SiT3809
80 MHz to 220 MHz MEMS VCXO

SiTime
The Smart Timing Choice™

Features

- Any frequency between 80.000001 MHz and 220 MHz with 6 decimal places of accuracy
- 100% pin-to-pin drop-in replacement to quartz-based VCXO
- Frequency stability as tight as ±10 ppm
- Widest pull range options from ±25 ppm to ±1600 ppm
- Industrial or extended commercial temperature range
- Superior pull range linearity of ≤1%, 10 times better than quartz
- LVCMOS/LVTTL compatible output
- Four industry-standard packages: 2.5 mm x 2.0 mm (4-pin), 3.2 mm x 2.5mm (4-pin), 5.0 mm x 3.2 mm (6-pin), 7.0 mm x 5.0 mm (6-pin)
- Instant samples with Time Machine II and field programmable oscillators
- RoHS and REACH compliant, Pb-free, Halogen-free and Antimony-free

Applications

- Telecom clock synchronization, instrumentation
- Low bandwidth analog PLL, jitter cleaner, clock recovery, audio
- Video, 3G/HD-SDI, FPGA, broadband and networking

INSTANT SAMPLES
GREEN SOLUTIONS
LIFETIME WARRANTY

Electrical Specifications

Table 1. Electrical Characteristics[1, 2, 3]

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Frequency Range						
Output Frequency Range	f	80.000001	–	220	MHz	
Frequency Stability and Aging						
Frequency Stability	F_stab	-10	–	+10	ppm	Inclusive of Initial tolerance[4] at 25°C, and variation over temperature, rated supply voltage and load.
		-25	–	+25	ppm	
		-50	–	+50	ppm	
Aging	F_aging	-5	–	+5	ppm	10 years, 25°C
Operating Temperature Range	T_use	-20	–	+70	°C	Extended Commercial
		-40	–	+85	°C	Industrial
Supply Voltage and Current Consumption						
Supply Voltage	Vdd	1.71	1.8	1.89	V	Additional supply voltages between 2.5V and 3.3V can be supported. Contact SiTime for additional information.
		2.25	2.5	2.75	V	
		2.52	2.8	3.08	V	
		2.97	3.3	3.63	V	
Current Consumption	Idd	–	34	36	mA	No load condition, f = 100 MHz, Vdd = 2.5V, 2.8V or 3.3V
		–	30	33	mA	No load condition, f = 100 MHz, Vdd = 1.8V
Standby Current	I_std	–	–	70	µA	Vdd = 2.5V, 2.8V, 3.3V, $\overline{ST}$ = GND, output is Weakly Pulled Down
		–	–	10	µA	Vdd = 1.8V, $\overline{ST}$ = GND, output is Weakly Pulled Down
VCXO Characteristics						
Pull Range[5, 6]	PR	±25, ±50, ±100, ±150, ±200, ±400, ±800, ±1600			ppm	See the Absolute Pull Range and APR table on page 8
Upper Control Voltage	VC_U	1.7	–	–	V	Vdd = 1.8V, Voltage at which maximum deviation is guaranteed.
		2.4	–	–	V	Vdd = 2.5V, Voltage at which maximum deviation is guaranteed.
		2.7	–	–	V	Vdd = 2.8V, Voltage at which maximum deviation is guaranteed.
		3.2	–	–	V	Vdd = 3.3V, Voltage at which maximum deviation is guaranteed.
Lower Control Voltage	VC_L	–	–	0.1	V	Voltage at which minimum deviation is guaranteed.
Control Voltage Input Impedance	Z_in	100	–	–	kΩ	
Control Voltage Input Capacitance	C_in	–	5	–	pF	
Linearity	Lin	–	0.1	1	%	
Frequency Change Polarity	–	Positive slope			–	
Control Voltage Bandwidth (-3dB)	V_BW	–	8	–	kHz	Contact SiTime for 16 kHz and other high bandwidth options

Electrical Specifications (continued)

Table 1. Electrical Characteristics[1, 2, 3]

