IoT Solutions & Product Frequency Reference Guide

The Internet of Things [IoT] is the new wireless touchstone connecting live information, control mediums and hubs to wireless devices such as phones, tablets and computers. These applications are widely used in Smart Homes, Smart Cities, Smart Factories, Smart Healthcare, Smart Agriculture and Smart Energy. Communication protocols and transmission frequencies are guided by standards such as IPv6, UDP, QUIC, Aeron and uIP. As a result, next generation MCUs, SoCs or FPGAs created to meet new communication requirements have challenged chipset designers to develop architectures that provide improved fast communication along with low noise performance, but also at low power consumption. Utilizing low power elements helps continuous operation over long periods of time, but also increase challenges like reductions in oscillator gain margin and signal to noise ratios.

Currently there are billions of connected IoT devices. An exponential increase of connected devices is expected over the next decade, as 5G infrastructures will be readily available along with more affordable consumer devices. The seemingly limitless connections promised by 5G will continue to burden infrastructures and push the boundaries of chipset performance, requiring the timing block and associated frequency reference to provide very reliable low power operation.

CTS Enhanced Crystals

New CTS models [412W, 416W, 402W, 425W, 403W] provide enhanced design parameters targeted for low power wireless protocols used in IoT enterprises for consumer and industrial [IIoT].

Key 4xxW Crystal Parameters

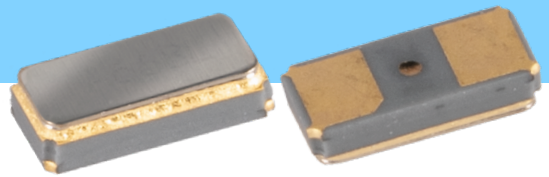
- Low Plating Capacitance [C_0], <3.0pF
- Low ESR Ranges [R_1]
- Small Load Capacitance Options [C_L]
- Temperature Range to -40°C to +125°C
- Stability Options – ±10ppm to ±150ppm
- Fundamental Crystal Designs
- Small Ceramic Surface Mount Package
- Tape and Reel Packaging

Low ESR Tuning Fork Crystals

CTS Low ESR Series Tuning Fork Crystals, offer resistances as low as 50k ohms maximum, grant portable or handheld electronics the use of low power FPGAs and microcontrollers [MCUs] to preserve battery life for long hours of operation.

Key TFE Crystal Parameters

- Low Plating Capacitance [C_0], 1.0pF Typical
- Low ESR Values [R_1] <50k Ohms
- Small Load Capacitance Options [C_L]
- Temperature Range to -40°C to +85°C
- Small Ceramic Surface Mount Package
- Tape and Reel Packaging

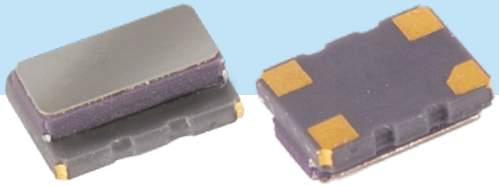


RTC TCXO @ 32.768kHz

For applications that need a more precise 32.768kHz reference, common for GPS function, the CTS RTC solution is Model TT32 TCXO.

Key TT32 TCXO Parameters

- Low Current Consumption, <2µA
- Tight Frequency Stability, ±5.0ppm
- Temperature Range to -40°C to +85°C
- Small Ceramic Surface Mount Package
- Tape and Reel Packaging



