



THE IMPACT OF ACCELERATION SENSITIVITY ON QUARTZ CRYSTALS

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A quartz crystal at the heart of every oscillator providing the base timing frequency for the circuit.

The resonant frequency of every quartz crystal will be affected by acceleration forces and the effect on the crystal is in proportion to the force applied. Acceleration creates frequency shifts in components due to acceleration-induced stress. The magnitude of these frequency shifts is determined by the quartz crystal's acceleration or "g-sensitivity" vector and the characteristics of the applied acceleration force.

The range of typical g-sensitivities for bulk-mode quartz crystals can span several orders of magnitude, from less than 1×10^{-10} per g for a carefully made precision SC cut to greater than 1×10^{-7} per g for a low cost AT cut crystal. Acceleration sensitivity is linearly proportional to applied force up to acceleration levels of around 50 g, depending on the crystal mounting structure.

The following are the key points to note when designing low acceleration sensitive oscillators:

1: The crystal mounting structure is critical. Crystal manufacturers have spent many years in perfecting their crystal mounting structures.

2: Consider the actual location within a system the oscillator is being placed. Within a system the acceleration forces may be different in different areas and so this requires consideration.

3: Note that Phase Noise is affected by acceleration forces. Although it is not possible to eliminate completely the effects of acceleration on the frequency of a quartz crystal oscillator, by understanding the vector nature of the crystal's g-sensitivity characteristic, the impact in most applications can be minimized.

This is an important topic that is often underestimated in practice. Acceleration sensitivity is often overlooked until vibration or phase noise effects start to show up in the real application. Mounting structure, axis dependency and the actual position in the system can all make a real difference.

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