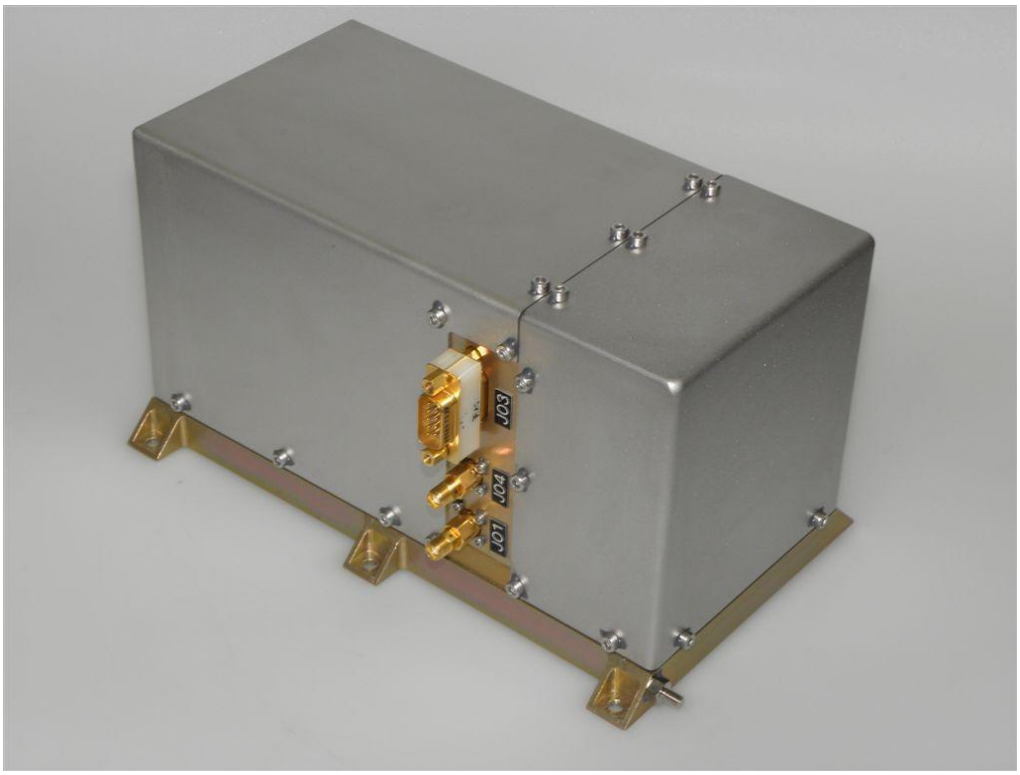
iSource+™ Space-Qualified RAFS Spec

November 2011

Rubidium Atomic Frequency Standard (RAFS)

High Precision & Performance Source



Navigation and Science | Space

Applications

©SpectraTime
sales@spectratime.com
spectratime.com

Europe Headquarters
+41.32.732.16.66

North America Sales Offices
+1.512.470.3980

Product Characteristics:

• Volume	2.5 liters
• Thermal sensitivity over -10°C to 15°C	< $\pm 5 \times 10^{-14}$ /°C
• Stability	< 4×10^{-14} / 10'000sec
• Long term stability	< 2×10^{-10} / year
• Power supply range	23V to 33V unregulated or 50V regulated
• Output frequency	10MHz

