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# Design of GNRFET based Static Random Access Memory for IoTs in Aeronautical Applications

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**Abstract:** In this paper, the Static Noise Margin (SNM) and Power consumption of SRAM at different voltage supply and temperatures of Static Random Access Memory for IoTs utilizing Energy efficient GNRFET Technology is simulated using hspice. Further, the Simulation of various Waveforms of the GNRFET SRAM have been presented. SNM is present in SRAM cell which is effect the stability in read operation of the SRAM cells. SRAM cell stability analysis is a based on Static Noise Margin (SNM) investigation when in read mode.. The SRAM cell SNM during read operations analyzing various alternatives to improve cell stability.. The role of GNRFET improves its power efficiency and speed which play vital role in Aeronautical Engineering for various IoT applications. SNM is 6.7@1V, Average Power is 2.24@1V, SNM Is 2.43@45ºC, and Average Power is 1.25@45ºC.

**Index Terms:** GNR, GNRFET, Power Consumption, Cell Ratio, CMOS, Pull-up Ratio, SNM), Nano-electronic.

## I. INTODUCTION

The power consumption is key consideration in system design as the demand for the IoT devices and embedded systems continuously increases day by day [1- 2]. The on-chip caches can decrease the speed gap between the processor and main memory. These on-chip caches are usually realized by SRAM cells. The write power is generally larger than the read power due to large power dissipation in driving the cell bit lines to full swing. The power dissipated in bit-lines represents 70 per cent of the total SRAM power consumed in write operation. Numerous procedures have been projected to reduce the write power consumption by dropping the voltage swing level on the bit lines in the memory. It is possible to improve cell stability during read operations while reducing word line voltage by SNM [8-10].

This paper is divided into four sections first section covers introduction with second one the GNRFET and the third one simulation and analysis and finally discussion is elaborated in section four just before references.

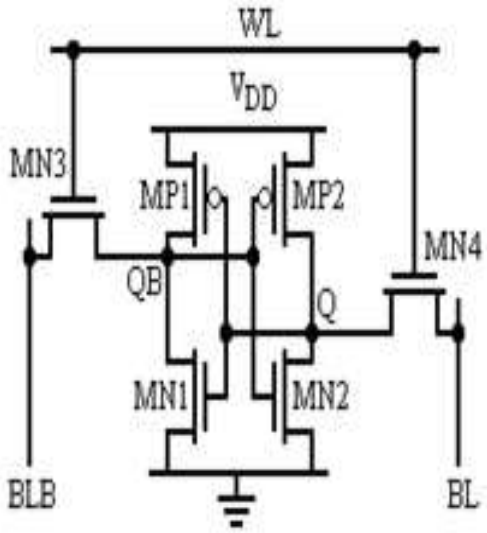


Figure 1: CMOS SRAM Cell [2]

## II- GRAPHENE NANO-RIBBON FIELD-EFFECT TRANSISTOR (GNRFET)

Graphene-based technology offers promising solutions to the performance challenges faced by conventional silicon technology in IoT devices. Graphene's exceptional electrical conductivity, high carrier mobility, suitability, and flexibility

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for high-frequency and high-temperature can significantly enhance the speed and efficiency of integrated circuits. However, carbon nanotubes, graphene sheets can be produced at wafer scale, facilitating integration with existing CMOS manufacturing processes [7, 9, 12]. The graphene nanoribbon field-effect transistor (GNRFET), which utilizes narrow strips of graphene as the channel material, represents a significant advancement in nanoelectronics. GNRFETs, with their reduced size and improved electrostatic control, can offer higher performance and better EDP performance compared to conventional CMOS transistors. GNRFET model was designed for IoT devices, where each device may have one or more Graphene Nano-Ribbons (GNRs) [3-6].

