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A Study on impetus to explore the MEMS based Microwave for FET and MOSFET

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Abstract-Microwave switches play a significant role in a very microwave radar technology additionally as in communication systems. They're utilized in a range of applications, like in satellite payload for choice between main and redundant subsystems, in digital electrical device and part shifters for choosing reference & attenuating/phase-shifting ways, and in transmit-receive modules with common antenna. Microwave switches are often enforced victimization FET, PIN diode, waveguides, etc. Lately, MEMS based mostly switches have exhibited terribly low insertion loss isolation in microwave frequencies. Like solid state switches, MEMS based switches will simply be integrated with GaAs or Si based high performance MMICs. MMIC technology to form compact multifunctional parts for high-value applications MEMS Switch style. The most benefits of RF-MEMS switches over alternative change devices like transistors and PIN diodes, are low insertion losses (typical zero.2 dB – 0.5 dB), high isolation (typical forty five dB), and high dimensionality over an outsized information measure. GaAs pHEMT is advantageous for high speed analogue ICs, such as laser driver and transimpedance amplifier used in OC-192(10Gbps) or OC-768(40Gbps), the wide-band fiber communication. This approach provides a wide flexibility in the circuit designing system.

Keywords: MEMS, FET, PIN diode, SPDT switch, RF-MEMS switches, MEMS-MOSFET hybrid switch

I. INTRODUCTION

Batteries are widely used to power wireless sensor nodes and mobile devices, but they require periodic exchange or recharge. Instead of batteries or as an energy source for recharge, the harvested energy from light, heat, or vibration available in our environments can be utilized for low average power electronic devices that have a very low (< 1%) operation duty cycle. With the ever increasing demand for tiny and a lot of reliable systems, attention has been targeted for a few time on exploiting the advances in element process to fabricate a number of the normally used parts on element.

The conception of fabricating small scale mechanical devices that may operate just like the ones created victimization standard technology has been of interest for a few times within the semiconductor trade. It's solely within

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the recent past that this has gained momentum owing to the strides created in element fabrication technology. Micro electro mechanical systems or a lot of normally referred to as MEMS was the result. MEMS have several applications like accelerometers, pressure sensors, and optical switches. Though this technology has been used for a few times in these fields, it's solely recently that job has been wiped out the sector of RF MEMS switches. RF MEMS switches are getting used to change power between the transmitter and therefore the receiver or in antenna.

II. MEMS Switches

The drive for MEMS switches for RF applications had been within the main as a result of the very linear characteristics of the flip an outsized vary of frequencies. MEMS RF switches area unit obtainable in two configurations, series and shunt. as a result of the name suggests, a series switch is serial with the power line and either closes or opens the road to point out it ON or OFF .

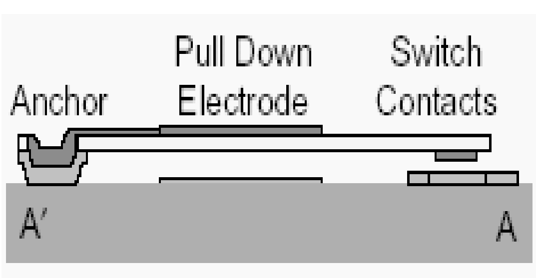

Fig 1 MEMS Series Switch

In associate extremely shunt switch the flexibility line is sandwiched between a pair of ground lines so the switch activates to short the flexibility on the signal line to very cheap therefore preventing the flexibility from going past the switch (Figure 2). In associate extremely series switch the contacting surface is usually at the highest of a severally supported cantilever beam with an impression conductor to a lower place the beam. By applying a voltage to the management conductor the beam area unit usually force right right down to complete the affiliation between a pair of conductors. A series switch area unit usually additional classified into broad-side or in-line looking forward to the plane of propulsion. among the in-line Figure 2 Series switch [1]

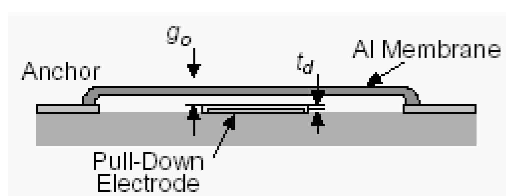

Figure 2. Shunt switch

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configuration the propulsion plane is co-linear with the cable (Figure 3).

