# SA.45s Space CSAC

## Chip-Scale Atomic Clock


**CSAC**

Microsemi invented portable atomic timekeeping with the world's first family of miniature and chip scale atomic clocks.

Choose CSAC for best-in-class stability, size, weight, and power consumption.

## Features

- Power consumption <120 mW
- Less than 17 cc volume, 1.6" × 1.39" × 0.45"
- Radiation-tolerant: 20 krad
- SEL, SEU tested to 64 MeV-cm$^2$/mg (contact factory for details)
- 10 MHz CMOS-compatible output
- 1PPS output and 1PPS input for synchronization
- RS-232 interface for monitoring and control
- Short-term stability (Allan Deviation) of $3.0 \times 10^{-10}$ at TAU = 1 sec

## Applications

- Satellite timing and frequency control
- Satellite clock reference
- Assured position, navigation, and timing (PNT)
- Atomic clock accuracy
- Satellite cross-linking

The Microsemi SA.45s Commercial Space Chip-Scale Atomic Clock's (CSAC) potential for low size, weight, and power (SWaP), and high timing performance at relatively low cost makes it very attractive for low Earth orbit (LEO) applications. In addition to being a stand-alone atomic clock with a 10 MHz output, the CSAC also has a 1PPS output and can be disciplined with a 1PPS input. The Space CSAC retains this functionality and is a timing module that can be disciplined with a GPS-derived 1PPS input.

The SA.45s provides 10 MHz and 1PPS outputs at standard CMOS levels, with short-term stability (Allan Deviation) of $3.0 \times 10^{-10}$ at TAU = 1 sec, typical long-term aging of $<9 \times 10^{-10}$/month, and maximum frequency change of $\pm 5 \times 10^{-10}$ over an operating temperature range of –10 °C to 70 °C.

A standard CMOS-level RS-232 serial interface is built into the SA.45s. This is used to control and calibrate the unit and to provide a comprehensive set of status monitors. The interface is also used to set and read the CSAC's internal time-of-day clock.

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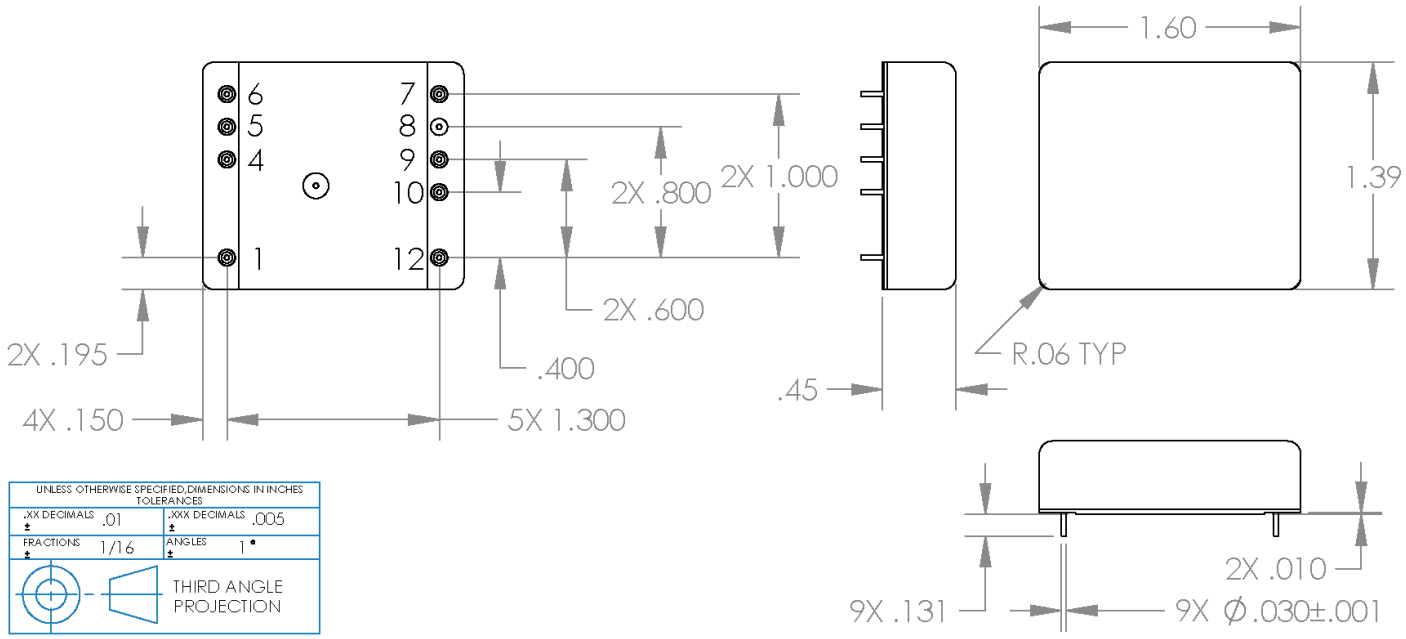
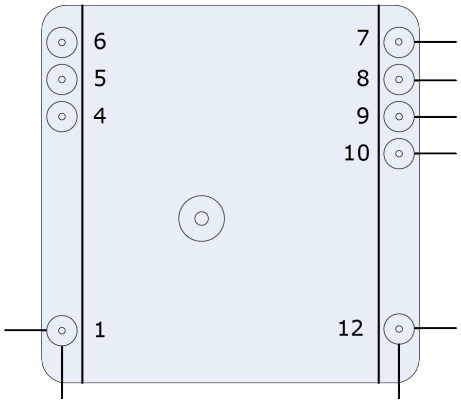
### Mechanical Interface