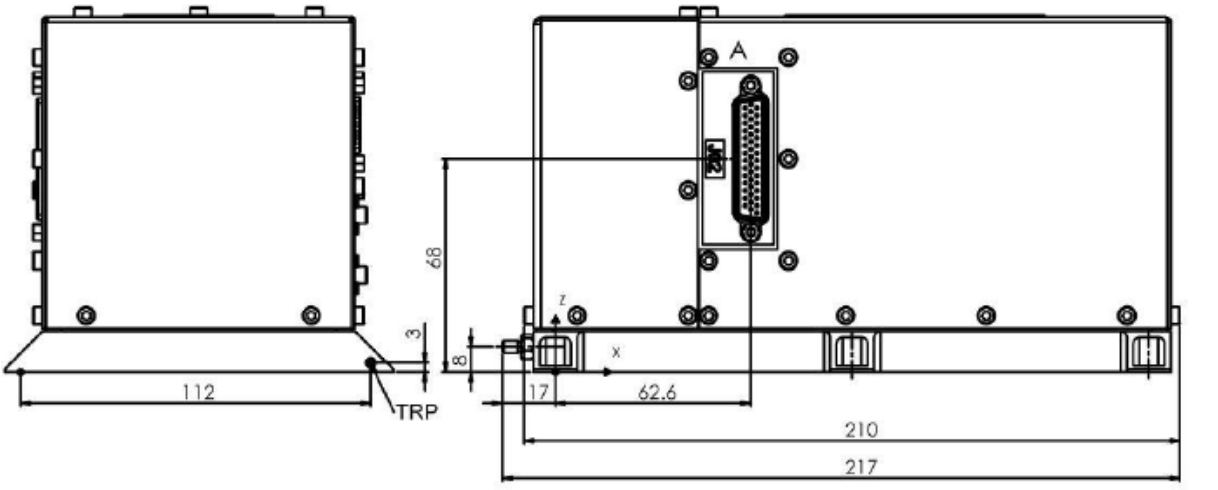
Main Features:

- Very low temperature sensitivity
- Excellent short term stability
- Small volume
- Rb lamp extended life expectancy (>20 years)

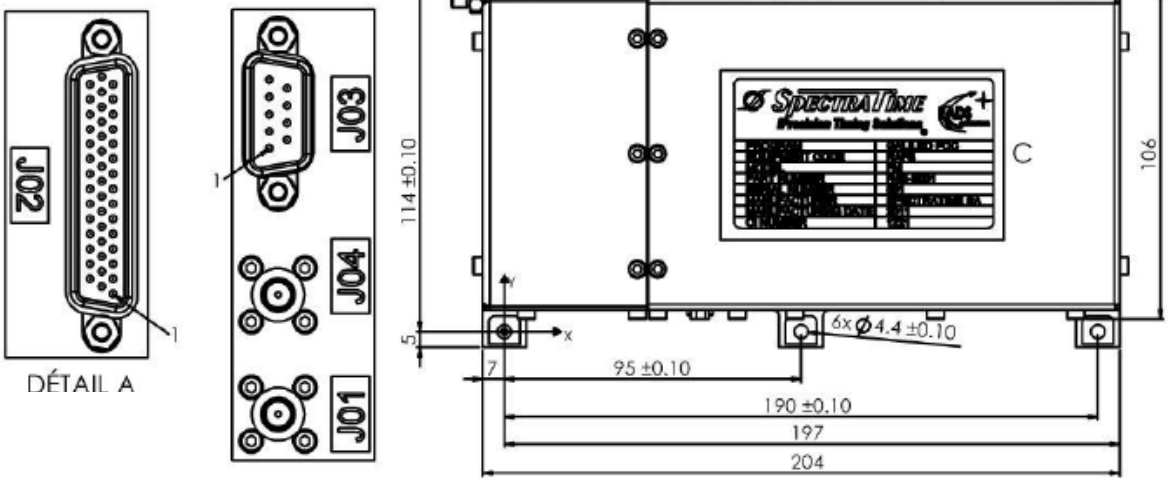
Main Applications:

- Navigation satellites
- Space scientific missions
- Military communication satellites
- Tracking and guidance control
- Advanced low orbit digital communication sat.

