Pletronics, Inc.
19013 36th Ave. W, Suite H • Lynnwood, WA 98036 USA
Manufacturer of High Quality Frequency Control Products

Fundamental Differences Between
Pletronics 3rd Overtone AT-Cut Crystal Oscillators and SAW Oscillators

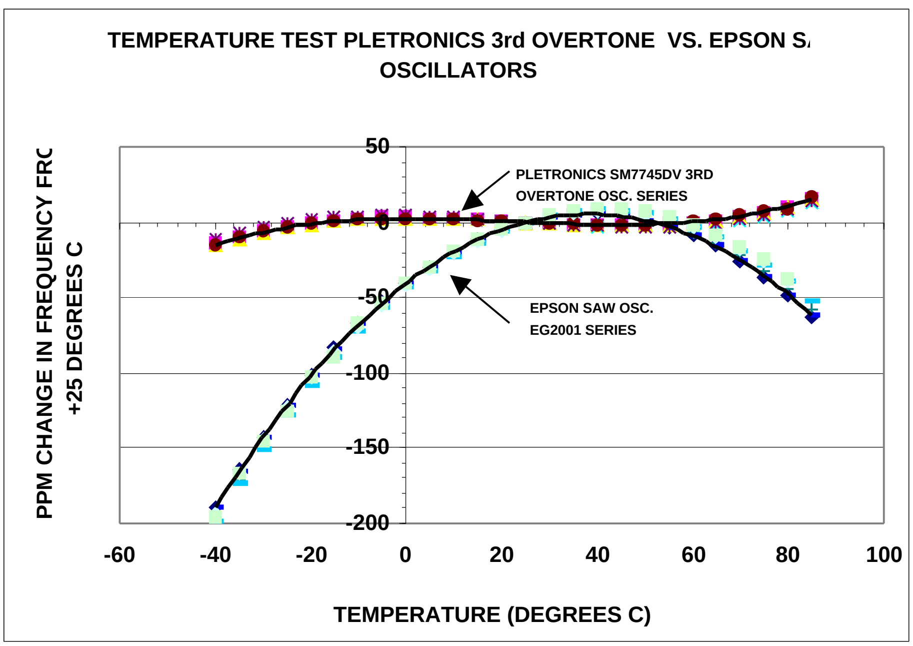
A study was conducted to determine basic fundamental differences in the parameters of both the 3rd overtone oscillator and the SAW oscillator. These parameters are extremely important in many communications systems. Two popular frequencies were chosen for this study, 106.25 MHz and 125.00 MHz.

Oscillators with a 3rd overtone AT-cut quartz crystal resonator have an output spectrum similar to oscillators with a SAW resonator; they both resonate at the output frequency. Both output spectrums do ***not*** contain sub-harmonics due to multiplication or have excessive noise due to internal phase locking.

The fundamental differences between the two resonators are the Q and the frequency-temperature coefficient. The quartz crystal resonator Q is higher and the frequency drift over temperature lower than the SAW resonator. These differences produce the following results:

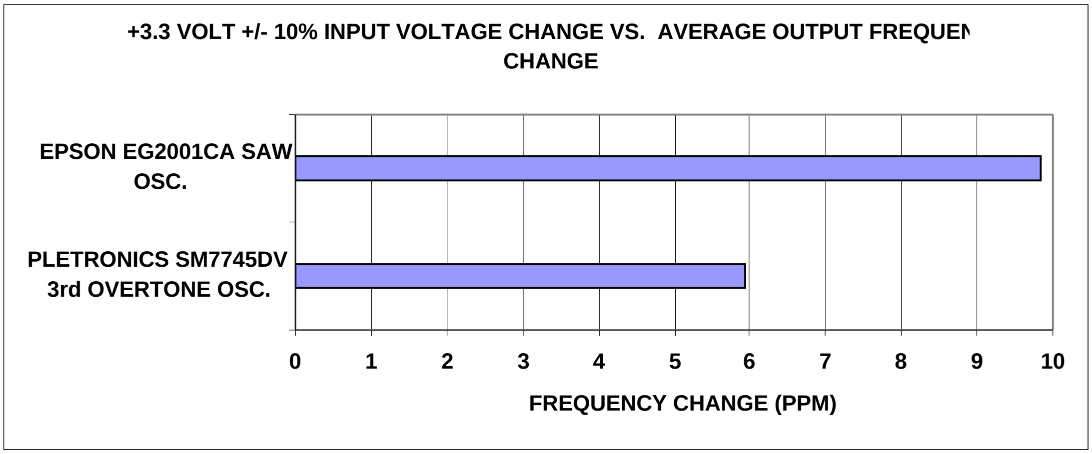
FREQUENCY STABILITY OVER THE OPERATING TEMPERATURE RANGE

The 3rd overtone AT-cut resonator frequency verses temperature characteristic follows a cubic third order curve. The SAW resonator has a frequency verses temperature curve that follows the shape of a parabola over the operating temperature range. This parabola shape for the SAW oscillators produces a very fast frequency slope at both the lower and upper ends of the operating temperature. The SAW oscillators from – 40 to +85°C are 661.21% worse than the 3rd overtone quartz oscillators. Over the temperature range of –20 to +70°C, the SAW oscillators are 305.43% worse.



