# Space CSAC-SA65

## Chip-Scale Atomic Clock


### Features

- Power consumption <120 mW
- Less than 17 cc volume, 1.6" × 1.39" × 0.45"
- Radiation Tolerant: At least 30 krad (Si) Cobalt Gammas
- 64 MeV and 120 MeV proton irradiations up to $1 \times 10^{11}$ protons/cm$^2$ total fluence demonstrated full recoveries to all observed events after power cycling
- 10 MHz CMOS-compatible output
- 1PPS output and 1PPS input for synchronization
- Comprehensive monitoring and control interface
- Short-term stability (Allan Deviation) of $3 \times 10^{-10}$ at $\tau = 1$ sec
- IPC-610 Class 2

### Applications

- Satellite timing and frequency control
- Satellite clock reference
- Assured Position, Navigation and Timing (PNT)
- Atomic clock accuracy
- Satellite cross-linking

### The Space Chip Scale Atomic Clock (CSAC)

The Space Chip Scale Atomic Clock (CSAC) is a radiation-tolerant, low power consumption device ideal for Low Earth Orbit (LEO) missions. It offers atomic accuracy and built-in 1 PPS disciplining for synchronized applications like earth observation, which require precise time-stamping. The CSAC's atomic stability allows it to operate independently of external references such as GNSS for extended periods while maintaining accuracy. Its small temperature coefficient ensures reliable performance despite significant temperature fluctuations in LEO environments.

Manufactured as a Commercial Off-the-Shelf (COTS) part to IPC-610 Class 2 standards, the space CSAC uses radiation-tolerant commercial electronic components. COTS products typically have shorter lead times and lower costs compared to traditional space-grade oscillators. A "careful COTS" approach ensures each batch undergoes rigorous radiation screening to exceed 30 krad before production, bridging the gap between pure COTS and costly full rad-hard space-grade components.

Aside from radiation tolerance, the Space CSAC is functionally equivalent to a standard CSAC-SA65. It provides 10 MHz and 1PPS outputs at standard CMOS levels, with short-term stability (Allan Deviation) of $3 \times 10^{-10}$ at $\tau = 1$ sec. It accepts a 1PPS input for calibration to an external reference clock such as a GNSS derived timing signal.

CLOCKSTUDIO™

This product is compatible with Microchip's Clockstudio™ software tool for control and analysis of atomic clocks: microchip.com/clockstudio

## Specifications[1]

### Stability

| Observation Time | ADEV |
|---|---|
| **τ = 1 s** | $3 \times 10^{-10}$ |
| **τ = 10 s** | $1 \times 10^{-10}$ |
| **τ = 100 s** | $3 \times 10^{-11}$ |
| **τ = 1000 s** | $1 \times 10^{-11}$ |

| Frequency Drift[2] | |
|---|---|
| **Monthly** | $<9 \times 10^{-10}$ |
| **Yearly** | $<1 \times 10^{-8}$ |

| Offset | Phase Noise (SSB) |
|---|---|
| **1 Hz** | <–50 dBc/Hz |
| **10 Hz** | <–70 dBc/Hz |
| **100 Hz** | <–113 dBc/Hz |
| **1 kHz** | <–128 dBc/Hz |
| **10 kHz** | <–135 dBc/Hz |
| **100 kHz** | <–140 dBc/Hz |

### Performance Parameters

| Specification | Details |
|---|---|
| **Warm-up Time** | <180 s |
| **Analog Tuning** | Range: $\pm 2.2 \times 10^{-8}$<br>Resolution: $1 \times 10^{-11}$<br>Input: 0 V–2.5 V into 100 kΩ |
| **Digital Tuning** | Range: $\pm 1 \times 10^{-6}$<br>Resolution: $1 \times 10^{-12}$ |
| **Maximum Offset at Shipment** | $\pm 5 \times 10^{-11}$ |
| **Maximum Retrace (48 hrs Off)** | $\pm 5 \times 10^{-10}$ |

### Radiation Tolerance

| Radiation Tolerance[3] | |
|---|---|
| **TID** | >30 krad (Si) Cobalt Gammas,<br>$<5 \times 10^{-10}$ frequency offset change |
| **SEL, SEU** | 64 MeV and 120 MeV proton irradiations up to $1 \times 10^{11}$ protons/cm$^2$ total fluence demonstrated full recoveries to all observed events after power cycling |

[1] At input voltage Vcc = 3.3 VDC and ambient temperature = 25°C, unless otherwise specified.