Package: (all dimensions in millimeters)



Connectors Orientation



SPECIFICATIONS

Parameter	value	Unit
PERFORMANCES		
Frequency (sine) Main Auxiliary	 10.00 10.00	 MHz MHz
Frequency accuracy (after commissioning phase)	$\leq$ 2 x 10^{-10}	
Freq. Stab Short Term (typical) 1 sec 10 sec 100 sec 1000 sec 10000 sec (drift removed) flicker floor (drift removed)	 4 x 10^{-12} 1.3 x 10^{-12} 4 x 10^{-13} 1.3 x 10^{-13} 4 x 10^{-14} 4 x 10^{-14}	
Freq. Stab Long Term (typical)	2 x 10^{-10}	Per year
Outputs Signal Level	13 $\pm$1	dBm
Return loss (nominal output impedance 50 Ω)	20	dB
Spurious Signals (band +/- 200KHz) Outside	< -80 < -60	dB dB
Harmonics	< -30	dBc
Phase Noise (TBD MHz) 1Hz 10 Hz 100 Hz 1000 Hz 10000 Hz 100000 Hz	 -90 -120 -130 -140 -145 -145	 dBc dBc dBc dBc dBc dBc
PHYSICAL CHARACTERISTICS		
Envelope and dimensions	L=217 W=124 H=117	mm mm mm
Mass	3.4	Kg
Stiffness	> 100	Hz
OPERATIONAL REQUIREMENTS		
Design Lifetime	12	Years
INTERFACES		
ELECTRICAL POWER INTERFACE		
Normal Power Line Voltage	23 - 33 unregulated or 50 regulated	V V
TM/TC INTERFACE		
TC List RAFS ON RAFS OFF	 HLC HLC	
TM List RAFS ON/OFF (isolated via opto-coupler) RAFS Lock Indication RAFS Rb Light RAFS Rb Signal I/P Main Bus Voltage	 Relay/Switch Digital 0 or 5 0-5 0-5 0-5	 V V V V

