VLSI Implementation of a High Performance Barrel Shifter

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Abstract— A barrel shifter is a combinational logic circuit with n data inputs, n data outputs, and a set of control inputs that specify how to shift the data between input and output. In this project we have implemented 4-Bit Barrel Shifter which has 4 data inputs D0,D1,D2,D3 and 4 data outputs Y0,Y1,Y2,Y3 using VLSI Technology. Three modules have been designed which consist of four 2:1 Multiplexer in each module. Each module has one select line. Select lines of first and third module determines how many bits to shift. Select line of second module specifies shifting of data either to left or right. Third module provides you your desired output. We have implemented 2:1 mux using transmission gates which requires 6transistors.

Key words: Barrel shifter, vlsi, mux, not gate, register

I. INTRODUCTION

Barrel shifter is a digital circuit that can shift a data word by a specified number of bits. It can be implemented as a sequence of multiplexers (mux.), and in such an implementation the output of one mux is connected to the input of the next mux in a way that depends on the shift distance. A barrel shifter that is part of a microprocessor CPU can typically specify the direction of shift (left or right), the type of shift (circular, arithmetic, or logical), and the amount of shift (typically 0 to n-1 bits, but sometimes 1 to n bits), where n is data inputs and data outputs of barrel shifter. Barrel shifters are often required for performing data shifting and rotation in many key computer operations from address decoding to computer arithmetic. Barrel shifter circuits are essential elements in the design of data paths for DSP applications. A Significant reduction in area and power required by the barrel shifter circuit is achieved by implementing rightward operations as operations in leftward direction. A significant reduction in delay is possible by reducing the length of critical path.

A. Operations:

A barrel shifter primarily offers six operations; rotate right, rotate left, shift right logical, shift left logical, and shift right arithmetic. Occasionally, the shift left arithmetic operation is also included, but it is not supported in the designs detailed here due to its infrequent use.

Rotate: A rotate is a cyclic shift either to the left or right. This means that as bits are shifted out of the data vector on one side, they are shifted into the data vector on the other side. During this process, all bits from the input are routed to the output. Their position in the output, however, is not necessarily the same as it was in the input.

As shown in Figure 1, a k-bit rotate right moves k low order bits to the most significant end of the bit vector. Likewise, as shown in Figure 1.2, a k-bit rotate left moves k high order bits to the least significant end of the bit vector. The remaining (n-k) bits are shifted so as to fill the void left by the k bits shifted in a cyclic manner.

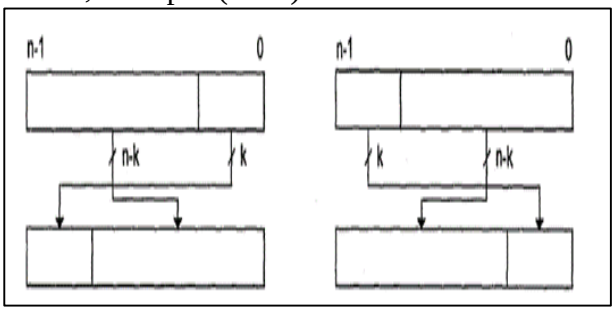
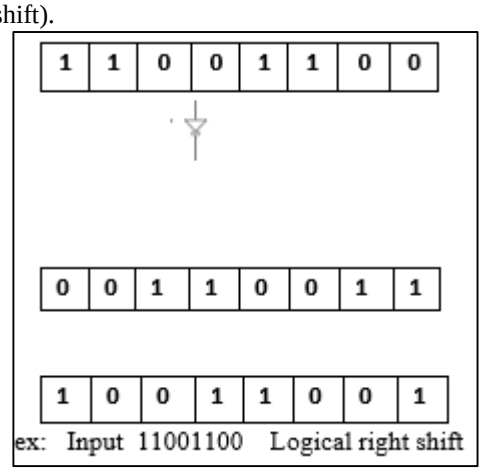


Fig. 1: Rotate Right

B. Proposed Barrel Shifter:

We already have discussed about different kind of barrel shifter available commercially, over which modified barrel shifter provides much better outcome against other conventional barrel shifter. Here we explain the proposed barrel shifter , here we design the three control module which control the overall operation of barrel shifter, which include shift/ direction control unit,shift amount control unit and central control unit. Shift or direction control unit control the shifting of bit either left or right direction after getting instruction from central control unit. Shift amount control unit control the how much bits to be shifted. Central control unit control the overall action of direction control unit and shift amount control unit and generate the output. suppose we have input bit 11001100 and we want to shift it. If we use barrel shifter then first barrel shifter check which shift/direction is required either logical, arithmetic or rotate and also check how much bits to be shifted after performing these two major operation generate the proper output.