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
LVCMOS Output Characteristics						
Duty Cycle	DC	45	–	55	%	f <= 165 MHz, all Vdds. Refer to Note 11 for definition of Duty Cycle.
		40	–	60	%	f > 165 MHz, all Vdds. Refer to Note 11 for definition of Duty Cycle.
Rise/Fall Time	Tr, Tf	–	1.5	2	ns	Vdd = 1.8V, 2.5V, 2.8V or 3.3V, 10% - 90% Vdd level
Output High Voltage	VOH	90%	–	–	Vdd	IOH = -7 mA (Vdd = 3.0V or 3.3V) IOH = -4 mA (Vdd = 2.8V or 2.5V) IOH = -2 mA (Vdd = 1.8V)
Output Low Voltage	VOL	–	–	10%	Vdd	IOL = 7 mA (Vdd = 3.0V or 3.3V) IOL = 4 mA (Vdd = 2.8V or 2.5V) IOL = 2 mA (Vdd = 1.8V)
Input Characteristics						
Input Pull-up Impedance	Z_in	–	100	250	kΩ	For the OE/$\overline{ST}$ pin for 6-pin devices
Input Capacitance	C_in	–	5	–	pF	For the OE/$\overline{ST}$ pin for 6-pin devices
Startup and Resume Timing						
Startup Time	T_start	–	–	10	ms	See Figure 7 for startup resume timing diagram
OE Enable/Disable Time	T_oe	–	–	115	ns	f = 80.000001 MHz, all Vdds. For other freq, T_oe = 100 ns + 3 clock periods
Resume Time	T_resume	–	7	10	ms	See Figure 8 for resume timing diagram
Jitter						
RMS Period Jitter	T_jitt	–	1.5	2	ps	f = 156.25 MHz, Vdd = 2.5V, 2.8V or 3.3V
		–	2	3	ps	f = 156.25 MHz, Vdd = 1.8V
RMS Phase Jitter (random)	T_phj	–	0.5	1	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz

Notes:
1. All electrical specifications in the above table are specified with 15 pF output load and for all Vdd(s) unless otherwise stated.
2. The typical value of any parameter in the Electrical Characteristics table is specified for the nominal value of the highest voltage option for that parameter and at 25°C temperature.
3. All max and min specifications are guaranteed across rated voltage variations and operating temperature ranges, unless specified otherwise
4. Initial tolerance is measured at Vin = Vdd/2
5. Absolute Pull Range (APR) is defined as the guaranteed pull range over temperature and voltage.
6. APR = pull range (PR) - frequency stability (F_stab) - Aging (F_aging)

Table 2. Pin Description. 4-Pin Configuration
(For 2.5 x 2.0 mm and 3.2 x 2.5 mm packages)

Pin	Symbol	Functionality	
1	VIN	Input	0-Vdd: produces voltage dependent frequency change
2	GND	Power	Electrical ground
3	CLK	Power	Power supply voltage
4	VDD	Input Power	Oscillator output power[7]

Note:
7. A capacitor value of 0.1 µF between VDD and GND is recommended.

Top View

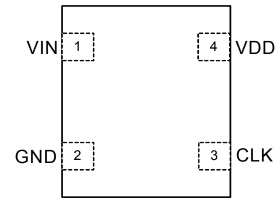


Figure 1.

Table 3. Pin Description. 6-Pin Configuration
(For 5.0 x 3.2 mm and 7.0 x 5.0 mm packages)

Pin	Symbol	Functionality	
1	VIN	Input	0-Vdd: produces voltage dependent frequency change
2	NC/OE/$\overline{ST}$	No Connect	H or L or Open: No effect on output frequency or other device functions
		Output Enable	H or Open[8]: specified frequency output L: output is high
		Standby	H or Open[8]: specified frequency output L: output is low (weak pull down)[9]. Oscillation stops
3	GND	Power	Electrical ground
4	CLK	Output	Oscillator output
5	NC	No Connect	H or L or Open: No effect on output frequency or other device functions
6	VDD	Power	Power supply voltage[10]

Top View

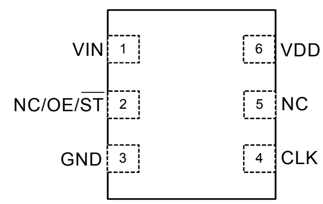


Figure 2.

Notes:
8. In OE or ST mode, a pull-up resistor of 10 kΩ or less is recommended if pin 2 in the 6-pin package is not externally driven. If pin 2 needs to be left floating, use the NC option
9. Typical value of the weak pull-down impedance is 5 mΩ
10. A capacitor value of 0.1 µF between VDD and GND is recommended.

