

MEMS Timing Solutions Improve Touchscreen Devices

One of the first commercial applications of MEMS (micro-electro mechanical systems) technology was for sensors used in automotive safety systems. MEMS technology has spread to other applications including microphones for mobile phones and acceleration sensors and gyroscopes for portable gaming devices and tablets. Now MEMS technology is successfully used in timing devices such as resonators, oscillators and clock generators used in a wide variety of electronics systems.

MEMS timing is now bringing new benefits to systems that use touchscreen technology. Touchscreens, used for human-machine interface, have become widely used in many devices especially in portable consumer devices that use capacitive touch sensing as the primary method of user interface.

MEMS Timing

Oscillators, resonators and clock generators are used as a clock or timing reference source. A typical electronic system uses several timing devices depending on system complexity and the number of subsystems as shown in Figure 1.

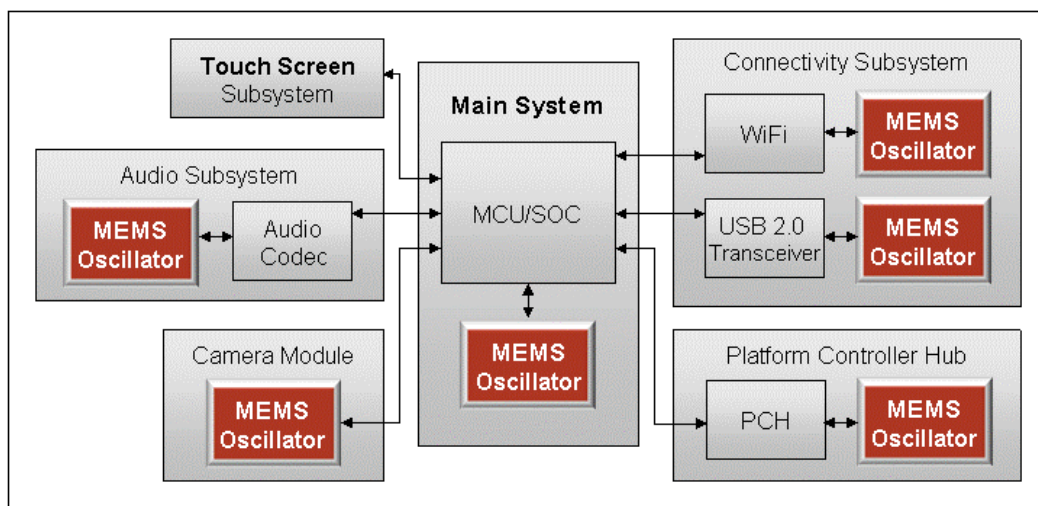


Figure 1: MEMS oscillators in a typical tablet PC design with touchscreen

In devices with a touchscreen, the screens are covered with a dielectric coating material. As users touch the screen, they change the electrode capacitance and send a signal to the system processor (MCU or SOC). This signal is clocked by a timing device as shown in Figure 2.

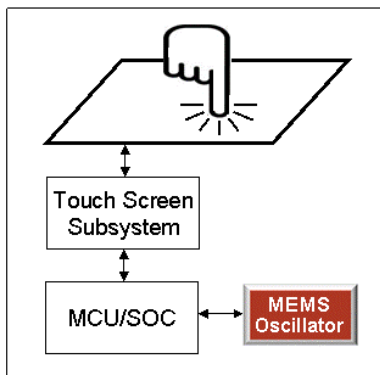


Figure 2: MEMS clocking for touch sensing applications

For several decades, quartz crystal based oscillators, clock generators and resonators were the primary reference timing components used in electronics. MEMS-based oscillators, clock generators and resonators are now rapidly replacing quartz devices. The growing use of MEMS timing is due to a number of performance and supply-chain advantages including the following benefits that apply to portable touchscreen devices.

