SMALLSAT PROPULSION OVERVIEW

AURORA OFFERING FOR 50-500 KG SATELLITES

INTRODUCTION

This document overviews the technical capabilities provided by Aurora Propulsion Technologies for SmallSats in the 50-500 kg mass bracket.

This document is divided into two sections:

- Plasma Brake products, and
- Thruster products

The stated prices are non-binding Rough Order-of-Magnitude estimates and may change depending on product variant, customization and purchase volume.

This document was updated 2025-06 and information is valid for 3 months.

GENERAL INFORMATION

Company name	Aurora Propulsion Technologies
Address	Otakaari 5, 02150 Espoo, Finland
Contact	sales@auroraapt.fi or firstname.lastname@auroraapt.fi

Standard deliverables	Our list prices include by default the following deliverables: 1 Flight Model 1 FlatSat Model for electrical interface testing 1 Mechanical Mock-up for mechanical interface testing On-premise integration support: typically 2 people for 2-3 days (travel expenses and delivery, taxes, customs etc covered by customer)
Warranty & support	Warranty given for acceptance testing and other approved tests by the customer prior to launch, limited to 3-6 months. Customer support included throughout integration, including on-premise support. During operations, basic support included; engineering work such as software update available at hourly pricing.
Export control	Not under ITAR. Finnish export control applies: a light process that requires end user information.

PLASMA BRAKE PRODUCTS

THEORY

The Plasma Brake, or “electrostatic tether”, is a propellantless tether-based deorbiting system. It uses a thinner-than-hair aluminum tether that is deployed from the satellite and charged to a high voltage (nominally –1000 V). The electric field generated interacts with the environmental plasma, redirecting it and hence exchanging momentum, which generates a drag force (known as Coulomb Drag). This system has been studied in the academia; this site lists the publications on the topic (including the electric sail which is the same device utilized in the Solar Wind instead of LEO).

AUTONOMY

The Plasma Brake is uniquely suitable for autonomous deorbiting as it can be built to be deployed even if the satellite is dead on arrival. This was explored in a recently finished ESA CleanCube project “Charon”. Various levels of independence can be chosen from:

1. full dependence on the platform
2. independence of the ADCS
3. independent decision making (allowing the system to deploy in case of satellite ground link communication failure)
4. full independence of even the power system of the host spacecraft.

EFFECTIVENESS

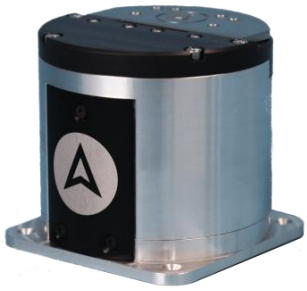
The drag force generated is enough to deorbit the satellite in 0.5 - 5 years, but not high enough to allow controlled deorbiting, limiting its use to designed-for-demise satellites that fully burn up in the atmosphere upon re-entry.

The factors affecting the drag force magnitude are

- Tether length (linear effect on drag force)
- Altitude (near linear up to ~1000 km – not exponential like aero drag)
- Solar cycle (up to 10x effect between extremes)
- (Tether voltage (square root effect on drag force))

Aurora has a simulation framework that estimates the deorbit duration using actual historical orbital plasma density data, allowing for reliable analysis of system performance.

PRODUCT: SMALL PLASMA BRAKE



Two sizes of systems exist, with the small one currently in TRL 8 (due for launch in October 2025). It's designed to fit in a CubeSat but will be functional for satellites up to ~100 kg as-is on most orbits. Additionally, with small alterations the system can be made applicable for satellites up to 200 kg. This variant is deployed by spinning: the centrifugal force pulls out the tether from the reel. It requires adding angular momentum, as the moment of inertia of the system increases when the tether is deployed; hence using reaction wheels is not sufficient for the initial spin. However, the spin can be either generated by the platform magnetorquers, or an Aurora ARM-C thruster installed with the Plasma Brake.

Small Plasma Brake Specifications given in the table below. Example customized values are also provided for a possible SmallSat-compatible system, including an extended tether length and reduced spin rate.