Table 4. Absolute Maximum Limits

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	Min.	Max.	Unit
Storage Temperature	-65	150	°C
VDD	-0.5	4	V
Electrostatic Discharge	–	2000	V
Soldering Temperature (follow standard Pb free soldering guidelines)	–	260	°C

Table 5. Thermal Consideration

Parameter	θJA, 4 Layer Board (°C/W)	θJA, 2 Layer Board (°C/W)	θJC, Bottom (°C/W)
7050	191	263	30
5032	97	199	24
3225	109	212	27
2520	117	222	26

Table 6. Environmental Compliance

Parameter	Condition/Test Method
Mechanical Shock	**MIL-STD-883F, Method 2002**
Mechanical Vibration	**MIL-STD-883F, Method 2007**
Temperature Cycle	**JESD22, Method A104**
Solderability	**MIL-STD-883F, Method 2003**
Moisture Sensitivity Level	**MSL1 @ 260°C**

Phase Noise Plot

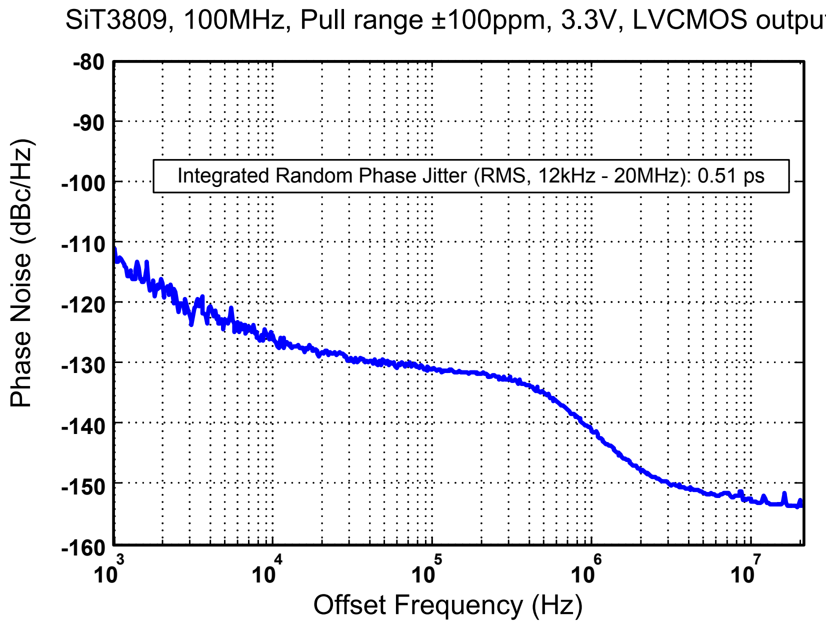


Figure 3. Phase Noise

Test Circuit and Waveform

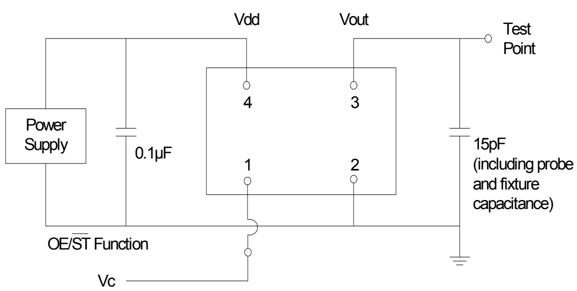


Figure 4. Test Circuit (4-Pin Device)

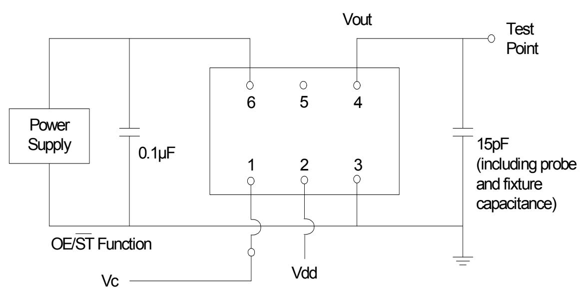


Figure 5. Test Circuit (6-Pin Device)

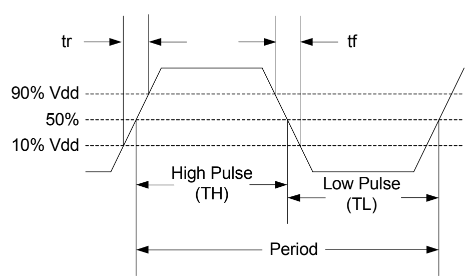
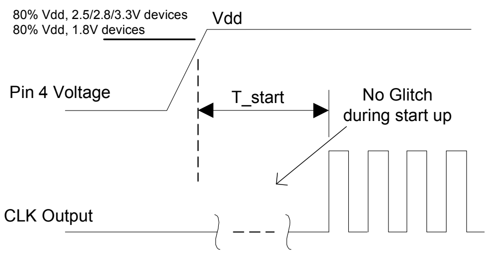


