Frequency Control Products

Small Package TCXO User Guide

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In order to optimize the performance of CTS small package Temperature Compensated Crystal Oscillators [TCXOs], several user tips should be considered for every application design. This guide, associated with the CTS models outlined in Table 1, will cover several key topics to help engineers jumpstart design activity.

CTS Small Package TCXO Models					
516	520	525	532	580	535
517	521	526	533	581	536

Table 1 CTS TCXO Models

VOLTAGE SUPPLY - BYPASS CAPACITOR

Proper filtering of high frequency noise riding on the voltage supply line is critical to eliminating the injecting of that noise into the oscillator and throughout the system. It is recommended that a 0.1µF [100nF] capacitor be inserted from the Vcc pin to circuit ground. The bypass capacitor placement should be as close to the Vcc pad as possible with a short trace routing to circuit ground. See Figure 1.

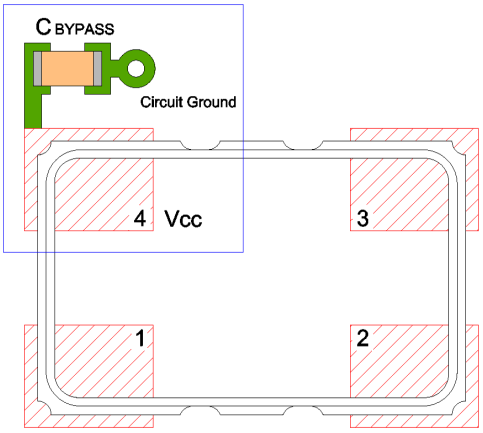

Figure 1 Bypass Capacitor Connection

OUTPUT LOAD CONNECTION

Driving the proper application load will provide the best phase noise result while maintaining the specified temperature stability profile. A load mismatch can cause reflection of the timing signal back into the oscillator output pin, creating a noisy condition. Since the TCXO is frequency compensated at the factory using the defined data sheet load, any deviation will cause a difference in the frequency vs. temperature performance.

OUTPUT ENABLE CONTROL PIN

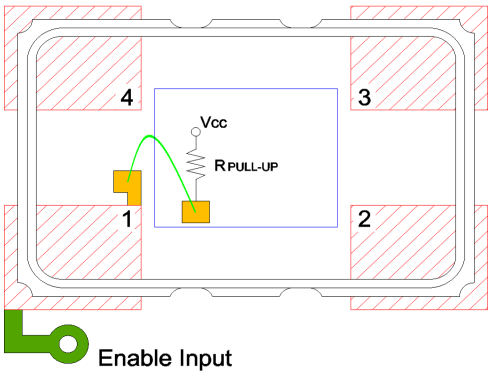

Figure 2 Output Enable

If the TCXO has the optional Output Enable Control pin, connect a noise-free voltage supply per the requirements outlined in the associated product data sheet to provide a clean output signal. This pin can also be left disconnected, and the output will be enabled through an internal pull-up resistor. See Figure 2.

When the enable pin is connected to ground, the output signal is disabled and the oscillator will be at a high impedance state. Table 2 shows a typical truth table highlighting the output state for a given enable pin connection.

Enable Truth Table	
Pin 1	Pin 3
Logic 1	Output Enabled
Open	Output Enabled
Logic 0	Output Disabled, High Impedance

Table 2 Enable Truth Table Example

VOLTAGE CONTROL [Vc] PIN

TCXOs equipped with the voltage control option [VCTCXO] require a clean voltage supply, per the requirements outlined in the associated product data sheet. Any noise on the Vc line can be translated to the output signal of the oscillator.

Vc CONNECTION PIN, TCXO ONLY

The Vc pin can be left Open or connected to Ground when used as a TCXO.

AC COUPLING CAPACITOR CLIPPED SINE OUTPUT ONLY

TCXOs providing a Clipped Sine output waveform need to be DC isolated from the device they are clocking. It is recommended to place a 1nF [1,000pF] capacitor between the oscillator output and the chipset input. This coupling capacitor is also referred to as a DC-Cut capacitor. See Figure 3.

CLIPPED SINE WAVE CONVERSION TO CMOS

The Clipped Sine Wave output is a popular TCXO waveform option used in many applications. It has low power consumption that improves thermal characteristics for better aging, frequency stability, and phase noise performance when compared to CMOS output devices. Clipped Sine devices may have better availability than their CMOS equivalents.

A Clipped Sine output waveform can be converted to a square wave format, using an inverter such as 74HC04. An RF resistor will need to be added between the output pin of the TCXO and the clock input of the chipset being driven, and the external RF resistor value should be between 100k to 10M Ohms.

VOLTAGE CONTROL FILTER CAPACITOR [Vc filter] Models 535 and 536 Only

Models 535 and 536 are equipped with a Vc filter pin that is used to achieve the best possible phase noise behavior of the device. The typical phase noise plots, shown in the CTS catalog data sheets, are representative of the performance using the Vc filter pin. Connecting a capacitor valued 33nF – 0.1uF from Pin 7 to ground provides this enhanced performance. See Figure 5.

Figure 6 and Table 3 show typical phase noise benefits using the Vc filter option. When the Vc filter is not connected, the phase noise is the same value at offset frequencies of 1Hz and 10kHz or higher, but it deteriorates between 10Hz to 1kHz. The maximum deterioration is about 12dB/Hz at the offset frequency of 100Hz.

