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"IMPLEMENTATION OF LOW POWER TIQ BASED FLASH ADC"

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Abstract: This paper presents an 8-bit Flash ADC design based on Threshold Inverter Quantization (TIQ) comparators, replacing the traditional resistive ladder to achieve reduced area and enhanced speed. SAPON technology is employed to significantly lower power consumption. The design is implemented and simulated in 180nm CMOS technology using TANNER EDA, demonstrating improved efficiency suitable for high-speed, low-power applications.

Keywords: 8-bit Flash ADC, TIQ comparator, SAPON technology, 180 nm CMOS, Tanner EDA, Resistive-ladder replacement

I. INTRODUCTION

The growing demand for compact, high-speed, and energy-efficient signal conversion has driven innovation in ADC architectures. This paper proposes an 8-bit Flash ADC using Threshold Inverter Quantization comparators and SAPON technology in 180 nm CMOS via TANNER EDA to achieve reduced area, low power, and high-speed operation.

II. SYSTEM OVERVIEW

The paper describes an 8-bit Flash ADC implemented with Threshold Inverter Quantizer (TIQ) comparators and a 2:1 MUX-based encoder. 255 TIQ comparators are employed to identify 256 discrete voltage values, constructing a thermometer code out of the analog input. All TIQ comparators are implemented in CMOS inverters with carefully designed threshold voltages. The SAPON approach is implemented inside the TIQ comparator array to minimize power dissipation by selectively enabling only necessary paths while in operation.

The output of the thermometer is input to an array of 2:1 multiplexers to create a small and efficient encoder that reduces the sequence to an 8-bit binary output. The binary output is equivalent to the digital representation of the input voltage.

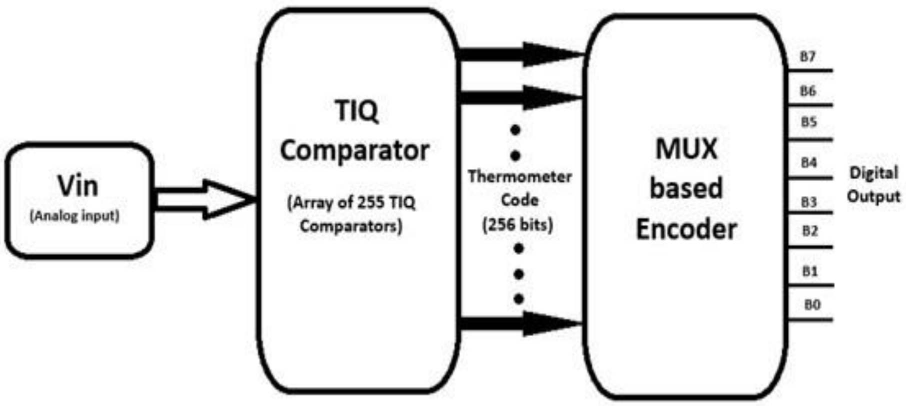

Fig. 1. Overall System Workflow

The implementation, in 180nm CMOS technology, provides high speed, low area, and energy-efficient analog-to-digital conversion—suited for low-power, high-speed applications in portable communication systems.

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Block Diagram Explanation

The three main blocks of the system are:

Analog Input (Vin): Continuous analog voltage provided as input.

TIQ Comparator Array (255 comparators): All the comparators provide '1' or '0' depending on whether Vin is greater than or lesser than its specific threshold. The SAPON technique is utilized here to enhance power efficiency.

2:1 MUX-based Encoder:

Translates thermometer code to an 8-bit binary output via a cost-effective array of multiplexers. provides real-time remote maneuverability in addition to autonomous functions.

III. IMPLEMENTATION

An 8-bit Flash ADC using TIQ comparators and MUX2:1-based encoder has been presented in this paper, in order to harness the advantage of power savings with the SAPON technique. The design is realized in 180nm CMOS technology in the 1.8 V line supply.

A. SAPON Technique

Within the comparator array of the TIQ, SAPON is adopted to save power on a dynamic basis. Only those comparators necessary for a given input range are enabled, while the rest get disabled in idle states, thus cutting down static and dynamic power consumption considerably with no performance trade-offs-an interesting case of design for large comparator arrays in superscalar Flash ADCs.

