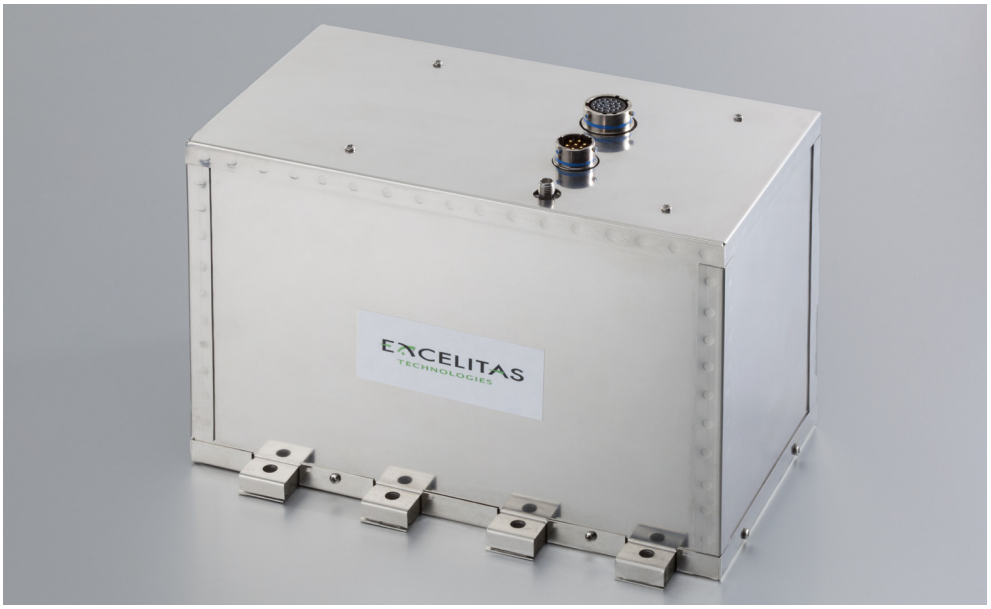
DATASHEET
Frequency Standards

High-Performance Space-Qualified
Rubidium Atomic Frequency Standard (RAFS)



Key Features

- High-Stability: $2x10^{-12}$ at $\tau = 1$ second
- Low Power: ≤ 14 watts
- Low Drift: ≤ 5x10-14/day
- High-Reliability: 700,000 Hr MTBF
- Fully Space-Qualified
- Radiation Hardened
- Negligible Environmental Sensitivities
- Small Size: 5.0" x 8.5" x 6.0"
- Low Weight: < 14 lbs.

Applications

- Global Navigation Satellite Systems (GNSS)

The Excelitas Rubidium Atomic Frequency Standard (RAFS) is an exceptionally High-Performance and High-Reliability Space-Qualified rubidium (Rb) clock developed for Global Navigational Satellite Systems. It is the highest performance device of this type currently available, combining exceptional stability and low drift with negligible environmental sensitivity, while offering the low size, weight and power advantages of a rubidium frequency standard. The design has been fully documented and qualified for all space requirements, including radiation. The RAFS offers exceptional performance as a precise time and frequency reference for demanding applications.

The RAFS employs classical rubidium gas cell atomic frequency standard principles. It utilizes a physics package with a discrete isotopic filter cell for best stability. The relatively large, cool absorption cell and thin film spectral filter provide exceptionally high signal-to-noise ratio and excellent short term stability. Calorimetric Rb lamp process control and screening assures long life. The "natural frequency" output of 13.4 MHz permits the use of a low complexity, single loop design for improved reliability. Operation at low fixed magnetic bias field improves stability and reduces magnetic and radiation sensitivity. An integral baseplate temperature controller greatly reduces the overall temperature sensitivity by utilizing a thermal insulator that can be tailored to meet various panel operating temperatures. While the RAFS may be operated in air, operating in a vacuum environment that eliminates barometric sensitivity, the extremely low temperature, magnetic, radiation and voltage sensitivities mean that the unit has extremely low sensitivity to all environmental effects, providing a very low flicker floor. The low aging rate of $<5x10^{-14}$/day is exceptionally smooth and modelable using either a log or diffusion fit to the data.

