# CX4VSM CRYSTAL

30 kHz to 250 kHz

Ultra-Miniature Low Profile
Surface Mount Quartz Crystal

## DESCRIPTION

STATEK's ultra-miniature CX4VSM quartz crystals are hermetically sealed in surface mount ceramic packages and custom laser-tuned to frequencies ranging from 30 kHz to 250 kHz. This high quality tuning fork resonator is intended for use in Pierce (single inverter) oscillators with a maximum process temperature not to exceed 260°C.

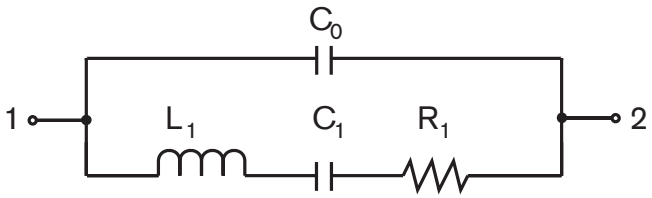
## FEATURES

- Ultra-miniature, surface mount design
- Available with glass or ceramic lid
- Hermetically sealed ceramic package
- Quartz crystal tuning fork design
- High shock and vibration survival
- Excellent aging characteristics
- Designed for low power applications
- Full military testing available
- Designed and manufactured in the USA

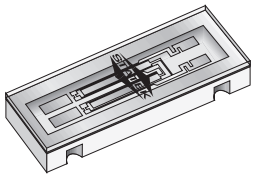
## APPLICATIONS

- Medical Implantable and Non-Implantable Devices
- Military Devices
- Smart Card
- Transponder / Animal Migration
- Space Limited Devices
- Handheld Battery Operated Devices
- Down Hole / Industrial Instrumentation
- Computer / Computer Peripherals

## EQUIVALENT CIRCUIT

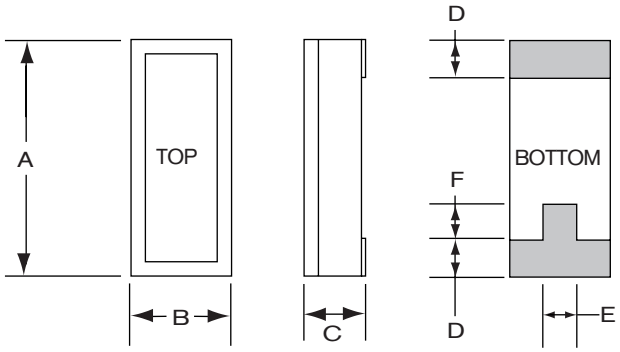



$R_1$ Motional Resistance $L_1$ Motional Inductance
$C_1$ Motional Capacitance $C_0$ Shunt Capacitance



Glass Lid Shown

## PACKAGE DIMENSIONS

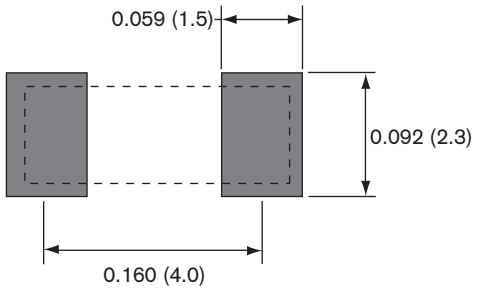



| | TYP. | | MAX. | |
|---|---|---|---|---|
| DIM | inches | mm | inches | mm |
| A | 0.197 | 5.00 | 0.210 | 5.33 |
| B | 0.072 | 1.83 | 0.085 | 2.16 |
| C | - | - | see below | |
| D | 0.036 | 0.91 | 0.046 | 1.16 |
| E | 0.020 | 0.51 | - | - |
| F | 0.025 | 0.64 | - | - |

## THICKNESS (DIM C)

| Lid | Termination | Maximum | |
|---|---|---|---|
| | | inches | mm |
| Ceramic | SM1 | 0.050 | 1.27 |
| | SM2/SM4 | 0.051 | 1.30 |
| | SM3/SM5 | 0.053 | 1.35 |
| Glass | SM1 | 0.045 | 1.14 |
| | SM2/SM4 | 0.046 | 1.17 |
| | SM3/SM5 | 0.048 | 1.22 |

## SUGGESTED LAND PATTERN




inches (mm)

10103 - Rev E

## SPECIFICATIONS

Specifications are typical at 25°C unless otherwise noted.
Specifications are subject to change without notice.

| Parameters | Fundamental | | Overtone |
|---|---|---|---|
| Frequency, (kHz) | 32.768 | 100 | 200 |
| Motional Resistance $R_1$(kΩ) | 50 | 18 | 2.4 |
| Motional Capacitance $C_1$ (fF) | 2.3 | 1.07 | 2.2 |
| Quality Factor Q (k) | 40 | 85 | 140 |
| Shunt Capacitance $C_0$ (pF) | 1.1 | 0.7 | 1.2 |
| Load Capacitance (pF)[1] | 9 | 8 | 5 |
| Turning Point (°C)[1] | 25 | 10 | 29 |