Figure 6. Waveform

Notes:

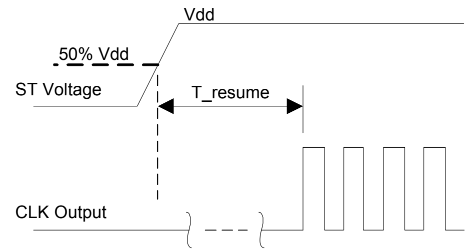
11. Duty Cycle is computed as Duty Cycle = TH/Period.
12. SiT3809 supports the configurable duty cycle feature. For custom duty cycle at any given frequency, contact SiTime.

Timing Diagram



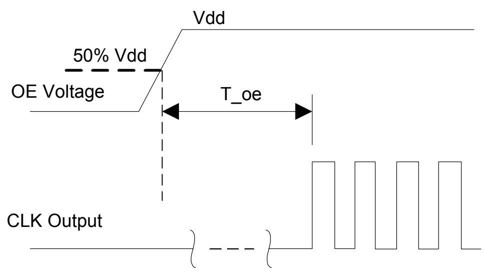
T_start: Time to start from power-off

Figure 7. Startup Timing (OE/$\overline{\text{ST}}$ Mode)



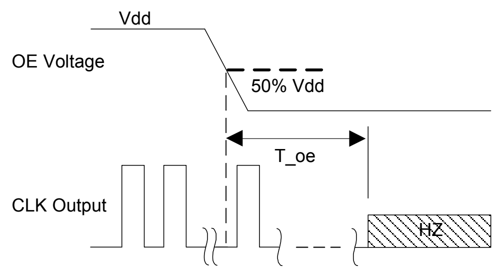
T_resume: Time to resume from ST

Figure 8. Standby Resume Timing ($\overline{\text{ST}}$ Mode Only)



T_oe: Time to re-enable the clock output

Figure 9. OE Enable Timing (OE Mode Only)



T_oe: Time to put the output in High Z mode

Figure 10. OE Disable Timing (OE Mode Only)

Notes:

13. SiT3809 supports “no runt” pulses and “no glitch” output during startup or resume.
14. SiT3809 supports gated output which is accurate within rated frequency stability from the first cycle.

Instant Samples with Time Machine and Field Programmable Oscillators

SiTime supports a field programmable version of the SiT3809 MEMS VCXO for fast prototyping and real time customization of features. The field programmable devices (FP devices) are available for all four standard SiT3809 package sizes and can be configured to one's exact specification using the Time Machine II, an USB powered MEMS oscillator programmer.

Customizable Features of the SiT3809 FP Devices Include

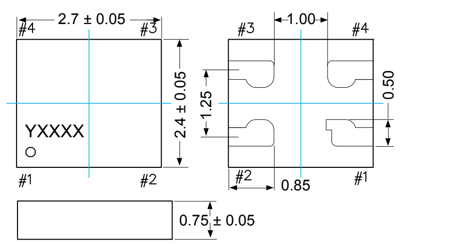
- Any frequency between 80.000001 MHz to 220 MHz
- Three frequency stability options: ±10 ppm, ±25 ppm, ±50 ppm
- Two operating temperatures: -20 to 70°C or -40 to 85°C
- Four supply voltage options: 1.8V, 2.5V, 2.8V, and 3.3V
- Eight pull range options: ±25 ppm, ±50 ppm, ±100 ppm, ±150 ppm, ±200 ppm, ±400 ppm, ±800 ppm, ±1600 ppm

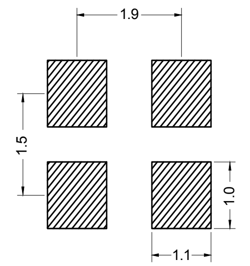
For more information regarding SiTime's field programmable solutions, visit http://www.sitime.com/time-machine and http://www.sitime.com/fp-devices.

SiT3809 is typically factory-programmed per customer ordering codes for volume delivery.

