Trends in RF Oscillator Applications

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Frequency-control devices provide the &quotheartbeat&quot of all kinds of RF equipment. The system clock is as vital as any other component of the functional whole. It should come as little surprise then, that the market forces at work upon the frequency-control sector are basically the same as those that are shaping the RF industry as a whole: constant pressure to deliver higher performance, higher functionality, smaller package size, lower power consumption, lower pricing and faster turnaround of new designs.

Miniaturization through Integration

The bursting of the telecoms bubble has done little to slow demand for electronic products that can communicate. Mobile phone handsets and PDAs are everywhere, and are decreasing in size and price, exerting similar constraints on each of their components. As a result, for high-volume standard oscillator products, the balance of volume shipments has shifted from 7 &#215 5 mm to 5 &#215 3 mm surface-mount devices (SMDs) over the past year. One approach to size and cost issues is to develop all-silicon oscillators, though at this time frequency stability remains well short of what can be achieved using crystal oscillators (XOs).

Further up the performance ladder, temperature-compensated crystal oscillator (TCXO) technology is advancing apace. For commonly used output frequencies in wireless and networking applications, comparatively low-cost TCXOs now offer stability over operating temperature range to well within &#177 1 ppm from a 7 &#215 5 mm SMD, with similarly specified 5 &#215 3 mm devices also starting to emerge.

Integration of global positioning system (GPS) functionality into a growing number of portable devices &#151 including GSM handsets &#151 is driving the demand for small, low-power TCXOs that perform toward the top end of the stability scale. This is thanks to single-chip temperature-compensation technology pioneered by C-MAC. Such technology offers stability typically an order-of-magnitude better than thermistor-based TCXOs, and can also meet the low-voltage (2.5 V supply) requirements of specialist applications, such as portable handsets for the Tetra emergency services radio system.

Across the XO spectrum, but especially for high-volume components, customers are seeing cost benefits due to economies of scale as manufacturers focus their production lines towards ceramic SMDs. Metal and plastic packages are increasingly the preserve of more specialized applications and pre-existing designs.

Faster Networks, Higher Frequencies

High-speed data networks and the growing popularity of Voice over Internet Protocol (VoIP) telephony are placing new demands on commonly used communications equipment and the timing devices that go into it. For example, a typical new &quotconverged&quot (i.e., VoIP-enabled) telephone system has to be able to handle off-site data traffic as well as the comparatively low bit rates of voice calls.

Higher data rates mean faster clocking, which can be achieved using a relatively low-frequency oscillator linked to a multiplier circuit. However, a high-frequency timing device allows a simpler, more efficient circuit design to be achieved, creating strong demand for oscillators with output frequencies of 100 MHz and above. Selection of a crystal overtone allows the oscillator manufacturer to multiply the output frequency without adversely affecting jitter performance.

In high-frequency communications designs, small package size is often more important than stability, so such applications are usually the domain of voltage-controlled crystal oscillators (VCXO) and simple packaged crystal oscillators (SPXOs). Differential outputs such as positive-referenced emitter-coupled logic (PECL) and low-voltage differential signaling (LVDS) are increasingly specified, as they offer sharp rise and fall times and so help to reduce data corruption.

Across the communications industry, increasingly varied and sophisticated systems are being developed to deal with multiple protocols and data types. Manufacturers of, for example, base station equipment are seeking economies in Non-Recurring Engineering (NRE) spending by outsourcing certain aspects of the design process. Specialist semiconductor companies have stepped up to the challenge with off-the-shelf single-chip and modular timing solutions that can be programmed to accept multiple-input reference clock signals and deliver a variety of outputs. At the heart of such a system lies a high-stability oscillator providing system synchronization and holdover. It is this that defines the overall performance of the solution.

Increasingly, frequency control manufacturers are working closely with semiconductor companies to support these timing solutions. Besides stability over temperature range, the oscillator needs to adhere to strict short-term stability constraints such as jitter and wander. Because the semiconductor vendors subject the oscillators to rigorous testing not just of performance but of ability to drive their own timing circuitry, the customer is assured of a sophisticated timing solution that has been proven to work within its intended environment.

Satellite and Wireless Broadband

Despite much debate about broadband wireless infrastructure, in industrialized nations it remains something of a niche technology &#151 useful in rural areas and for high-speed private networks, but less so for consumers already well-served by fixed-line broadband. However, in less-developed regions, where fixed-line infrastructure is patchy or nonexistent, wireless broadband is a comparatively cost-effective alternative.

A key enabler in medium-range networks is a high-stability oscillator with low phase noise, needed to lock onto low-level and intrinsically noisy incoming signals. While this is the natural domain of the oven-controlled crystal oscillators (OCXO) silicon-based temperature-compensation technology is being extended to create TCXOs that will serve the purpose using a smaller device with lower power consumption and cost. This technology will develop to serve a growing number of niche applications with similar requirements, such as satellite communications for TV broadcast cameras and secure battlefield communications.

A further recent development at the interface of OCXO-TCXO performance is the temperature-compensated OCXO (TC-OCXO,) designed to deliver the high stability of an OCXO from a device with the low power consumption, small size and light weight comparable to those of a TCXO. TC-OCXOs are aimed at mobile, battery-powered and remote applications such as GPS, satellite comms, distress beacons and secure radio.

You Need It… When?!

Last but not least, in the age of global competition, speed to market with a new design is critical to success. In the frequency-control sector, where components must often be custom built to individual specifications, prototype development and delivery times can run into weeks or even months &#151 less than satisfactory for

a designer with tight deadlines to meet. Oscillator vendors can now respond with increasingly sophisticated programmable SPXOs, VCXOs and TCXOs. These are factory-tuned and delivered at any output frequency within a wide range, to a variety of specifications, typically within five working days.

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