Application Brief

# BAW Oscillator Solutions for Energy Infrastructure

## BAW Resonator Technology

BAW is a micro-resonator technology that enables the integration of high-precision and ultra-low jitter clocks directly into packages that contain other circuits.
In the LMK6C and CDC6C LVCMOS oscillator families, BAW is integrated with a co-located precision temperature sensor, a ultra-low jitter, low power output divider, and a small power-reset-clock management system consisting of several low noise LDOs.

Figure 1 shows the structure of the BAW resonator technology. The structure includes a thin layer of piezoelectric film sandwiched between metal films and other layers that confine the mechanical energy. The BAW utilizes this piezoelectric transduction to generate a vibration.

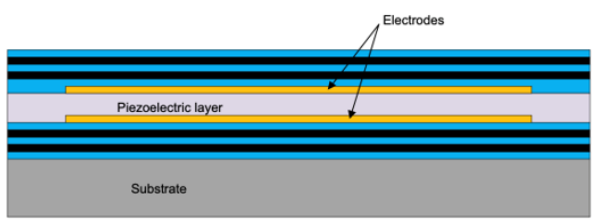


**Figure 1. Basic Structure of a Bulk Acoustic Wave (BAW) Resonator**

## BAW Oscillator in Energy Infrastructure

The CDC6C and LMK6C LVCMOS BAW Oscillator families can be used as a drop-in replacement in energy infrastructure designs.

Figure 2 and Figure 3 demonstrate basic block diagrams a Smart Meter application in which the BAW Oscillator is incorporated. The flexibility in frequency, supply voltage, and package size allow for the BAW Oscillators to be used throughout out the entire system for alternative clocking needs. If synchronization is required for the main clocks of the isolated ADCs, a network synchronizer such as LMK05318B can be used.

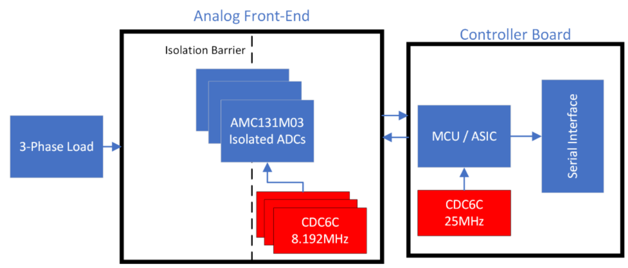


**Figure 2. Smart Meter Block Diagram with BAW Oscillator**

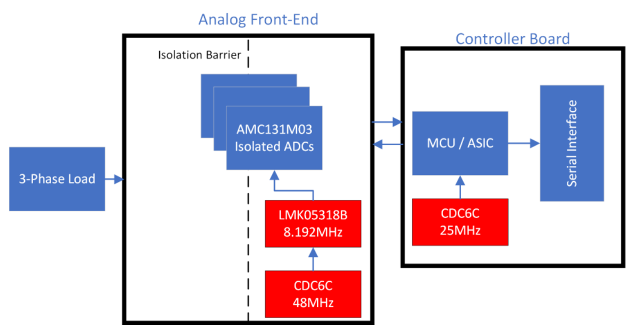


**Figure 3. Smart Meter Block Diagram with Network Synchronizer**

## Benefits of the BAW Oscillator

One of the key benefits of the BAW oscillators in comparison to MEMs and Quartz oscillators is the exceptional jitter performance. Figure 4 shows the jitter performance of the LMK6C (LVCMOS) BAW oscillator for a 25MHz output clock. Improved jitter performance of the main clock of the ADCs can result in superior signal-to-noise ratio.

