

# Cost-effective replacement for quartz crystals

by Tunc Cenger, Mobius Microsystems

Imagine a design engineer whose product requires an ultra-thin form factor and an injection-molded plastic casing. The package height and reliability of traditional, low-cost crystals may be a concern in the mechanical design of that system. Suppose that design needs to incorporate high-speed, high-bandwidth interface protocols in order to transmit and receive data at multiple gigabit/s speeds with acceptable bit error rates (BER), the PHY circuit needs to generate the required GHz frequencies by multiplying its native crystal frequency. It must do so without degrading the phase noise of this reference frequency signal. In such cases, higher frequency references are needed to reduce phase noise. Unfortunately, high frequency crystals are more costly to manufacture than fundamental mode (<50MHz) crystals.

These are some of the scenarios we considered when we looked at the current landscape of frequency generation. We wanted to know the ideal replacement for quartz crystals, of which 10 billion are sold each year. We also analyzed the technology that is best suited to replace a component so deeply entrenched and ubiquitous.

## WHAT MAKES CMOS THE IDEAL PLATFORM?

After extensive research, we concluded that there are four reasons that make CMOS technology the ideal platform on which we build the most viable, cost-effective and high-performance replacement for quartz crystals:

1. For all practical purposes in consumer, computation and storage applications, CMOS does not impose any high frequency limitations. It can operate from kHz to hundreds of MHz frequencies.
2. A monolithic, single-die CMOS frequency reference can be assembled in the thinnest IC packaging available, so frequency reference is no longer the limiting factor in the form and thickness of the end-product.
3. CMOS technology benefits from well-studied and well-understood reliability

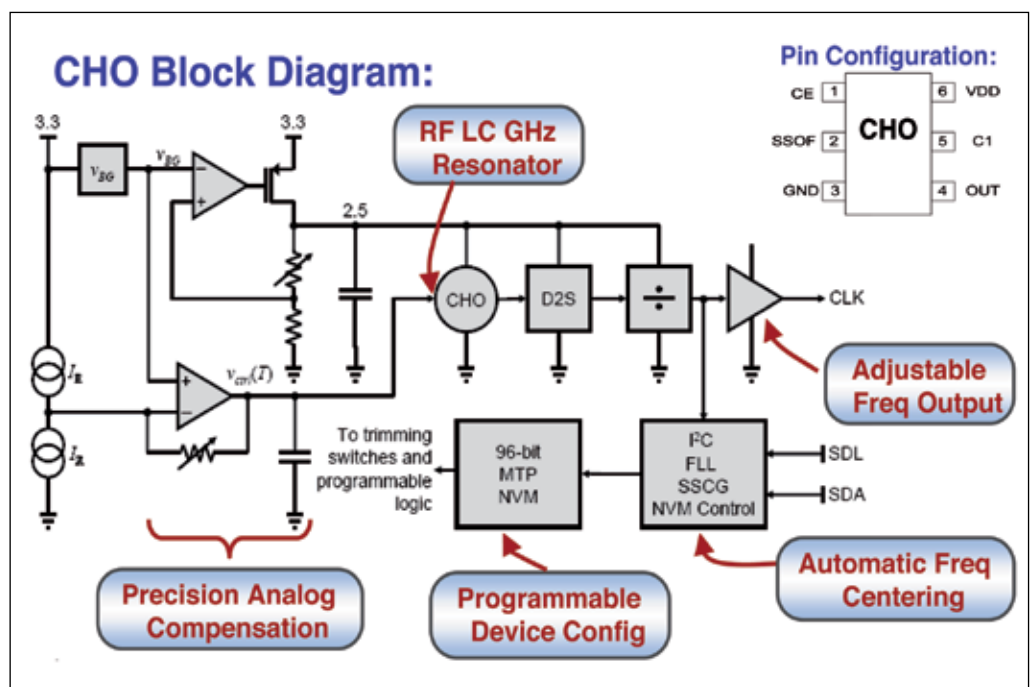


Figure 1: CHO block diagram.

models, so designers no longer need to be concerned about crystal over-tone or power-up failures.

4. Finally, the absence of any mechanical or piezoelectric resonator – whether quartz or MEMS – enables an easily integrable frequency reference.

The CMOS harmonic oscillator, or CHO, is the outcome of the conclusion that standard CMOS is the optimum platform for the future of frequency electronics. At the core of the CHO device is an LC (inductor-capacitor) resonator, which runs at GHz speeds. Unlike common LC resonators that have long been used in low jitter PLLs, CHO is designed to maintain its frequency accuracy in an open-loop configuration.