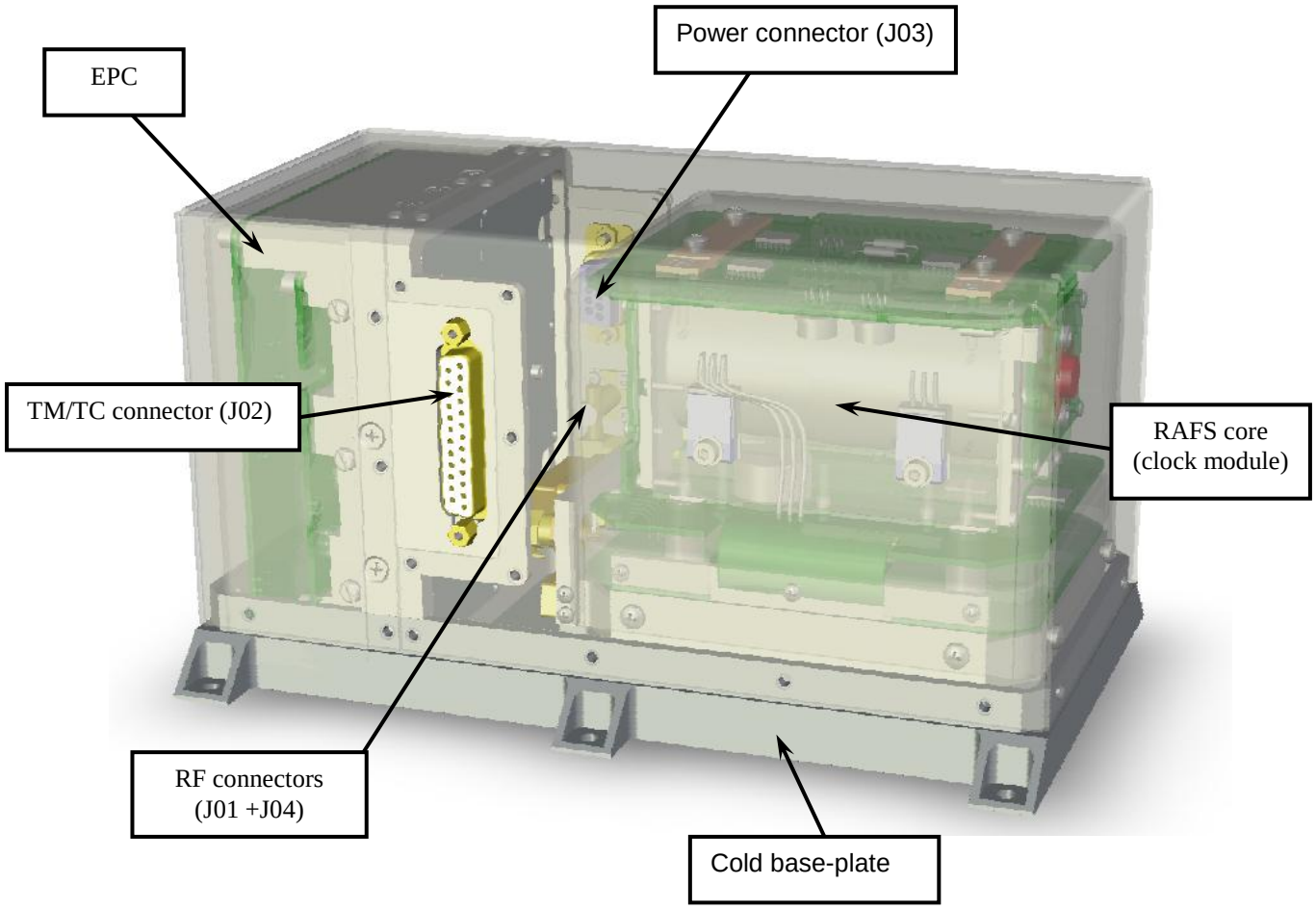
Parameter	value	Unit
Main Bus Current	0-5	V
TCB Temperature	NTC	
EPC Temperature	NTC	
STRUCTURAL & MECHANICAL INTERFACES		
Surface Finish-Flatness		
Overall contact area	< 0.2	mm
Local flatness	< 0.1/100	mm/mm
Roughness	< 3.2	μm
Interconnections		
RF outputs	SMA (J01 + J04)	
TM/TC Interface	SUB-D 50 (J02)	
Power Interface	SUB-D 09 (J03)	
ENVIRONMENTAL & THERMAL INTERFACE		
Interface Heat Flux	<0.3	W/cm^2
Power dissipation		
During warm-up	< 55	W
During nominal operation	< 35	W
Temperature limits		
Operating	-5 to +10	°C
Short-term variation	<= +/- 1	°C
Acceptance	-10 to +15	°C
Qualification	-15 to + 20	°C
Cold start	-21	°C
Non-operating	-15 to + 70	°C
PRODUCT ASSURANCE		
Reliability figure (MEO)	<1200	FIT
IN ORBIT ENVIRONMENTS		
Vacuum level	10^{-5}	mbar
Magnetic field	< +/- 0.5	Gauss
Radiation Environment.	LEO/MEO/GEO orbits	

RAFS Description

The Rubidium Atomic Frequency Standard (RAFS) is a state-of-the-art ultra-stable atomic clock able to deliver a frequency stability of about 3 to $5x10^{-14}$ over averaging intervals of 10'000 s.

The RAFS unit is composed of two main parts. The clock it-self named "RAFS core" and the Electronic Power Conditioning name "EPC" which includes the DC/DC converter and the electrical interface to the satellite.

The EPC design could be adapted to the satellite need.



RAFS general function and diagram

The RAFS is a Rb clock. The Rb clock essentially consists of a voltage-controlled crystal oscillator (VCXO) which is locked to a highly stable atomic transition in the ground state of the Rb87 isotope. While the frequency of the VCXO is at the convenient standard frequency of 10 MHz, the Rb clock frequency is at 6.834 GHz in the microwave range. The link between the two frequencies is done through a phase-stabilized frequency multiplication scheme whereby a synthesized frequency is admixed to enable exact matching.