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Two Multiplexers Realized Using Two New Schmitt Trigger Circuits

Sk. Apsana Parveen[1], M.S.S.Rukmini[2] and Avireni Srinivasulu[3]

[1,2,3]Dept. of E.C.E, Vignan's University (VFSTR University), Vadlamudi-522 213, Guntur, A.P, India

Email: [1]apsanaparveen.shaik@gmail.com, [2]msssrukmini@yahoo.co.in, [3]avireni_s@yahoo.com

ABSTRACT

In this paper, we have proposed two new multiplexers realized using two new Schmitt trigger circuits. The proposed circuits are implemented by verifying the multiplexer functionality. These circuits are attractive for low voltage and high speed applications, and may also be useful in power electronics control circuits and electronic applications too. The propound circuits are simulated using Cadence and model parameters of gpdk 180 nm CMOS technology process with supply rail voltage of +1 V and sinusoidal input waveform of amplitude is +2 V with 1 MHz frequency.

Keywords: CMOS Schmitt trigger, Multiplexer, Inverter

1. INTRODUCTION

Schmitt trigger circuits are widely used in both analog and digital applications [1]. The operation amplifier with two resistors in positive feedback is designed as conventional Schmitt trigger circuits. These types of circuits are inappropriate for CMOS integration because of involvement of op-amp design challenges (for example, high DC gain and low offset requirements), and accuracy limitation of resistors [2]. If Schmitt trigger circuits are realized in depleted SOI technology, then the uncertainty in switching trip points occurs by the floating-body- induced hysteresis. This tends to reduce the waveform shaping capability and performance [3]-[5]. The most important difference between the Schmitt trigger circuit and comparator is DC transfer characteristics. The comparator shows only one switching threshold where as, the Schmitt trigger shows various switching threshold values for both positive and negative threshold values [6].

Most of the time, it is necessary to convert an applied analogue input into digital output. For many more reasons, the noise is gradually increasing by circuit behavior and also the rise time and fall time is however slow. All these requirements are implemented in a circuit known as Schmitt trigger circuit [7]. An unwanted random fluctuation of analogue signal causes noise in digital signals. By this the circuits do not operate approximately. Analog signal suffers from different types of noises like flicker noise, shot noise, cross talk noise and thermal noise etc [8].

CMOS Schmitt trigger circuits are more prefered than the conventional Schmitt trigger circuits. CMOS Schmitt trigger circuit permutes a sinusoidal waveform into a stable value i.e. logical one or logical zero. Advantages of these circuits over conventional Schmitt trigger circuits are high noise immunity, dual switching thresholds (positive going and negative going), well suited for ultra low voltage applications, less power consumption during transitions, waveform shaping under noisy conditions in electronic circuits, and thresholds present less variations with respect to the temperature alterations [9] -[13].

Schmitt trigger circuits are nonlinear positive feedback circuits [14]. These circuits have been used in the input buffers to increase noise immunity. The conventional Schmitt trigger contains a Schmitt trigger and a level converter. The Schmitt trigger circuit receives the input signal from the I/O pad and rejects the input noise, then the level converter can convert the signal swing from V_{CC} to V_{DD} [15] - [16]. The output state depends on input state and changes only as the input level crosses preset threshold level. These circuits are extensively used to drive the load with fast switching low power loss and low power supply. Schmitt trigger circuits are also acting as signal restoring circuits [17]. Schmitt trigger circuits are widely used, because it filters any type of noise and exhibits a plain digital signal. The main demerit in executing the conventional type of Schmitt trigger is a high power requirement which makes the unusable appearance on both analog and digital fields. The CMOS Schmitt triggers circuits are simple because of these circuits generate high accuracy measurements, scaling down and low cost Schmitt trigger. The major application of Schmitt trigger circuits is to abolish the chatter in signal shaping and on or off states [18].

In some of the published papers based on Schmitt trigger circuits, the characteristic of low power operation is not well thought-out; such circuits are implementd only for medium power applications [19]. Conventional CMOS Schmitt trigger circuits are generally designed either as a differential pair based on the positive feedback or differential threshold voltage for NMOS and PMOS transistors [20]-[21]. The extensive applications of CMOS Schmitt trigger circuits are functional generators, communication circuits similar to pulse width modulation and signal conditioning (to eliminate noise from input signals to digital output) relaxation oscillator, semiconductor memory design, Voltage Controlled Oscillators (VCO's) frequency modulation, sawtooth waveform generation, retinal focal-plane sensors, wireless transponders, sub-threshold SRAM, and amplitude modulation [22]-[29].

