Ultra Low Phase Noise 16GHz Oscillator using a Distributed Bragg Resonator

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Abstract:- This paper presents the design of a 16GHz oscillator using a high Q distributed Bragg resonator with an aperiodic arrangement of high purity alumina plates. The resonator demonstrates an unloaded Q up to 160,000 & the plates are held in place using Spira-Shield O-Ring gaskets to maintain mechanical stability. Preliminary phase noise measurements demonstrate -75dBc/Hz at 100Hz offset & -134dBc/Hz at 10kHz offset.

Introduction:- The oscillator used in time sensitive electronic systems sets the ultimate phase noise performance of the system & it is therefore essential to develop ultra-low phase noise oscillators to ensure that phase noise, jitter & Allan deviation are minimized. The work presented in this paper builds on the work published on Distributed Bragg Resonators in [1,2] by this research group & by Breeze, Krupka & Alford [3]. The key advantage of Distributed Bragg resonators is that they offer high power operation of greater than 100mW with high Qs.

Design:- The high Q resonator uses an aperiodic arrangement of high purity alumina plates demonstrating an unloaded Q up to 160,000. To maintain mechanical stability & reduce EM leakage, the plates are held in place using Spira-Shield O-Ring gaskets. A significant amount of the energy is constrained at the centre of the cavity by the plates & away from the lossy end walls. A feedback oscillator design is used with two single stage amplifiers. It is hoped that a higher power parallel amplifier design will replace the single stage devices in the next iteration which will also reduce the flicker noise corner of the devices[4].

Measurements:- Phase noise measurements have been made using an R&S FSWP 50 as shown in Fig 1. These demonstrate -74dBc/Hz at 100Hz offset and -134dBc/Hz at 10kHz offset which closely match the theoretical phase noise. The parameters used in the theoretical simulation are: Q_0=125,000, Q_L=85,000, NF= 7.2dB, F_C=50kHz & P_{AVO}= 1dBm. Improvements of 20 to 30dB are possible with higher powers, Q and lower flicker noise corners. *Sponsors:*- Keysight & EPSRC.

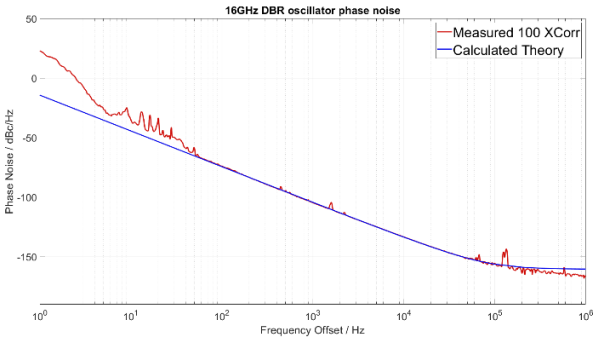

Fig. 1: Oscillator phase noise measurements of a 16GHz DBR oscillator. Measured phase noise of -75dBc/Hz at 100Hz offset & -134dBc/Hz at 10kHz offset.

[1] S. Bale & J. Everard, "High-Q X-band distributed Bragg resonator utilizing an aperiodic alumina plate arrangement," *IEEE Transactions on Ultrasonics, Ferroelectrics, & Frequency Control*, vol. 57, no. 1, pp. 66-73, Jan. 2010

[2] S. J. Bale, P. D. Deshpande, M. Hough, S. J. Porter & J. K. A. Everard, "High-Q Tuneable 10-GHz Bragg Resonator for Oscillator Applications," *IEEE Transactions on Ultrasonics, Ferroelectrics, & Frequency Control*, vol. 65, no. 2, pp. 281-291, Feb. 2018

[3] Jonathan Breeze, Jerzy Krupka, Neil McN Alford; Enhanced quality factors in aperiodic reflector resonators. *Appl. Phys. Lett.* 8 October 2007; 91 (15)

[4] R. Boudot & E. Rubiola, "Phase noise in RF & microwave amplifiers," *IEEE Transactions on Ultrasonics, Ferroelectrics, & Frequency Control*, vol. 59, no. 12, pp. 2613–2624, Dec. 2012.