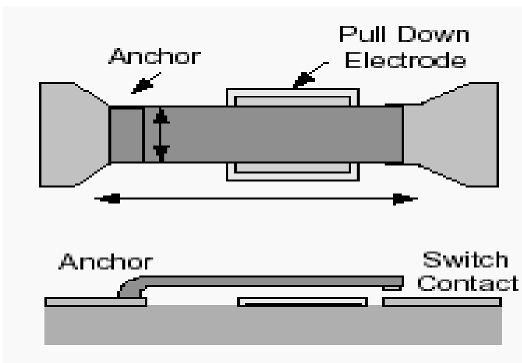
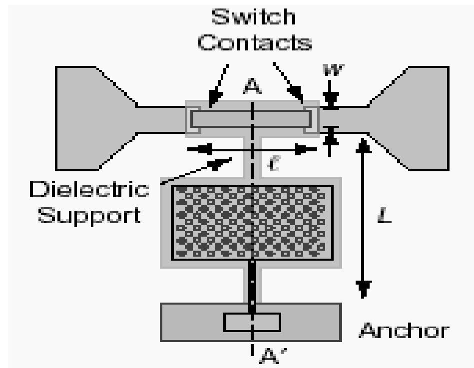


Fig 3 Series switch

In associate inline shunt switch the beam is clamped at every the ends and so the management plate pulls down the beam once a potential is applied to it. This ensures that the signal finds a shorter path to rock bottom and does not depart this world to the following network. among the broad-side configuration the propulsion plane (A-A') is perpendicular to the cable (Figure 4).



MEMS switches can also be classified supported the propulsion mechanisms into categories like static, magnetism and thermal. static ways that settle for the essential columbic force of attraction between two oppositely charged plates. this is often the most effective of all the ways that as a result of it does not involve any special method steps that do not appear to be supported by ancient CMOS method (Figure 5). magnetism ways that of propulsion settle for aligning a magnetic material in AN extremely flux [2]. By dynamic the direction of the alignment the switch area unit usually turned or OFF. can be often a novel technique and has some blessings compared to alternative ways but wants special method involving magnetic materials

III. CIRCUIT OPERATION

For the primary demonstration, to simulate a chargeable battery, a 470 µF electrical

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condenser is employed as a electrical phenomenon load and a diode is enclosed to stop reverse discharge as shown in Fig. 4. As AN energy harvester, we have a tendency to use four star cells (with a complete size of fifty five millimetre × twenty seven mm) taken from business calculators.

Thermal propulsion involves pattern two materials with all completely different thermal enlargement coefficients [3]. Once the materials unit of measurement heated the beam bends far from the fabric with the higher thermal enlargement constant. Another thermal technique employs kind memory alloys 4]. These thermal ways that hasn't been terribly hip despite the latching properties owing to the required power consumption.

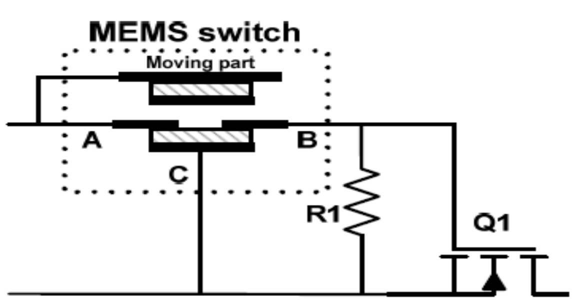

Fig. 5 Schematic diagram of the MEMS-MOSFET

The hybrid switch ,A and B are signal lines they're connected nonparallel, generating AN open-circuit voltage of fifteen V on AN workplace table beneath indoor lighting conditions (300 lux). Since the output power from the star cells during this condition is extremely low, it ought to be first of all accumulated.

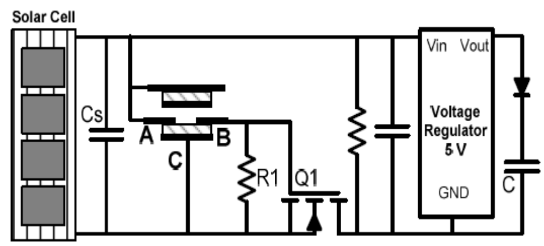

Fig. 6. A capacitor (rechargeable battery) charging circuit employing MEMS-MOSFET switch.