In most of the circuits, it is necessary to select a single data line or signal from several data lines or signal as suchs. The selected data line or signal is required on the output; such type of circuit is preferred as Multiplexer. A multiplexer is a combinational circuit. The circuit selects digital information from one to many input data lines. A set of selection lines control the particular input data line. Multiplexer operates like an electronic switch that selects one of those two sources. For multiplexers, there will be 2^n input data lines for which there are n selection lines. There are different combinations of multiplexers based on the 'n' value such as 2:1, 4:1 and so on. Higher order multiplexers are achieved by expanding the range of inputs. There are numerous applications of multiplexers: Time Division Multiplexing (TDM), Frequency Division Multiplexing

(FDM), Implementation of Combinational Logic Circuits, Analog to Digital (A/D) Circuits, Digital to Analog (D/A) Circuits, and also useful in Data Acquisition Systems [30].

In this paper, we have presented two multiplexer realized using Schmitt trigger circuits. The remaining part of the paper is mentioned as: the propound circuit operation is described in sec. 2. The simulated outputs are verified in section 3. The final paper is concluded in sec. 4.

2 PROPOSED CIRCUITS

A. Proposed Schmitt trigger circuit-1and its application as a Multiplexer-1

The proposed Schmitt trigger circuit-1 is shown in Fig. 1 and the corresponding multiplexer made of Fig. 1 is shown in Fig. 2 and their aspect ratios are indicated in table 1.

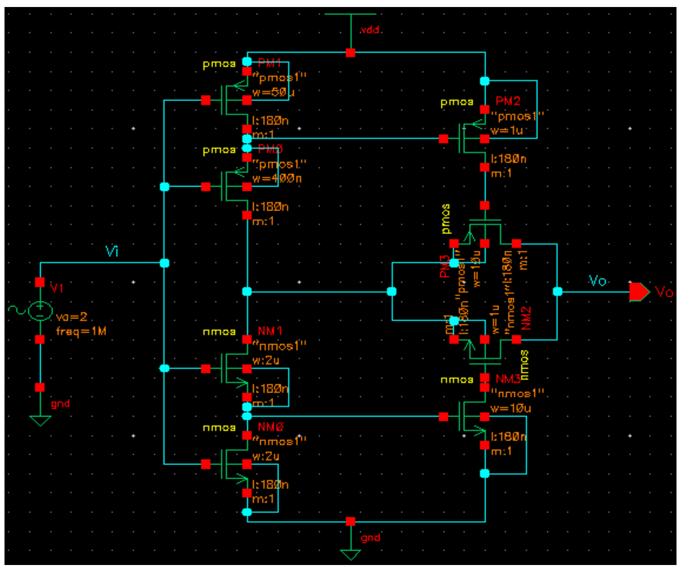

Figure 1: Proposed Schmitt trigger circuit-1

The circuit consists of an inverter and eight transistors. The inverter inverts the given pulse waveform for enabling the multiplexer to work satisfactorly. When the enable signal is high, then the inverted signal is connected to transistor P_1 by switching of into ON condition and the non inverted signal is connected to N_1 by switching of into ON condition. When the applied sinusoidal input waveform is greater than the threshold voltage then the transistors P_2 is turned OFF and N_2 is turned ON. The transistor P_4 is ON because of the input voltage of P_2 is greater than the voltage of pulse input of P_1. By this the transistor P_3 is OFF and the transistors N_1, N_2, N_3, and N_4 are ON. When the enable signal is high the output voltage switches to low. Comparably when the enable signal is low, then the output is high by switching transistors P_1, P_2 are

OFF and ON. The transistors P_3 and P_4 are ON and OFF respectively. And transistors N_1, N_2, N_3 and N_4 are OFF.

Proposed Schmitt trigger circuit-1 application as a multiplexer-1 is shown in Fig. 2 with enable (En), enable bar (En_bar) and V_{in}.

