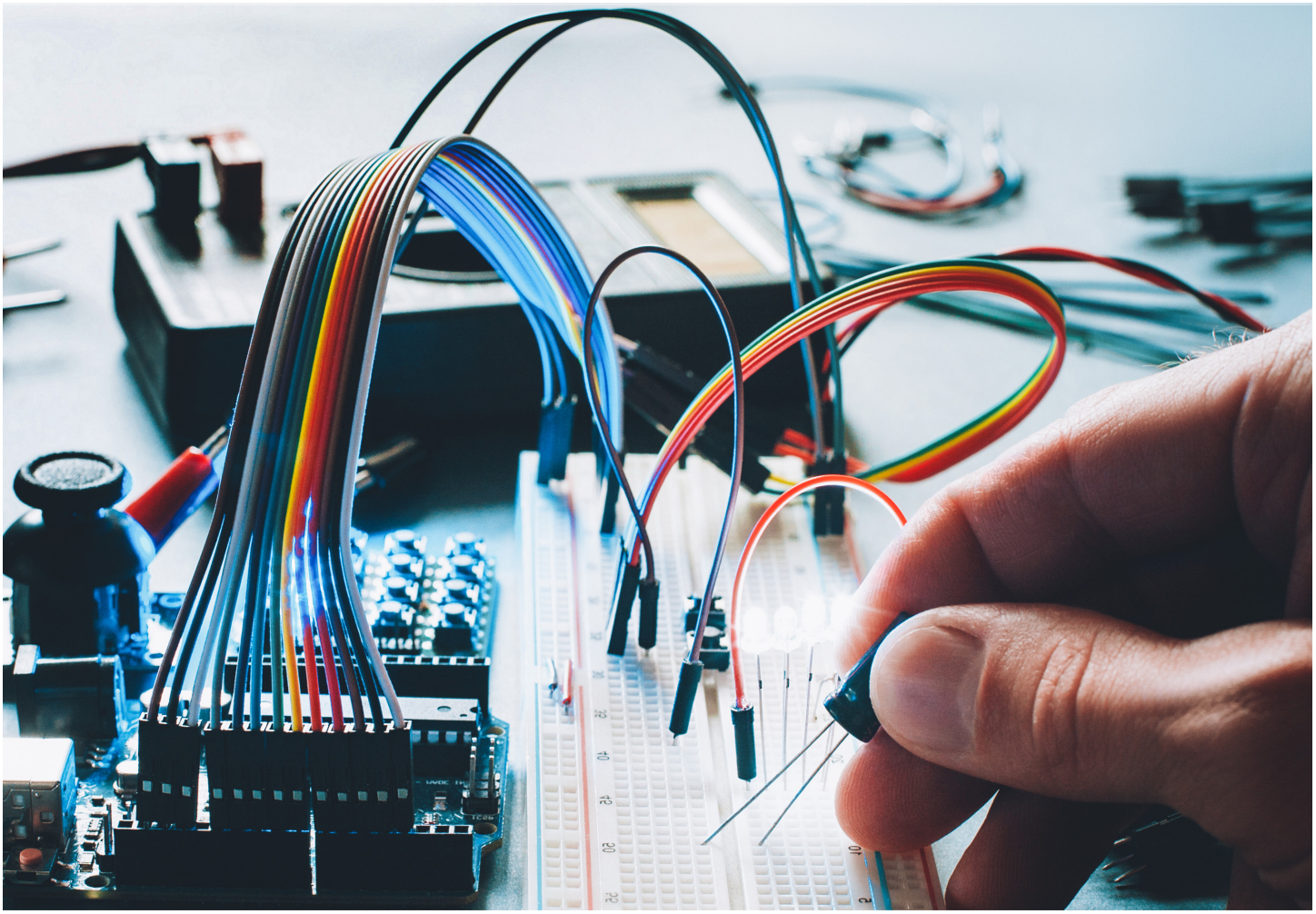
Is an RTC Module Timing Solution Right for Your Project?



