered by a safe, storable, and non-toxic 'green' propellant – **water** – which is electrolyzed on orbit to deliver high performance bipropellant propulsion.

## Capabilities

HYDROS is a novel high-TRL propulsion architecture that uses a hybrid electrical/chemical scheme to provide small spacecraft with both high thrust ( $\geq 1.5$  N) and high  $I_{sp}$  ( $\geq 310$  s) propulsion. HYDROS propulsion systems enable secondary payloads to perform missions requiring orbit agility and large  $\Delta V$ s while launching with the ultimate 'green' propellant: **water**. Once on orbit the HYDROS system splits the water propellant using electrical power to produce hydrogen and oxygen gas which is then combusted in a bipropellant thruster.

- Sized to fit within the keep-in zones of 15" diameter launch vehicle separation ring.
- Flexible system CONOPS allows HYDROS to scale performance to meet mission imposed power limits.



## Performance

HYDROS-M delivers high performance bipropellant propulsion in bolt-on system which is readily adapted to any microsatellite bus.

- Can be mounted within a launch vehicle separation ring with the addition of a truncated 'propulsion interface' cone.
- Provides the same performance as a 6.5 mN continuously operated thruster
- Stores over 6L of water in a freeze tolerant tank
- Provides  $\sim 200$  m/s of  $\Delta V$  for a 100kg Spacecraft

Metric	Value
Impulse per Thrust Event	$> 1.75$ Ns
$I_{sp}$	$> 310$ s
Average Thrust	$> 1.2$ N
Minimum Time to Refill Plenums	269 s
Water Capacity	6.2 kg
Total Number of Thrust Events	10,300
Total Impulse Delivered	$> 18,023$ Ns

## Specifications

- $>3$  year LEO mission design life
- Scalable power consumption
  - 2W active standby
  - $< 5$ W survival heater
  - As little as 7 W operational power
- High level command interface
  - RS-422
  - Ethernet
  - Other options available
- SWaP

Metric	Base Thruster
Mass	12.6 kg Wet (6.4 kg Dry)
Size	$\varnothing 381$ mm x 191 mm
Power	7 W – 40 W

TRL 6+ | Flight Units Available NOW!

# HYDROS™ -C

'Green' High-Performance Propulsion for Small Satellites



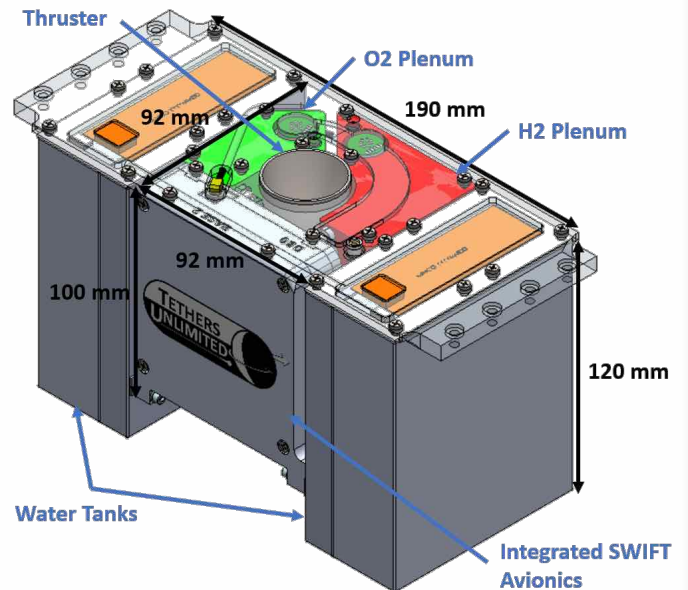
Transformative Technologies  
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HYDROS-C provides: high impulse, high thrust, flexible propulsion, and enables orbital agility for CubeSats and other small satellites. HYDROS-C utilizes a safe, storable, and non-toxic 'green' propellant – **water** – which is electrolyzed on orbit to deliver high performance bipropellant propulsion.

## Capabilities

HYDROS is a novel high-TRL propulsion architecture that uses a hybrid electrical/chemical scheme to provide small spacecraft with both high thrust ( $\geq 1.5$  N) and high  $I_{sp}$  ( $\geq 310$  s) propulsion. HYDROS propulsion systems enable secondary payloads to perform missions requiring orbit agility and large  $\Delta V$ s while launching with the ultimate 'green' propellant: **water**. Once on orbit, the HYDROS system splits the water propellant using electrical power to produce hydrogen and oxygen gas and then combusts these gases in a bipropellant thruster.

- Scalable tankage options are readily optimized to meet mission  $\Delta V$  requirements.
- Flexible system CONOPS allows HYDROS to scale performance to meet mission-imposed power limits.



## Performance

HYDROS-C delivers high performance bipropellant propulsion in a  $< 1$  U form factor.

- Provides the same performance as a 2.1 mN continuously operated thruster

A 2U 'Saddle Bag' tank configuration has been developed to be readily integrated into a variety of CubeSat and SmallSat configurations.

- 2x H<sub>2</sub>O Tanks store 740g of water propellant
  - Freeze tolerant design
- Provides  $\sim 200$  m/s of  $\Delta V$  for a 6U CubeSat

Metric	Value
Impulse per Thrust Event	$> 1.75$ Ns
$I_{sp}$	$> 310$ s
Average Thrust	$> 1.2$ N
Minimum Time to Refill Plenums	825 s
In 2U 'Saddle Bag' Configuration	
Water Capacity	0.74 kg
Total Number of Thrust Events	1,230
Total Impulse Delivered	$> 2,151$ Ns

## Specifications

- $> 3$  year LEO mission design life
- Flexible mounting options
  - Flanges for deck mounting
  - Ears for rail mounting
- Scalable power consumption
  - 2W active standby
  - $< 5$ W survival heater
  - As little as 5W operational power
- High level command interface
  - RS-422
  - Ethernet
  - Other options available
- Low SWaP

Metric	2U 'Saddlebag' Configuration	Base Thruster
Mass	2.6 kg Wet (1.87 kg Dry)	1.02 kg (Dry)
Size	$\sim 2$ U (190 x 120 x 92 mm)	$\sim 1$ U (92 mm <sup>3</sup> )
Power	5 W – 25 W	

**Flight Qualification Targeted for Q4 2017! Flight Units Available Q1 2018!**