[2] Typical, after 30 days of continuous operation.

[3] Contact factory for detailed exposure reports.

### Electrical

| RF Output | |
|---|---|
| **Frequency** | 10 MHz |
| **Format** | CMOS |
| **Amplitude** | 0 V to 3.0 V |
| **Load Impedance** | 1 MΩ |
| **Quantity** | 1 |
| **1PPS Output** | |
| **Rise/fall Time (10%–90%) at Load Capacitance 10 pF** | <10 ns |
| **Pulse Width** | 10 µs to 500,000 µs |
| **Level** | 0 V to 3.0 V |
| **Logic High (VOH) Min** | 2.80 V |
| **Logic Low (VOL) Max** | 0.30 V |
| **Load Impedance** | 1 MΩ |
| **Quantity** | 1 |
| **1PPS Input** | |
| **Format** | Rising edge |
| **Low Level** | <0.5 V |
| **High Level** | 2.5 V to 3.0 V |
| **Load Impedance** | 1 MΩ |
| **Quantity** | 1 |
| **Serial Communications** | |
| **Protocol** | RS232 |
| **Format** | CMOS 0 V to 3.0 V |
| **Tx/Rx Impedance** | 1 MΩ |
| **Baud Rate** | 57600 |
| **Built-In Test Equipment (BITE) Output** | |
| **Format** | CMOS 0 V to 3.0 V |
| **Load Impedance** | 1 MΩ |
| **Logic** | 0= Normal operation<br>1= Alarm |
| **Power Input** | |
| **Operating** | <120 mW |
| **Warmup** | <140 mW |
| **Input Voltage (Vcc)** | 3.3 ± 0.1 VDC<br>(5V absolute maximum) |

## Environmental

| Specification | Details |
|---|---|
| **Operating Temperature** | –40°C to 80°C |
| **Temperature Sensitivity (TempCo)** | $\pm 3 \times 10^{-10}$ Maximum Frequency Change over Operating Temp Range (Maximum Rate of Change 0.5°C per Minute) |
| **Voltage Sensitivity** | $\pm 4 \times 10^{-10}$ Maximum Frequency Change over allowable Voltage Range |
| **Magnetic** | $\pm 9 \times 10^{-11}$/Gauss Maximum frequency change per Gauss (≤2.0 Gauss) |
| **Radiated Emissions** | Compliant to FCC part 15, Class B, when mounted properly onto host PCB |
| **Vibration** | Maintains lock under MIL-STD-810G, Operational, 7.7 grms per Figure 514.7E-1. Category 24 |
| **Humidity** | 0%–95% RH per MIL-STD-810, Method 507.4 |
| **Storage and Transport (Non-operating)** | |
| **Temperature** | –55 °C to 105 °C |
| **Vibration** | MIL-STD-810G, 7.7 $g_{rms}$ per Figure 514.7E-1. Category 24 |
| **Shock** | MIL-STD-202-213A, Condition E, 1000 g |