### Pin Description

| Pin Number | ID |
|---|---|
| 1 | Tune |
| 2 | N/A |
| 3 | N/A |
| 4 | BITE |
| 5 | Tx |
| 6 | Rx |
| 7 | $V_{cc}$ |
| 8 | GND |
| 9 | 1 PPS IN |
| 10 | 1 PPS OUT |
| 11 | N/A |
| 12 | 10 MHz OUT |

### Bottom View



# SA.45s Space CSAC

## Chip-Scale Atomic Clock

## Specifications[1]

### Electrical

#### RF Output

- Frequency: 10 MHz
- Format: CMOS
- Amplitude: 0 V to $V_{CC}$
- Load impedance: 1 MΩ
- Quantity: 1

#### 1PPS Output

- Rise/fall time (10%–90%) at load capacitance 10 pF: <10 ns
- Pulse width: 100 µs
- Level: 0 V to $V_{CC}$
- Logic high ($V_{OH}$) min: 2.80 V
- Logic low ($V_{OL}$) 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 $V_{CC}$
- Input impedance: 1 MΩ
- Quantity: 1

#### Serial Communications

- Protocol: RS232
- Format: CMOS 0 V to $V_{CC}$
- Tx/Rx impedance: 1 MΩ
- Baud rate: 57600

#### Built-In Test Equipment (BITE) Output

- Format: CMOS 0 V to $V_{CC}$
- Load impedance: 1 MΩ
- Logic: 0= Normal operation<br>1= Alarm

#### Power Input

- Operating: <120 mW
- Warmup: <140 mW
- Input voltage ($V_{CC}$): 3.3 ± 0.1 $V_{DC}$

### Environmental

- Operating temperature: –10 °C to 70 °C
- Maximum frequency change over operating temp range (maximum rate of change 0.5 °C per minute): $\pm 5 \times 10^{-10}$
- Magnetic sensitivity (≤2.0 Gauss): $\pm 9 \times 10^{-11}$/Gauss
- Radiated emissions: Compliant to FCC part 15, Class B, when mounted properly onto host PCB
- Vibration: Maintains lock under MIL-STD-810, Method 514.5, Procedure 1, 7.7 $g_{rms}$
- Humidity: 0%–95% RH per MIL-STD-810, Method 507.4

#### Storage and Transport (Non-operating)

- Temperature: –55 °C to 85 °C
- Vibration: MIL-STD-810, Method 514.5, Procedure 1, 7.7 $g_{rms}$
- Shock (1 ms half-sine): 1000 g

### Performance Parameters

- 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: $1 \times 10^{-12}$

### Phase Noise (SSB)

| Frequency | CSAC |
|---|---|
| 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 |

### Frequency Accuracy

- Maximum offset at shipment: $\pm 5 \times 10^{-11}$
- Maximum retrace (48 hrs off): $\pm 5 \times 10^{-10}$
- 1 PPS sync: ±100 ns

[1]At input voltage $V_{CC}$ = 3.3 $V_{DC}$ and ambient temperature = 25 °C, unless otherwise specified.

# SA.45s Space CSAC

## Chip-Scale Atomic Clock

### Aging

| Type[2] | SA.45s[3] |
|---|---|
| Monthly | $<9 \times 10^{-10}$ |
| Yearly | $<1 \times 10^{-8}$ |

[2]After 30 days of continuous operation.
[3]All CSAC units are tested for aging specs as per the datasheet and meet the specs at the time of shipment. However, continuous operation of CSAC over extended period of time may yield unpredictable aging performance, resulting in failure to meet the aging specs and may not be suitable for certain applications.

### Short-Term Stability (Allan Deviation)

| Type | SA.45s |
|---|---|
| $\tau = 1$ s | $3 \times 10^{-10}$ |
| $\tau = 10$ s | $1 \times 10^{-10}$ |
| $\tau = 100$ s | $3 \times 10^{-11}$ |
| $\tau = 1000$ s | $1 \times 10^{-11}$ |

### Radiation Tolerance

| Type | SA.45s |
|---|---|
| TID | 20 krad, $<5 \times 10^{-10}$ frequency offset change |
| SEL, SEU | Tested to 64 MeV-cm$^2$/mg (contact factory for details) |

### Physical

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

### Solder

Hand solder using 63/37 tin/lead solder with maximum soldering tip of 329 °C (625 °F).

### Ordering Information

| Part Number | Description | Output Frequency |
|---|---|---|
| 090-02984-007 | Space chip-scale atomic clock | 10 MHz |

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