

Quartz as a reference material for radio frequency waves: the best performances ever obtained on quartz oscillators with stressed compensated cut

Patrice Salzenstein ^{1*}, Alexander Kuna ², Frédéric Lefebvre ^{3*}

¹ Centre National de la Recherche Scientifique (CNRS), UMR6174 FEMTO-ST, Université de Franche Comté, 15b avenue des Montboucons, F25030 Besançon Cedex, France

² Institute of Photonics and Electronics of the Academy of Sciences, Prague, Czech Republic

³ Oscilloquartz Adron company, Avenue des Paquiers 1, CH2072 Saint-Blaise, Switzerland

* corresponding authors e-mails : patrice.salzenstein@cnrs.fr lefebvre@oscilloquartz.com

In this paper, we review the best performances ever obtained in terms of phase noise for radio frequency quartz oscillators using stressed compensated cut quartz resonators. The general characteristics are given in reference [1]. These oscillators are of the OSA 8607 series. The phase noise of quartz resonators is measured on a resonator phase noise bench [2]. The performances in terms of Allan variance are evaluated in reference [3]. The best performances are obtained on a modified OSA 8607 prototype [4], and confirmed by a determination using another bench on another principle [5]. A reflection on the confidence of measures is carried out [6]. The best performances ever obtained remain in the 2.5×10^{-14} to 3.2×10^{-14} range for a 10 – 20 seconds integration time for such oscillators at a 5 MHz nominal frequency as shown on Fig. 1.

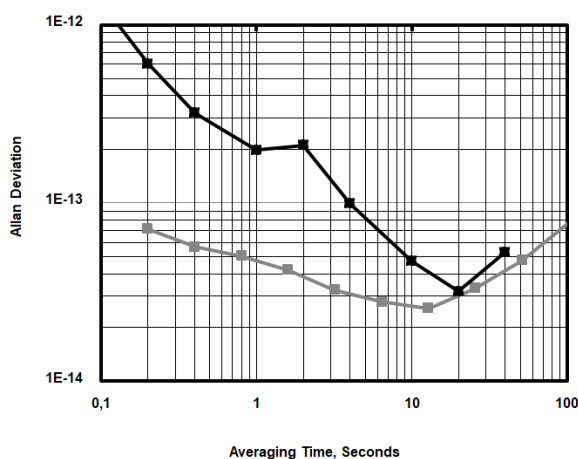


Fig. 1: Best performances obtained on a OSA 8607 quartz oscillator at 5 MHz. The flicker frequency modulation (FFM) floor is in the range of 2.5×10^{-14} to 3.2×10^{-14} for 10 – 20 s integration time. In grey the best result measured by Dual Mixer Time Difference Multiplication, in black the confirmation of this state-of-the-art performance measured with a time interval analyzer (TIA). For the black curve, results are limited by the TIA for lower averaging time and by aging for upper averaging times.

References:

- [1] Salzenstein P., "[Recent progress in the performances of ultrastable Quartz resonators and oscillators](#)," Int. J. for Sim. and Mult. Design Optimization 7, A8 (6) (2016). doi:10.1051/smdo/2016014
- [2] Salzenstein P., Kuna A., Sojdr L., Sthal F., Cholley N. and Lefebvre F., "[Frequency stability measurements of ultra-stable BVA resonators and oscillators](#)," Electronics Letters 46(10), 686-688 (2010). doi:10.1049/el.2010.0941
- [3] Kuna A., Cermak J., Sojdr L., Salzenstein P., Lefebvre F., "[Lowest Flicker-Frequency Floor Measured on BVA Oscillators](#)," IEEE Trans. on UFFC 57(3), 548-551 (2010) doi:10.1109/TUFFC.2010.1446
- [4] Salzenstein P., Kuna A., Sojdr L. and Chauvin J., "[Significant step in ultra high stability quartz crystal oscillators](#)," Electronics Letters 46(21), 1433–1434, (2010). doi:10.1049/el.2010.1828
- [5] Salzenstein P., "[Frequency and temperature control for complex system engineering in optoelectronics and electronics: an overview](#)," Int. J. for Sim. and Mult. Design Optimization 11, 7 (2020). doi:10.1051/smdo/2020001
- [6] Salzenstein P., Kuna A., Lefebvre F., "[Evaluation of the accuracy of the method for measuring state-of-the-art ultra-high stability quartz crystal oscillators](#)," 2013 Joint European Frequency and Time Forum & International Frequency Control Symposium (EFTF/IFC), Prague, Czech Republic, pp 157-159 (2013). doi:10.1109/EFTF-IFC.2013.6702072