- Smaller footprint and lower cost with all-silicon die inside industry standard low-cost plastic packages or ultra-small CSPs (chip scale packages)
- Improved system performance and reliability with immunity to shock, vibration and noise
- Readily available products with a wide variety of features

Reliable and Resilient Systems

Products with touchscreens are often used in harsh and noisy environments. Touchscreen-based devices are often used in industrial applications in environments with vibration and EMI, or in portable consumer devices that experience shock and vibration. Exposure to these environmental stressors can impact system performance. Quartz-based oscillators are fragile and are known to have reliability issues. In contrast, silicon MEMS oscillators are extremely reliable and resilient as shown in the following table.

	SiTime MEMS Oscillators
Reliability	20x better than quartz oscillators (<2 FIT, 500 hrs MTBF)
EMI Noise Sensitivity	54x better than quartz oscillators
Power Supply Noise Sensitivity	3x better than quartz SAW oscillators
Vibration Sensitivity	Up to 30x better than quartz oscillators
Shock Resistance	Up to 25x better than quartz

When operating in certain environments, many oscillators will degrade and not conform to datasheet specifications. Due to the unique silicon MEMS resonator design and analog circuit design, SiTime's silicon MEMS oscillators are much more robust against EMI, shock and vibration as shown in the following graphs.

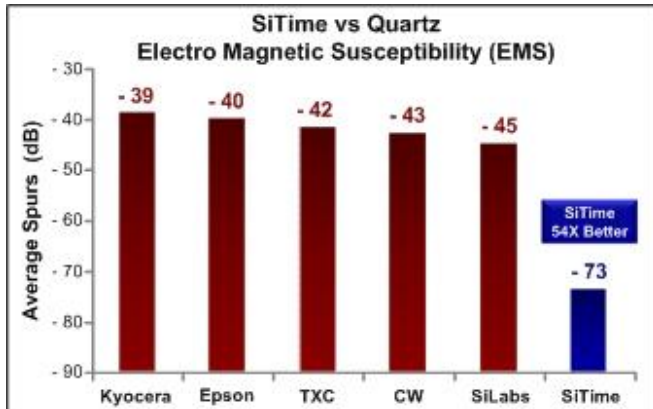


Figure 3: Electro magnetic susceptibility

SiTime oscillators have the best EMS (electromagnetic susceptibility) performance as shown in Figure 3. This is due to SiTime's unique oscillator design with an internal differential architecture for best common mode noise rejection. Additionally, the electrostatically-driven MEMS resonator is inherently more immune to EMS.

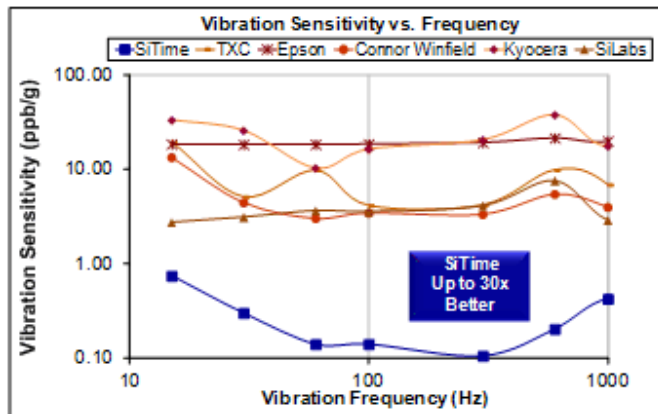


Figure 4: Vibration sensitivity

Vibration can degrade the performance of oscillators. SiTime oscillators are less sensitive to vibration compared to other oscillators as shown in Figure 4. The very small mass (up to 3000 times less than quartz resonators) and structural design of SiTime resonators make them extremely immune to external forces such as vibration and shock.