Standard Calibration Tolerance for 32.768 kHz[2]

| | | | |
|---|---|---|---|
| Glass Lid: | ± 30 ppm (0.003%) | ± 100 ppm (0.01%) | ± 1000 ppm (0.1%) |
| Ceramic Lid: | ± 100 ppm (0.01%) | ± 1000 ppm (0.1%) | ± 10000 ppm (1.0%) |

| | |
|---|---|
| Drive Level | 0.5 µW MAX |
| Temperature Coefficient (k) | -0.035 ppm/°C² |

Note: Frequency f at temperature T is related to frequency $f_0$ at turning point temperature $T_0$ by: $\frac{f-f_0}{f_0} = k(T-T_0)^2$

| | |
|---|---|
| Aging, first year | 3 ppm |
| Shock, survival[3] | 5,000 g, 0.3 ms, 1/2 sine |
| Vibration, survival | 20 g RMS, 10-2,000 Hz random |
| Operating Temp. Range | -10°C to +70°C (Commercial)<br>-40°C to +85°C (Industrial)<br>-55°C to +125°C (Military) |
| Storage Temp. Range | -55°C to +125°C |
| Max Process Temperature | 260°C for 20 sec. |

1. Other values available
2. Tighter tolerances available
3. Higher shock available

## TERMINATIONS

| Designation | Termination |
|---|---|
| SM1 | Gold Plated |
| SM2 | Solder Plated |
| SM3 | Solder Dipped |
| SM4 | Solder Plated (Pb Free) |
| SM5 | Solder Dipped (Pb Free) |

## PACKAGING OPTIONS

CX4VSM - Tray Pack

- 16mm tape, 7" or 13" reels
  (Reference tape and reel data sheet 10109)

## HOW TO ORDER CX4VSM CRYSTALS

CX4V S C SM1 — 32.768K , 100 / I

- S: "S" if special or custom design. Blank if standard
- C: C = Ceramic Lid, Blank = Glass Lid
- SM1: SM1 = Gold Plated (Pb Free), SM2 = Solder Plated, SM3 = Solder Dipped, SM4 = Solder Plated (Pb Free), SM5 = Solder Dipped (Pb Free)
- 32.768K: Frequency K = kHz
- 100: Calibration Tolerance @25°C (in ppm)
- I: Operating Temp. Range: C = -10°C to +70°C; I = -40°C to +85°C; M = -55°C to +125°C; S = Customer Specified

## TYPICAL APPLICATION FOR A PIERCE OSCILLATOR

The CX4 family of surface mount crystals are ideal for small, high density, battery operated portable products. The CX4 crystal designed in a Pierce oscillator (single inverter) circuit provides very low current consumption and high stability. A conventional CMOS Pierce oscillator circuit is shown below. The crystal is effectively inductive and in a PI-network circuit with $C_D$ and $C_G$ provides the additional phase shift necessary to sustain oscillation. The oscillation frequency ($f_0$) is 50 to 150 ppm above the crystal's series resonant frequency ($f_S$).

### Drive Level

$R_A$ is used to limit the crystal's drive level by forming a voltage divider between $R_A$ and $C_D$. $R_A$ also stabilizes the oscillator against changes in the amplifiers output resistance ($R_0$). $R_A$ should be increased for higher voltage operation.

### Load Capacitance

The CX4 crystal calibration tolerance is influenced by the effective circuit capacitances, specified as the load capacitance ($C_L$). $C_L$ is approximately equal to:

$$C_L = \frac{C_D \times C_G}{C_D + C_G} + C_S \qquad (1)$$

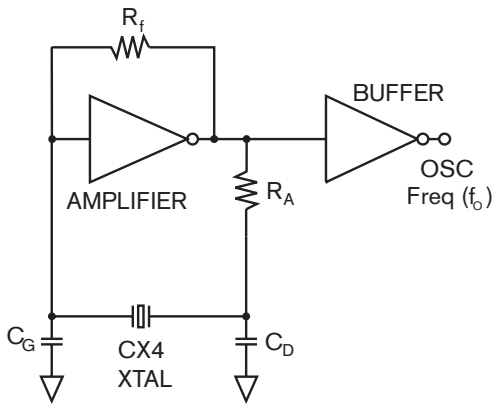
NOTE: $C_D$ and $C_G$ include stray layout to ground and $C_S$ is the stray shunt capacitance between the crystal terminal. In practice, the effective value of $C_L$ will be less than that calculated from $C_D$, $C_G$ and $C_S$ values because of the effect of the amplifier output resistance. $C_S$ should be minimized.

The oscillation frequency ($f_0$) is approximately equal to:

$$f_0 = f_S \left[ 1 + \frac{C_1}{2(C_0 + C_L)} \right] \qquad (2)$$

Where $f_S$ = Series resonant frequency of the crystal
$C_1$ = Motional Capacitance
$C_0$ = Shunt Capacitance

## CONVENTIONAL CMOS PIERCE OSCILLATOR CIRCUIT

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