



Media Q&A

SiTime Emerald Platform | MEMS Timing Solution for 5G

Timing Basics

Q: What is an oscillator?

A: An oscillator (XO) is an active electronic device that generates a clock signal using a resonator and an oscillation circuit. XOs are also known as OSC and SPXO in various geographies. Because a clock signal needs to be stable, one of the key metrics of performance of an oscillator is frequency stability, i.e. the variation of frequency over temperature. Typical frequency stability of XOs is between ± 10 and ± 100 ppm (parts per million). In addition to standard oscillators, unique features can be added to XOs to create specialized oscillators such as SSXO (spread spectrum oscillator) or VCXO (voltage-controlled oscillator) and DCXO (digitally controlled oscillator). High-precision oscillators include TCXO (temperature-compensated oscillator) with typical stability of ± 0.1 to ± 5 ppm and OCXO.

Q: What is an OCXO?

A: OCXO stands for oven controlled oscillator. These devices have very good stability, typically better than ± 50 ppb (parts per billion), and more commonly in the range of ± 5 to ± 20 ppb. OCXOs achieve high stability by encasing the resonators along with temperature-sensing and compensation circuits inside a heated metal enclosure to create an oven with a relatively constant temperature. A double-oven OCXO (an oven inside another oven) can reach $< \pm 1$ ppb stability. Quartz based OCXOs use complex constructions, consume high power (up to 2.5W for a double oven OCXO), and come in large package sizes such as 25x20 mm. Quartz-based OCXOs are extremely sensitive to environmental disturbers such as thermal shock, airflow, vibration and shock, and they also suffer from poor batch-to-batch consistency. SiTime's Emerald Platform™ solves these quartz-OCXO problems, and is the industry's first MEMS-based oscillator that delivers OCXO-level frequency stability of ± 5 ppb in the smallest 9x7 mm form factor.

Q: What are the different technologies used for oscillators?

A: Prior to the advent of MEMS, quartz was the primary technology used in the implementation of oscillators. SAW (surface acoustic wave) was also utilized mostly for high frequency, low jitter oscillators. SiTime took an early lead in the commercialization of MEMS oscillators, and since 2007, has shipped over 1 billion units of MEMS oscillators. MEMS technology now is used for a wide variety of oscillators including ultra-low power kHz XOs, ultra-low jitter differential XOs, in-system programmable XOs and ultra-stable TCXOs and OCXOs.

Q: Where can I find more information on timing basics?

A: SiTime's *Glossary of Timing Terminology* is one of the most comprehensive sources of information on types of timing devices and other oscillator terminology and can be downloaded at: https://www.sitime.com/sites/default/files/gated/Oscillator-Glossary-SiTime_1.pdf



Product and Applications

Q: What is Emerald?

A: The Emerald Platform is the first family of MEMS-based OCXOs and a game-changing timing solution for 5G infrastructure. It is the first MEMS OCXO that enables 5G equipment to be deployed anywhere, in any environment and it is the only programmable OCXO in the industry.

Q: What makes SiTime's Emerald timing solution unique?

A: In 5G deployment, equipment is located closer to the customer, and is subject to more thermal shock, vibration, high temperature and humidity. To reliably deliver the speed and services of 5G, a new approach to timing was required. Using innovative design techniques, we developed the Emerald Platform OCXOs with 20 times higher dynamic performance than legacy quartz OCXOs. These new OCXOs are a game-changer in 5G timing and has been very well-received by early customers.

Q: What functions do SiTime MEMS timing products provide?

A: Every digital electronic system requires a timing signal to act as a reference clock or for synchronization – in essence, a heartbeat for the system. The timing signal can come from a resonator, oscillator, or a clock generator, as explained below.

Q: What benefits does the SiTime Emerald Platform offer to customers?

A: SiTime's MEMS timing solutions are expected to be the heartbeat of 5G, IoT and automotive electronics. Emerald solves critical timing challenges for 5G infrastructure, enabling new services such as network slicing, ADAS, and M2M communications and sets new performance benchmarks in the \$1.5 billion telecom and networking timing market: 10 times more immune to thermal shock, 20 times more immune to vibration, and 75% smaller. It provides unprecedented ease-of-use, reduces design complexity and accelerates time to revenue. Unlike quartz OCXOs, Emerald does not need protective components, and has no placement or airflow restrictions. Most importantly, it offers the greatest flexibility: it is the only programmable OCXO in the industry.

Q: Why is Emerald critical for 5G applications?

