CS00079

20 ppm, Ultra-Low Power 32.768 kHz Quartz XTAL Replacement

The Smart Timing Choice™

Features

- Small SMD package: 2.0 x 1.2 mm (2012)[1]
- Pin-compatible to 2012 XTAL SMD package
- Fixed 32.768 kHz output frequency
- <20 ppm frequency tolerance
- Ultra-low power: <1 μA
- Supports coin-cell or super-cap battery backup voltages
- Vdd supply range: 1.5V to 3.63V over -40°C to +85°C
- Oscillator output eliminates external load caps
- Internal filtering eliminates external Vdd bypass cap
- Pb-free, RoHS and REACH compliant

Note: 1. For the smallest 32 kHz XO in CSP (1.2mm^2), consider the SiT1532

Applications

- Mobile Phones
- Tablets
- Health and Wellness Monitors
- Fitness Watches
- Sport Video Cams
- Wireless Keypads
- Ultra-Small Notebook PC
- Pulse-per-Second (pps) Timekeeping
- RTC Reference Clock
- Battery Management Timekeeping

INSTANT SAMPLES

GREEN SOLUTIONS

LIFETIME WARRANTY

TempFlat MEMS™

Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Frequency and Stability						
Fixed Output Frequency	Fout		32.768		kHz	
Frequency Stability						
Frequency Tolerance [2]	F_tol			20	ppm	T_A = 25°C, post reflow, Vdd: 1.5V – 3.63V.
Frequency Stability [3]	F_stab			75	ppm	T_A = -10°C to +70°C, Vdd: 1.5V – 3.63V.
				100		T_A = -40°C to +85°C, Vdd: 1.5V – 3.63V.
				250		T_A = -10°C to +70°C, Vdd: 1.2V – 1.5V.
25°C Aging		-1		1	ppm	1st Year
Supply Voltage and Current Consumption						
Operating Supply Voltage	Vdd	1.2		3.63	V	T_A = -10°C to +70°C
		1.5		3.63	V	T_A = -40°C to +85°C
Core Operating Current [4]	Idd		0.90		μA	T_A = 25°C, Vdd: 1.8V. No load
				1.3		T_A = -10°C to +70°C, Vdd max: 3.63V. No load
				1.4		T_A = -40°C to +85°C, Vdd max: 3.63V. No load
Output Stage Operating Current [4]	Idd_out		0.065	0.125	μA/Vpp	T_A = -40°C to +85°C, Vdd: 1.5V – 3.63V. No load
Power-Supply Ramp	t_Vdd_ Ramp			100	ms	T_A = -40°C to +85°C, 0 to 90% Vdd
Start-up Time at Power-up [5]	t_start		180	300	ms	T_A = -40°C ≤ T_A ≤ +50°C, valid output
				450		T_A = +50°C ≤ T_A ≤ +85°C, valid output
Operating Temperature Range						
Industrial Temperature	T_use	-40		85	°C	

Notes:

2. Measured peak-to-peak. Tested with Agilent 53132A frequency counter. Due to the low operating frequency, the gate time must be ≥100 ms to ensure an accurate frequency measurement.
3. Stability is specified for two operating voltage ranges. Stability progressively degrades with supply voltage below 1.5V. Measured peak-to-peak. Inclusive of Initial Tolerance at 25°C, and variations over operating temperature, rated power supply voltage and load.
4. Core operating current does not include output driver operating current or load current. To derive total operating current (no load), add core operating current + (0.065 μA/V) * (peak-to-peak output Voltage swing).
5. Measured from the time Vdd reaches 1.5V.

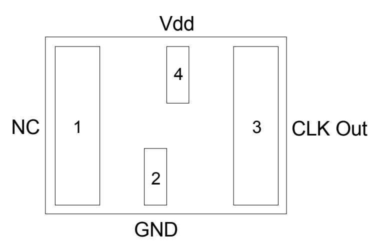
Electrical Characteristics (continued)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
LVCMOS Output Option, T_A = -40°C to +85°C, typical values are at T_A = 25°C						
Output Rise/Fall Time	tr, tf		100	200	ns	10-90% (Vdd), 15 pF load, Vdd = 1.5V to 3.63V
			50	80		10-90% (Vdd), 5 pF load, Vdd ≥ 1.62V
Output Clock Duty Cycle	DC	48		52	%	
Output Voltage High	VOH	90%			V	Vdd: 1.5V – 3.63V. I_{OH} = -10 μA, 15 pF
Output Voltage Low	VOL			10%	V	Vdd: 1.5V – 3.63V. I_{OL} = 10 μA, 15 pF