Item	Value off-the-shelf	Example customized value
Initial spin rate	5-10 deg/s	2-4 deg/s
Satellite mass range (for 5 year deorbit)	Up to 120 kg (550 km) Up to 75 kg (700 km)	Up to 250 kg (550 km) Up to 150 kg (700 km)
Total impulse	Unlimited (no propellant required)	
Thrust level	Varies (the relevant question is deorbit duration)	
Power consumption	0.5 W during deorbiting	1 W during deorbiting
System mass	0.45 kg	1 kg
System volume	80 mm diameter, 75 mm depth	100 mm ^3
Redundancy	Typical CubeSat known-to-be-good COTS components used, for example FRAM MCU	Redundancy or rad-hardness can be included (critical rad-hard components already identified)
Power interface	12 V, 3v3	
Data interface	Proprietary RS-422	Your specification
Command	Password needed to allow deployment to prevent accidental triggering	(Watchdog-based autonomous deployment is possible)
TRL	8 (launch October 2025)	Prior versions launched earlier but not deployed due to platform failures
Spin rate generator	Satellite ADCS	Included thruster
Autonomy	No autonomy	Auto-spin and auto-trigger
Lead time	6 months	12-24 months

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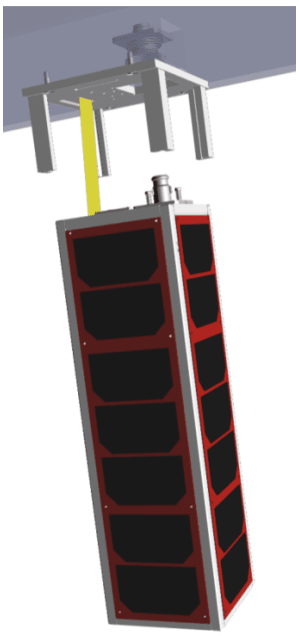
PRODUCT: LARGE PLASMA BRAKE



The larger Plasma Brake system is designed for the 50-500 kg class of satellites. It can host a tether up to 5 km in length and does not require spinning the satellite. Instead, it uses gravity gradient to stabilize the tether. This system has higher performance and poses less requirements on the platform, but is at a lower TRL and is more complex. The system is being developed under an ESA ARTES program contract, reaching TRL 6 in 2026.

Instead of deploying an end mass from the satellite, the whole module ("Remote Unit") detaches and leaves the tether between itself and the satellite (the "Base Unit" staying on the side of the satellite). This allows it to generate a large enough gravity gradient. The voltage is hence generated by the Remote Unit fully independently, continuing the deorbiting even if the satellite experiences a failure.

Item	Nominal value
Satellite mass range (for 5 year deorbit)	Up to 1000 kg (550 km) Up to 500 kg (700 km)
Total impulse	Unlimited (no propellant required)
Thrust level	Varies (the relevant question is deorbit duration)
Power consumption	None (independent power generation)
System mass	4 kg
System volume	300*130*100 mm^3
Lifetime	Not defined (no inherent limiter such as propellant)
Redundancy	Fully redundant: 95 % reliability requirement by ESA
Data interface	Proprietary RS-422 (prior to deployment only)
Command	Password needed to allow deployment to prevent accidental triggering
TRL	4 (6 in 2026; looking for IOD in 2027)
Autonomy	Nominally requires ADCS to point and stabilize prior to deployment but otherwise independent
Lead time	First delivery 2027-Q1; expected lead time 9 months

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THRUSTER PRODUCTS

RESISTOJET THRUSTER

The technology is the resistojet thruster, warm-gas thruster designed for water but capable of supporting multiple propellants. Its baseline specifications with water are 1.5 mN steady-state thrust at 7-8 W of power and up to 100 s of Isp. For SmallSats, its main use is for collision avoidance, attitude control or proximity operations, often as an auxiliary thruster system to a high-Isp main thruster. It can feed propellant from the same system (Xenon HET + 4*resistojet demo launched in 2023), allowing for additional capabilities at minimal cost, volume and mass overhead.

A larger variant of the thruster is under development, targeting a 10 mN thrust level with improved Isp.

The ARM family of products (Aurora Resistojet Module) all utilize the same thruster in different configurations of tank, electronics, and number and direction of thrusters.