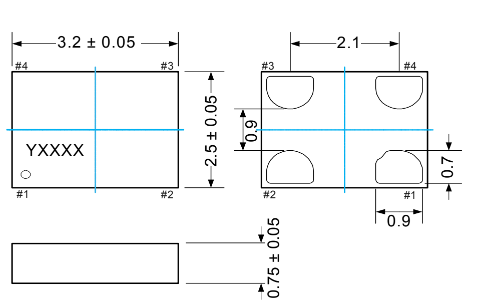
Dimensions and Patterns

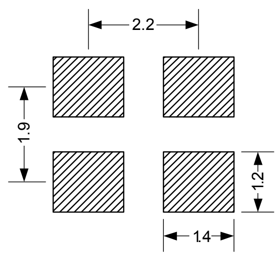
Package Size – Dimensions (Unit: mm)[15]	Recommended Land Pattern (Unit: mm)
2.7 x 2.4 x 0.75 mm (100% compatible with 2.5 x 2. 0 mm footprint)	



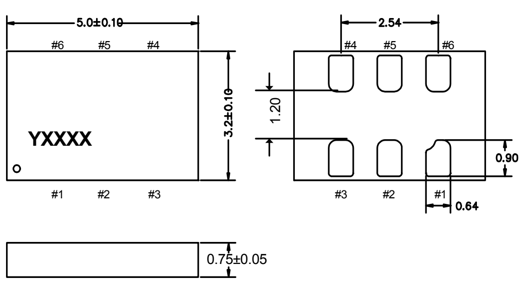


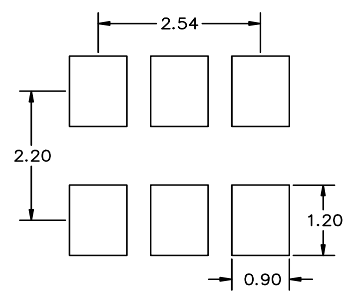
3.2 x 2.5 x 0.75 mm



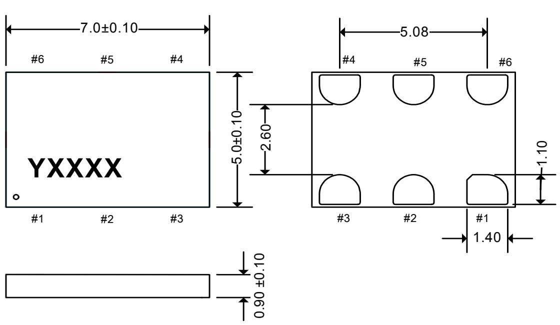


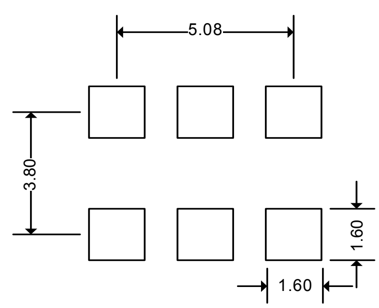
5.0 x 3.2 x 0.75 mm





7.0 x 5.0x 0.90 mm





Note:

15. 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.

Ordering Information

SiT3809AC-22-33EH-125.123456D

Part Family
"SiT3809"

Revision Letter
"A" is the revision

Temperature Range
"C" Commercial, -20 to 70°C
"I" Industrial, -40 to 85°C

Output Drive Strength[16]
"-" Default below the line

Package
"G" 2.5 x 2.0 mm x mm
"2" 4-pin, 3.2 x 2.5 mm x mm
"C" 6-pin, 5.0 x 3.2 mm x mm
"D" 6-pin, 7.0 x 5.0 mm x mm

Frequency Stability
"F" for ±10 ppm
"2" for ±25 ppm
"3" for ±50 ppm

Packing Method
"T": 12 mm Tape & Reel, 3ku reel
"Y": 12 mm Tape & Reel, 1ku reel
"D": 8 mm Tape & Reel, 3ku reel
"E": 8 mm Tape & Reel, 1ku reel
Blank for Bulk

Frequency
80.000001 to 220 MHz

Pull Range Options
"M" for ±25 ppm
"B" for ±50 ppm
"E" for ±100 ppm
"G" for ±150 ppm
"H" for ±200 ppm
"X" for ±400 ppm
"Y" for ±800 ppm
"Z" for ±1600 ppm

Feature Pin
"N" for No Connect in 6-pin devices, Default value in 4-pin device
"E" for Output Enable (6-pin only)
"S" for Standby (6-pin only)

Supply Voltage
"18" for 1.8 V ±5%
"25" for 2.5 V ±10%
"28" for 2.8 V ±10%
"33" for 3.3 V ±10%

Note:
16. Contact SiTime for different drive strength to drive multiple loads or to reduce EMI.