B. TIQ Comparator Design

Each TIQ comparator is implemented using a CMOS inverter with asymmetric transistor sizing for a given switching threshold (V_{th}). By methodically varying the W/L ratio of both PMOS and NMOS devices, 255 comparators are engineered to detect 256 different voltage levels over the input range (0–1.8V). The analog input is then simultaneously applied to all the comparators, producing a thermometer code at the output with logic ‘1’ for Vin > V_{th} and ‘0’ otherwise.

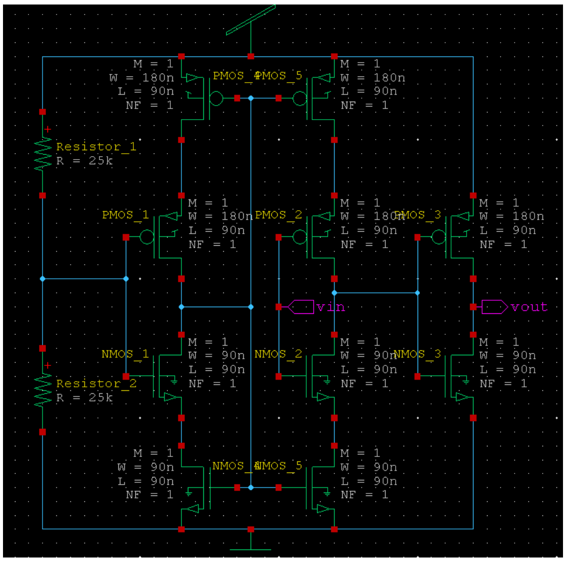

Fig 1 TIQ comparator Design

C. 2:1 MUX-Based Encoder Schematic

The binary conversion of thermometer code is done through a certain structured array of 2:1 multiplexer. Each MUX has two inputs (A and B), a select line (S), and one output (Y), such that:

$$Y = \overline{S} \cdot A + S \cdot B$$

The multiplexers are cascaded in stages to yield the final 8-bit binary output. This particular encoder design emphasizes speed and uses less area for binary generation. Leakage-reduction techniques such as LECTOR logic may also be used if efficiency is desired.

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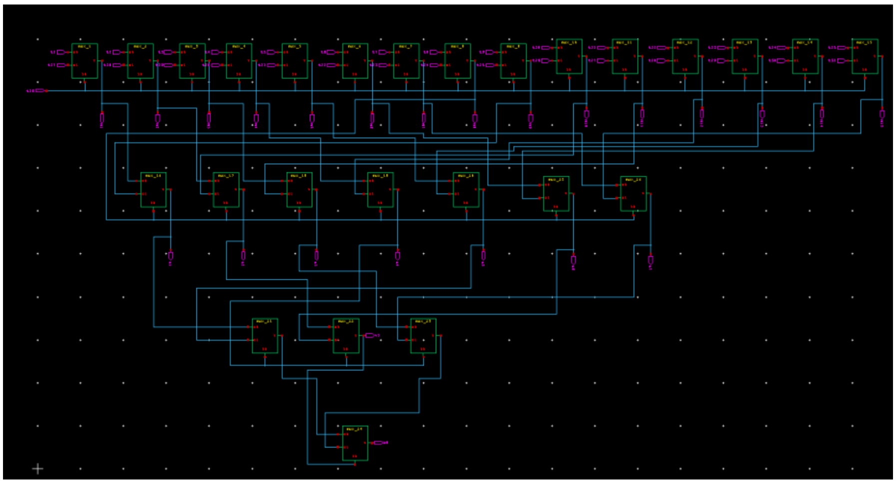

Fig 2 the 2:1 MUX Based encoder

D. **Resolution: 8 bits (256 quantization levels)**

The operating frequency of the system reaches 500 MHz. The system's bandwidth covers an area of 400 MHz. The technology implemented here is 180nm CMOS. The operational system requires 1.8V as its supply voltage. Power optimization for the implementation uses the SAPON technique within TIQ array. The design of this implementation yields fast analog-to-digital conversion with minimal power requirements and minimal space utilization which is suitable for communication systems as well as real-time embedded processors and portable low-power devices. The final 8-bit binary output is formed through a series of cascaded multiplexers.The encoder design creates binary signals quickly while occupying minimal space.