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Introduction

Timing solutions are critical to today's electronics. Many engineers rely on the internal real-time clock (RTC) functionality that comes embedded in microcontroller units (MCUs) and system on chips (SoCs). Those functions rely on crystal, crystal oscillator (XO), and temperature compensated crystal oscillator (TCXO) options as external frequency sources that translate into system clocks, which then determine the accuracy of the RTC function. In some cases, it may be more beneficial to use RTC module timing solutions instead. This paper lays out the barriers and benefits of various timing solutions and offers guidance on when and why an RTC module timing solution may be a better choice and outlines the specific benefits of choosing Epson RTC module timing solutions.

The Criticality of Timing Solutions

Smart speakers, utility meters, security cameras, healthcare devices, autonomous vehicles—the list of electronic devices and systems that need timekeeping functions is varied and endless. Many engineers choose to rely on the timing functions already available on microcontroller units (MCUs) and system on chips (SoCs). Real-time clock (RTC) solutions embedded in MCUs and SoCs provide basic functions such as time of day, calendars, system wakeup functions, time stamping, event scheduling, and timers, to name only a few. These are basic functions and—in some design use cases—are all that is required.

The timing used by these embedded RTC functions is almost always derived from external frequency sources, typically crystals, crystal oscillators (XOs), and temperature compensated crystal oscillators (TCXOs). These frequency sources determine the timing accuracy of the RTC functions.

Engineers whose systems require RTC functions have two options: they can leverage the RTC functions integrated in the MCU or SoC they're designing with and select the best external timing source, or they can use an RTC module timing solution that combines timing source and RTC functions. The engineer's design cycle, product performance, and range of functionality will differ greatly depending on which option the engineer chooses.

The Capability Range of Common Timing Solutions

Timing solutions—from the least to most complex and capable—are crystals, XOs, TCXOs, and RTC modules. Let's consider the benefits and challenges of each.

Crystals

Quartz crystals are the most basic of timekeeping solutions and, as such, are inexpensive. They provide an accurate, stable frequency at room temperature.

They are, however, sensitive to environmental factors like humidity and the frequency stability degrades as the temperature rises or falls. Crystals typically require additional external components, such as capacitors and resistors and may demand additional design time for crystal tuning.

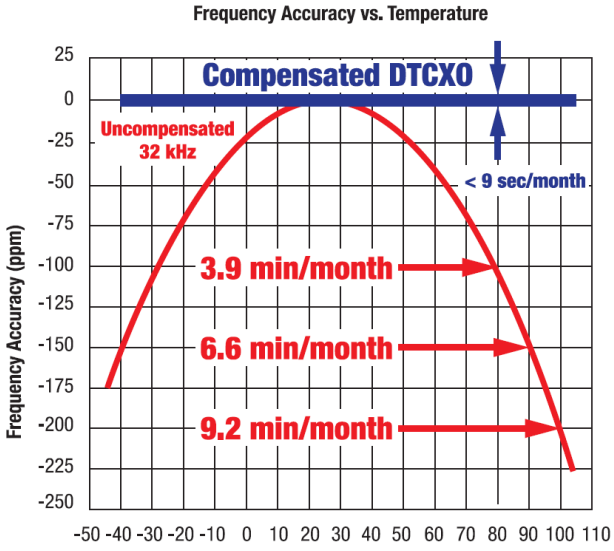
Crystal Oscillators

XOs leverage the same crystal quartz mentioned above and integrate the oscillation circuit. At room temperature, they offer the accurate, stable frequency of a crystal while reducing the need for external components. XOs are also more robust in environmental conditions like high humidity because crystal and oscillation circuit are integrated in one package. They may also be used to clock multiple application specific integrated circuits (ASICs). Like crystals, XOs' frequency stability degrades as the temperature deviates from 25C.

Temperature Compensated Crystal Oscillators

As the name suggests, TCXOs are crystal oscillators with added temperature compensation circuitry. TCXOs offer accurate frequency stability over a wide temperature range, adjusting the frequency output as the temperature fluctuates. For example, a standard 32kHz crystal will deviate more than 9 minutes per month when the system is at 105C. With Epson's TCXO, the error will be less than 21 seconds per month at the same temperature.

