IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 7, Issue 2, February 2018

Low Power and High Speed Multiplier Designs using FinFET Technology

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Abstract: The preference to optimize the layout metrics of overall performance, strength, area, fee, and time to market (opportunity cost) has now not changed for the reason that of the IC enterprise. In truth, Moore's law is all about optimizing those parameters. however, as scaling of producing nodes progressed in the direction of 20-nm, some of the tool parameters couldn't be scaled any in addition, specifically the strength deliver voltage, the dominant component in figuring out dynamic electricity. This research is to lessen the strength and put off at the FinFET based array multiplier. The backend device Synopsys HSPICE is selected for the analysis of power dissipation and put off of multiplier. In this paper, four- enter multiplier is designed and simulated in 32 nm era the usage of FinFET technology. Simulation end result imply that the proposed technique offer improvement in term of strength consumption and delay over MOSFET.

Keywords: FinFET, Average Power, Multiplier

1. INTRODUCTION

As nanometer technique technologies have advanced, chip density and running frequency have extended, making energy consumption in battery-operated portable gadgets a first-rate concern. Even for no portable devices, electricity consumption is critical because of the improved packaging and cooling expenses in addition to ability reliability issues. Therefore, the principle design purpose for VLSI (Very-Large-Scale Integration) designers is to meet overall performance necessities within a power budget. [3] Scaling of gate MOSFET in nm face exceptional assignment due to the extreme quick channel effect that reason an exponential growth in the sub-threshold and gate–oxide leakage technology[1]. FinFET are encouraging substitute for bulk MOS at the nanoscale due to the fact the fabrication technology of FinFET and MOSFET almost identical[2]. FinFET (fin-type)[4] offer interesting strength –delay tradeoff and higher characteristics (brief channel effect) in nanometer which will meet the overall performance expected via the global technology roadmap for semiconductor for the drawing close technological node[5].
Since the fabrication of MOSFET, the minimal channel length has been shrinking continuously. The inducement in the back of this lower has been an growing hobby in excessive speed gadgets and in very large scale integrated circuits. The sustained scaling of traditional bulk tool calls for innovations to avoid the limitations of essential physics constraining the conventional MOSFET tool shape. Within the situation of battery-operated portable devices electricity intake, chip density and running frequency has elevated due to superior nanometer system technologies [1] - [3]. Even within the case of nonportable devices, strength consumption is likewise very vital because of the increase in packaging density and cooling costs in addition to potential reliability problems. for that reason, strength performance has assumed accelerated importance, to satisfy the overall performance requirements inside a electricity price range for VLSI designers. velocity and area are also essential parameters and right tradeoff among them ought to be drawn while designing a circuit.

2. FINFET TECHNOLOGY

FinFET is categorized as a sort of Metal oxide semiconductor field effect transistor /MOSFET known as DGFET. It become first advanced at the university of Berkley California via Chenning Hu and his colleagues. In FinFET the NMOS in CMOS technology is replaced with N-FinFET and PMOS with P-FinFET, then, both gates of FinFET are tied collectively. [7] with the aid of the usage of this approach, we will layout a FinFET model of a CMOS common sense circuit or a bypass transistor good judgment circuit that keeps the same functionalities the MOSFET model. [6] within the period in-between, FinFET provides higher circuit performances and reduces leakage present via effective suppression of quick-channel effect and near-best sub-threshold swing [9]. In the i-gate mode, the fast channel outcomes (threshold voltage roll- off, sub threshold swing degradation and drain prompted barrier reducing) are truly less severe than those of the device inside the double-gate mode [2]. Figure 1 shows two different configurations of FinFET Device.

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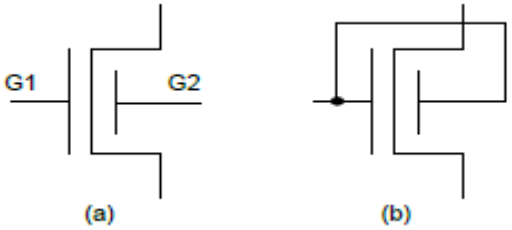

Figure 1: FinFET Configurations (a) Independent Gates (b) Shorted Gates [9]

