

SIMULATION OF TUNABLE CAPACITOR USING COMSOL



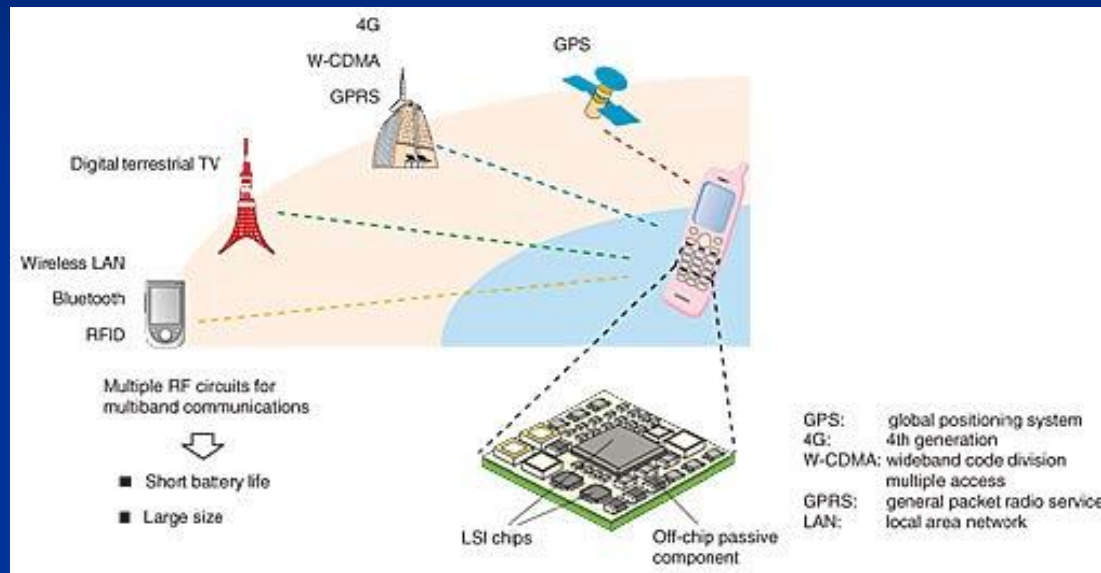
- Centre for Nano Science and Engineering (CeNSE)
Indian Institute of Science



MOHAMED IRFAN P
M TECH, CeNSE.
SR: 11296.

Guided by :GK Ananthasuresh

Why we need varicap?



www.ntt-review.jp

Different technology works at different frequency, but we need to access all these using a single device...!!, we need to use our tool in a wider spectrum...!!

- Variable capacitors are used in communication equipment, radios, televisions etc.
- They can be adjusted by consumers by tuning controls
- Trimmers are internal adjusted capacitors that a consumer cannot adjust



For microelectronics

- Tank capacitors would be difficult to squeeze into your mobile phone and laptop.
- Current technology uses semi-conductor variable capacitors called varactors (varicaps)



Problem with reverse-biased semiconductor diodes

- Large energy losses
- Limited tuning range
- “leakage” current, thereby static power dissipation.
- Poor Q factor.
- Highly Pron to noises.

Benefits of mems varactor

- Low tuning voltage.
- High, stable tuning range.
- High quality factor.
- Low harmonic distortion.
- May be simultaneously fabricated with other IC-compatible passive or active components.