The key innovation is an analog control circuitry that compensates for process, voltage and temperature variations to stabilize the oscillating frequency with sufficient accuracy in that open-loop configuration (see Figure 1).

The technology enables CHO to support many common consumer electronics and storage system interfaces, and eliminate crystal oscillators from today's designs. The oscillator is offered in a broad selection of output frequency and package options to fit the needs of various applications. The integrated and space-saving design eliminates the common frequency drift problems associated with the crystal's load capacitors, and offers excellent shock and vibration immunity.

In practical terms, the benefits of the CHO products are immediately applicable in the market today. For instance, CHO frequency references offer the potential to make USB flash drives thinner, cheaper, and able to achieve higher frequencies and transfer bandwidths. They can also be used to develop reliable hard drives that utilize the shock and vibration immunity of the CMOS implementation and avoid power-up failures.

The "first" announced product in the CHO

FEATURE

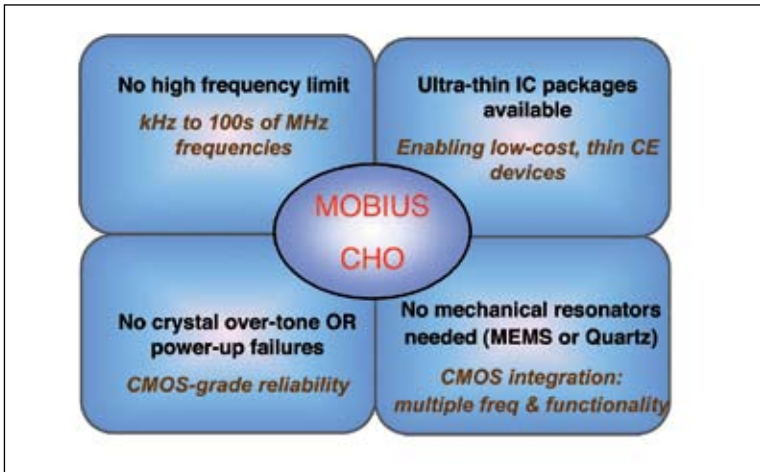


Figure 2: Four reasons that make Cmos technology the ideal platform.

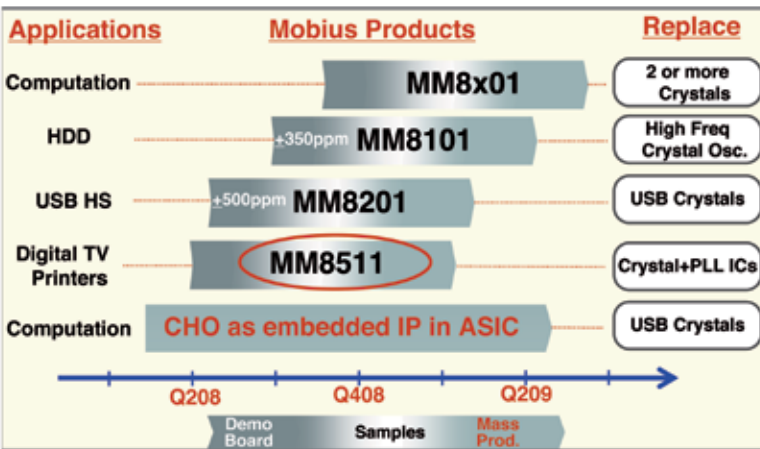


Figure 3: Product roadmap.

portfolio, the MM8511, integrates the monolithic frequency source with an industry standard spread spectrum clock generator (SSCG) to address system-level EMI issues. The MM8511 demonstrates the ability to integrate multiple functions on a single CMOS device. Conventionally, the SSCG function is implemented in two components: a quartz crystal and a PLL IC. The integrated MM8511 lowers BOM count and reduces board real-estate while minimizing clock jitter and lowering power consumption. Furthermore, the part is designed to have the same footprint as the industry-standard crystal and PLL combination, making it literally a drop-in replacement.

The Mobius roadmap (Figure 3) shows that the next product will be the MM8201 for USB HS 2.0, which will achieve the requirement for 500ppm frequency accuracy and won't need crystals to achieve excellent BER; following that is the MM8101 for S-ATA Gen2 applications in hard drives that will achieve 350ppm accuracy. Eventually the portfolio will offer devices that replace two or more crystals each. ■

**About the author**

Tunc Cenger is the director of marketing at Mobius Microsystems. Prior to Mobius, he served as business manager for mobile audio products at Maxim, where he was responsible for new product introductions, revenue growth, and product line management. Prior to that, he held marketing and design engineering positions at Cypress Semiconductor. Cenger holds a B.S.E.E. with Top Honors in Microelectronics from Istanbul Technical University.



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