A: As mobile operators move into 5G and edge computing, they will require much tighter time synchronization in the radio equipment, which necessitates the use of an OCXO. Prior to 5G, this OCXO was deployed in a well-controlled environment. Now, the computing, core network, and radio will be collapsed into a system that may be deployed in an uncontrolled environment such as a tower, rooftop, and lamppost. In this environment, the OCXO will be exposed to vibration and temperature extremes. This change in deployment architecture requires new thinking and an evaluation of the benefits of MEMS and quartz timing technologies. The Emerald Platform is a MEMS-based Stratum 3E solution.

Q: What is Stratum 3E?

A: Stratum levels are defined by Bellcore GR-1288, Clock for Synchronized Network. They represent accuracy levels of the clock for certain levels of network performance. A Stratum 3 clock has a free run stability of ± 4.6 ppm over 20 years and a hold-over requirement of ± 0.37 ppm (± 370 ppb) over 24 hours, both inclusive of frequency errors under all conditions. Stratum 3E is a more accurate version of Stratum 3, with the same ± 4.6 ppm free run stability, but with a 24 hour hold-over spec of ± 0.01 ppm (± 10 ppb), 37 times tighter than Stratum 3.

**Q: What are the advantages of Emerald versus legacy quartz OCXOs?**

Legacy quartz OCXOs are custom built, from the ground up. There are severe limitations on the availability of features, such as frequencies, output types, operating temperature, and in-system control. SiTime's Emerald Platform MEMS OCXOs do not have these limitations. Using a programmable analog architecture, the Emerald OCXO offers any frequency between 1 and 220 MHz, ensuring that the customer can select the optimal frequency for their application. The device also offers two output types, LVCMOS and clipped sine-wave, for optimal board performance. In the near future, the Emerald OCXO will also offer extended temperature operation (-40 to +95C, -40 to +105C) and an I2C serial interface for in-system programmability.

Q: What makes SiTime's timing solutions unique?

A: SiTime is the only company to use MEMS First™ and EpiSeal™ processes to produce MEMS resonators. These resonators are paired with a CMOS IC that employs advanced analog technology to make a high-performance clock oscillator. These patented technologies, along with SiTime's MEMS and analog expertise and knowhow, bring a series of unique advantages like smallest size, high reliability and quality, vibration and shock immunity, and the ability to maintain high levels of frequency stability under fast temperature ramps.

Q: How does Emerald solve the usability challenges of quartz OCXOs?

A: Because of the sensitivity of legacy quartz OCXOs, customers have to take many precautions to ensure reliable operation. A key challenge is the board placement of the OCXO, which needs to be located far away from stressors such as heat and airflow-induced thermal shock. This results in increased routing complexity and potential signal integrity problems. Designers have also tried using specialized plastic OCXO covers for thermal isolation, which introduces additional manufacturing steps and production complexity. Emerald MEMS OCXOs eliminate all of these problems; they simplify design, reduce development time, accelerate revenue, while improving system performance.

Q: Where do you think MEMS timing solutions will proliferate in the future?

A: MEMS timing solutions bring unique benefits that are not offered by traditional timing solutions. In particular, the 5G and communications, automotive, and IoT markets will greatly benefit from the size, reliability, and performance of SiTime's MEMS timing solutions.

In networking and communications, timing and synchronization is essential to the entire system. The resiliency of MEMS timing provides unfailing performance that is critical for the deployment of 5G as it rolls out into less controlled, harsher environments. The same need for reliability and dynamic performance is driving the growing use of MEMS resonators in automotive, where systems must operate dependably in challenging conditions. In IoT, MEMS timing provides small size, low weight, and low power.

Q: When are Emerald products available?

A: Samples of the Emerald MEMS OCXO SiT5711/12 are available now for qualified customers. Production quantities will be available in Q2 2019 and stocked at catalog distributors such as Digi-Key and Mouser.

Q: Where can I get more information on SiTime solutions?

A: Please visit the SiTime web site at www.sitime.com



About SiTime

Q: How is SiTime positioned for the 5G market?

A: Innovation is a hallmark of SiTime. Our mission is to innovate and solve difficult timing problems for large markets, and 5G fits this profile perfectly. SiTime has already shipped over a billion units and has become one of the fastest growing semiconductor companies from 2014-2017 by offering MEMS timing solutions that offer unique benefits that are not available with traditional timing solutions. Looking forward, we will continue to expand our roadmap and TAM with new products for 5G, and extend our leadership in the \$1.5 billion networking and telecommunications timing market.

Q: Why does SiTime use “X” within its product category names (i.e., TCXO, OCXO)?

A: While all of SiTime’s devices use MEMS resonator technology (and not quartz crystal technology), we have chosen to not replace the “X” in the above acronyms with a “M” because these product category names have been established in the market for many decades and are associated with certain timing functions. As SiTime devices offer the same or better functionality, it causes less confusion to continue with the same well-known acronyms.

Q: Who is the press contact at SiTime?

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