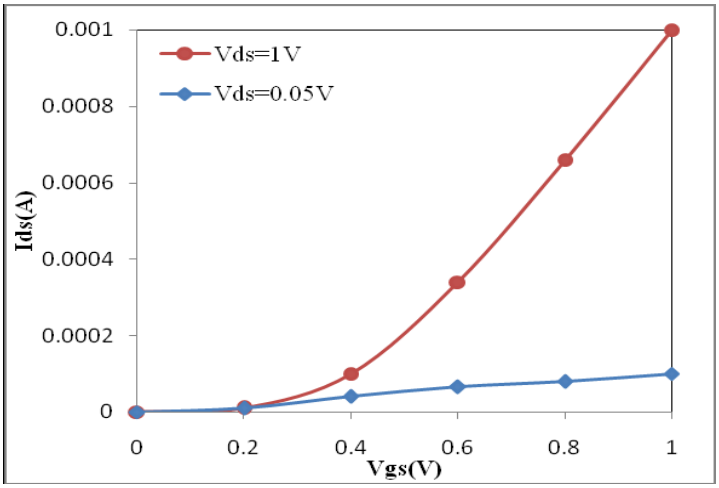

Figure 2 ID-VGS characteristics double-gate n-type FinFET Device of gate length LG = 32 nm

By using different methodologies used in section 3 we can design different logic gates. Logic gates can be configured in one of the following modes, (1) Shorted-gate (SG) mode of operation back gate is tied to front gate, in this case we get improved drive strength and have better control over the channel. (2) Independent-gate (IG) mode, in which independent signals drive the two device gates; back gate can have a different voltage from front gate. This may reduce the number of transistors in the circuit. (3) Low-power (LP) mode, we are applying a low voltage to n-type FinFET and high voltage to p-type FinFET. This varies the threshold voltage of the devices, which reduces the leakage power dissipation at the cost of increased delay. A hybrid IG/LP-mode is a combination of LP and IG modes.

Hence there is a rising demand for these chip driven products in the present and upcoming future. To meet with these demands we must reduce the size, power, and efficiency. Out of which power dissipation has become an important objective in the design of both analog and digital circuits. It is demonstrated that because of neglecting short-circuit current, previous techniques proposed to optimize the area of a fan-out tree may result in excessive power consumption. The total active mode power consumption, the clock power, and the average leakage power of the combinational circuits are reduced by up to 55% , 29%, and 53%, respectively, while maintaining similar speed and data stability as compared to the circuits implemented in CMOS and FinFET technology.

3. MULTIPLIER

The multipliers play a prime position in arithmetic operations in virtual signal processing programs. the existing development in processor designs purpose at low energy multiplier structure utilization of their processor circuits. So, the want for low strength multipliers has accelerated. subsequently the designers listen more on low energy green circuit designs. typically the computational performance of dsp processors is affected by its multipliers performance. for this reason we placed over a strong care to conquer those drawbacks using our design. Processors performance is typically determined from its multiplier pace and deliver voltage. as a consequence to speed up the processor basically a parallel multiplier may be used comparative to serial multipliers for better performance. If speed is not an difficulty in multiplier designs then partial merchandise can be summed serially to reduce the risk of layout complexity but velocity and occasional energy has became an critical standards in designing today's energy efficient processors.

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4. PROPOSED MULTIPLIER DESIGN USING FINFETS

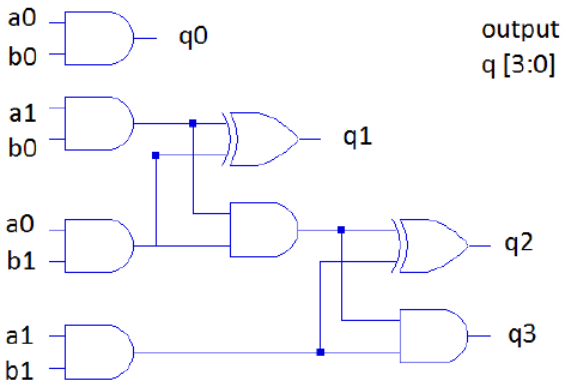

Figure 3: Multiplier Diagram

The consequences are calculated on synopsis HSPICE by using coding the nodes of the circuit diagram, the circuit diagram nodes are given special node call, for which the FINFET version from BSIMCMG is blanketed and simulated. The 2-bit opcode selects the result of either logical or mathematics block if you want to be the output of the Multiplier.