## Physical

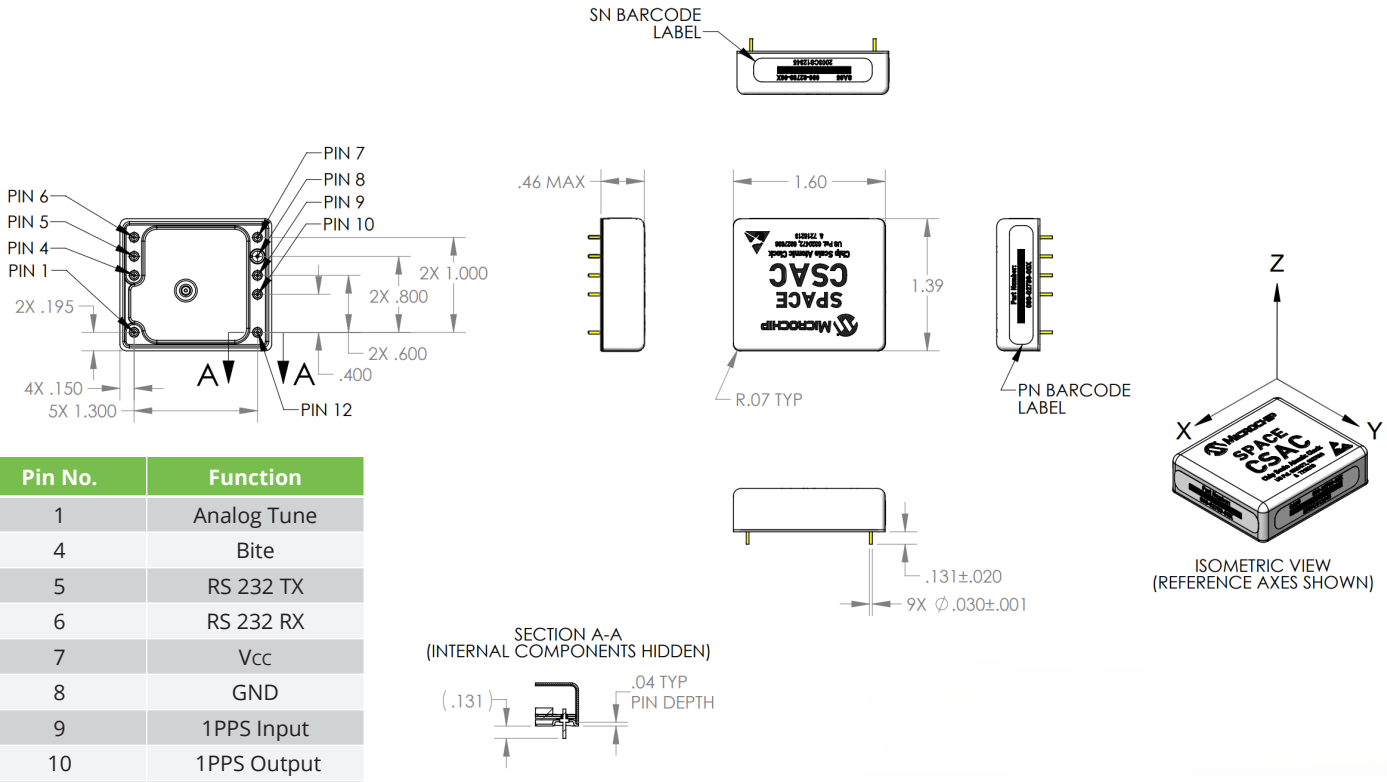
| Specification | Detail |
|---|---|
| **Weight** | <35 g (<1.23 oz) |
| **Size** | 1.6" × 1.39" × 0.45" |
| **MTBF** | >100,000 hours |

## Solder

| Type | Detail |
|---|---|
| **RoHS Compliant** | Hand solder using 96.5/3/0.5 tin/silver/copper with maximum solder tip temperature of 370°C (698°F) and a dwell time of <5s |

## Ordering Information

| Part Number | Description | Output Frequency |
|---|---|---|
| **090-02789-007** | Space chip-scale atomic clock | 10 MHz |




| Pin No. | Function |
|---|---|
| 1 | Analog Tune |
| 4 | Bite |
| 5 | RS 232 TX |
| 6 | RS 232 RX |
| 7 | Vcc |
| 8 | GND |
| 9 | 1PPS Input |
| 10 | 1PPS Output |
| 12 | RF Output |