Pin Configuration

SMD Pin	Symbol	I/O	Functionality
1	NC	No Connect	No Connect. Will not respond to any input signal. When interfacing to an MCU's XTAL input pins, this pin is typically connected to the receiving IC's X Out pin. In this case, the CS00079 will not be affected by the signal on this pin. If not interfacing to an XTAL oscillator, leave pin 1 floating (no connect).
2	GND	Power Supply Ground	Connect to ground. All GND pins must be connected to power supply ground.
3	CLK Out	OUT	Oscillator clock output. When interfacing to an MCU's XTAL, the CLK Out is typically connected to the receiving IC's X IN pin. The CS00079 oscillator output includes an internal driver. As a result, the output swing and operation is not dependent on capacitive loading. This makes the output much more flexible, layout independent, and robust under changing environmental and manufacturing conditions.
4	Vdd	Power Supply	Connect to power supply 1.5V ≤ Vdd ≤ 3.63V for operation over -40°C to +85°C temperature range. Under normal operating conditions, Vdd does not require external bypass/decoupling capacitor(s). Internal power supply filtering will reject more than ±150 mVpp with frequency components through 10 MHz. Contact factory for applications that require a wider operating supply voltage range.

SMD Package (Top View)



System Block Diagram

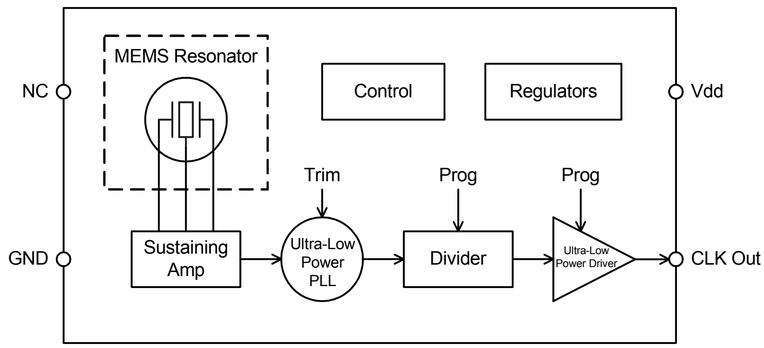


Figure 1.

Absolute Maximum

Attempted operation outside the absolute maximum ratings may cause permanent damage to the part. Actual performance of the IC is only guaranteed within the operational specifications, not at absolute maximum ratings.

Parameter	Test Condition	Value	Unit
Continuous Power Supply Voltage Range (Vdd)		-0.5 to 3.63	V
Short Duration Maximum Power Supply Voltage (Vdd)	≤30 minutes, over -40°C to +85°C	4.0	V
Continuous Maximum Operating Temperature Range	Vdd = 1.5V - 3.63V	105	°C
Short Duration Maximum Operating Temperature Range	Vdd = 1.5V - 3.63V, ≤30 mins	125	°C
Human Body Model ESD Protection	HBM, JESD22-A114	3000	V
Charge-Device Model (CDM) ESD Protection	JESD220C101	750	V
Machine Model (MM) ESD Protection	T_A = 25°C	300	V
Latch-up Tolerance	JESD78 Compliant		
Mechanical Shock Resistance	Mil 883, Method 2002	10,000	g
Mechanical Vibration Resistance	Mil 883, Method 2007	70	g
2012 SMD Junction Temperature		150	°C
Storage Temperature		-65°C to 150°C	

Description

The CS00079 is an ultra-small and ultra-low power 32.768 kHz oscillator optimized for mobile and other battery-powered applications. The CS00079 is pin-compatible and footprint compatible to existing 2012 XTALs when using the SiTime solder-pad layout (SPL). And unlike standard oscillators, the CS00079 features NanoDrive™, a factory programmable output that reduces the voltage swing to minimize power.

The 1.2V to 3.63V operating supply voltage range makes it an ideal solution for mobile applications that incorporate a low-voltage, battery-back-up source such as a coin-cell or super-cap.

