3-bit CMOS based TIQ comparator Flash ADC

Swagatika Meher
Odisha University of Technology and Research, Bhubaneswar, Odisha, India

***Abstract*— This study describes a 3-bit high-speed and low-power Flash Analog to Digital Converter. The conventional Flash ADC contains the resistor ladder network, comparator, and encoder. Power consumption is higher in typical Flash ADCs since resistor ladder networks are used. The Threshold Inverter Quantization (TIQ) comparator and mux-based encoding technique has been employed in 3-bit Flash ADC to get over this problem and speed up the conversion rate. These designs increase speed and reduce power consumption by employing simply a series of inverters and multiplexers.**

Keywords*— *Flash ADC, Low power, High speed, Threshold Inverter Quantization, Priority Encoder

[1] Reference Circuit Details and Waveforms

The conventional Flash ADC is depicted in Fig. 1 and is made up of a series of resistor ladder, comparator array, and encoder to convert thermometer code into binary code. For n-bit ADC, 2^n resistors in the resistors ladder and 2^n-1 comparators are used in the comparator array. The thermometer code produced by the comparator array can be encoded into binary code using a thermometer to binary code encoder. The encoder's output is the final output that corresponds to the analog signal provided at the input.

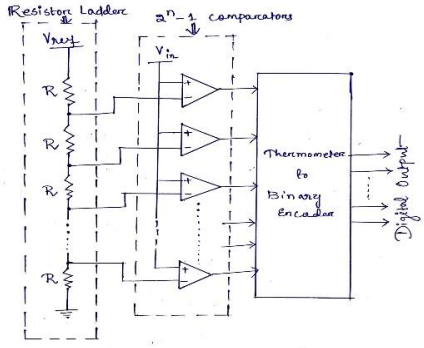

Fig.1: Schematic diagram of traditional Flash type ADC

Fig.2 shows a schematic diagram of TIQ comparator used in ADC. In analog section of 3-bit ADC, 2^n-1 comparators that is, 7 TIQ comparators have been connected parallelly using CMOS inverters.

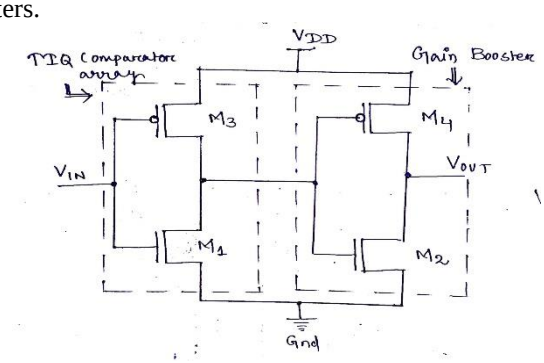

Fig.2: Schematic diagram of TIQ comparator

Fig.3 shows the proposed block diagram of TIQ based Flash ADC. The difference in TIQ technique is the resistive network is modified by the TIQ comparator. In TIQ technique, it uses two cascaded CMOS inverters as a comparator. While the second inverter serves as a gain booster, the first inverter internally creates switching voltage (V_S). As we adjust the size of CMOS, the cascading inverters produce various switching voltages internally which serves as reference voltages. The purpose of TIQ comparator is to transform an input voltage (V_{in}) toward logic '1' or '0' by estimating a reference voltage (V_{ref}) with the V_{in}. If $V_{in} > V_{ref}$, the comparator output is '1', otherwise '0'. This occurs when transistor width is altered while keeping the transistor length constant. The gain boosters create sharper thresholds for comparator outputs and offer a complete digital output voltage swing. The comparator outputs the thermometer code are turned to a binary code.

The more effective 8:3 MUX based priority encoder is employed in the digital section since it uses less power. It has '2^n' input lines and 'n' output lines. This encoder is designed using Verilog code, which is used to convert the thermometer code generated in the comparator to 3-bit binary code.

Fig.4 shows the waveforms of the proposed 3-bit Flash ADC using TIQ comparator.

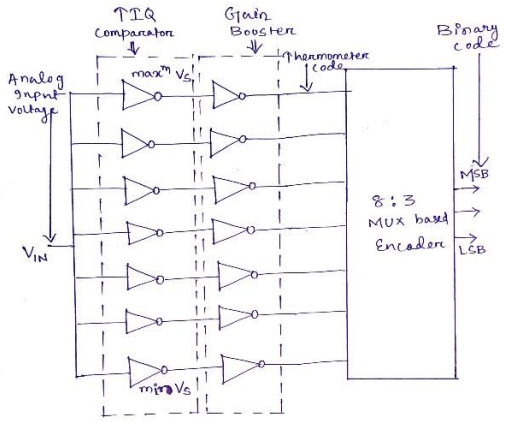

Fig.3: Proposed block diagram of 3-bit TIQ based flash ADC

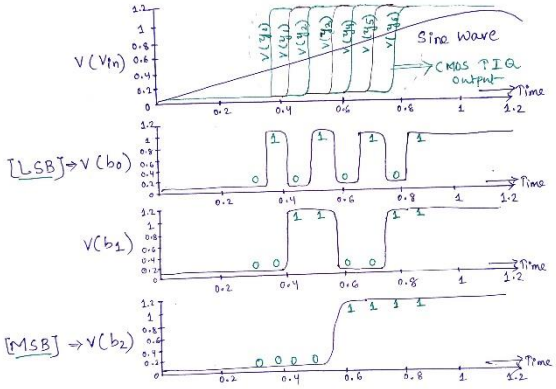

Fig.4: Simulation results of 3-bit CMOS flash TIQ based ADC

References

[1] https://doi.org/10.1109/WiSPNET.2016.7566395
[2] https://doi.org/10.1109/ICSTM.2015.7225451