IV. RESULTS

The 2:1 MUX schematic was successfully able to implement and able to integrate with the comparator.

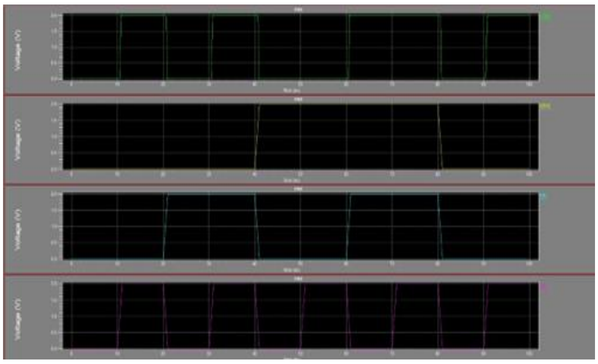

Fig 3: Waveform of the 2:1 MUX.

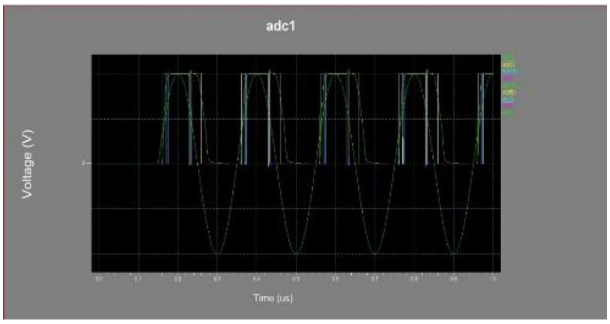

Fig 4**:** Waveform of the integrated ADC .

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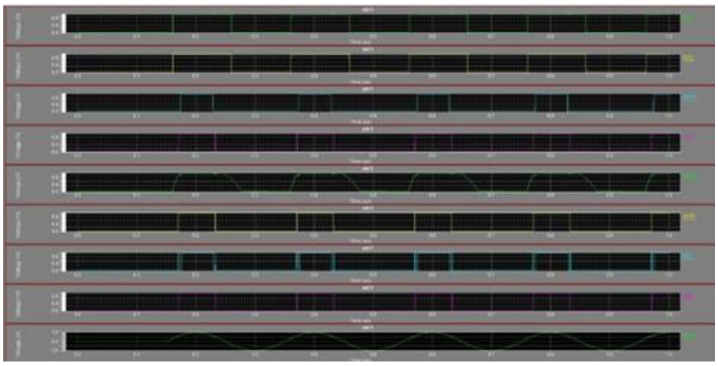

Fig 5: Waveform of the integrated ADC with separated waveform.

```
* BEGIN NON-GRAPHICAL DATA

Power Results
v2 from time 0 to 1e-006
Average power consumed -> 9.385105e-003 watts
Max power 1.328611e-002 at time 9.69625e-007
Min power 8.866637e-003 at time 5.46327e-007

* END NON-GRAPHICAL DATA

* BEGIN NON-GRAPHICAL DATA

MEASUREMENT RESULTS

delay = 3.8926e-009
    Trigger = 1.6667e-007
    Target  = 1.7056e-007

* END NON-GRAPHICAL DATA
*

* Parsing                        0.02 seconds
* Setup                          0.69 seconds
* DC operating point            14.16 seconds
* Transient Analysis           106.10 seconds
* Overhead                       0.75 seconds
* -----------------------------------------
* Total                        121.71 seconds

* Simulation completed

* End of T-Spice output file
```

Figure 6: Non graphical data.

V. CONCLUSION

The 8-bit flash ADC realized with TIQ comparators was successfully implemented and validated. CMOS inverters with input thresholds varying from one inverter to the other converted the analog input into a thermometer code without any additional references.

The thermometer code was then directed to a simple 2:1 MUX-based encoder to provide a binary output. The entire project served as a very good experience in understanding the concept of TIQ operation and, more broadly also, mixed-signal circuit design.

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