FREQUENCY STABILITY OF QUALITY QUARTZ CRYSTAL OSCILLATORS: PERFORMANCE AND SOME CRITICAL APPLICATIONS

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SUMMARY

The short-term fractional frequency stability of high quality quartz crystal oscillators is excellent and is competitive with the best quantum device frequency stabilities. The stability of a few parts in 10^{13} for averaging times of 100 seconds has several critical applications in time and frequency work. Improved stabilities to a few parts in 10^{14} appear to be possible.

ABSTRACT

For time intervals, tau, of one second or less, the short-term fractional frequency stability of high quality quartz crystal oscillators is superior to all other known frequency sources. For time intervals in the range of 1 to 10 seconds, these quartz crystal oscillators are at least as good as all other devices, such as hydrogen maser oscillators and rubidium gas cell frequency standards. For time intervals in the range from 10 to 1000 seconds, only hydrogen maser oscillators and the best cesium beam frequency standards are capable of frequency stabilities which exceed those of the best quartz crystal oscillators.

The stability of good quartz crystal oscillators has been found to be at least as good as 2 parts in 10^{13} for time intervals, tau, in the vicinity of 10 seconds, and is not much different for tau equal to 100 seconds.

This superb stability of quartz crystal oscillators, together with their other desirable features, indicates their use in several critical applications. These include long baseline interferometry, stable frequency reference for the cavity tuning servo in the hydrogen maser frequency standard, and stable frequency reference for evaluating the accuracy capability of cesium beam frequency standards, as well as the slaved oscillator in even the finest atomic frequency standards.

At the Colloque, I will discuss the measured frequency stability of commercially available quartz crystal oscillators, and some of their critical applications (accomplished and proposed). I will also mention some possibilities of achieving fractional frequency stabilities in the few parts in 10^{14} range with quartz crystal oscillators in the future. The nature of the flicker of frequency noise of quartz crystal oscillators will be discussed.

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