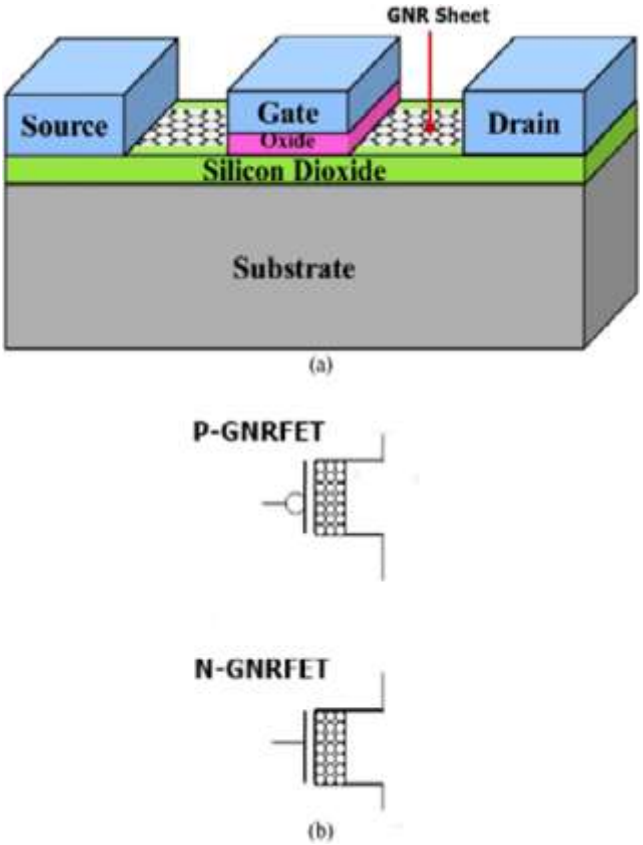


Fig. 2. (a) GNRFET Structure (b) GNRFET Symbol [3].

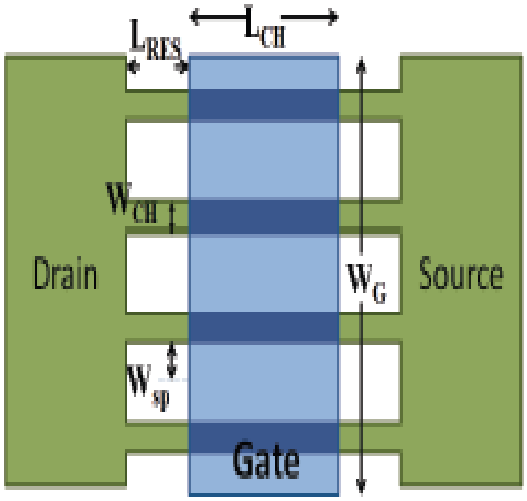


Fig. 3. The structure of a four-ribbon MOSFET-type GNRFET. A common drain and a common source are shared by the ribbons [3].

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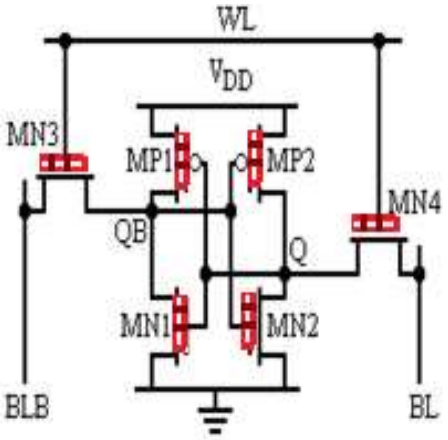


Figure 4: Proposed GNRFET based SRAM cell

## III- SIMULATION AND ANALYSIS

Static Noise Margin of the SRAM cell depends on the cell ratio, supply voltage and also pull up ratio. For stability of the SRAM cell, good SNM is required that is depends on the value of the cell ratio, pull up ratio and also for supply voltage. Cell ratio is the ratio between sizes of the driver transistor to the load transistor during the read operation. Pull up ratio is also nothing but a ratio between sizes of the load transistor to the access transistor during write operation [11].SRAM cell stability analysis is typically based on Static Noise Margin (SNM) investigation and SNM affects both read and write margin. This work represents the simulation of SRAM cells at different voltages and temperatures. All simulations of SRAM cells have been carried out at HSPICE tool.

