NEL FREQUENCY CONTROLS, INC.

ISO 9001 CERTIFIED

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Jitter comparison of various crystal technologies

Jitter is affected by a number of variables internal to the oscillator. The bulk of these variables are the same sources as we see causing long term variation in frequency such as capacitance variation with temperature, propagation delay variations with temperature and voltage, frequency changes in the crystal with temperature changes, etc. The amount of frequency change is dependant on the conditions the unit is subjected to. A comparison of the sensitivity of crystal technologies to these variable can be made by comparing the amount the crystal moves with a given change in the circuits load capacitance (defined as pullability). Three technologies were selected for this comparison, 1. The traditional bulk crystal operating on the 5th overtone response, 2. The surface acoustic wave (SAW) crystal, and 3. the inverted mesa crystal operating on the fundamental response (inverted mesa is somewhat descriptive of the process of etching away the center of the bulk crystal to get the very high frequency fundamental frequency without losing the strength of the lower frequency bulk crystal). Since the characteristics of each technology changes with frequency, a fixed 310 MHz was selected for comparative purposes.

All at 310 MHz

Technology	Shunt Cap. (pf)	Motional Cap. (ff)	Pullability (140pf to 160pf)
5th overtone Bulk Crystal	2.19	0.0876	0.04 ppm
SAW	4.3	2.38	1.01 ppm
Inverted Mesa Bulk Crystal	6.081	28.683	11.82 ppm

From this comparison the 5th overtone bulk crystal would be the stiffest or least likely to move with variation in the circuit, the SAW coming in second and the inverted mesa being the worst. Thus, assuming the circuit is the same for all three crystal types the jitter would be lower on the 5th overtone crystal compared to the SAW and inverted mesa types.

Other factors can also contribute to the jitter issue for a given design. Circuit complexity and specific oscillator design configuration (the actual circuit selected and the load capacitance it is operating at) can contribute to the jitter variation. Power supply decoupling internal to the oscillator package will assist in reducing the jitter caused by power supply noise. EMI shielding via a metal package or metal cover (creating a faraday shield) will reduce the affects of EMI from the surrounding area.

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