SiTime's MEMS oscillators consist of MEMS resonators and a programmable analog circuit. Our MEMS resonators are built with SiTime's unique MEMS First™ process. A key manufacturing step is EpiSeal™ during which the MEMS resonator is annealed with temperatures over 1000°C. EpiSeal creates an extremely strong, clean, vacuum chamber that encapsulates the MEMS resonator and ensures the best performance and reliability. During EpiSeal, a poly silicon cap is grown on top of the resonator cavity, which eliminates the need for additional cap wafers or other exotic packaging. As a result, SiTime's MEMS resonator die can be used like any other semiconductor die. One unique result of SiTime's MEMS First and EpiSeal manufacturing processes is the capability to integrate SiTime's MEMS die with a SOC, ASIC, microprocessor or analog die within a package to eliminate external timing components and provide a highly integrated, smaller, cheaper solution to the customer.

XTAL Footprint Compatibility (SMD Package)

The CS00079 is a replacement to the 32 kHz XTAL in the 2.0 x 1.2 mm (2012) package. Unlike XTAL resonators, SiTime's silicon MEMS oscillators require a power supply (Vdd) and ground (GND) pin. Vdd and GND pins are conveniently placed between the two large XTAL pins. When using the SiTime Solder Pad Layout (SPL), the CS00079 footprint is compatible with existing 32 kHz XTALs in the 2012 SMD package. Figure 2 shows the comparison between the quartz XTAL footprint and the SiTime footprint. For applications that require the smallest footprint solution, consider the SiT1532 XO available in a 1.2mm^2 CSP.

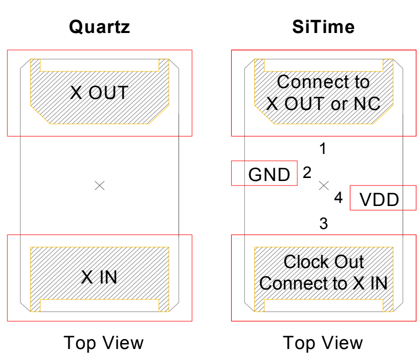


Figure 2. CS00079 Footprint Compatibility with Quartz XTAL Footprint [6]

Frequency Stability

The CS00079 is factory calibrated (trimmed) to guarantee frequency stability to be less than 20 ppm at room temperature and less than 100 ppm over the full -40°C to +85°C temperature range. Unlike quartz crystals that have a classic tuning fork parabola temperature curve with a 25°C turnover point, the CS00079 temperature coefficient is extremely flat across temperature. The device maintains less than 100 ppm frequency stability over the full operating temperature range when the operating voltage is between 1.5 and 3.63V as shown in Figure 3.

Functionality is guaranteed over the 1.2V - 3.63V operating supply voltage range. However, frequency stability degrades below 1.5V and steadily degrades as it approaches the 1.2V minimum supply due to the internal regulator limitations. Between 1.2V and 1.5V, the frequency stability is 250 ppm max over temperature.

When measuring the CS00079 output frequency with a frequency counter, it is important to make sure the counter's gate time is ≥100ms. The slow frequency of a 32 kHz clock will give false readings with faster gate times.

For applications that require a wider supply voltage range >3.63V, or operating frequency below 32 kHz, see the alternative 32 kHz product options on the SiTime web site; www.sitime.com.

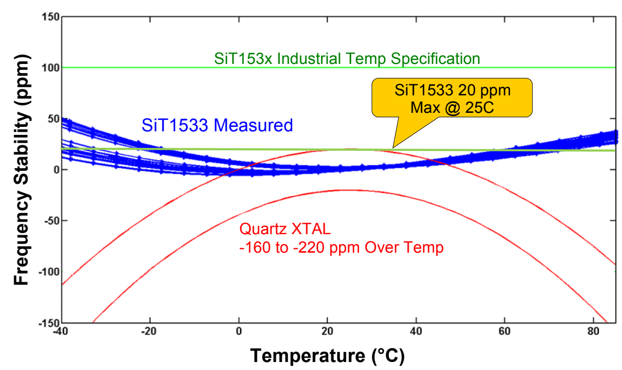


Figure 3. SiTime vs. Quartz

Power Supply Noise Immunity

The CS00079 is an ultra-small 32 kHz oscillator. In addition to eliminating external output load capacitors common with standard XTALs, this device includes special power supply filtering and thus, eliminates the need for an external Vdd bypass-decoupling capacitor. This feature further simplifies the design and keeps the footprint as small as possible. Internal power supply filtering is designed to reject AC-noise greater than ±150 mVpp magnitude and beyond 10 MHz frequency component.