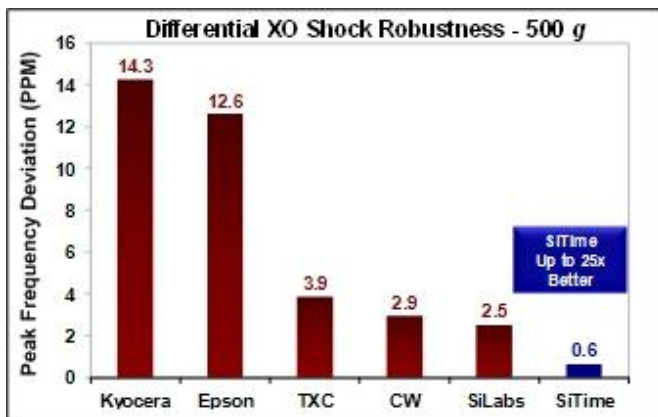


Figure 5: Shock robustness

SiTime oscillators are much more robust compared to quartz oscillators. With a proprietary single-point, center-anchored MEMS resonator design, SiTime oscillators can withstand at least 50,000 g shock and maintain their electrical performance during shock events.

See Resiliency and Reliability Applications Notes at <http://www.sitime.com/support/application-notes> for complete details on test conditions and methodologies, test results and oscillators under test [1].

Reducing EMI

In addition to external noise, internal system noise can degrade performance of touchscreen devices. EMI noise can be reduced through the spread spectrum modulation or edge rate tuning features in SiTime MEMS oscillators [2] [3]. Devices with touch sensing systems such as tablets typically use single-ended oscillators. Using spread spectrum modulation in single-ended clock signals is an effective method for reducing EMI on the main frequency and its harmonics throughout the system. Spread spectrum clocking, available as center-spread or down-spread, reduces the peak EMI radiation by spreading the frequency over a larger frequency range.

EMI can also be reduced by slowing the output clock edge rate through programming options in MEMS oscillators. Most harmonics can easily be reduced by >20 dB while maintaining peak-to-peak clock swing. In contrast, typical quartz oscillators cannot be programmed to provide slower rise/fall times. Without spread spectrum or edge rate control, design engineers are required to find other more expensive and time-consuming solutions such as shielding, filtering or PCB layout modification to resolve EMI issues.

Smaller and Programmable Timing Solutions

Small size is a critical for most portable touchscreen devices. SiTime offers the industry's smallest 32 kHz clocks in 1.5 x 0.8 x 0.55H mm chip-scale packages. Because SiTime's 32 kHz devices do not require capacitors, the footprint is reduced by up to 85% compared to common 2.0 x 1.6 mm 32 kHz crystal resonators and their supporting capacitors.

MEMS-based MHz oscillators are available in tiny 2.0 x 1.6 mm and 2.0 x 2.5 mm industry-standard low-cost plastic packages. These packages from are pin-compatible drop-in replacements for quartz devices. They can be soldered onto existing boards without modifying or redesigning the PCB. This eliminates second source issues for portable device manufacturers.

MEMS oscillators from SiTime have a programmable architecture that allows products to be easily configured with custom frequencies between 1 Hz to 625 MHz with up to six decimal places of accuracy. SiTime oscillators have other programmable features including a wide range of supply voltages and frequency stability options. This programmability allows designers to optimize system design and allows SiTime to offer the widest range of timing products with very short lead-times of three to five weeks for production volume. This is especially important for manufacturers of portable consumer products that experience shorter product life cycles or seasonal demand.

Summary

Manufacturers of touchscreen tablets and smart phones must continually improve features and performance while lowering costs. MEMS oscillators provide several benefits that meet these demands.

- Small packages for thinner and smaller end products
- Reliable and robust components that can sustain high performance operation through various conditions including changes in temperature, shock and vibration experienced by hand-held products and noisy environments
- Programmable architecture that enables a wide range of features and readily available products
- Lowest cost timing solutions

References

- [1] SiTime Corp., *Resilience and Reliability of Silicon MEMS Oscillators*,
<http://www.sitime.com/support/application-notes>
- [2] SiTime Corp., *SiTime Spread Spectrum Clock Oscillators*,
<http://www.sitime.com/support2/documents/AN10005-Spread-Spectrum-Oscillators.pdf>
- [3] SiTime Corp., *Rise and Fall Time Selection for 8103, 8003, and 9003*,
<http://www.sitime.com/support2/documents/AN10005-Spread-Spectrum-Oscillators.pdf>