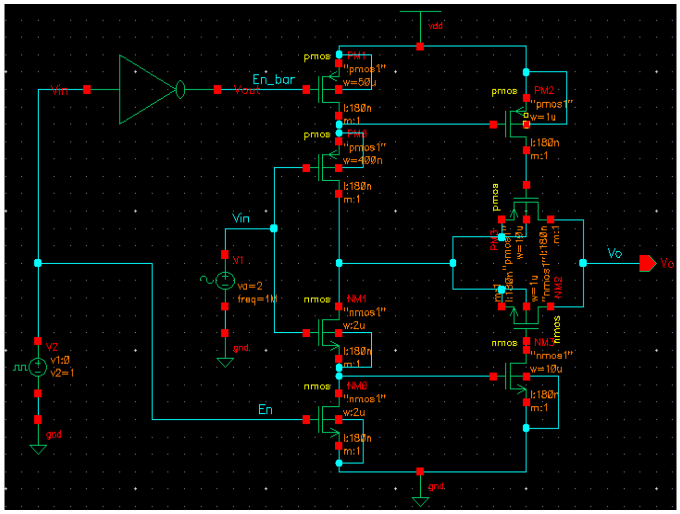

Figure 2: Multiplexer made of Fig. 1 Schmitt trigger circuit

Table 1 - Aspect ratios of proposed Schmitt trigger circuit-1

S. No	Transistor	W (μm)	L (μm)
1.	P_1	50	0.18
2.	P_2	0.4	0.18
3.	P_3	10	0.18
4.	P_4	1	0.18
5.	N_1, N_2	2	0.18
6.	N_3	1	0.18
7.	N_4	10	0.18

B. Proposed Schmitt trigger circuit-2 and its application as a Multiplexer-2

The proposed Schmitt trigger circuit-2 is shown in Fig. 3 and its application as a multiplexer is shown in Fig. 4 and their aspect ratios are indicated in table 2. When the enable signal is high, then the transistors P_1 and N_1 is ON, and the applied input sinusoidal waveform is greater than the threshold voltage then transistors P_2, P_3 are OFF and transistors N_2, N_3 are ON. Then the transistors P_5 and P_4 are ON and OFF respectively, while the transistors N_2, N_3, N_4 and N_5 are ON by switching the output voltage to low. Similarly, when the enable signal and the applied input waveform are low, then the output voltage has shifted to high. By switching transistors P_1, P_2 to OFF and ON, P_3, P_4, P_5 are switched into ON, OFF, ON and OFF and the transistors N_1, N_2, N_3, N_4 and N_5 are OFF.