Note:

6. On the Sitime device, X IN is not internally connected and will not respond to any signal. It is acceptable to connect to chipset X OUT.

Power-up

The CS00079 starts-up to a valid output frequency within 300 ms (150ms typ). To ensure the device starts-up within the specified limit, make sure the power-supply ramps-up in approximately 10 - 20 ms (to within 90% of Vdd). Start-up time is measured from the time Vdd reaches 1.5V. For applications that operate between 1.2V and 1.5V, the start-up time will be longer.

CS00079 Full Swing LVCMOS Output

Figure 4 shows the typical LVCMOS waveform (Vdd = 1.8V) at room temperature into a 15 pF load.

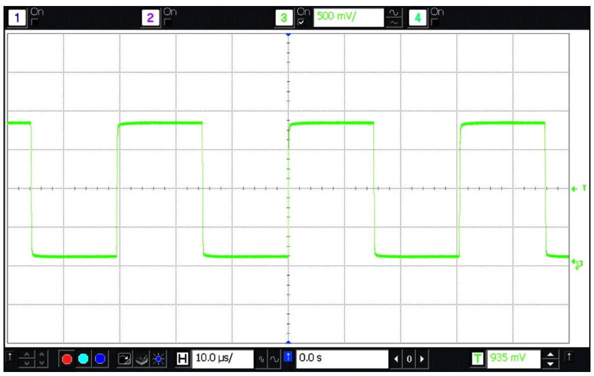


Figure 4. LVCMOS Waveform (Vdd = 1.8V) into 15 pF Load

Calculating Load Current

No Load Supply Current

When calculating no-load power for the CS00079, the core and output driver components need to be added. The equation is as follows:

Total Supply Current (no load) = I_{dd} Core + (65nA/V)($Vout_{pp}$)

***Example 1**: Full-swing LVCMOS*

- Vdd = 1.8V
- Idd Core = 900nA (typ)
- $Vout_{pp}$ = 1.8V (LVCMOS)

Supply Current = 900nA + (65nA/V)(1.8V) = 1017nA

Total Supply Current with Load

To calculate the total supply current, including the load, follow the equation listed below.

Total Current = Idd Core + Idd Output Driver (65nA/V*$Vout_{pp}$) + Load Current (C*V*F)

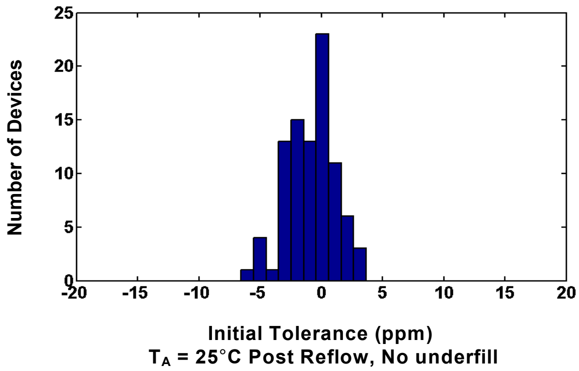
***Example 1**: Full-swing LVCMOS*

- Vdd = 1.8V
- Idd Core = 900nA
- Load Capacitance = 10pF
- Idd Output Driver: (65nA/V)(1.8V) = 117nA
- Load Current: (10pF)(1.8V)(32.768kHz) = 590nA
- Total Current = 900nA+117nA+590nA = 1.6µA

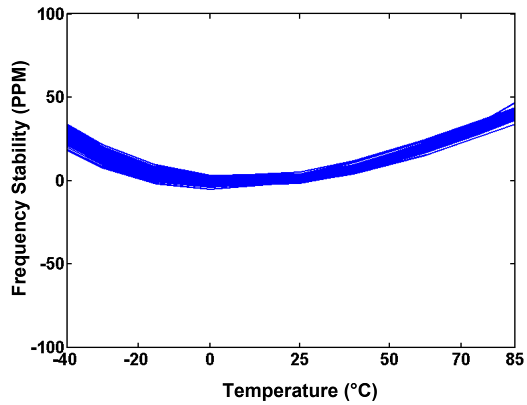
Typical Operating Curves

(T_A = 25°C, Vdd = 1.8V, unless otherwise stated)