A crystal oscillator at nominal 13.4 MHz produces the output signal via an output amplifier. This RF output path is hardened against transient radiation. The 13.4 MHz crystal oscillator also excites the Rb physics package via a phase modulator and frequency multiplier chain. This produces a discriminator signal that is processed by a servo amplifier to lock the crystal oscillator to the Rb atomic resonance. Temperature controllers, a lamp exciter and a precision C-field source support the operation of the physics package, while a dc/dc converter and linear regulators provide power for the RAFS circuits. An integral controller stabilizes the RAFS baseplate temperature and several analog monitors are available to assess the operation of the unit.

EXCELITAS TECHNOLOGIES

TABLE 1 Specifications

Input Power	28.0 VDC ± 4.0 VDC
	≤ 39 W total steady-state with BTC
	≤ 14W basic clock at +45°C baseplate
	≤ 65 W during warm-up
Warm-up	≤ 1 hour to ± $2x10^{-10}$
Monitors	0 to +5 VDC, 5kΩ source impedance

TABLE 2 Baseplate Temperature Controller (BTC)

Set-Point	+45°C ± 1°C
Stabilization Factor	integral controller
Thermal Insulator	0.7 W/°C
Heater Demand Power	≤ 28 W

TABLE 3 Outputs

RF Output	13.40134393 MHz Sinewave
	+18 dBm ± 1.5 dB
	All harmonics ≤ 50 dBc
	All spurious ≤ -85 dBc ($f_o \le f \le 2f_o$)
	≤ -50 dBc ($2f_o \le f \le 3f_o$)
Analog Monitors	Lock, Light, Signal, VCXO, Baseplate Temperature (2)
	Ovens (3), Power Supplies (4), ALC, C-Field, BTC

TABLE 4 Frequency

Nominal Frequency	13.40134393 MHz
Accuracy	± $1x10^{-9}$ at shipment
Trim Range	None (Fixed C-Field)
Stability $\sigma y(\tau)$	≤ $2x10^{-12}\ \tau^{-1/2}$ + $2x10^{-14}$ ($1 \le \tau \le 10^5$ seconds, drift removed)
Drift	≤ $1x10^{-13}$/day at BOL operation
	≤ $5x10^{-14}$/day after 1 year of continuous operation
Phase Noise, f(f)	≤ -95 dBc/Hz at f = 1 Hz, decreasing at -10 dB/decade to f = 100 kHz
Temperature Sensitivity	≤ $2x10^{-13}$/°C typical w/o BTC, below noise level for ± 1.5°C with BTC
Voltage Sensitivity	≤ $3x10^{-12}$ for 25.5 VDC to 28.0 VDC
Magnetic Sensitivity	≤ $1x10^{-12}$/Gauss
Barometric Sensitivity	≤ $1x10^{-13}$/mbar typical
Retrace	≤ $5x10^{-12}$ (to same environmental conditions)

TABLE 5 Environmental Specifications

Operating Temperature	Full performance with BTC range between -4°C and +21°C panel temperature.
	Functional between -20°C to +45°C panel temperature.
Storage Temperature	-34°C to +71°C
Altitude	Sea level to vacuum
Vibration	12.4g rms, 20 Hz to 2 kHz
Pyroshock	1500 g max to 10 kHz
Thermal Cycling	-34°C to +71°C
Acceleration	20 g
Radiation	Hardened to withstand natural and manmade space environments, including phase-continuous operation through transient radiation
EMI	Per MIL-STD-461E
EMP / SGEMP	Hardened to withstand
On-Off cycling endurance	≥ 1000 cycles