III. OPERATION

The switch consists of 3 stacked electrodes. the center conductor is movable and therefore the high and bottom electrodes add a push pull manner.

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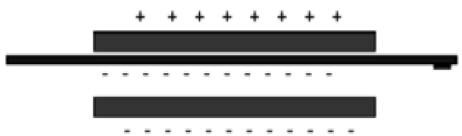

Fig 7 Switch operation

IV. SIMULATIONS

FEA (finite component analysis) consists of a laptop model of a fabric or style that's loaded and analyzed for specific results. Mathematically, the structure to be analyzed is divided into a mesh of finite sized parts of easy form. at intervals every component, the variation of displacement is assumed to be determined by easy polynomial form functions and nodal displacements. Equations for the strains and stresses ar developed in terms of the unknown nodal displacements.

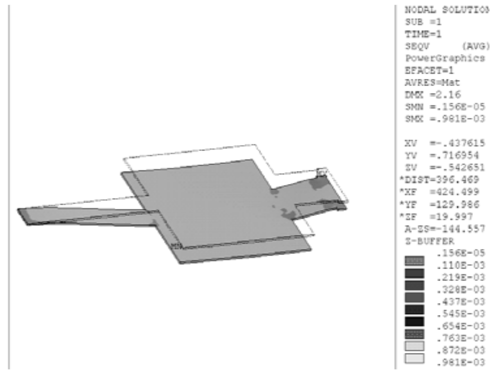

Fig 8 Snapshot of switch showing stresses across it

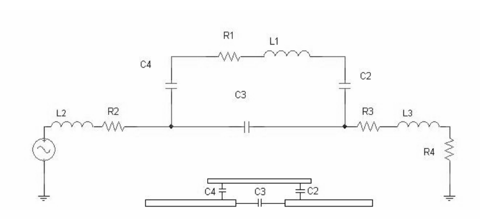

Fig 9 Electrical equivalent of the switch in OFF state

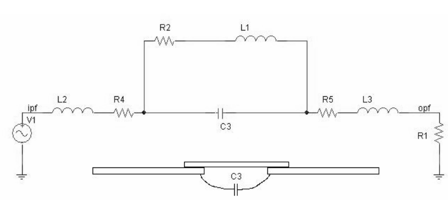

Fig 10 Electrical equivalent of switch in

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ON state

V. HEMT OPERATION

The operation of the HEMT is somewhat completely different styles of transistor and as a result it's ready to provides a greatly improved performance over the standard junction or MOS FETs, and particularly in microwave radio applications. Electrons from the n-type region move through the Bravais lattice and lots of keep close to the hetero-junction. These leptons for a layer that is only 1 layer thick forming what is cited as a pair of dimensional lepton gas. Among this region the electrons are ready to move freely as a results of there don't seem to be any completely different donor electrons or various things thereupon electrons will collide and so the standard of the electrons at intervals the gas is extraordinarily high.

A bias applied to the gate designed as a schottky barrier diode is used to modulate the number of leptons at intervals the channel designed from the 2 D lepton gas and in turn this controls the conductivity of the device. this might be compared to the extra ancient styles of transistor where the dimension of the channel is changed by the gate bias.

VI. CONCLUSIONS

All the simulations purpose to the actual fact that a RF MEMS switch that may be motivated with a CMOS compatible voltage whereas handling RF powers within the order of many watts and having latching properties is possible.

REFERENCES

[1] Rebeiz, G.M., Muldavin, J.B.," RF MEMS switches and switch circuits", IEEE Microwave Magazine , Volume: **2** Issue :**4,** pp: 59 –71, Dec 2001

[2] Junho Joung, Jun Shen, Grodzinski, P., IEEE Transactions on Magnetics,Volume: **36,** Issue: **4**, pp2012 – 2014, 2000

[3] Blondy, P., Cros, D., Guillon, P., Rey, P., Charvet, P., Diem, B., Zanchi, C., Quoirin, J.B." Low voltage high isolation MEMS switches", Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems, 2001. , pp: 47 –49, 2001

[4] Lai, B.K., Kahn, Harold, Phillips, S.M., Heuer, A.H., Quantitative Phase Transformation Behavior in TiNi Shape Memory Alloy Thin Films, Journal of Materials Research, Vol. 19, No. 10, pp2822-2833, 2004.