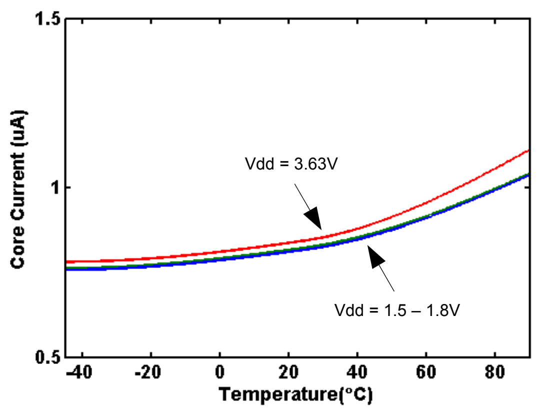
Initial Tolerance Histogram



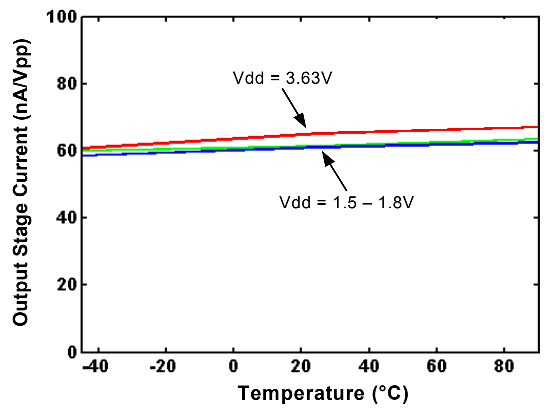
Frequency Stability Over Temperature



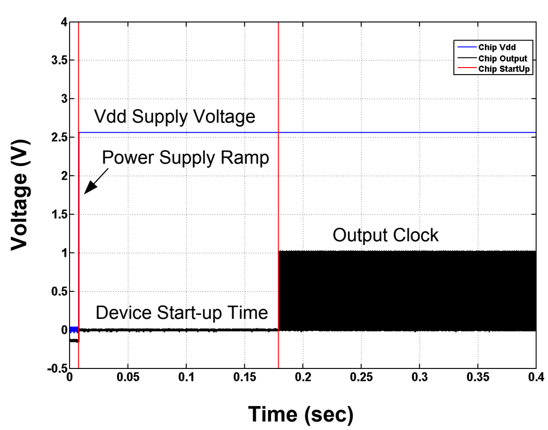
Core Current Over Temperature



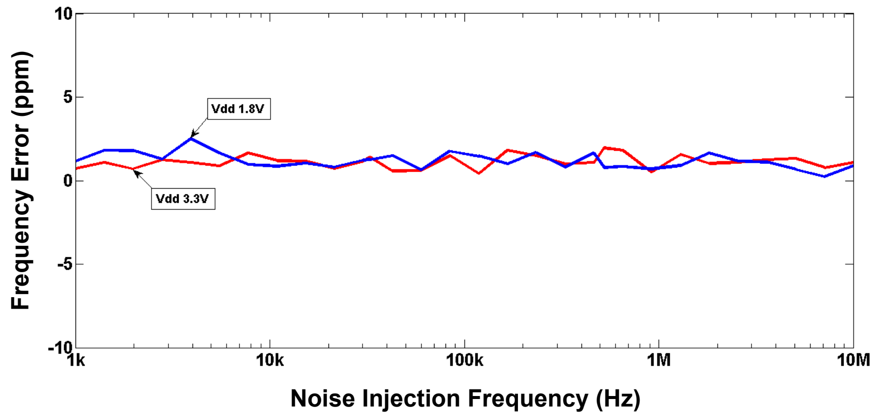
Output Stage Current Over Temperature



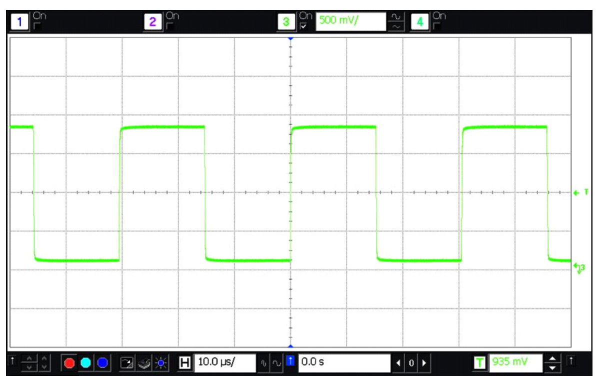
Start-up Time



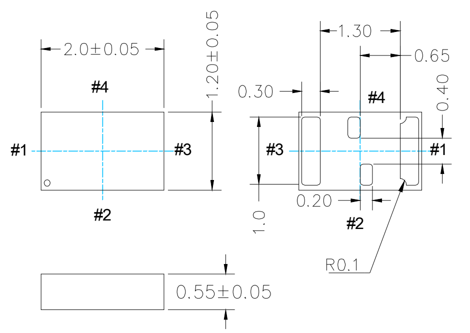
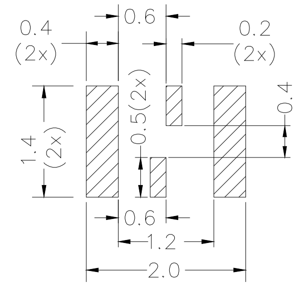
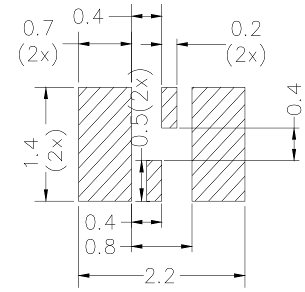
Power Supply Noise Rejection
(+/-150mV Noise)



LVCMOS Output Waveform
(V_{swing} = 1.8V, CS00079AI-H4-DCC-32.768)



Dimensions and Patterns

Package Size – Dimensions (Unit: mm)[7]	Recommended Land Pattern (Unit: mm)	
2.0 x 1.2 mm SMD	**SiTime Only SPL**	**XTAL Compatible SPL**
		

Note:

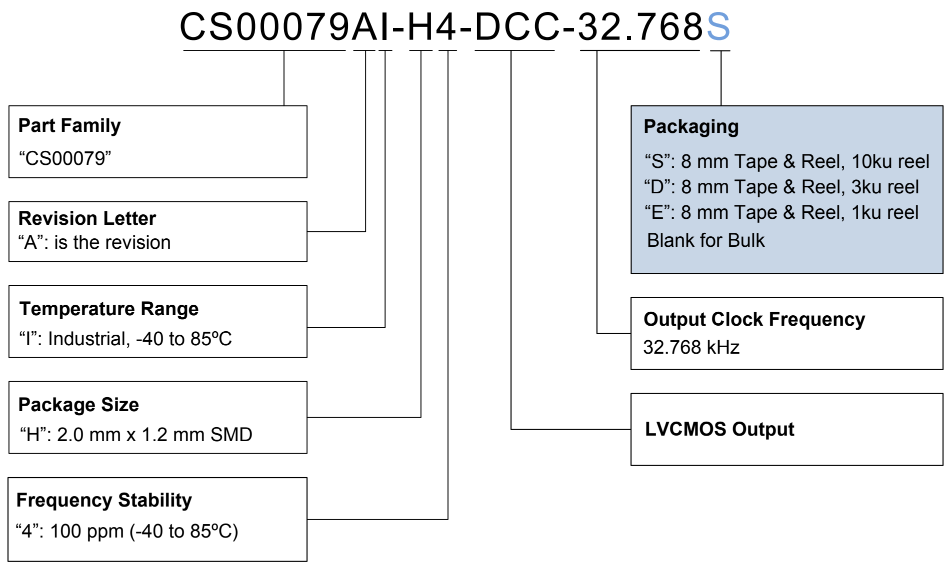
7. Top marking: Y denotes manufacturing origin and XXXX denotes manufacturing lot number. The value of “Y” will depend on the assembly location of the device.

Manufacturing Guidelines

1) No Ultrasonic Cleaning: Do not subject the CS00079 to an ultrasonic cleaning environment. Permanent damage or long term reliability issues to the MEMS structure may occur.

2) For additional manufacturing guidelines and marking/tape-reel instructions, click on the following link:
http://www.sitime.com/component/docman/doc_download/243-manufacturing-notes-for-sitime-oscillators

Ordering Information



Revision History

Version	Release Date	Change Summary
1.0	9/2/14	Rev 0.9 Preliminary to Rev 1.0 Production Release • Updated start-up time specification • Added typical operating plots • Separated initial tolerance spec for condition with and without underfill • Added Manufacturing Guidelines section
1.1	10/9/14	• Start-up Time at Power-up spec changes • Output Rise/Fall Time spec changes