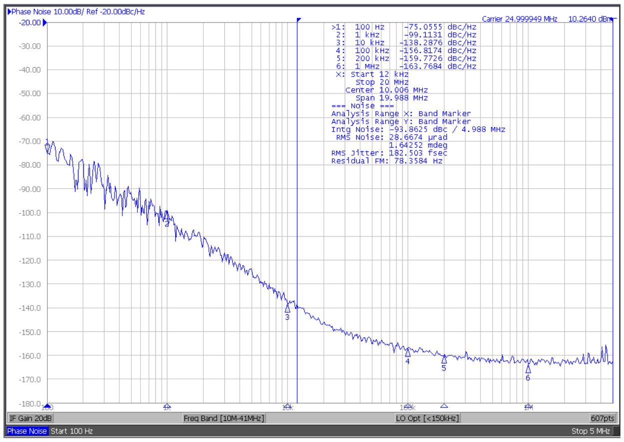


**Figure 4. BAW Oscillator 25MHz Phase Noise Performance**

TI's BAW Oscillator family supports 1.8V-3.3V supply voltages and are available in standard 4-pin DLE (3.2mm × 2.5mm), DLF (2.5mm × 2mm), DLX (2mm x 1.6mm), and DLY (1.6mm x 1.2mm) packages, which save space in compact board designs. Figure 5 showcases BAW Oscillator layouts on the left in comparison to typical crystal layouts for several package sizes. Crystals require up to four external components to tune the resonant frequency and maintain active oscillation. Active oscillators such as the CDC6C or LMK6C only require a single capacitor for power supply filtering, which simplifies the BOM and significantly reduces the layout area required. Additionally, parasitic capacitance from PCB traces will not affect the frequency accuracy of an active oscillator which allows it to be placed much farther away from the receiver compared to crystal.

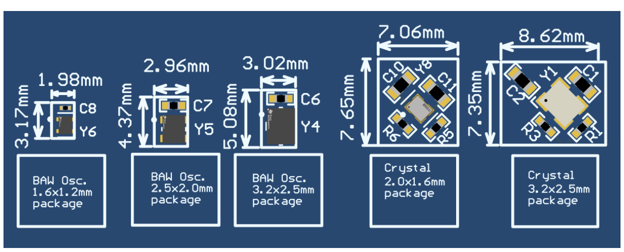


**Figure 5. Layout Comparison Between Crystal and BAW Oscillators in Standard Package Sizes**

BAW Oscillators offer high grade reliability in terms of temperature stability and vibration sensitivity. Figure 6 compares BAW performance to Quartz over a -40°C to 105°C temperature range. Over temperature, the BAW oscillator has a ± 10ppm frequency accuracy.

## Trademarks

All trademarks are the property of their respective owners.

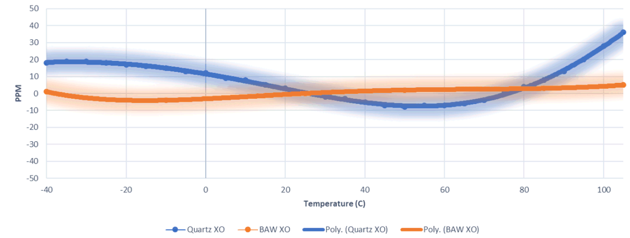


**Figure 6. Temperature Stability Comparison of BAW Oscillator and Quartz Oscillator**

Figure 7 shows the vibration sensitivity of the BAW oscillator. The BAW oscillator has a typical vibration sensitivity of 1ppb/g, which is significantly better than the 5-10ppb/g sensitivity of quartz oscillator designs.

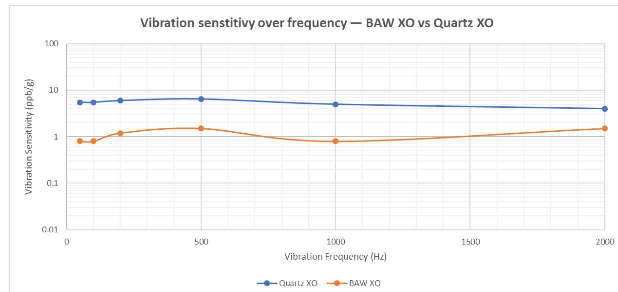


**Figure 7. Vibration Sensitivity Comparison of BAW Oscillator and Quartz**

BAW oscillators have superior EMI performance compared to other technologies. Figure 8 compares the CISPR 11 radiated emissions across a 550MHz-800MHz frequency band for the CDC6C BAW oscillator and a MEMS-based oscillator. This measurement was performed using an 8.192MHz clock frequency on an AMC131M03 EVM. The BAW oscillator radiates significantly less power in the even harmonics of the clock frequency, and also emits less peak power in the odd clock harmonics.

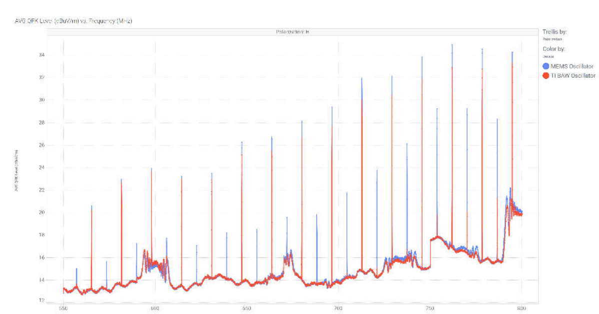

**Figure 8. CISPR 11 Radiated Emissions: BAW Oscillator vs. MEMS Oscillator**

# IMPORTANT NOTICE AND DISCLAIMER