[5] Balaraman,D., Bhattacharya,S.K., Ayazi,F., Papapolymerou,J.," Low cost low actuation voltage copper MEMS switch", Microwave Symposium Digest, 2002 IEEE MTT-S International, Volume: 2 , pp: 1225 - 1228, 2002

[6] Tai-Ran Hsu, MEMS and micro systems design and manufacturing, McGraw-Hill, Boston, 2002

[7] Strohm, K.M., Schauwecker, B., Pilz, D.; Simon, W., Luy, J.-F.," RF-MEMS switching concepts for high power applications", Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems, 2001., pp: 42 –46, 2001

[8] Pacheco, S.P., Katehi, L.P.B., Nguyen, C.T.- C.," Design of low actuation voltage RF MEMS switch", Microwave

Symposium Digest., 2000 IEEE MTT-S International,Volume:1, pp: 165 -168, 2000

[9] Lakamraju, N., Kim, B., Phillips, S.M., Low Voltage Actuated High Power RF MEMS Switch, Proceedings of the SPIE MEMS, MOEMS and Micromachining, Vol. 54, pp: 193-201, 2004

[10] Daniel Hyman and Mehran Mehregany," Contact Physics of Gold micro contacts for MEMS switches" Proceedings of the Fortyfourth IEEE Holm Conference on Electrical Contacts, pp:133 – 140, 1998.

[11] R. Amirtharajah and A. P. Chandrakasan, "Self-powered signal processing using vibration-based power generation," IEEE J. Solid-State Circuits, Vol. 33, No. 5, pp. 687-695, May 1998.

[12] C. O. Mathúna, T. O'Donnell, R. V. Martinez-Catala, J. Rohan, and B. O'Flynn, "Energy harvesting for long-term deployable wireless sensor networks," Talanta, Vol. 75, No. 3, pp. 613-623, May 2008.

[13] N. Kong and D. Ha, "Low-power design of a self-powered piezoelectric energy harvesting system with maximum power point tracking," IEEE Trans. Power Electron., Vol.27, No. 5, pp.2298-2308, May 2012.

[14] G. D. Szarka, B. H. Stark, and S. G. Burrow, "Review of power conditioning for kinetic energy harvesting system," IEEE Trans. Power Electron., Vol.27, No. 2, pp.803-815, Feb. 2012.

[15] S. Cheng, R. Sathe, R. Natarajan, and D. P. Arnold, "A voltage-multiplying self-powered AC/DC converter with 0.35-V minimum input voltage for energy harvesting applications," IEEE Trans. Power Electron., Vol.26, No. 9, pp.2542-2549, Sep. 2011.

[16] Y. Sun, N. H. Hieu, C-J Jeong, S-G Lee, "An Integrated High-Performance Active Rectifier for Piezoelectric Vibration Energy Harvesting System," IEEE Trans. Power Electron., Vol.27, No. 2, pp.623-627, Feb. 2012.

[17] G.-B. Chung and K. D. T. Ng, "Analysis of an AC/DC Resonant Pulse Power Converter for Energy Harvesting Using a Micro Piezoelectric Device," Journal of Power Electronics, Vol. 5, No.4, pp.247-256, Oct. 2005.

[18] S. Roundy, P.K. Wright, and J. M. Rabaey, Energy Harvesting for Wireless Sensor Networks, Kluwer Academic Publishers, Chap. 1, 2003. (1) R. Hadaway, et.al: GaAs MANTECH Technical Digest, p.13 (1999)

[19] T.Ohshima, R.Shigemasa, M.Sato, M.Tsunotani and T.Kimura: Solid-State Electron. 43, p.1519 (1999)

[20] A.Nishino, T.Ohshima, M.Tsunotani, S.Seki and T.Kimura: OFC Technical Digest, p.365 (1999)

[21] H.Ikeda, T.Ohshima, M.Tsunotani, T.Ichioka and T.Kimura: IEEE J. Solid-State Circuits, 36, p.1303 (2001)