Table 7. APR Definition

Absolute pull range (APR) = Norminal pull range (PR) - frequency stability (F_stab) - Aging (F_aging)

	Frequency Stability		
Nominal Pull Range	± 10	± 25	± 50
		APR (PPM)	
± 25	± 10	–	–
± 50	± 35	± 20	–
± 100	± 85	± 70	± 45
± 150	± 135	± 120	± 95
± 200	± 185	± 170	± 145
± 400	± 385	± 370	± 345
± 800	± 785	± 770	± 745
± 1600	± 1585	± 1570	± 1545

Table 8. Ordering Codes for Supported Tape & Reel Packing Method[17]

Device Size	12 mm T&R (3ku)	12 mm T&R (1ku)	8 mm T&R (3ku)	8 mm T&R 1ku)
2.5 x 2.0 mm	–	–	D	E
3.2 x 2.5 mm	–	–	D	E
5.0 x 3.2 mm	T	Y	–	–
7.0 x 5.0 mm	T	Y	–	–

Note:
17. "–" indicates "not available."

Table 9. Additional Information

Document	Description	Download Link
Manufacturing Notes	Tape & Reel dimension, reflow profile and other manufacturing related info	http://www.sitime.com/component/docman/doc_download/85-manufaturing-notes-for-sitime-oscillators
Qualification Reports	RoHS report, reliability reports, composition reports	http://www.sitime.com/support/quality-and-reliability
Performance Reports	Additional performance data such as phase noise, current consumption and jitter for selected frequencies	http://www.sitime.com/support/performance-measurement-report
Termination Techniques	Termination design recommendations	http://www.sitime.com/support/application-notes
Layout Techniques	Layout recommendations	http://www.sitime.com/support/application-notes
VCXO Specifications	Definition of key VCXO specifications such as APR and Kv	http://www.sitime.com/support2/documents/AN10020_VCXO_SpecDefinitions_rev1.pdf
VCXO in PLL Design	Selection of VCXO parameters and trade-offs in PLL designs	http://www.sitime.com/support2/documents/AN10021_VCXO_PLL_Design_Guidelines_1v0.pdf

Revision History

Table 10. Datasheet Version and Change Log

Version	Release Date	Change Summary
0.6	1/24/2013	Preliminary
1.0	3/18/14	• Preliminary removed from title • Updated features and application • Updated electrical specifications table • Updated figure 4, • Added new 6-pin device for figure 5 • Updated timing diagrams • Updated ordering information drawing • Updated APR table • Updated ordering codes for tape and reel table • Reformatted additional information table columns
1.01	1/8/15	• Corrected CLK and VDD functionality description in Table 2 • Revised VIN functionality description in Table 3

Supplemental Information

The Supplemental Information section is not part of the datasheet and is for informational purposes only.

Silicon MEMS Outperforms Quartz

Silicon MEMS Outperforms Quartz

SiTime
The Smart Timing Choice™

Best Reliability

Silicon is inherently more reliable than quartz. Unlike quartz suppliers, SiTime has in-house MEMS and analog CMOS expertise, which allows SiTime to develop the most reliable products. Figure 1 shows a comparison with quartz technology.

Why is SiTime Best in Class:

- SiTime's MEMS resonators are vacuum sealed using an advanced EpiSeal™ process, which eliminates foreign particles and improves long term aging and reliability
- World-class MEMS and CMOS design expertise

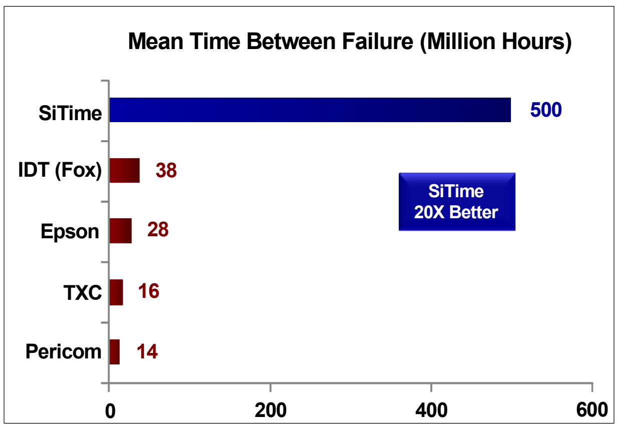


Figure 1. Reliability Comparison[1]

Best Aging

Unlike quartz, MEMS oscillators have excellent long term aging performance which is why every new SiTime product specifies 10-year aging. A comparison is shown in Figure 2.