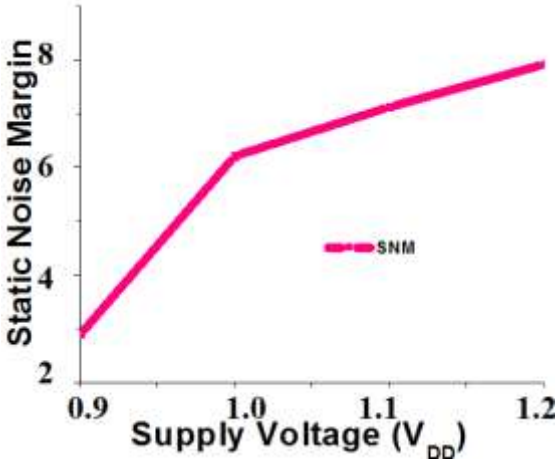


Figure 5 : SNM Vs Supply Voltage for Proposed GNRFET based SRAM

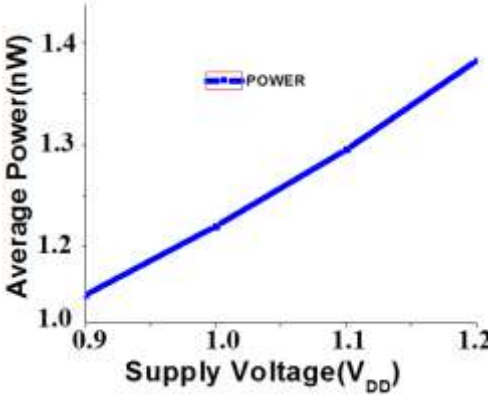


Figure 6: Average Power Vs Supply Voltage for Proposed GNRFET based SRAM

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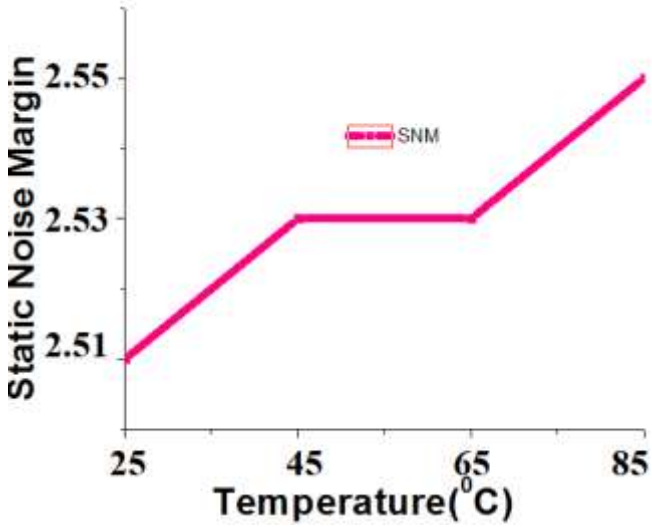