OUTPUT FREQUENCY SENSITIVITY TO CHANGE OF INPUT VOLTAGE

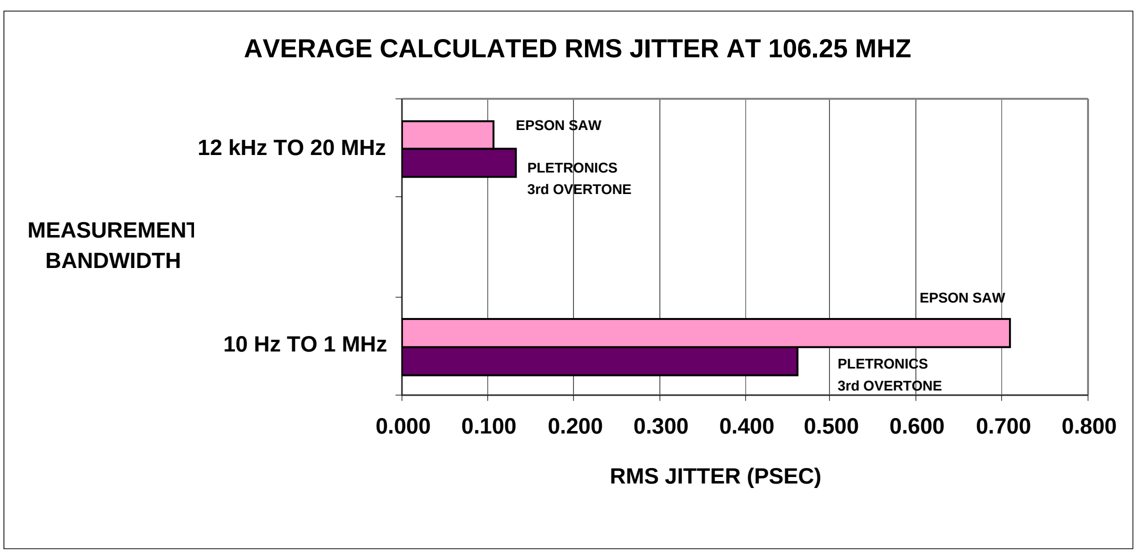
Because of the lower Q of the SAW resonator, the power supply frequency-pushing factor is 65.7% worse for the SAW oscillators than it is for the 3rd overtone oscillators. This is very important in systems that have low-level noise and ripple modulating the input voltage supply that powers the oscillator. If low frequency noise is present, it has a direct effect on the phase noise and jitter by modulating the output of the oscillator.



RMS JITTER

When the RMS jitter was calculated for the 106.25 MHz oscillators, in the 10 Hz to 1 MHz bandwidth, the SAW oscillators were 53.25% worse, and for the 125.00 MHz oscillators, they were 69.16% worse than the 3rd overtone oscillators. The better jitter for the 3rd overtone oscillators is a direct result of the higher Q of the quartz resonator.

The RMS jitter in the 12 kHz to 20 MHz bandwidth, the SAW is 25.23% better for the 106.25 MHz oscillators and 16.57% worse for the 125.00 MHz oscillators as compared with the 3rd overtone oscillators. This difference is related to the phase noise floor of each oscillator's output gate.

