ENPULSION NANO

For **15 years**, FOTEC has followed a **technology push from ESA** developing a FEEP propulsion technology for a precise orbit control of scientific satellites in formation flight. This very mature and worldwide unique technology is meeting a **strong need in an emerging market of satellite constellations** (hundreds of small satellites performing a task together). ENPULSION has been founded as a Spin-Out together with FOTEC to meet this market demand by preparing to scale the production of this thruster to several hundred units per year.

FLIGHT HERITAGE

The *ENPULSION NANO* was successfully verified in orbit in early 2018, performing independently confirmed orbit changes. More than 100 propulsion units have been launched on various spacecraft by early 2022.

DYNAMIC PRECISE THRUST CONTROL

The thrust can be controlled through the electrode voltages, providing excellent controllability over the full thrust range and a low thrust noise.

MATURE TECHNOLOGY

The *ENPULSION NANO* is a mature technology, developed under ESA contracts for 15 years. In this time more than 100 emitter have been tested and an ongoing lifetime test has demonstrated more than 20,000 h of firing without degradation of the emitter performance.

CONTROLLABLE SPECIFIC IMPULSE UP TO 6,000 S

Due to the efficient ionization process, which allows the capacity to ionize up to 60% of the evaporated indium atoms, the *ENPULSION NANO* can provide a higher specific impulse than any other ion propulsion system currently on the market.

SAFE AND INERT SYSTEM COMPLIANT DURING LAUNCH

The *ENPULSION NANO* contains no moving parts and the propellant is in its solid state at room temperature. Avoiding any liquid and reactive propellants as well as pressurized tanks significantly simplifies handling, integration and launch procedures.

REDUNDANT NEUTRALIZER CATHODES

As the *ENPULSION NANO* expels an ion current of up to 4 mA, the module needs means to prevent spacecraft charging. This is achieved by the use of two electron sources acting as neutralizers. Once electrons have left the neutralizer, they will be pulled towards the positive potential of the ion plume. The PPU is able to measure and control this charge balancing electron current.

COMPACT BUILDING BLOCKS

The *ENPULSION NANO* is used as a compact pre-qualified building block to provide custom solutions at a commodity price and ultra-short lead times. Although building blocks are completely self-contained propulsion systems, the whole cluster can be operated as a single plug-and-play unit.

ENPULSION
NANO

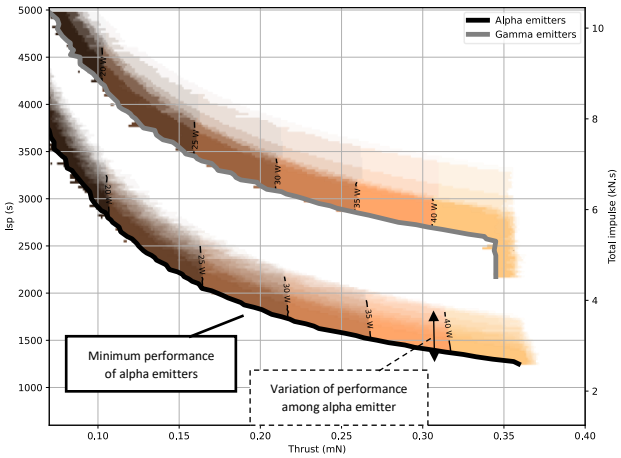
PROPERTIES AND PERFORMANCE

While the required power to operate the *ENPULSION NANO* starts at around 10 W, at higher thrust levels one can choose between high-thrust and high-specific-impulse operation. The *ENPULSION NANO* can operate at an I_{sp} range of 1,500 to 5,000 s.

At any given thrust point, higher I_{sp} operation will increase the total impulse, while it will also increase the power demand. The thruster can be operated along the full dynamic range throughout the mission. This means that high I_{sp} and low I_{sp} maneuvers can be included in a mission planning, as well as high-thrust orbit maneuver and low-thrust precision control maneuvers. The firmware of the *ENPULSION NANO* has been optimized with lessons learnt from in-orbit verification.

DYNAMIC THRUST RANGE[1]	10 TO 350 µN
NOMINAL THRUST	330 µN
SPECIFIC IMPULSE	1,500 TO 5,000 s
PROPELLANT MASS	220 g ± 5%
TOTAL IMPULSE[2]	> 5,000Ns
POWER AT NOMINAL THRUST	40 W INCL. NEUTRALIZER
OUTSIDE DIMENSIONS	100.0* x 100.0* x 82.5 mm
MASS (DRY / WET)	680 / 900 g
TOTAL SYSTEM POWER	8 – 40 W
HOT STANDBY POWER[3]	3-5 W
COMMAND INTERFACE	RS422/RS485
SUPPLY VOLTAGE	12 V, 28 V, OTHER VOLTAGES UPON REQUEST

*) can be customized



Depending on available power the user can choose from any operational point - data shown is for 12 V configuration

Since the founding of the company in 2016 we have delivered to customers hundreds of thrusters, more than 100 of which are currently in space. We have, therefore, developed an empirical understanding of the intrinsic variation of the performance and parameters of emitters in these thrusters in their production process and in their application in different types of missions. This enables us, starting from January 1st, 2022, to offer you our new Emitter Selection Service which allows you to select between three distinct types of crown emitters.

- Alpha (α) emitters provide the best balance between price, performance, and guaranteed delivery times. This is the perfect solution for commercial constellation applications.
- Beta (β) emitters are the best solution whenever cost optimization is your most important driver.
- Gamma (γ) emitters are hand-picked for their guaranteed peak performance and are especially appropriate for your missions in deep space, exploration, and others where emitter output needs to be taken to extremes

[1] The ENPULSION NANO can be operated at a wide range of thrust and specific impulse, depending on the power level available. The operational envelope is based on total system power including typical heater and neutralizers consumption. Performances shown above correspond to maximum thrust to power curves for different grades of emitters.
[2] Strongly depends on emitter option. See performance map for selection options.
[3] Depends on accommodation and resulting thermal environment