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## Design and Simulation of Precharge-Free Content-Addressable Memory (PCAM) Cell.

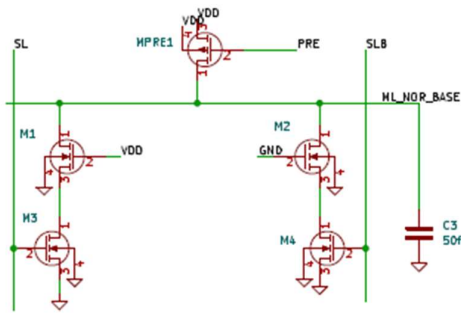
### Theory/Description :

The Content Addressable Memory (CAM) plays a pivotal role in achieving faster data retrieval, although conventional designs require very high-powered external clocks for precharging matchlines. In order to circumvent the problem of high-powered clocks, Precharge Free Content Addressable Memories (PCAMs) make use of internal data present in cells for self-precharging. But in conventional N-PCAMs, NMOS pass-transistors have been used for performing the XNOR function, which results in a drop in the threshold voltage, causing the evaluation node to become weak "1," hence making the search process very slow.

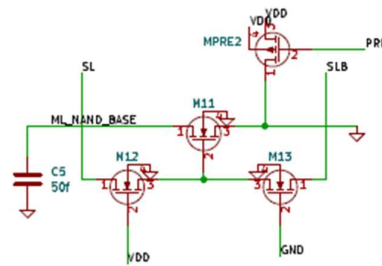
In this research work, the Proposed TG-PCAM architecture replaces the NMOS pass-transistor by a transmission gate, which utilizes parallel NMOS and PMOS transistors. This results in the perfect passing of a logic "1" with full  $V_{DD}$ , which helps in fast activation of the matchline evaluation transistor.

## Circuit Diagram(s) :

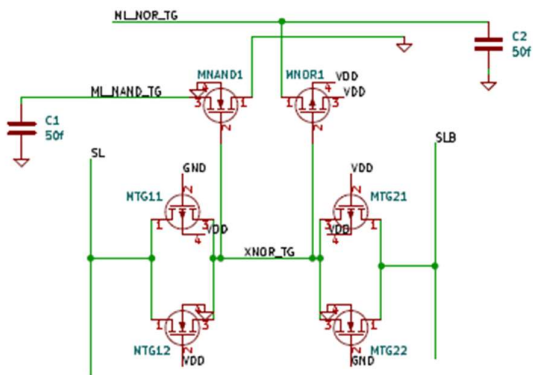
### NOR CAM cell



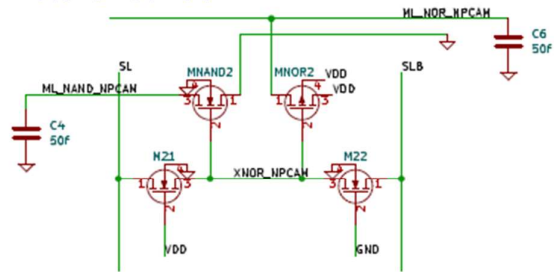
### NAND CAM cell



### TG PCAM cell



### NPCAM cell



## Results :

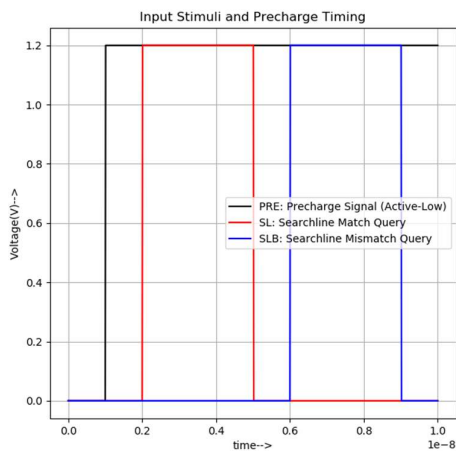


Figure 1 **Transient Analysis of Input Stimuli.** Validates the correct timing and scheduling for the Precharge and Searchline queries.

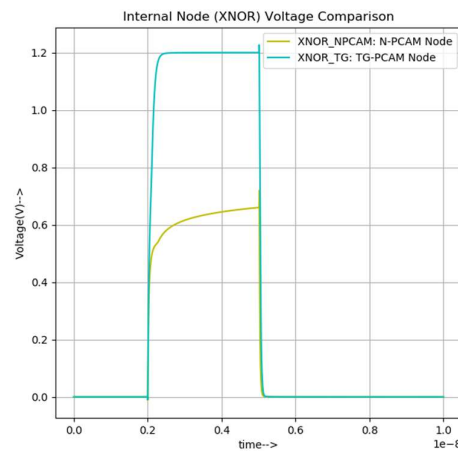


Figure 2 **XNOR Node Voltage Comparison.** Proves the TG-PCAM passes a full 1.2V, successfully eliminating the N-PCAM's threshold voltage drop.

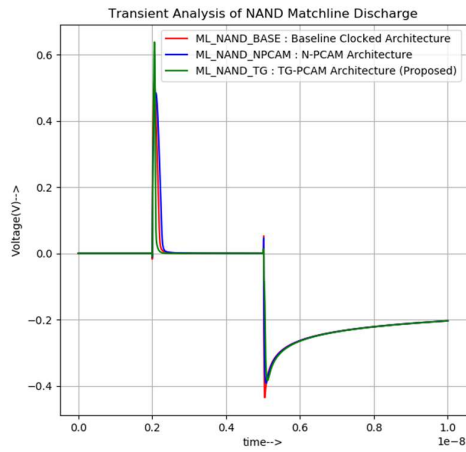


Figure 3 **NAND Matchline Outputs**. Compares overall discharge speeds across all architectures driving a 50fF capacitive load.

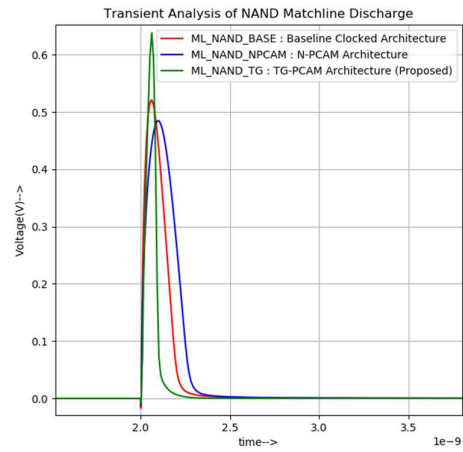


Figure 4 **High-Resolution Matchline Discharge**. Demonstrates the TG-PCAM achieves the fastest matchline discharge rate during the evaluation phase.

Transient analysis verifies that the TG-PCAM architecture can completely remove the threshold voltage drop from the N-PCAM structure (Figures 2). Through supplying full 1.2V supply voltage for the evaluating transistor, the TG-PCAM circuit provides the faster matchline discharge time with the 50fF load (Figures 3 and 4).

## References :

- Ramiro Taco, Esteban Garzón, Robert Hanhan, Adam Teman, Leonid Yavits, and Marco Lanuzza, "Designing Precharge-Free Energy-Efficient Content-Addressable Memories," pp. 2303–2314. <https://ieeexplore.ieee.org/abstract/document/10723100/>
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