MEMS Based Different Types of Resonator

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Abstract— MEMS is a micro-electro-mechanical system. It has actively developed into research and development in a broader range of applications, such as in analog system, switches, and in communication system, such as in the oscillator, filter part of RF transceivers.MEMS resonator have potential to replace the available technologies like quartz crystal resonator, LC filters, ceramic filter, SAW filters. There are different types of MEMS resonator such as clamped free resonator ,clamped-clamped resonator, free-free resonator, disc resonator. MEMS resonators can be utilized to meet the increasing count of RF components likely to be demanded by the next generation multi-band/multi-mode wireless devices, as it needs less area, less power consumption, less material.

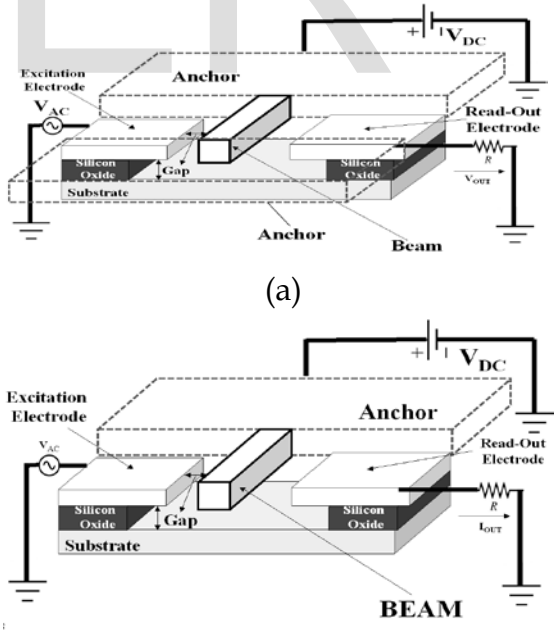
Index Terms— MEMS, micro-electro-mechanical system, quartz crystal resonator, LC filters, ceramic filter, SAW filter, MEMS resonators.

1 INTRODUCTION

MEMS are a micro electro mechanical system. They have been developed since the 1970s.They are essentially miniature devices that use a mechanical movement [1]. MEMS consist of mechanical, electrical systems whose order of size in microns. It is a technology used to miniaturize systems. Resonator is a system that having resonant behaviour, Resonance is a phenomenon where a system shows selective response at specific frequencies. The resonance occurs when the system is capable of storing energy and also Capable of transferring energy from one mode to another. Depending upon the principle of operation the resonance may occur in different domain like mechanical, electrical, electromagnetic, optical, acoustic etc. For example, in mechanical domain the system may vibrate with greater amplitude at some frequencies than the other. The frequency at which the system oscillates with greater amplitude is known as resonant frequency [2]. MEMS are widely used by systems in high (3–30MHz) ,very high (30– 300MHz) and even ultra-high (300 MHz–3GHz) frequency ranges .They provide a promising alternative to traditional electronic components especially for RF devices (e.g. mixers, tunable capacitors, inductors, switches, oscillators). From the industrial perspective, these technologies promise exactly what their applications need be, that is, high-capability devices and systems with portability and low power consumption. The use of these elements integrated into a single silicon chip, along with the CMOS circuitry, will improve the performance of systems with added benefits of reduced costs, power consumption and size[3].Based on beam position there are different types of resonator such as clamped free resonator , clamped-clamped resonator, free-free resonator.

1.1 Different Types Of Resonator

Clamped free resonator: According to A. Zainuddin, etal[3], it uses both clamped-clamped & clamped free resonator & gives comparison pts of both in terms of resonance frequency and pull in voltage. Fig 1shows electrical set up for both resonators. The clamped-clamped resonator requires maximally 10v DC voltage, while clamped free resonator requires 7.5v. For clamped-clamped the resonance frequency for mode1 is 19.42MHZ, for mode2 23.87MHZ. For clamped free resonator the resonance frequency for mode1 is 2.92MHZ and for mode2 is 3.68 MHZ. The lower pull in voltage values for clamped free structure show its potential to be applied in low power devices



(a)

(b)

Fig 1: Electrical setup for (a) Clamped-Clamped Beam Resonator (b) Clamped-Free beam resonator

Fixed-Fixed Beam Resonator: In this literature the author is Vivek Harshey etal[5], Figure 2 shows MEMS filer using fixed-fixed beam. it uses fixed-fixed beam MEMS resonator struc-

ture which has a resonance frequency of 8.5 MHz , the pull-in voltage of this resonator is 5.5v & Q of 10,000. It shows above factors with thermoelastic damping using COMSOL multiphysics software. It shows Eigen frequency analysis for different modes. The beam resonator was built using polysilicon. As it can be easily fabricated by the standard CMOS process and hence can be used in on chip RF circuit.

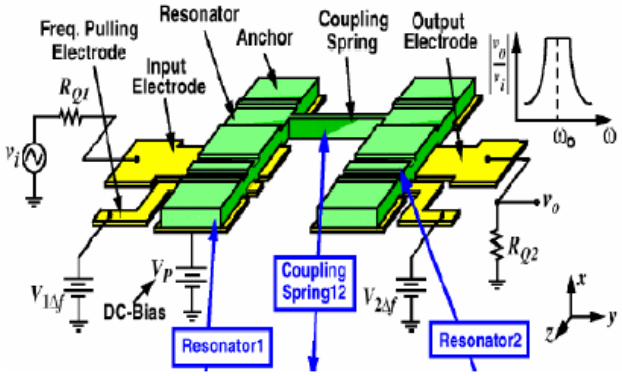


Fig 2: MEMS filer using fixed-fixed beam

SiC-based clamped-clamped filter: With reference to Yongmei Zhao, etal[6], it gives idea of the clamped-clamped filter. Figure 3.shows Perspective schematic of the SiC-based clamped-clamped filter.It uses two anchors & two beam coupled with coupling beam. As coupling beam position change and size of the resonator beam changes the frequency & BW changes. The effect of the coupling beam on the bandwidth of the filter was analyzed by FEA

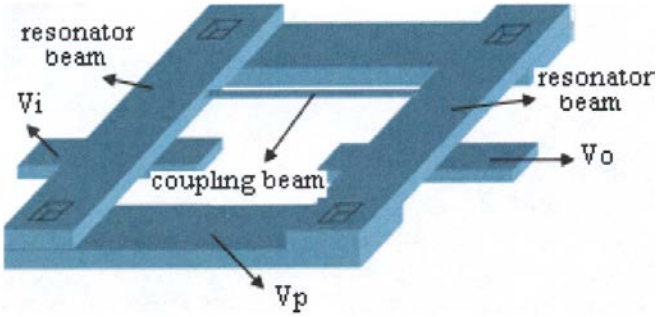


Fig 3:.Perspective schematic of the SiC-based clamped-clamped filter.

4 Conclusion

The study in the paper shows the design of clamped free beam resonator based on MEMS. Based on the discussion made above it is found that upto now, the designed resonance frequency for clamped free structure is 2.92MHZ & for that required Pull in voltage is 7.5v, but for some wireless standards such as GSM, IS-95, Bluetooth &RF transceiver requires high resonance frequency So, there is a need of high resonance frequency greater than 3MHZ & reduction in pull in voltage less than 7.5v.

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