MINIATURE FET OSCILLATOR STABILIZED BY A DUAL MODE DIELECTRIC RESONATOR LOADED CAVITY.

S.J.Fiedziuszko
Ford Aerospace & Communications Co.
Western Development Laboratories
3939 Fabian Way , Palo Alto, Ca. 94303

ABSTRACT.

A novel configuration of a stabilized FET oscillator is based on a dual mode dielectric resonator loaded cavity. Two orthogonal modes in such a cavity are utilized in a feedback loop as well as for additional output filtering. The principle of operation and experimental results are presented.

INTRODUCTION.

Use of high Q , temperature stable resonant elements is necessary to stabilize fundamental frequency oscillators. Recently developed dielectric resonators have shown low loss as well as excellent temperature stability [1] . Therefore, use of dielectric resonators in combination with bipolar or GaAS FETs becomes very attractive. Almost all dielectric resonator stabilized oscillators utilize single mode $TE01\delta$ in a cylindrical dielectric resonator, which is for certain D/L ratios considered fundamental (has lowest resonant frequency). The higher order modes were usually not considered in this application, with the notable exception of Khanna et al.. [2]. Khanna proposed the use of mode $HE11\delta+1$ in DRO's , especially at higher frequencies because fQ product (figure of merit) of $HE11\delta+1$ mode is about 50% higher than that of the $TE01\delta$ mode. The hybrid, degenerate mode $HE11\delta$ in a dielectric resonator loaded cavity was successfully used to implement high performance dual mode filters [3]. Field patterns of this mode and mode $TE01\delta$ are presented in Fig.1. This dual mode dielectric resonator loaded cavity was furthermore considered for the stabilization of fundamental oscillators and resulted in a novel configuration described below. The developed oscillators are easy to build and exhibit excellent electrical and temperature performance.

CIRCUIT DESCRIPTION.

A basic oscillator configuration[4]is presented in Fig.2 . Two major components ; (amplifier FET or bipolar transistor) and dual mode dielectric resonator cavity form the oscillator , which operates in a parallel feedback topology. A signal from the amplifier is coupled to mode #1 in a dielectric resonator which is also coupled to the output port. A 45 degree screw (or any discontinuity) excites mode #2 which is coupled to the input of the amplifier and forms the feedback loop. A coupling required for the oscillation can be easily adjusted by a coupling screw. In single mode dielectric resonator stabilized oscillators, the most frustrating problem is to determine (almost always experimentally) the proper position of the dielectric resonator in respect to the microstrip line (or lines), which is critical to the oscillators operation. The proposed configuration is very easy to work with and proof of concept oscillators always worked after proper adjustments of coupling by a 45 degree screw. Additional advantages include ; much wider tuning range (synchronous) with capacitive screws perturbing the eletric fields or by inductive screw(plate) , which perturbs magnetic fields of both modes . Also wider varactor tuning range is possible and injection or phase locking is fairly simple , due to the ease of additional coupling to the cavity.

EXPERIMENTAL OSCILLATOR.

Several proof of concept oscillators were initially built using discrete components (FET amplifier and a separate cavity). Typical output power was in order of 10 dBm ,due to the fact that low power amplifiers were used. The temperature stability was usually better than 1ppm/degree C. In Fig.3 a video average of the 7.2 GHz oscillator output as measured with a spectrum analyzer is presented. It can be seen that SSB phase noise is better than -90 dBc/Hz at frequency offset of 10 kHz in spite of the fact that insufficiently regulated voltages were used to bias the amplifier/oscillator. In addition , an integrated model of the oscillator was built and tested. A very high Q dielectric resonator fritted to a forsterite support manufactured by Panasonic was used. The unloaded Q of the assembly was greater than 10,000 at 8 GHz. A photograph of the oscillator is presented in Fig.4. Excellent temperature stability (less than 1ppm/degree C) and very good phase noise performance (in order of -100dBc 10 kHz offset) were achieved.

0149-645X/85/0000-0264 $01.00 © 1985 IEEE 1985 IEEE MTT-S Digest

CONCLUSION.

A new ,stable oscillator configuration was presented. As a base element, a high Q, exceptionally stable dual mode dielectric resonator loaded cavity is used. Excellent temperature and phase noise characteristics of the proposed configuration were demonstrated . In addition, the utilization of the mode HE11δ facilitates wide range , high Q varactor tuning of the oscillator.

