

# BET-MAX

## Electrospray Thruster System

High-resolution compact electrospray thrusters enabling precise, low noise attitude and orbital control.

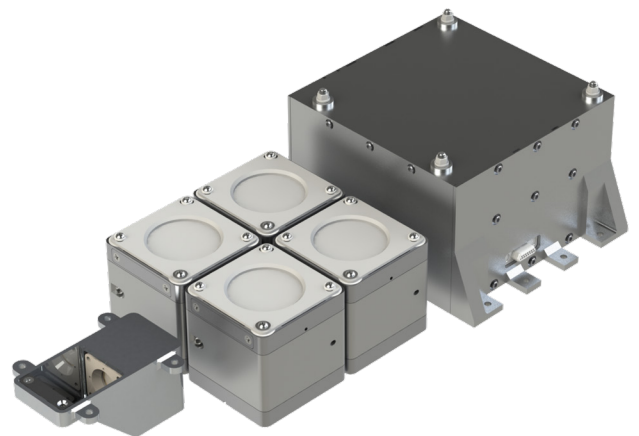
**Extremely precise thrust control on the order of nano-Newtons for pointing accuracy that exceeds reaction wheels by 100x.**

Busek's BET-MAX precision reaction control system provides the high-resolution control by using electrospray propulsion technology. Up to four 125 cm<sup>3</sup> BET-300-P thrusters per centralized PPU can be positioned as desired to provide attitude or orbital control within platforms as small as 3U.

Each thruster can provide throttled continuous thrust from <math>1\mu\text{N}</math> up to

Table: Standard Specifications

<b>Input Voltage:</b>	28 V (customizable)
<b>Pressurant:</b>	None
<b>System Power:</b>	Configuration dependent
<b>System Mass:</b>	0.8 kg BOL
<b>Interface:</b>	RS-485
<b>System Volume:</b>	1250 cm <sup>3</sup> (electronics, 4 thrusters, cathode)



### Mission Application Examples:

#### Spacecraft Attitude Control:

- Ultra-precise spacecraft pointing
- Deep space reaction wheel de-saturation

#### Disturbance Compensation:

- LEO drag compensation
- Gravity science

#### Precision Pointing Applications:

- Exoplanet / stellar observations
- Situation awareness
- Laser communications

#### Formation Flight:

- Non-Keplerian orbits
- Inspection / service
- Occultation sources
- Distributed apertures

## Thruster

The BET-MAX system consists of four BET-300-P passively-fed electro spray thrusters, one long-life and propellant-less Carbon Nanotube Field Emission Cathode (CNTFEC), controlled from a common set of electronics. The thrusters can be ganged in a common thrust vector for translational thrust, or easily distributed across a spacecraft for precision pointing applications.

Individual thrusters can provide throttled continuous thrust from <1uN up to 150uN, with sub-uN thrust noise (0.2uN/rtHz) over the full range of operational settings. Impulsive operation is also possible, with a minimum impulse of 2uNs.

Each individual thruster assembly includes integrated propellant storage and feed system sufficient for ~90Ns of total impulse (scalable tanks are available). Multiple engineering model thrusters have been subjected to and successfully passed environmental testing followed by full demonstration of total impulse capability.

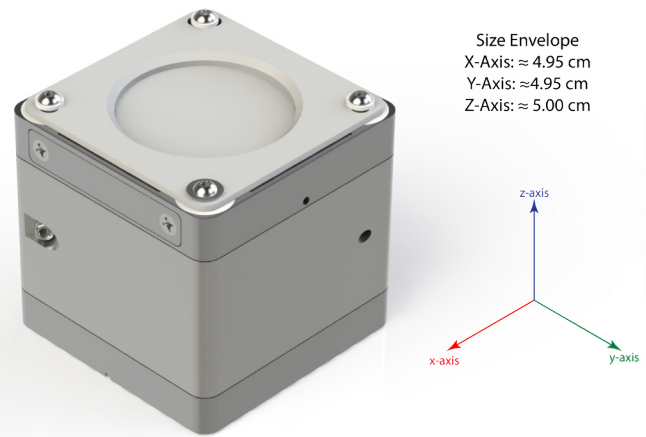


Table: BET-300-P Configurations

	Configuration A	Configuration B
<b>Propellant:</b>	EMI Im	EMI Im
<b>Nominal Thrust:</b>	55 $\mu$ N	55 $\mu$ N
<b>Maximum Thrust:</b>	150 $\mu$ N	100 $\mu$ N
<b>Minimum Impulse Bit:</b>	2 $\mu$ Ns	2 $\mu$ Ns
<b>Specific Impulse:</b>	850 seconds	2300 seconds
<b>Efficiency:</b>	28%	45%
<b>Total Impulse:</b>	92 Ns*	250 Ns**
<b>Wet Mass:</b>	166 g	166 g
<b>Volume:</b>	118 cm <sup>3</sup>	118 cm <sup>3</sup>
<b>Nominal Power:</b>	0.85 W	1.38 W
<b>Maximum Power:</b>	2.25 W	2.50 W
<b>System Nominal Power:</b>	12 W	14 W
<b>System Max Power:</b>	24 W	24 W

\*Demonstrated, \*\*Pending, 50Ns demonstrated to date, test ongoing

## Cathode and PPU

Flight model power processing unit (PPU) electronics include an integrated digital control interface unit with communication to the spacecraft via RS-422; each PPU is capable of driving up to four thrusters simultaneously, and independently across discrete channels.

Spacecraft charge neutralization is achieved using Busek's patented and flight qualified 1/2" CNTFEC. Integrated DCIU functionality include both real-time and scripted operation, with integrated thrust control modes.