Table 2 - Aspect ratios of proposed Schmitt trigger circuit-2

S. No	Transistor	W (µm)	L (µm)
1.	P_1	50	0.18
2.	P_2, P_3	1	0.18
3.	P_4, P_5	50	0.18
4.	N_1, N_2, N_3, N_4, N_5	1	0.18

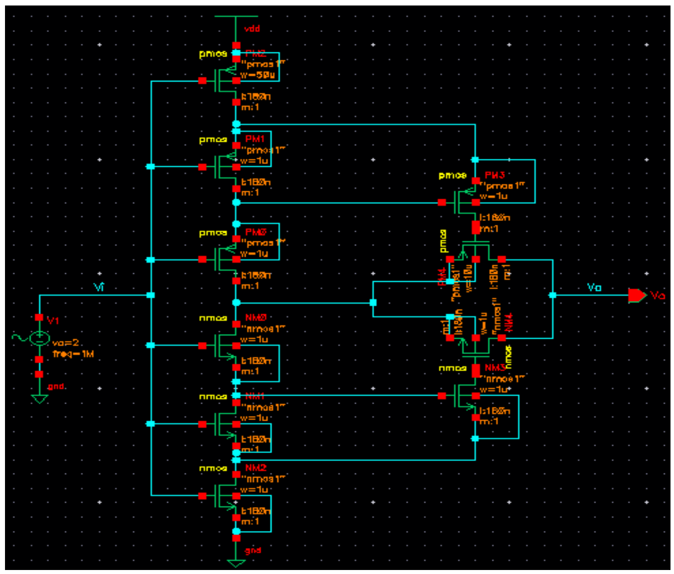

Figure 3: Proposed Schmitt trigger circuit-2

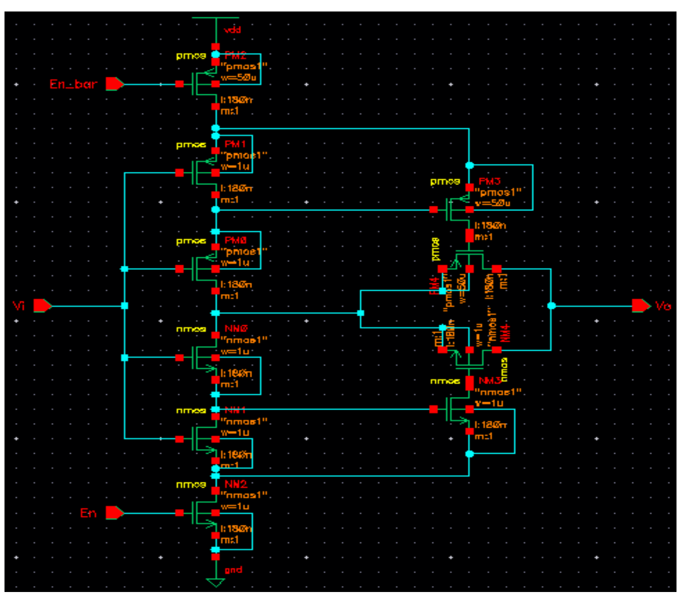

Figure 4: Multiplexer-2 using Fig. 3

3 SIMULATED RESULTS

The circuits in Fig. 1, 2, 3 and 4 were simulated using Cadence and the model parameters of gpdk 180 nm CMOS technology process. The applied sinusoidal input waveform of frequency 1 MHz, amplitude is +2 V and the supplied pulse for enabling multiplexer of voltages from 0 to 1 V. The propound circuits are operated at the supply rail voltage of +1 V. Figure 1 input and output waveforms are shown in Fig 5. Figure 2 input and output waveforms are shown in Fig. 6. The second proposed Fig. 3 input and output waveforms are shown in Fig 5. Figure 4 input and output waveforms are shown in Fig. 6. And also multiple block implementation of multiplexer with tri state Schmitt trigger circuit of Fig. 3 is shown in Fig. 9. Its input and output waveforms are indicated in Fig. 10.