Proposed structure

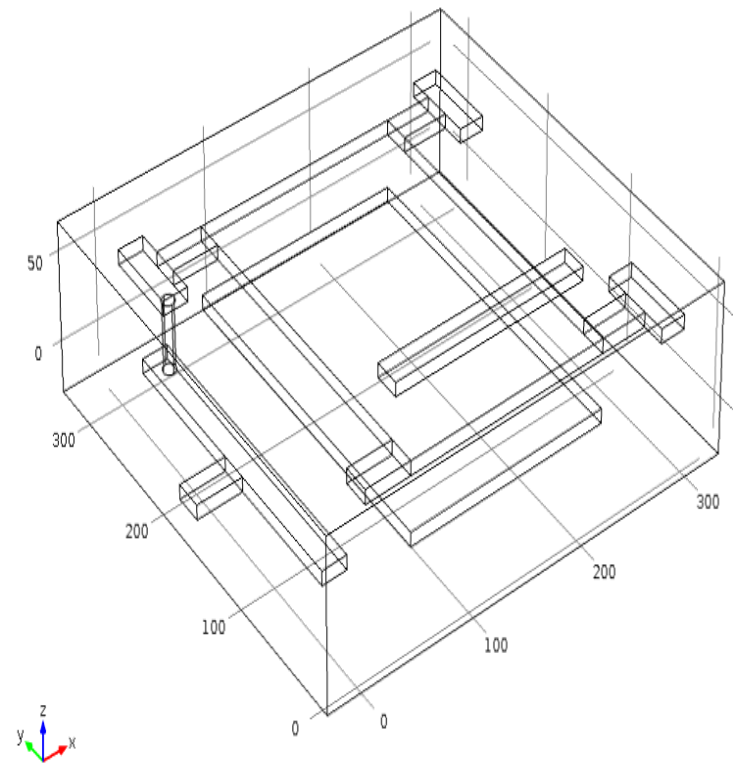
Design parameters

COMSOL
MULTIPHYSICS

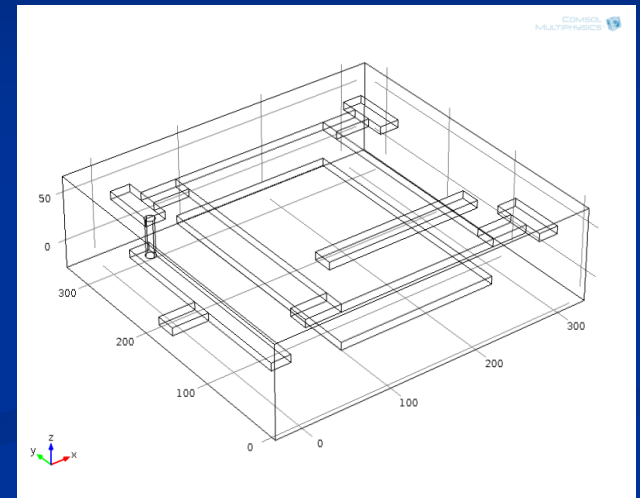
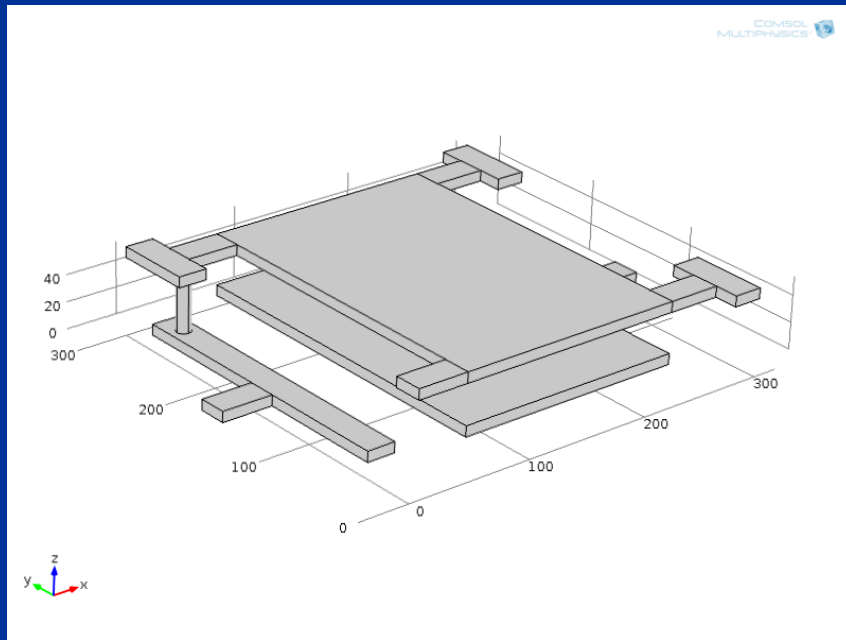
NAME	LENGTH			AXIS BASE POINT		
	X	Y	Z	X	Y	Z
BLK1	22	60	8	0	240	46
BLK2	40	22	8	22	259	46
BLK3	176	262	8	62	19	46
BLK4	40	22	8	238	259	46
BLK5	22	60	8	278	240	46
BLK6	40	22	8	238	19	46
BLK7	22	60	8	278	0	46
BLK8	40	22	8	22	19	46