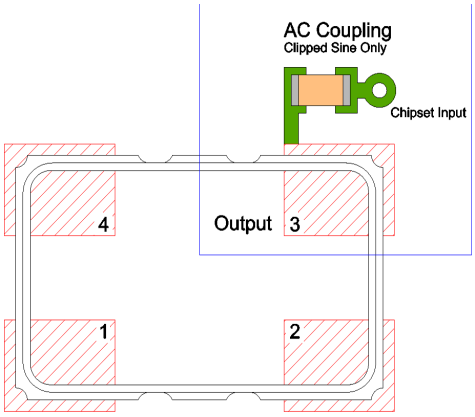

Figure 3 Coupling Capacitor Connection

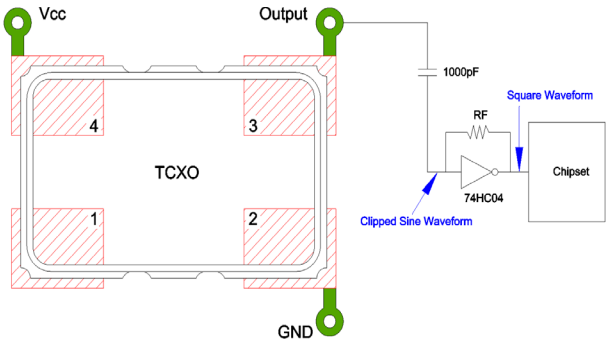

Figure 4 Waveform Conversion

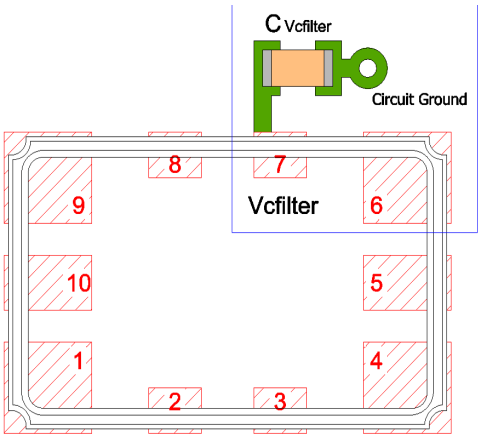

Figure 5 Vc filter Capacitor Connection

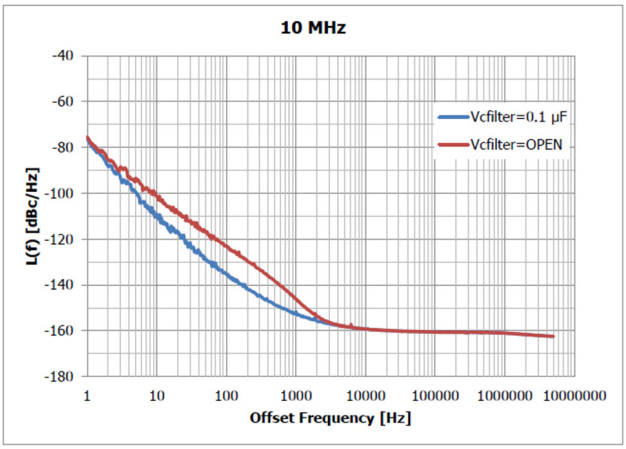

Figure 6 Vc filter Pin, Phase Noise Comparison

Offset Frequency	Phase Noise			
	Vc filter = 0.1uF	Vc filter = Open	Difference	Unit
1Hz	-76.4	-75.3	1.1	dBc/Hz
10Hz	-109.6	-101.1	8.5	dBc/Hz
100Hz	-135.4	-123.3	12.1	dBc/Hz
1kHz	-151.6	-146.0	5.6	dBc/Hz
10kHz	-159.2	-159.2	0.0	dBc/Hz
100kHz	-160.6	-160.5	0.1	dBc/Hz
1MHz	-161.0	-161.0	0.0	dBc/Hz

Table 3 Summary Information: Vc filter pin, Phase Noise Comparison

Note: Performance may vary depending on frequency value and noise environment in the operating application.

CONCLUSION

When employing the techniques described in this brief, optimum performance can be achieved for a given design. Contact CTS for additional support in reviewing your application needs.

ADDITIONAL REFERENCES

https://www.ctscorp.com/connect_product_line/tcxo/
https://www.ctscorp.com/wp-content/uploads/TCXO-Product-Overview-1.pdf
https://www.ctscorp.com/wp-content/uploads/Jitter-and-Phase-Noise.pdf
https://www.ctscorp.com/wp-content/uploads/Vibration-Induced-Phase-Noise-in-Quartz-Oscillators-7.28.21.pdf
https://www.ctscorp.com/wp-content/uploads/2015/10/AN1025.pdf

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CTS is a leading designer and manufacturer of products that Sense, Connect, and Move. We manufacture sensors, actuators, and electronic components in North America, Europe, and Asia, and provide solutions to OEMs in the in the aerospace & defense, medical, industrial, communications, information technology, and transportation industries.

FREQUENCY CONTROL EXPERTISE

We produce a variety of frequency control products, including crystals. clock oscillators, OCXO, TCXO/VCTCXO, timing modules, and VCXO. Our temperature compensated crystal oscillators (TCXOs) produce the highest frequencies available in the industry, allowing our customers to achieve top performance in their innovative application designs.

CTS' TCXOs and VCTCXOs are found in many applications, from optical networking equipment, to medical imaging, digital audio and video recoerding, military communication and radar, and portable electronics. With low cost and small package footprints, our products provide best in class performance and reasonable pricing while reducing our impact on the environment.

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