Multiphysics Modeling and Simulation of MEMS Based Variometer for Detecting the Vertical Speed of Aircraft in Avionics Applications

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Introduction: The main objective of this paper is to develop a MEMS based Variometer to measure the vertical speed and to sense the instantaneous rate of climb or descent of Aircrafts to meet the miniaturization requirements in avionics industry. When the pressures are equalized in level flight, the needle reads zero, which tells the pilot that aircraft flies in stable manner without any change in climb or descent. As static pressure in the atmosphere changes during entry to a climb or descent, the needle immediately shows a change of vertical direction.

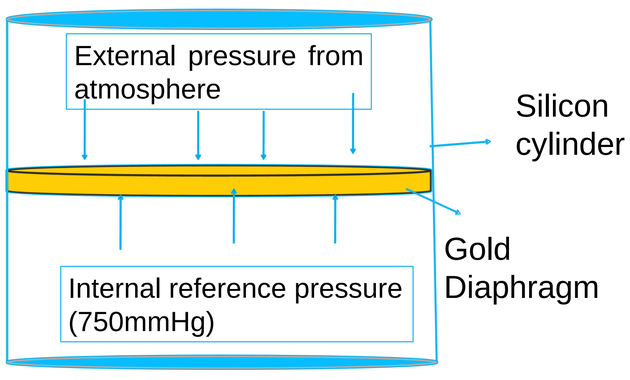

Figure 1: Model of proposed structure

Computational Methods:

The maximum center displacement is given as,

$$w_{max} = \frac{pr^4(1-\vartheta^2)}{16E\,h^3} \quad - \quad (1)$$

The equation relating pressure and barometric altitude is given by,

$$H_b = [1-(p/760)^{0.190263}] \quad -(2)$$

The relation between altitude and rate of climb is given by,

$$r = \frac{23770-h}{16.60} - \quad (3)$$

Where h in feet, t in minutes, r is in ft/min. Rate of climb is normally calculated in knots which is,1 knot=101.3 ft/min.

Results:

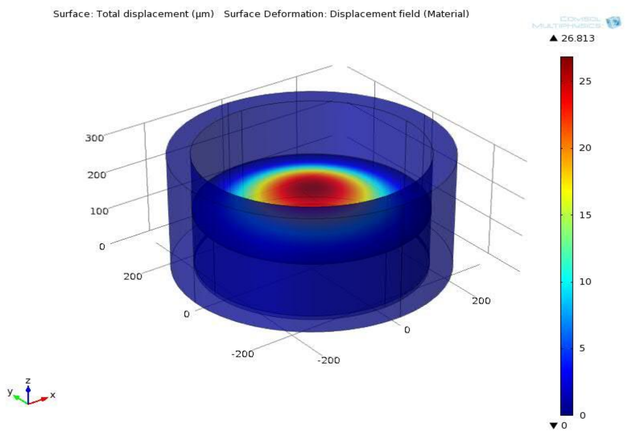

Figure 2: Center displacement of the diaphragm surface

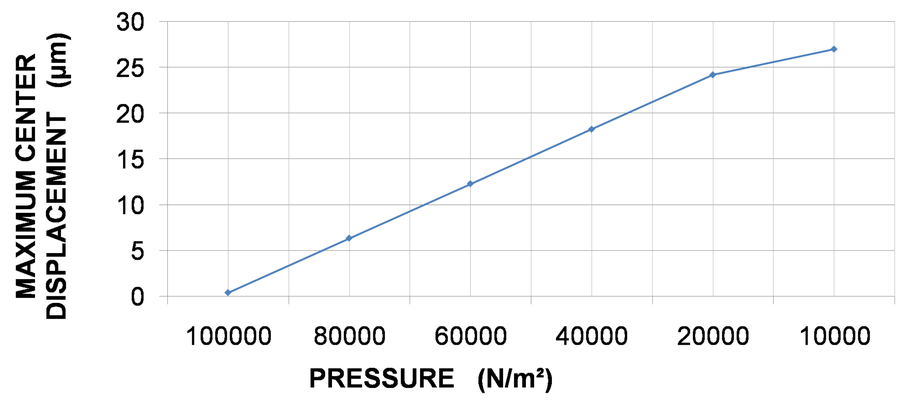

Figure 3: Change in diaphragm displacement according to the pressure

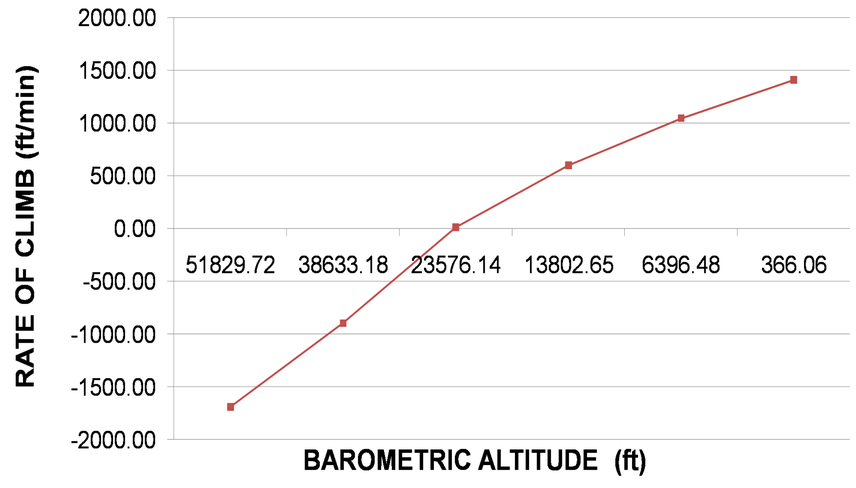

Figure 4: Change in rate of climb with altitude

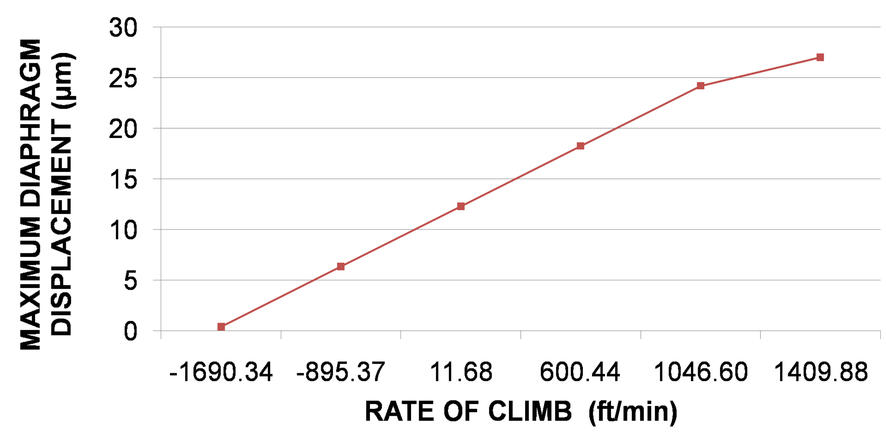

Figure 5: Change in diaphragm displacement with rate of climb

References:

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2. Teodor Lucian Grigorie, Liviu Dinca,Jenica-Ileana Corcau, Otilia Grigorie -“Aircrafts’ Altitude Measurement Using Pressure Information: Barometric Altitude and Density Altitude”. wseas transactions ON circuits AND systems. ISSN: 1109-2734 Issue 7, Volume 9, July 2010