Why is SiTime Best in Class:

- SiTime's MEMS resonators are vacuum sealed using an advanced EpiSeal process, which eliminates foreign particles and improves long term aging and reliability
- Inherently better immunity of electrostatically driven MEMS resonator

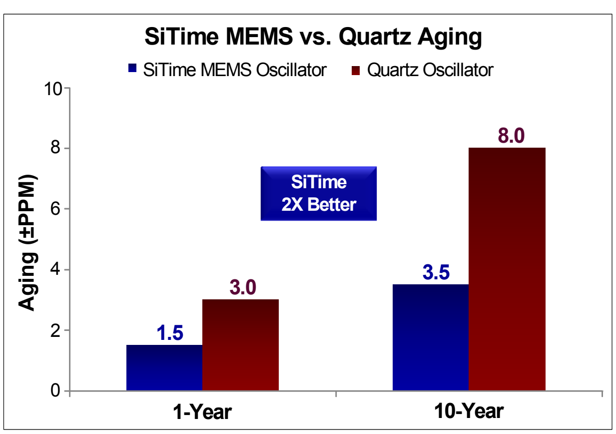


Figure 2. Aging Comparison[2]

Best Electro Magnetic Susceptibility (EMS)

SiTime's oscillators in plastic packages are up to 54 times more immune to external electromagnetic fields than quartz oscillators as shown in Figure 3.

Why is SiTime Best in Class:

- Internal differential architecture for best common mode noise rejection
- Electrostatically driven MEMS resonator is more immune to EMS

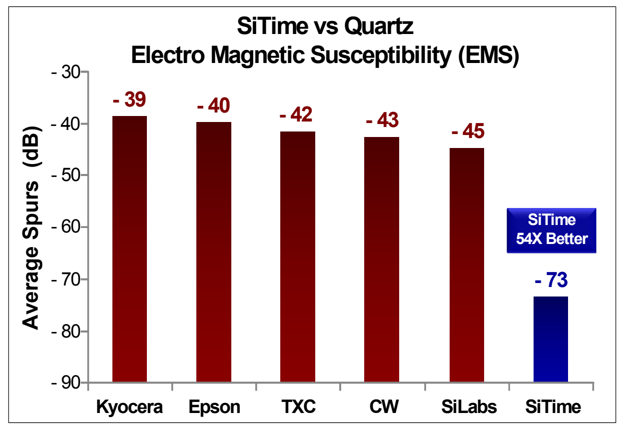


Figure 3. Electro Magnetic Susceptibility (EMS)[3]

Best Power Supply Noise Rejection

SiTime's MEMS oscillators are more resilient against noise on the power supply. A comparison is shown in Figure 4.

Why is SiTime Best in Class:

- On-chip regulators and internal differential architecture for common mode noise rejection
- Best analog CMOS design expertise

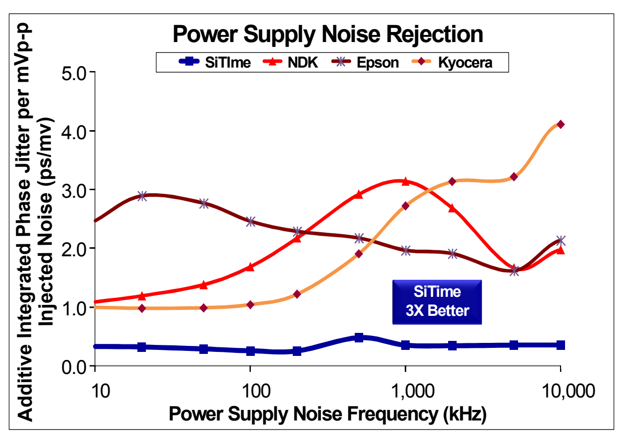


Figure 4. Power Supply Noise Rejection[4]

Best Vibration Robustness

High-vibration environments are all around us. All electronics, from handheld devices to enterprise servers and storage systems are subject to vibration. Figure 5 shows a comparison of vibration robustness.