5. SIMULATION RESULTS

The simulations performed in HSPICE are analyzed in this section. The table 1 respectively show the Average power comparison in Multiplier.

Table 1: Average Power Multiplier

Metric/Circuit	Multiplier 32nm Fin-FET	Multiplier 32nm MosFET
Average Power(µW)	0.535	3.17

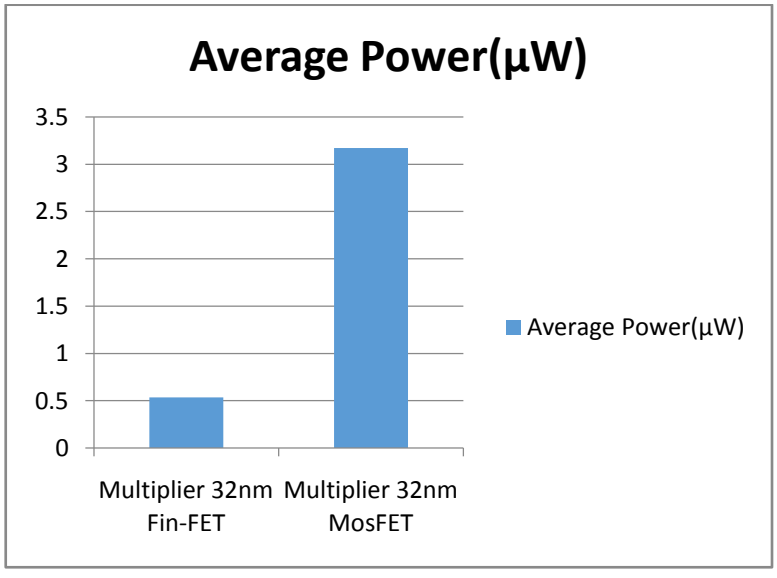

Figure 4: Multiplier Average Power

Figure 3 is representing bar graphical representation of Average power consumption comparison in FinFET device circuit and MosFET device circuit multiplier. The results clearly prove that a lot of power saving and high efficiency can be achieved by the use of FinFET.

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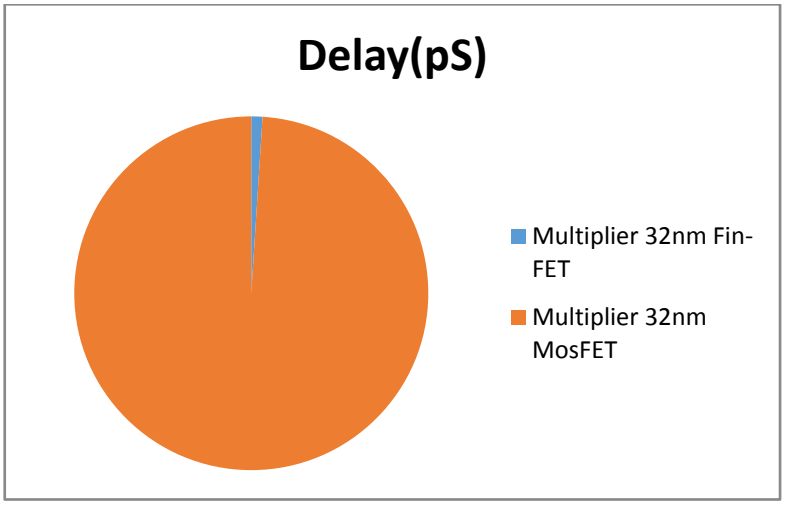

Figure 5: Delay in Multiplier FinFET and Multiplier MosFET

Figure 4 represents delay in Multiplier using FinFET and MOSFET. Table 2 represents results of delay in Multiplier.

Table 2: Delay Multiplier

Metric/Circuit	Multiplier 32nm Fin-FET	Multiplier 32nm MosFET
Delay(pS)	3.908	380

6. CONCLUSION

The use of FinFET over MOSFET inside the proposed approach reduces average power intake and postpone in Multiplier. The reduced short channel effects in FinFET and higher control over the gate of the FinFET improves the average power delay in proposed approach. As already shown in simulation consequences, the common power consumption and postpone are substantially reduced in FinFET than MosFET. The MOSFET has been used extensively in cutting-edge era. however below 32nm generation, controlling the channel of the MOSFET will become tough. So there is need to invent new generation so as to permit us to design gadgets beneath 32nm generation.

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