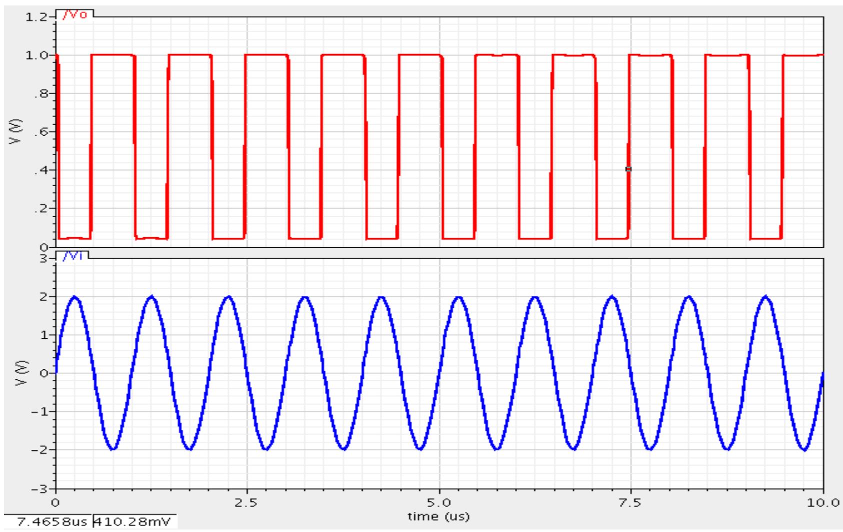

Figure 5: I/O waveforms of Fig. 1

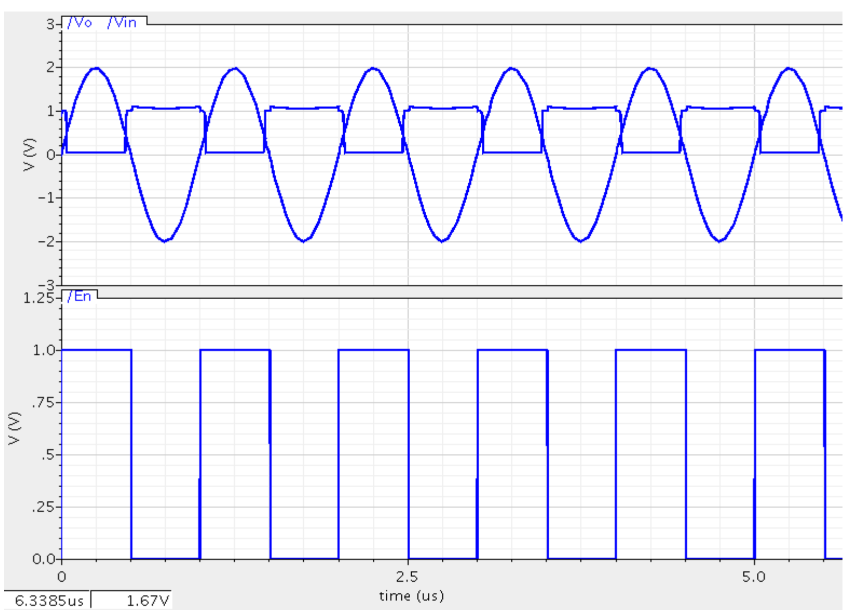

Figure 6: I/O waveforms of proposed Fig. 2

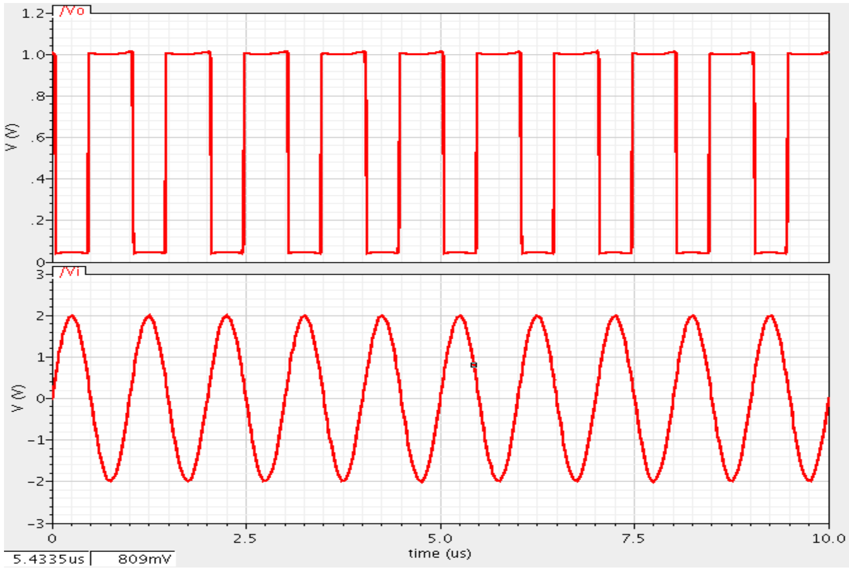

Figure 7: I/O waveforms of Fig. 3

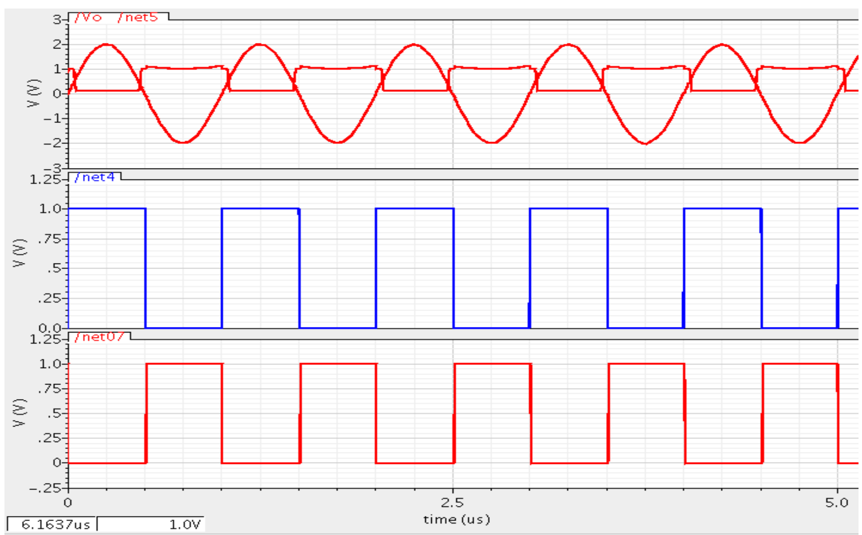

Figure 8: I/O waveforms of proposed Fig.4

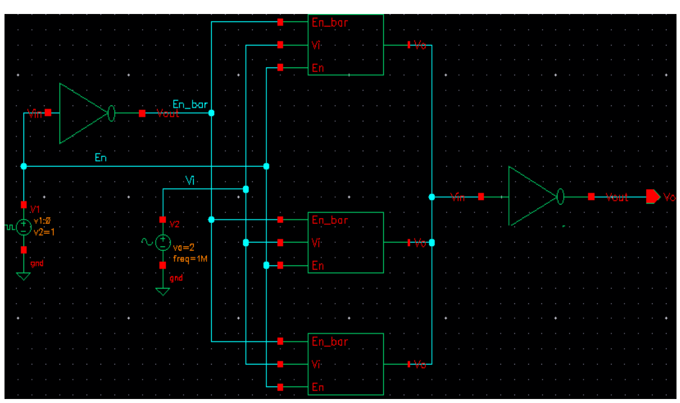

Figure 9: Multiple block implementation of multiplexer with tri state Schmitt triggers

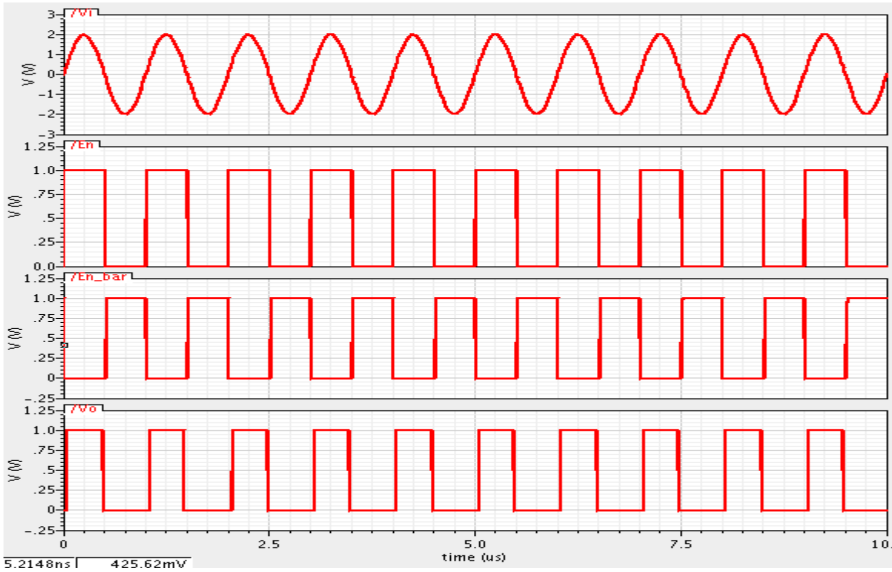

Figure 10: I/O waveforms of multiplexer made with tri state Schmitt trigger

4 CONCLUSION

In this paper two new multiplexers are realized based on two new Schmitt trigger circuits. The first circuit consists of an inverter and eight MOS transistors and the second circuit consists of an inverter and with ten MOS transistors. Two multiplexers are realized with two Schmitt trigger circuits. Multiple blocks are connected to implement a multiplexer circuit made of tri state Schmitt trigger components. These circuits have more benefits than those of conventional Schmitt trigger circuits compared in terms of delay, power consumption and temperature stability. These circuits are verified to observe the functionality. The outputs of the presented circuits are inverted in nature. All the proposed circuits are operated with a supply rail voltage of +1V and frequency of 1 MHz. These circuits are preferable for many applications in both analog and digital fields.

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