y
x

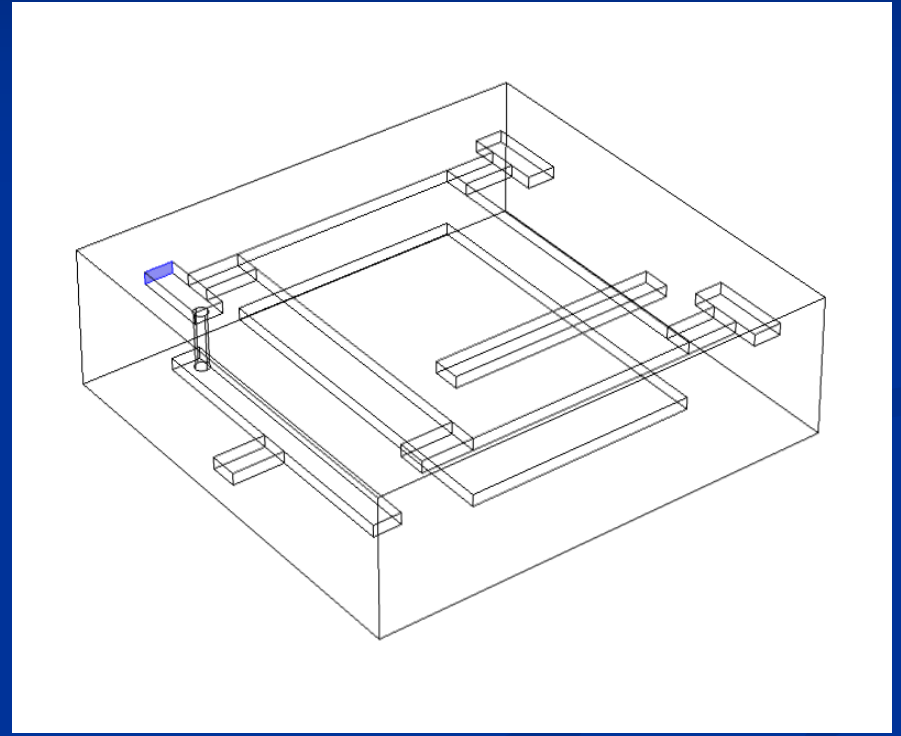
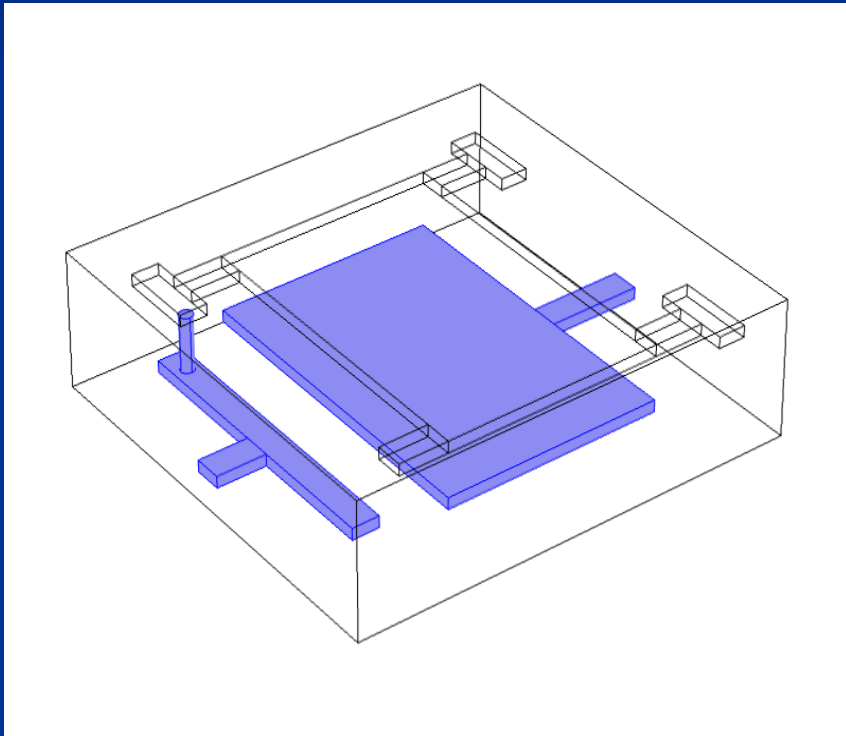
COMSOL
MULTIPHYSICS



