Technical Article

Testing TI BAW Resonator Technology in Mechanical Shock and Vibration Environments

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Wouldn't it be nice to know the condition of parts in your car exposed to mechanical vibrations or shock from the engine, or to get information about the status of systems operating under severe mechanical vibration conditions in an automated factory? With this information, you could perform predictive maintenance and replace fatigued parts before they fail completely, substantially reducing car problems or factory downtime. Check out this video demo of our crystal-less wireless TI BAW technology being put to the test and learn more in the technical article below.

Connect: Crystal-less wireless MCU demo in mechanical shock and vibration environments

How BAW technology resists mechanical shock and vibration

Two important parameters for measuring vibration and shock are the acceleration force and vibration frequency applied to IoT-connected devices. You'll find sources of vibration anywhere: inside a moving vehicle, a cooling fan in equipment or even a handheld wireless device. It is important that clock solutions provide a stable clock with strong resistance against acceleration forces, vibration and shock, as this assures stability throughout product life cycles under process and temperature variations.

Vibrations and mechanical shock affect resonators by inducing noise and frequency drift, degrading system performance over time. In reference oscillators, vibration and shock are common causes of elevated phase noise and jitter, frequency shifts and spikes, or even physical damage to the resonator and its package. Generally, external disturbances can couple into the microresonator through the package and degrade overall clocking performance.

One of the most critical performance metrics for any wireless device is to maintain a link between the transmitter and receiver and prevent data loss. Without the need for a crystal, BAW technology provides significant performance benefits for IoT products operating in harsh environments. Because BAW technology ensures stable data transmission, data syncing over wired and wireless signals is more precise and makes continuous transmission possible, which means that data can be processed quickly and seamlessly to maximize efficiency.

Evaluating BAW technology with high industry standards

TI has tested the CC2652RB *thoroughly against relevant military standards because many MCUs operate in environments susceptible to shock and vibration, such as factories and automotive vehicles.* Military standard (MIL)-STD-883H, Method 2002 is designed to test the survivability of quartz crystal oscillators. This standard subjects semiconductor devices to moderate or severe mechanical shock (with an acceleration peak of 1500 g) caused by sudden forces or abrupt changes in motion from rough handling, transportation or field operation. Shocks of this type could disturb operating characteristics or cause damage similar to what could result from excessive vibration, particularly if the shock pulses are repetitive.

Figure 1 shows a mechanical shock test setup for MIL-STD-883H, while Figure 2 shows the frequency variation of the CC2652RB compared to an external crystal solution. You can see that the maximum frequency deviation is about 2 ppm, while the external crystal solution is about 7 ppm at 2,440 GHz.

Figure 1. Mechanical shock test setup and test setup block diagram

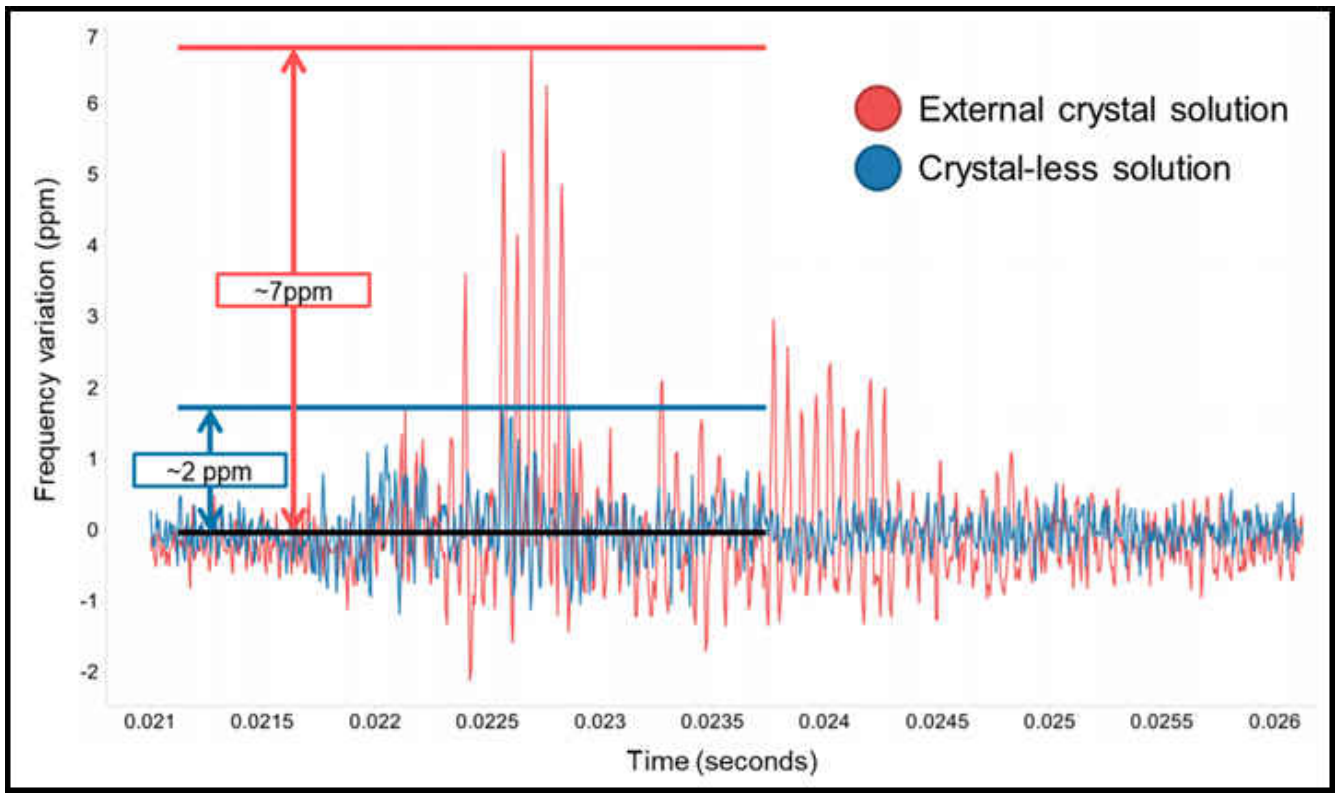

Figure 2. Comparing the maximum radio (2,440 GHz) frequency deviation (parts per million) induced by mechanical shock on both BAW and crystal devices

Conclusion

BAW technology represents real progress within the evolution of IoT by reducing the amount of space required in some critical devices, like those in the medical field, and enabling the use of IoT in places characterized by frequent shocks or vibrations. BAW technology will be one of the catalysts in the connected world of the future across a vast array of sectors.

To learn more about the tests we performed on this technology in mechanical stress environments, please read the whitepaper: Exploring IoT wireless connectivity in mechanical shock and vibration environment.

Resources

- CC2652RB product folder, tool folder and data sheet
- "Getting started with CC2652RB for crystal-less BAW operation" application report
- SimpleLink CC13x2 and CC26x2 software development kit

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