Similar to XOs, TCXOs do not require external components for oscillation.



Real-Time Clock Modules

Crystals, XOs, and TCXOs all provide a frequency reference for the RTC timekeeping functions. However, in some scenarios, it may be beneficial to bypass the RTC functionality embedded in MCUs or SoCs and turn to RTC modules instead. RTC modules are added externally to a design to

not only provide timing, but also provide additional functionality. RTC modules deliver optimized RTC functions beyond what are offered by MCUs and SoCs. Engineers use RTC modules for their precise timekeeping, low power consumption to extend battery life, and integrated power switching functions. Epson's RTC modules integrate the crystal to save board space and design time and some integrate the temperature compensation circuitry as well.

The Pros and Cons of Switching to RTC Modules

Many engineers simply choose to use the integrated timekeeping functions that come with the MCU or SoC they are using in their design. RTC modules can be seen as disruptive to the design process, requiring firmware code changes, additional board space, and BOM costs that make their use prohibitive. Though these issues are worth considering, RTC modules offer more opportunities for specialization and more complex features are simply not possible with the MCU or SoC RTC functions. That added functionality can make the case for the initial investments required to make the switch. The RTC module's low current consumption allows a system to have a longer battery life or even reduce the size of the battery. Epson's RX8111 and RX4111 consume 100nA and can operate for 19 weeks on a 0.47F supercapacitor.

RTC modules also often integrate power-switching circuitry which allows the system to maintain accurate time during power fluctuations and monitor primary and backup power. For example, Epson's RX8130 RTC module can detect power failures and provide supervisory functions for the MCU. RX8130 battery management function also prevents overcharging.

Plus, RTC modules with temperature compensation can provide more accurate time keeping in extreme environments. Epson's RX8804 enables systems to maintain timing accuracy of better than 21 seconds per month up to 105C versus 9 minutes per month without compensation.

The specialization in RTC modules can provide a performance and functionality that MCU or SoC cannot deliver.

Why Switch to Epson RTC Module Timing Solutions?

It's true that there are product and time costs involved in using RTC module timing solutions. But focusing only on those ignores the greater benefits of their use, as well as the potential for savings that may result from incorporating these timing solutions during the product design phase. Let's consider reasons to forego embedded MCU and SoC timing options and opt instead to use Epson

RTC modules.

With a traditional option, the MCU processor features an integrated RTC software function with external crystal providing the frequency reference. This can come at a low cost but runs the risk of high power consumption, low stability, calibration issues, and oscillator circuit design issues. Choosing an XO or TCXO to provide frequency reference to the MCU may remove some of these limitations.

Finally, by selecting an RTC module you can benefit from low power consumption, extraordinary accuracy, high reliability, and a simple design. When included at the start of the design process, Epson can help customers determine what operational, BOM, and power consumption savings may result from using Epson's RTC module timing solutions. The Epson team can help relieve some of the initial design constraints, offering suggestions that ease the transition from other solutions.

Adding Epson RTC module timing solutions can improve product functionality and accuracy for the products you create. Learn more about Epson RTC module timing solutions here or contact the Epson team to discuss your specific needs.

Epson RTC Module Timing Solutions

Industry	Functions they needed						
	Low Power	High Stability	High Reliability	Power Switching	Time Stamp	Charge Control	
Factory Automation	✓	✓	✓	✓	✓		RX8804, RX8900, RX8130
Security	✓	✓	✓		✓		RX8804, RX8900, RX8111, RX4111
Smart Meter		✓		✓	✓		RX8804, RX8900, RX8130
Medical	✓	✓	✓		✓		RX8804, RX8900, RX8111,RX4111
Office Automation	✓			✓	✓		RX8804, RX8900, RX8111, RX4111, RX8130
Consumer Electronics		✓		✓		✓	RX8804, RX8900, RX8130
Automotive	✓	✓	✓				RX8111, RX4111

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