Geometry



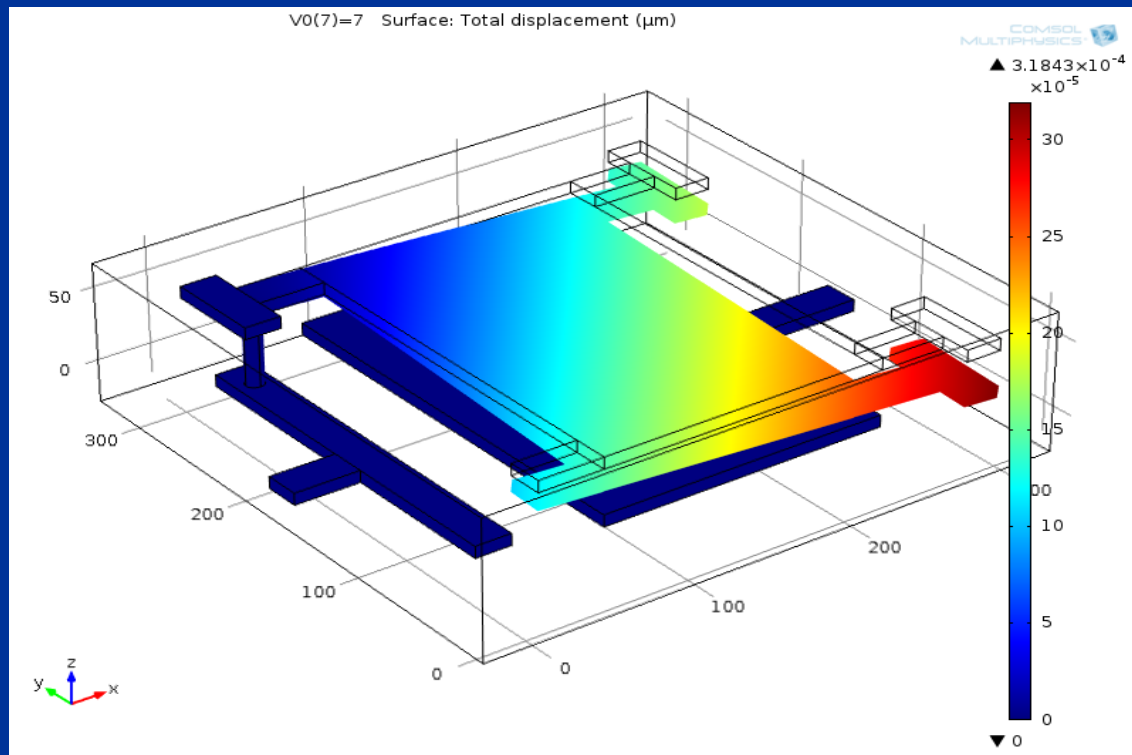
Fixed constraints



Simulation and results