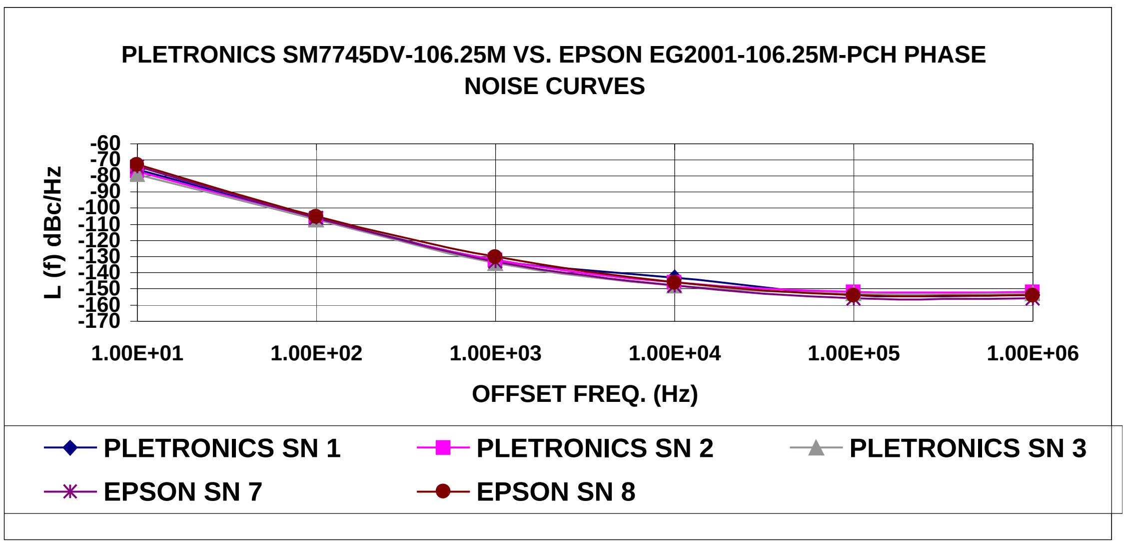


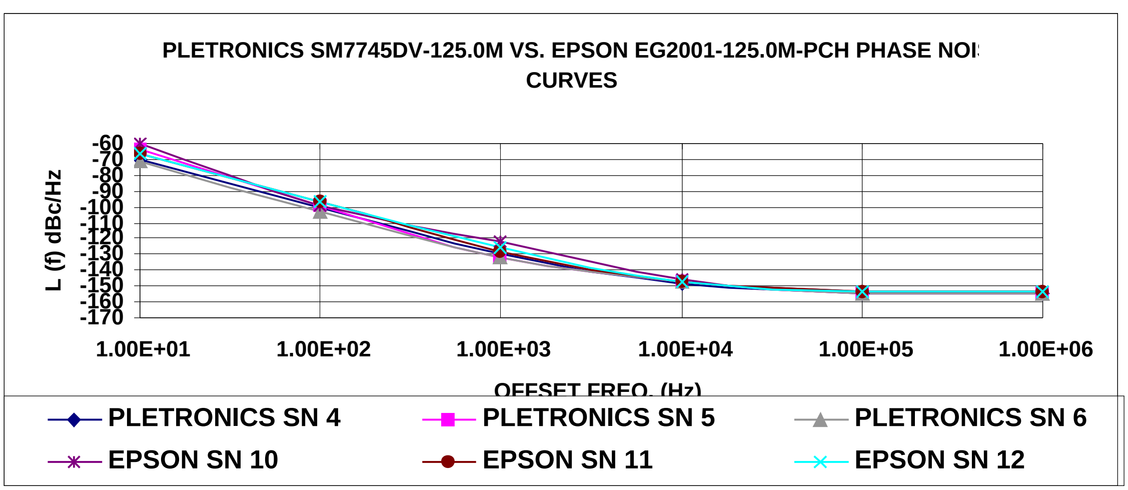
 Pletronics, Inc. (425) 776-1880, Fax: (425) 776-2760, ple-sales@pletronics.com, www.pletronics.com

PHASE NOISE

Resonator Q has a direct effect on the in-close phase noise. The higher Q factor of the 3rd overtone resonator yields a lower phase noise spectrum. The average phase noise at 10 Hz offset of the 3rd overtone oscillators is 3.83 dB better for the 106.25 MHz output and 4.67 dB better for the 125.00 MHz output as compared to the SAW oscillators. The RMS jitter, in the 10 Hz to 1 MHz bandwidth, is largely influenced by the noise from 10 Hz to 100 Hz offset. This lower close-in phase noise of the 3rd overtone oscillators yields a lower RMS jitter than the SAW oscillators.

Phase noise in the 12 kHz to 20 MHz bandwidth produced different results for the 106.25 MHz and the 125.00 MHz oscillators. The noise floor for the 106.25 MHz SAW oscillators was 2.0 dB better than the 3rd overtone oscillators, however, for the 125.00 MHz oscillators it was 1.34 dB worse. The phase noise floor for an oscillator, with a square wave output, is largely due to the noise produced by the output gate in each oscillator, not the resonator Q.





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Conclusion:
Pletronics 3rd Overtone Oscillators
vs.
SAW Oscillators

CHARACTERISTIC	SAW *Better* than 3rd OT AT-Cut By	SAW *Worse* than 3rd OT AT-Cut By
Supply Voltage vs. Frequency Change		65.70%
Frequency Stability vs. Temperature		
-40 to +85°C		661.21%
-20 to +70°C		305.43%
Jitter Related Phase Noise at 10 Hz Offset		
106.25 MHz		3.83 dB
125.0 MHz		4.67 dB
Total Integrated Phase Noise		
106.25 MHz		
10 Hz to 1 MHz Bandwidth		3.4 dB
12 kHz to 20 MHz Bandwidth	2.0 dB	
125.0 MHz		
10 Hz to 1 MHz Bandwidth		4.27 dB
12 kHz to 20 MHz Bandwidth		1.34 dB
RMS Jitter		
106.25 MHz		
10 Hz to 1 MHz Bandwidth		53.25%
12 kHz to 20 MHz Bandwidth	25.23%	
125.0 MHz		
10 Hz to 1 MHz Bandwidth		69.16%
12 kHz to 20 MHz Bandwidth		16.57%