A total of 10 thrusters have flown on two CubeSat missions (AuroraSat-1 in 2022 and Strider in 2023), with 4 more flying in October 2025.

The systems are typically delivered pre-fueled, with the fuelling interface welded shut. Alternatively, on-premise propellant top-up can be supported, performed either by Aurora or by customer.

PRODUCT: ARM-C

Aurora Resistojet module for Collision avoidance

The ARM-C is the smallest variant of the ARM product line, at < 0.1 kg of mass and a tiny form factor. It is mainly intended for collision avoidance maneuvers, but is also useful for spin-up maneuvers, for example those needed by the Small Plasma Brake.

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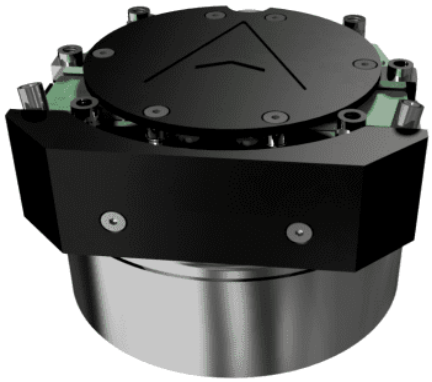
PRODUCT: ARM-O

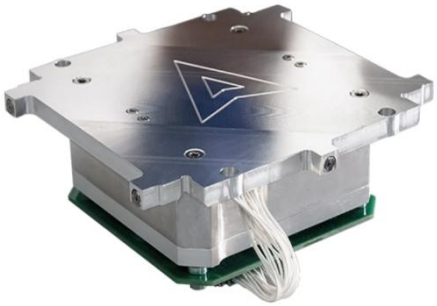
Aurora Resistojet module for Orbit control

The ARM-O is the larger variant of the ARM product line, allowing for medium total impulses typically between 100-400 Ns. At 0.5 - 1 litre volume, it's still a very compact system.



PRODUCT: ARM-A, ARM-3, ARM-6

Aurora Resistojet modules for Attitude control, 3-DoF and 6-DoF control



The more complex resistojet systems include 4-12 thrusters for other use cases such as reaction wheel desaturation (ARM-A) and proximity operations maneuvring (ARM-3 and ARM-6). These are typically highly customized based on the user's requirements, with similar specifications to the other ARM systems with different thruster configurations.

PRODUCT: ARM-E, MEPE

Aurora Resistojet Module for an External tank; Multimodal Electric Propulsion Engine

The thrusters can be integrated to an existing propellant system, with any number of thrusters in any configurations. The connections are made with 1.6 mm stainless steel piping that can direct the propellant to different sides of the satellite. The first such system is integrated as a part of the MEPE, where the thrusters utilize the same Xenon propellant system with a Hall Effect –based main thruster manufactured by Aliena Pte Ltd. This product was launched on its IOD in 2023.

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THRUSTER SYSTEM SPECIFICATIONS

Item	ARM-C	ARM-O, ARM-A etc	ARM-E
Propellant	Water	Water	Water, hydrocarbons, noble gases or other
Total impulse	3 Ns	100-400 Ns or more	Depends on propellant and tank
# of thrusters	1	2-6 (2*6 for ARM-6)	Any
Thrust level	1.5 mN BoL, 0.5 mN EoL	1.5 mN BoL, 0.5 mN EoL or 1 mN constant	Depends on propellant
Power consumption	7 W per thruster		
System mass	0.1 kg	0.5 - 1.2 kg	< 0.5 kg
System volume	25 * 30 * 50 mm^3	0.5 - 1 litres	Varies
Lifetime	~ 50 min of firing	10-30 h of firing	Varies
Redundancy	Dual+ redundancy against accidental activation. Other redundancy customizable		
Data interface	Direct electrical toggles	Direct electrical toggles, or RS422	
Prop loading	Delivered pre-filled		N/A
TRL	8 (launch in 2025-10)	6-7	9 for MEPE; 6-7 for others
Lead time	6 months	6-15 months	Varies

The straight-forward customizability includes thruster direction fine-tuning, tank size and electronics interface customization. Additionally, the electronics components may be changed to rad-hard with partial rad-hard qualification.