spaceopal
a DLR GfR and Telespazio company

Fly smarter and independently

HAUT IN SPACE

Because knowing your orbit and time changes everything

Spaceopal's HAUT-S is an onboard real-time orbit determination and time synchronization (ODTS) component for low Earth orbit (LEO) and low-middle Earth orbit (MEO) satellites, delivering decimeter-level orbit accuracy and nanosecond-level time synchronization for a wide range of space missions with anti-spoofing (OS NMA) and interference mitigation for enhanced resilience.

Discover how
autonomy begins

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GNSS			
Constellations	GPS, Galileo		
Signals	GPS L1C/A,L2C,L5, Galileo E1,E5a,E5b,E6 Galileo E6-B for HAS corrections		
Observations	Dual-frequency pseudoranges and carrier phases		
Corrections	Corrections provided by Galileo HAS		
Resilience	Galileo OS NMA Interference detection and mitigation		
Interfaces			
Telemetry / Telecommand	RS422, up to 921,600 Bit/s Ethernet		
Time synchronization	10 MHz reference frequency (i/o) Pulse-per-second		
GNSS antenna	RF input		
Cross-link for redundant systems	RS422		
SWaP			
Size	100x95x44 mm3		
Mass	< 0.5 kg		
Power consumption	< 5 W		
Input voltage	9 – 40 V		
Environmental Qualification			
Temperature	non-operational:	-40 – 80 °C	
Constellations	operational:	-20 – 70 °C	
Vibration	MIL-STD-810G		
Single event effects (SEE)	tested with proton irradiation up to 200 MeV		
Total ionizing dose (TID)	tested up to 35 krad		
Performance *continuously zenith pointing GNSS antenna, no maneuvers*		**with broadcast ephemeris**	**with HAS corrections**
Orbit accuracy 3D RMS (nominal/committed):	at 1,300 km altitude:	< 10 cm / 11 cm	< 7 cm / 9cm
	at 780 km altitude:	< 14 cm / 15 cm	< 11 cm / 12 cm
Orbit accuracy 1D LoS	at 1,300 km altitude:	< 7 cm	< 5 cm
	at 780 km altitude:	< 9.5 cm	< 7 cm
Timing accuracy	< 1 ns		
Real-time Navigation Filter			
Type	Extended Kalman Filter		
States	Satellite position and velocity, clock bias, inter-system bias, clock drift, empirical accelerations, satellite drag and radiation coefficients, carrier-phase float ambiguities		
Measurement update period	0.1 Hz		
PVT output rate	1 Hz		
Reduced Dynamics Orbit Model			
Gravitational potential	GOCO03S up to order and degree 70, including rate terms $\dot{C}_{20}$, $\dot{C}_{21}$ and $\dot{S}_{21}$		
Third-body gravitation	Point-mass model; truncated analytical series of luni-solar coordinates		
Atmospheric drag/solid Earth	Cannon-ball model; K_2 tides		
Empirical accelerations	Epoch-wise estimation for radial, along-track and cross-track components		
Flight heritage	SW flight heritage in Proba-V, TET, Bird, EuCROPIS missions		