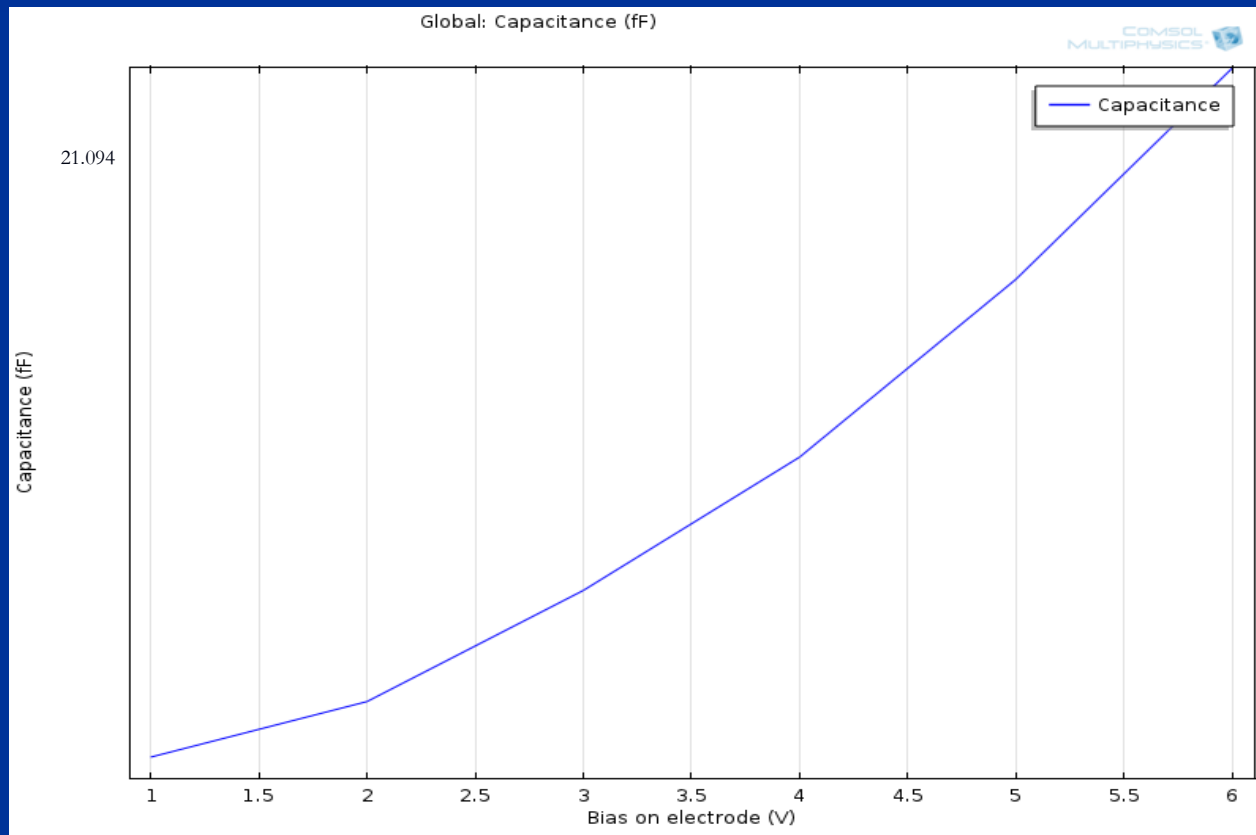
- Electromechanics Physics.
- Voltage range:0-7 Volts
- Pull in voltage is approximately 7.5V