Figure 4: SNM Vs Temperature for Proposed GNRFET based SRAM

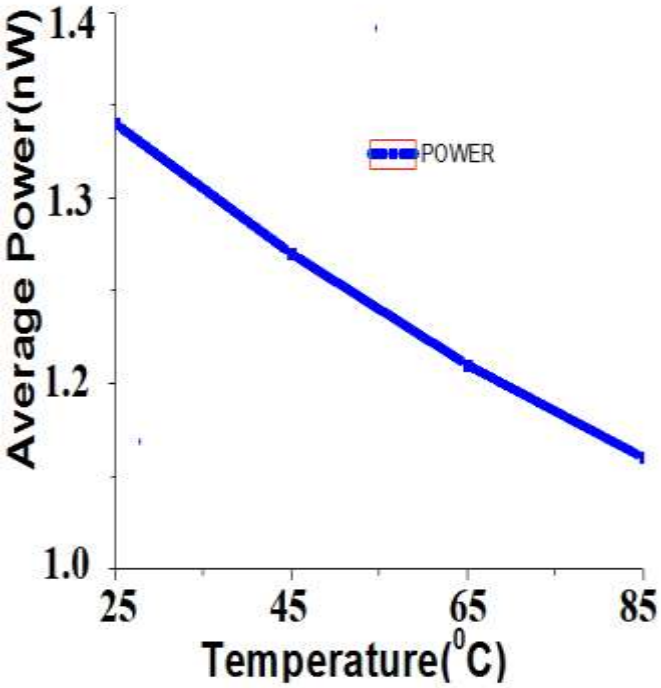


Figure 7: Average Power Vs Temperature for Proposed GNRFET based SRAM

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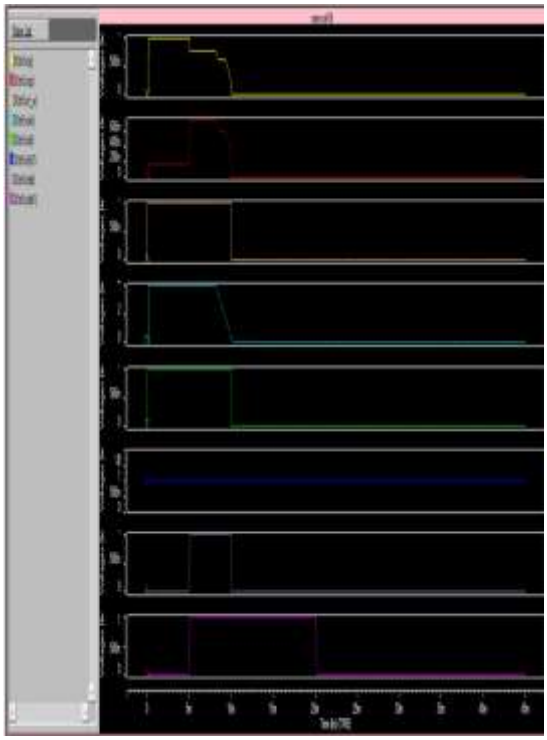

Figure 8: Waveforms at different node for Proposed GNRFET based SRAM

Table 1. Summary of the GNRFET Model used.

| **Device Types** | n-type/p-type GNRFET |
|---|---|
| **Device Dimensions**: | |
| Channel Length | 45nm |
| Channel Width (Minimum) per GNR | 381.5nm |
| Number of GNRs / device | 4 |
| Oxide Thickness | 2.5nm |
| Line Edge Roughness | 20% |
| Doping Fraction | 0.001 |

Table 2: Optimized Values of proposed SRAM using GNRFET

| **S. No.** | **Parameter** | **Value** |
|---|---|---|
| 1 | SNM | 6.7@1V |
| 2 | Average Power | 2.24@1V |
| 3 | SNM | 2.43@45ºC |
| 4 | Average Power | 1.25@45ºC |

## IV CONCLUSION

In the Proposed GNRFET based SRAM, the Static Noise Margin analysis increasing with both supply voltage and temperature. The Power consumption is increasing with supply voltage but decreasing with temperature. The supply voltage also play vital role in SRAM cell stability during read mode of SRAM cell also by lower power supply may

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reduce the leakage current for all cells in the memory. The world-line voltage, the bit-line voltage and the power-supply voltage all three voltages could be used to improve the SNM. GNRFET reduces delay and improves speed and is highly efficient in terms of power dissipations, a key need of future Aeronautical Engineering and IoT applications. SNM is 6.7 at 1V, Average Power is 2.24 at 1V, SNM is 2.43 at 45$^{o}$C, and Average Power is 1.25at 45$^{o}$C. These performance measuring parameters are sufficient for aeronautical applications in future IoT Devices.

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