FIGURE 1 Typical Performance

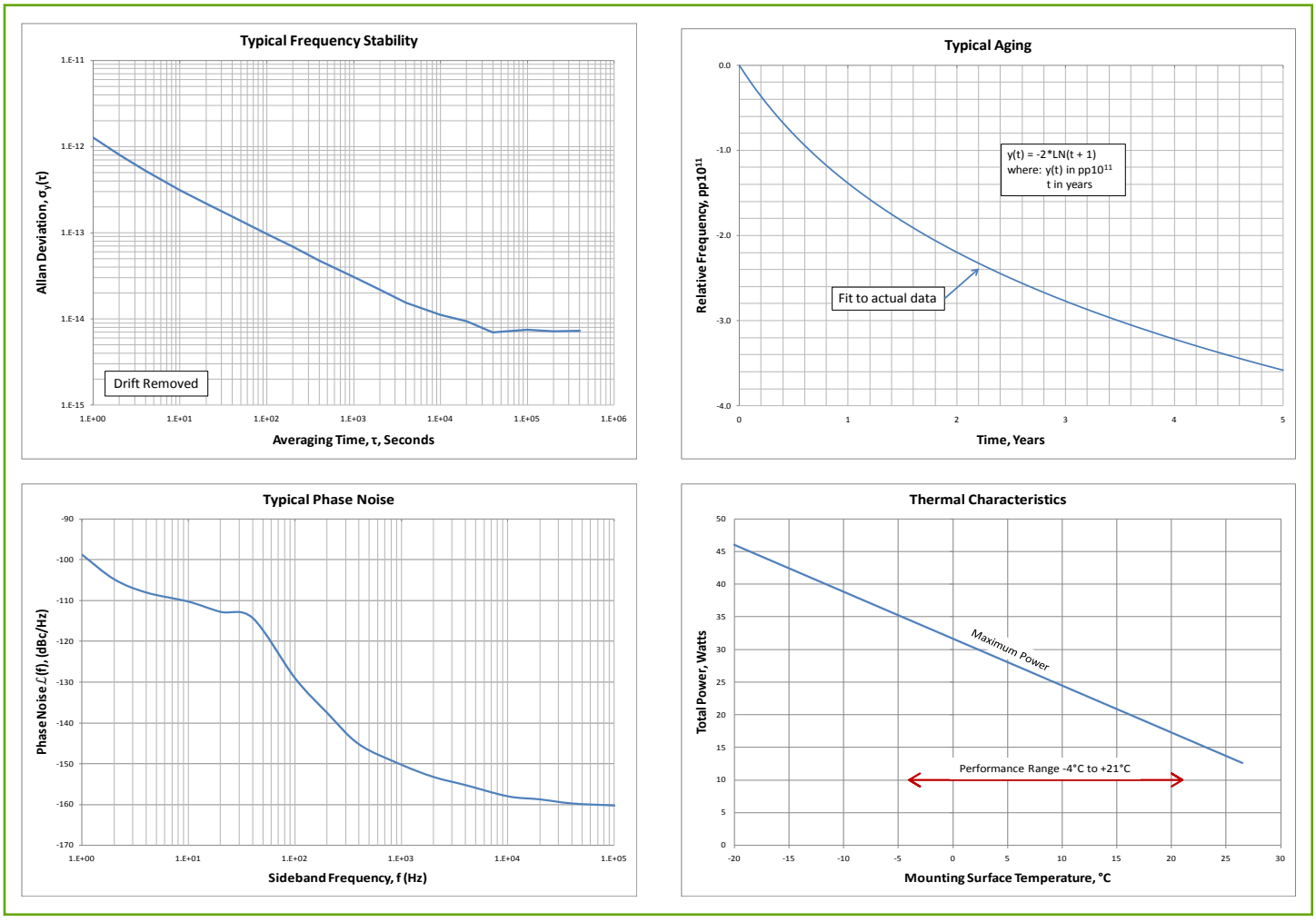
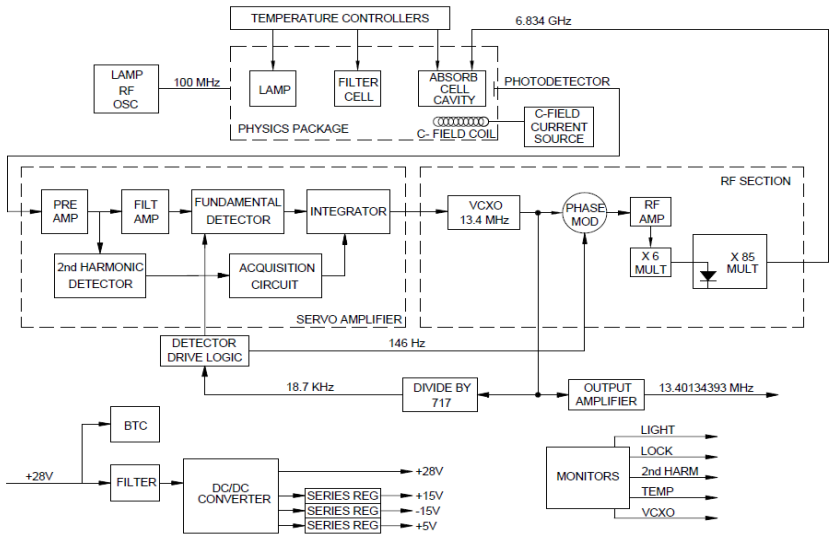
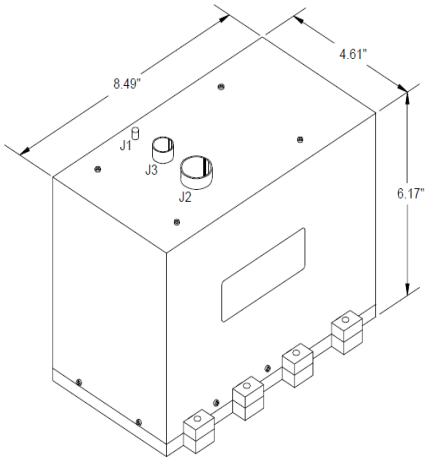