For more information and contact

https://www.ctscorp.com

https://www.ctscorp.com/connect_product_line/crystals/

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IoT Enhanced Crystals

Model/ Data Sheet	Package Size [mm]	Frequency [MHz]	Tolerance @ +25°C	Temperature Stability	Temperature Range	ESR Maximum [Ohm]	C0 Parameters [pF]
412W	1.2 x 1.0	32 – 80 Fundamental	±7ppm - ±30ppm	±10ppm - ±100ppm	-40°C to +85°C -40°C to +105°C -40°C to +125°C	100 – 60	1.0 Typ. <3.0 Max.
416W	1.6 x 1.2	24 – 52 Fundamental	±10ppm - ±30ppm	±10ppm - ±100ppm	-40°C to +85°C -40°C to +105°C -40°C to +125°C	150 – 80	1.0 Typ. <3.0 Max.
402W	2.0 x 1.6	16 – 52 Fundamental	±10ppm - ±30ppm	±10ppm - ±100ppm	-40°C to +85°C -40°C to +105°C -40°C to +125°C	150 – 50	1.0 Typ. <3.0 Max.
425W	2.5 x 2.0	16 – 52 Fundamental	±10ppm - ±30ppm	±10ppm - ±100ppm	-40°C to +85°C -40°C to +105°C -40°C to +125°C	100 – 40	1.0 Typ. <3.0 Max.
403W	3.2 x 2.5	10 – 54 Fundamental	±10ppm - ±30ppm	±10ppm - ±100ppm	-40°C to +85°C -40°C to +105°C -40°C to +125°C	150 – 35	1.0 Typ. <3.0 Max.

CTS Crystals

Low ESR Tuning Fork

Model/ Data Sheet	Package Size [mm]	Frequency [MHz]	Tolerance @ +25°C	Temperature Stability	Temperature Range	ESR Maximum [Ohm]	C0 Parameters [pF]
TFE16	1.6 x 1.0	32.768kHz Tuning Fork	±20ppm	-0.034ppm/°C² Temp Coefficient	-40°C to +85°C	60k	1.5 Typ.
TFE20	2.0 x 1.2	32.768kHz Tuning Fork	±20ppm	-0.034ppm/°C² Temp Coefficient	-40°C to +85°C	50k	1.8 Typ.
TFE32	3.2 x 1.5	32.768kHz Tuning Fork	±20ppm	-0.034ppm/°C² Temp Coefficient	-40°C to +85°C	50k	1.0 Typ.

CTS Crystals

RTC TCXO

Model/ Data Sheet	Package Size [mm]	Frequency [MHz]	Input Voltage [V]	Temperature Stability	Temperature Range	ESR Maximum [µA]	Output Load [PF]
TT32	3.2 x 2.5	32.768kHz HCMOS	+1.8V - +3.3V	±5.0ppm	-40°C to +85°C	2.0	15

CTS TCXO

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CTS Product Frequency Reference

Frequency	Wireless Protocol	CTS Solutions
32.768kHz	Real Time Clock Reference [RTC]	TFE16 TFE20 TFE32
12.00MHz	CAN Bus, USB	403W
13.56MHz	RFID	
16.00MHz	Wi-Fi, ZigBee, Bluetooth, Bluetooth Low Energy	403W 425W 402W
19.20MHz	DECT, GPS, Bluetooth Low Energy	
20.00MHz	Wi-Fi, Bluetooth, USB	
24.00MHz	Wi-Fi, Bluetooth, Bluetooth Low Energy	403W 425W 402W 416W
25.00MHz	Industrial, Scientific, Medical Radio Band	
26.00MHz	WLan, Wi-Fi, Bluetooth, Bluetooth Low Energy, GSM, Near-Field Communication	
27.12MHz	RFID	
30.00MHz	Industrial, Scientific, Medical Radio Band	
32.00MHz	ZigBee, Bluetooth, Bluetooth Low Energy, 6LowPan, RF4CE, LoRa	403W 425W 402W 416W 412W
37.40MHz	Wi-Fi, Bluetooth	
38.40MHz	DECT, Wi-Fi, Bluetooth	
40.00MHz	Wi-Fi, Bluetooth, Bluetooth Low Energy, Near-field Communication, SimpleLink	
48.00MHz	Wi-Fi, Bluetooth, USB	
52.00MHz	WLan, Wi-Fi, GSM	

See the CTS IoT whitepaper for details