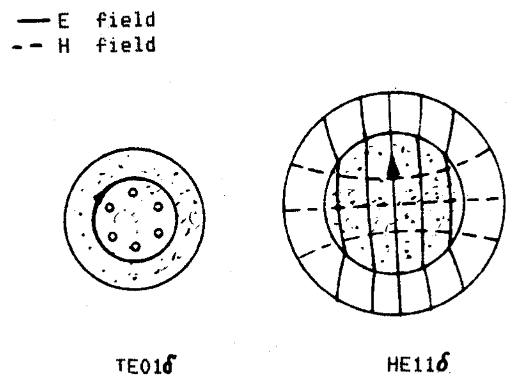

Fig.1 Field patterns of mode TE01δ and HE11δ in a dielectric resonator.

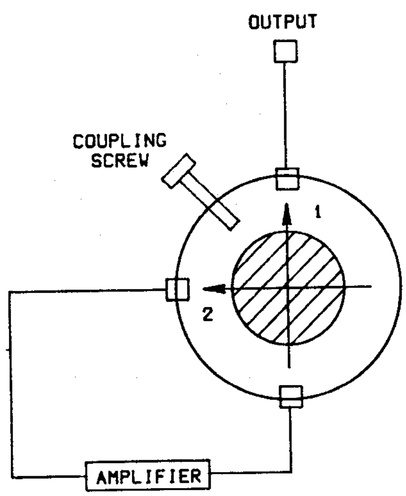

Fig.2 A basic oscillator configuration.

REFERENCES.

1. J.K.Plourde and C.L.Ren "Application of Dielectric Resonators in Microwave Components ", IEEE Trans. MTT, vol.29, No.4, pp.754-769 August 1981.

2.A.P.S.Khanna,Y.Garault, M.Guedira "Dielectric Resonator HE11δ +1 Mode Coupling to a Shielded Microstrip Line" IEEE MTT-S Digest ,pp. 527-529, May 1983.

3. S.J.Fiedziuszko "Dual-Mode Dielectric Resonator Loaded Cavity Filters " IEEE Trans. MTT vol.30, No.9 , pp.1311-1316 , Sept.1982.

4. U.S. Patent - pending

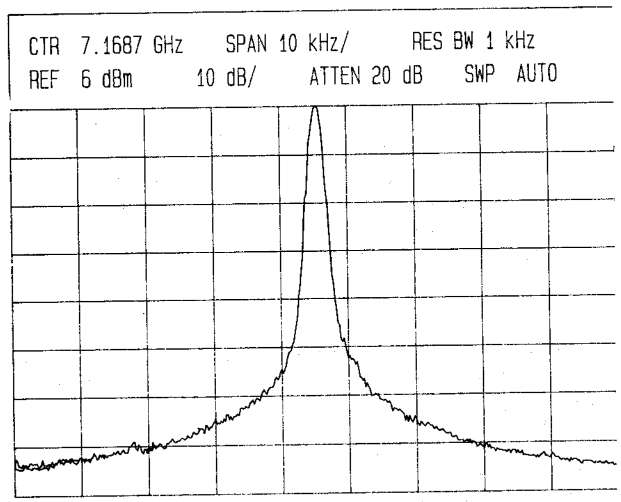

Fig.3 A video average of the 7.2 GHz oscillator output signal.

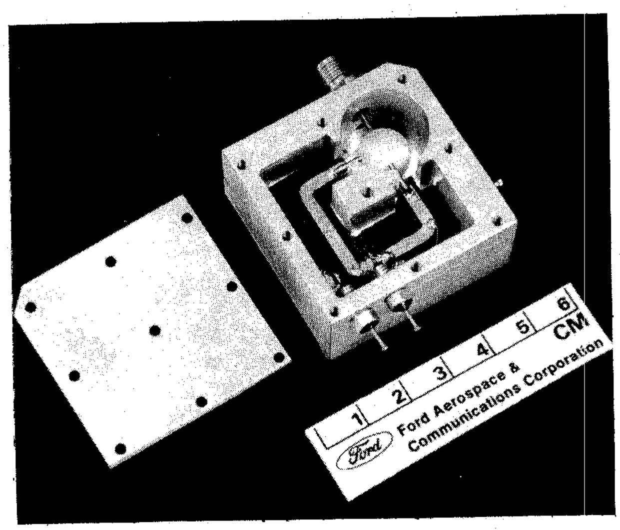

Fig.4 Miniature FET oscillator stabilized by a dual mode dielectric resonator.