FIGURE 2 Block Diagram/Mechanical





CONNECTORS:

J1- RF OUTPUT, SMA PER MIL-C-39012

J3- POWER, MINIATURE CIRCULAR CONNECTOR MS27508E10F99P (7 PINS) PER MIL-C-38999

J2- MONITOR, MINIATURE CIRCULAR CONNECTOR MS27508E12F35SA (22 SOCKETS) PER MIL-C-38999

About Excelitas Technologies

Excelitas Technologies is a global technology leader focused on delivering innovative, customized solutions to meet the lighting, detection, energetic, frequency standards and high-reliability power needs of OEM customers.

From aerospace and defense applications to industrial, safety and security, medical lighting, analytical instrumentation, and clinical diagnostics, Excelitas Technologies is committed to enabling our customers' success in their specialty end-markets. Excelitas Technologies has approximately 3,000 employees in North America, Europe and Asia, serving customers across the world.

defense@excelitas.com
www.excelitas.com/Defense

Excelitas Technologies
Energetic Systems
1100 Vanguard Blvd.
Miamisburg, Ohio 45432
USA
Telephone: (+1) 937.865.3800
Toll Free: (+1) 866.539.5916
Fax: (+1) 937.865.5170

Excelitas Technologies
Power Supplies
1330 East Cypress Street
Covina, California 91724 USA
Telephone: (+1) 626.967.6021
Toll Free: (+1) 800.363.2095
Fax: (+1) 626.967.3151

Excelitas Technologies
Frequency Standards
& Switching
35 Congress Street
Salem Massachusetts 01970
USA
Telephone: (+1) 978.745.3200
Toll Free: (+1) 800.950.3441
Fax: (+1) 978.745.0894

Excelitas Technologies
Lighting & Radiant Sources
44370 Christy Street
Fremont, California 94538-3180
USA
Telephone: (+1) 510.979.6500
Toll Free: (+1) 800.775.6786
Fax: (+1) 510.687.1140

Excelitas Technologies
Sensors
22001 Dumberry Road
Vaudreuil-Dorion, Quebec
Canada J7V 8P7
Telephone: (+1) 450.424.3300
Toll Free: (+1) 800.775.6786
Fax: (+1) 450.424.3345

Excelitas Technologies
International Sales Office
Bat HTDS BP 246, 91882
Massy Cedes, France
Telephone: +33 (1) 6486 2824

For a complete listing of our global offices, visit www.excelitas.com/ContactUs