3D plot of the deformed suspended top plate after applying DC voltage



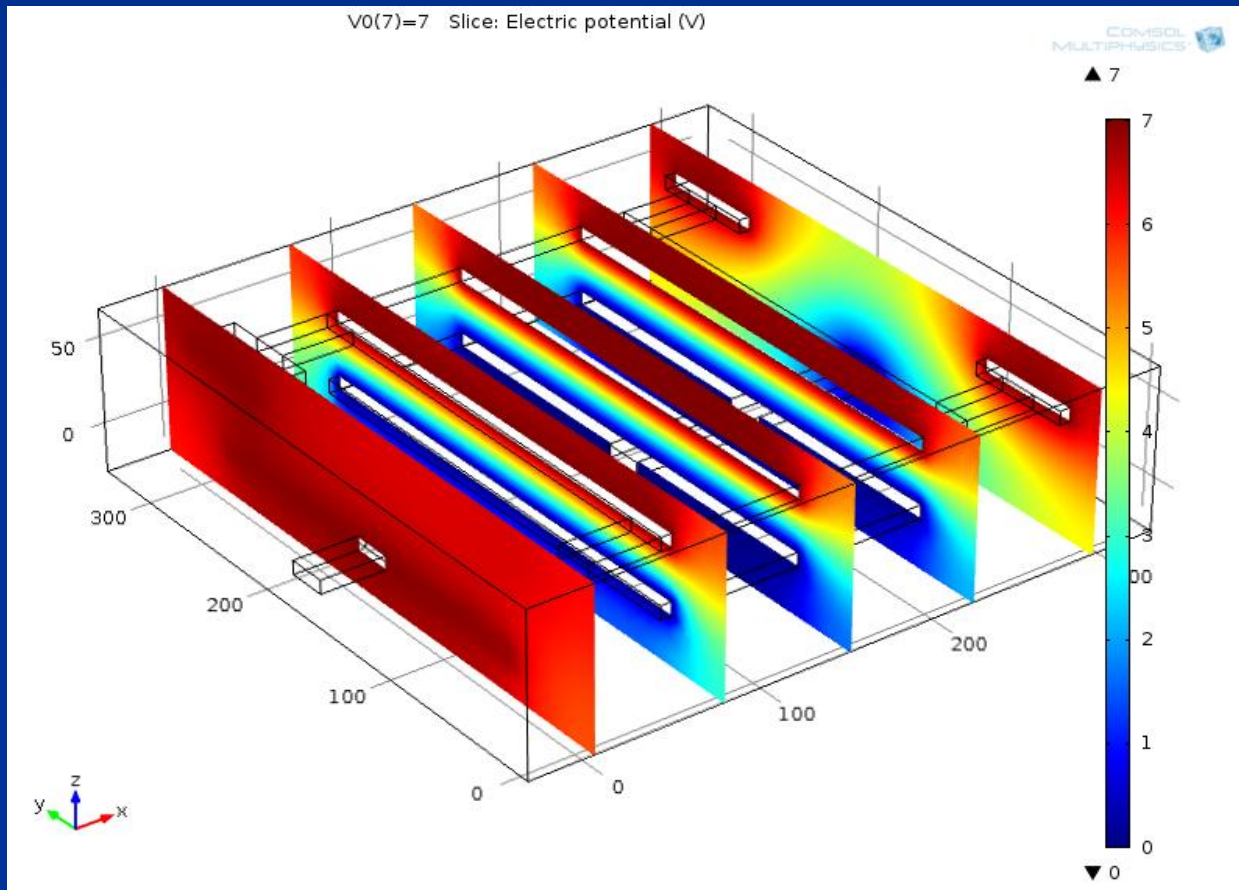
C-V characteristics

- Capacitance change for different applied voltages.
- Voltage: 0-7 volts



Electric potential profile

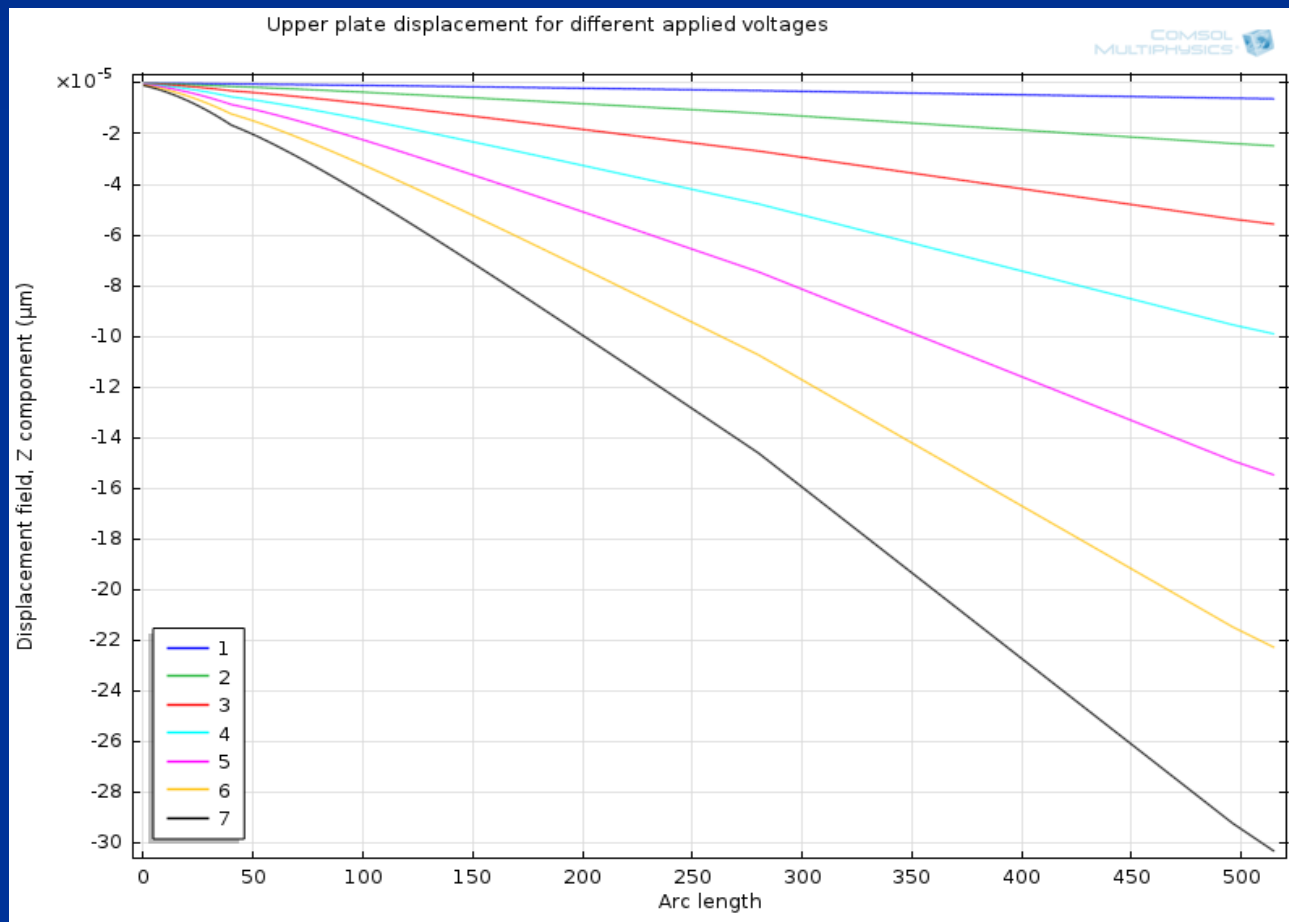
Under applied Voltage 7V



Displacement vs. Voltage Plot

Voltage applied: 0 to 7V

Maximum displacement = 38 μ m



Conclusion

- MEMS Varactor model for extended tuning range is developed.
- Model is simulated to obtain a operatable voltage range of 7V.
- Sudden change in the measured capacitance is around 7.5 Volts.
- Structure pull-in voltage: 7.5volts.
- Plate displacement: maximum $38\mu\text{m}$ (from $0\mu\text{m}$ to $38\mu\text{m}$).

References

- 1) en.wikipedia.com
- 2) Tunable MEMS Capacitor for RF Applications
Shriram H, Tushar Nimje¹, Dhruv Vakharia¹ 1BITS Pilani, Rajasthan, India
- 3) Tunable RF MEMS Capacitor for Wireless Communication
Xiuhan Lia, Yu Xiab, Jian Liub, Dongming Fangb, Haixia Zhangb, Beijing Jiaotong University.
- 4) RF MEMs Variable Capacitors for Tunable Filters, Charles L. Goldsmith, Andrew Malczewski, Zhimin J. Yao, Shea Chen, John Ehmke, David H. Hinzl.
- 5) <http://www.comsol.co.in/community/forums>

THANK YOU