SA.45s Space CSAC

Chip-Scale Atomic Clock

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 3.0×10^{-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 Microchip 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 3.0×10^{-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.

Specifications[1]

Electrical

RF Outputs	
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}
Load 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 1= Alarm
Power Input	
Operating	<120 mW
Warmup	<140 mW
Input Voltage (V_{CC})	3.3 ± 0.1 V_{DC}

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

Environmental

Specification	Details
Operating Temperature	–10 °C to 70 °C
Maximum Frequency Change over Operating Temp Range (Maximum Rate of Change 0.5 °C per Minute)	$\pm 5 \times 10^{-10}$
Frequency Change Over Allowable Input Voltage Range	$+/-4 \times 10^{-10}$
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-810G, Operational, 7.7 g_{rms} 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 85 °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

Performance Parameters

Specification	Details
Warm-up Time	<180 s
Analog Tuning	Range: $\pm 2.2 \times 10^{-8}$ Resolution: 1×10^{-11} Input: 0 V–2.5 V into 100 kΩ
Digital Tuning	Range: $\pm 1 \times 10^{-6}$ Resolution: 1×10^{-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

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
τ = 1 s	3×10^{-10}
τ = 10 s	1×10^{-10}
τ = 100 s	3×10^{-11}
τ = 1000 s	1×10^{-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

Type[2]	SA.45s[3]
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