Why is SiTime Best in Class:

- The moving mass of SiTime's MEMS resonators is up to 3000 times smaller than quartz
- Center-anchored MEMS resonator is the most robust design

Best Shock Robustness

SiTime's oscillators can withstand at least 50,000 *g* shock. They all maintain their electrical performance in operation during shock events. A comparison with quartz devices is shown in Figure 6.

Why is SiTime Best in Class:

- The moving mass of SiTime's MEMS resonators is up to 3000 times smaller than quartz
- Center-anchored MEMS resonator is the most robust design

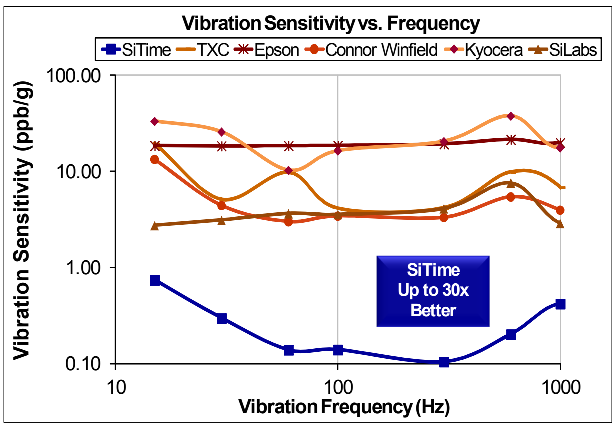


Figure 5. Vibration Robustness[5]

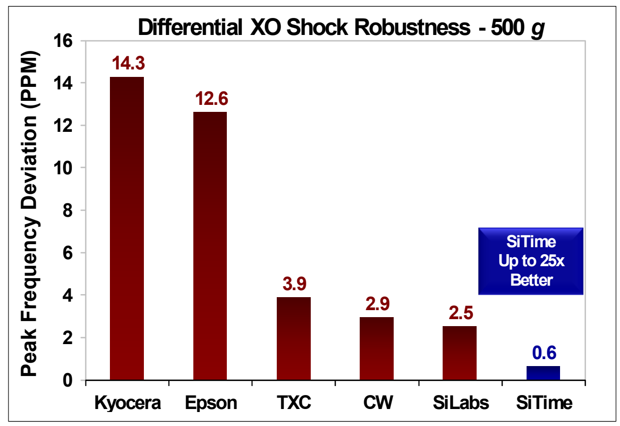


Figure 6. Shock Robustness[6]

Notes:

1. Data Source: Reliability documents of named companies.
2. Data source: SiTime and quartz oscillator devices datasheets.
3. Test conditions for Electro Magnetic Susceptibility (EMS):
   - According to IEC EN61000-4.3 (Electromagnetic compatibility standard)
   - Field strength: 3V/m
   - Radiated signal modulation: AM 1 kHz at 80% depth
   - Carrier frequency scan: 80 MHz – 1 GHz in 1% steps
   - Antenna polarization: Vertical
   - DUT position: Center aligned to antenna

   Devices used in this test:
   SiTime, SiT9120AC-1D2-33E156.250000 - MEMS based - 156.25 MHz
   Epson, EG-2102CA 156.2500M-PHPAL3 - SAW based - 156.25 MHz
   TXC, BB-156.250MBE-T - 3rd Overtone quartz based - 156.25 MHz
   Kyocera, KC7050T156.250P30E00 - SAW based - 156.25 MHz
   Connor Winfield (CW), P123-156.25M - 3rd overtone quartz based - 156.25 MHz
   SiLabs, Si590AB-BDG - 3rd overtone quartz based - 156.25 MHz
4. 50 mV pk-pk Sinusoidal voltage.
   Devices used in this test:
   SiTime, SiT8208AI-33-33E-25.000000, MEMS based - 25 MHz
   NDK, NZ2523SB-25.6M - quartz based - 25.6 MHz
   Kyocera, KC2016B25M0C1GE00 - quartz based - 25 MHz
   Epson, SG-310SCF-25M0-MB3 - quartz based - 25 MHz
5. **Devices used in this test:** same as EMS test stated in Note 3.
6. Test conditions for shock test:
   - MIL-STD-883F Method 2002
   - Condition A: half sine wave shock pulse, 500-g, 1ms
   - Continuous frequency measurement in 100 µs gate time for 10 seconds

   Devices used in this test: same as EMS test stated in Note 3
7. Additional data, including setup and detailed results, is available upon request to qualified customers. Please contact productsupport@sitime.com.

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