Shift /direction control unit: Shift /direction control unit control the shift type and direction of shift . rotate right, rotate left, shift right logical, shift left logical, and shift right arithmetic here we take the example of bit sequence 11001100. And we want to do logical shift and direction of shifting is right. In our proposed barrel shifter we used the NOT gate for performing logical shifting operation, after performing NOT operation in bit sequence 11001100 we get 00110011 and finally we get output of bit sequence 10011001 (1 bit shift).



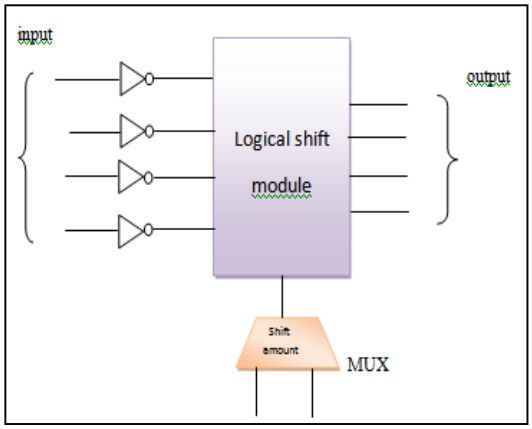


Fig. 1: Logical shift module

In arithmetic shift module for performing arithmetic shifting operation we use half adder Here input bit sequence applied in half adder then output of XOR circuit is used as a input to arithmetic shift module and output of AND gate is used as a input to next XOR circuit except output of last AND gate .Output of last AND gate is used as a input to arithmetic shift module

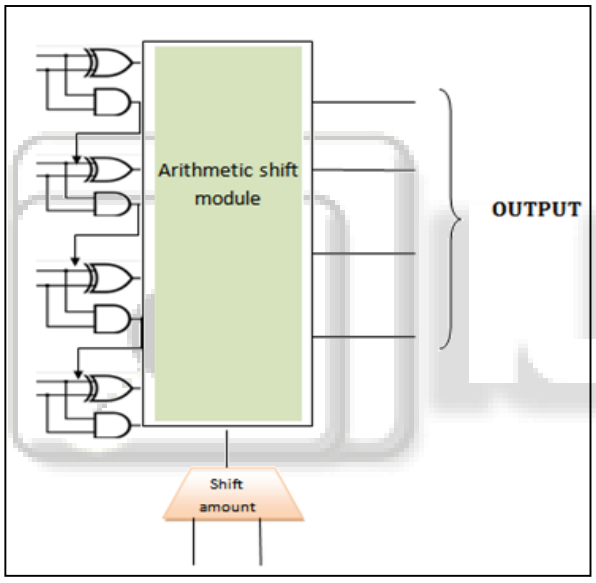


Fig. 2: Arithmetic shift module

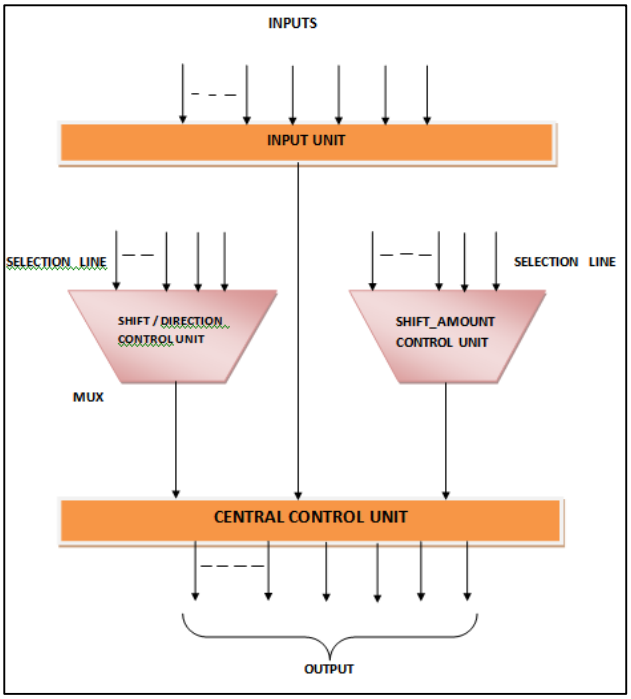


Fig. 3: Proposed block diagram of barrel shifter

II. SYNTHESIS AND SIMULATION

In VLSI design flow, Verification and validation are the important aspects. After RTL entry we have performed synthesis on XST (Xilinx Synthesis Tool) and verification on Xilinx ISE simulator & for validation we have implemented its bit file on FPGA.

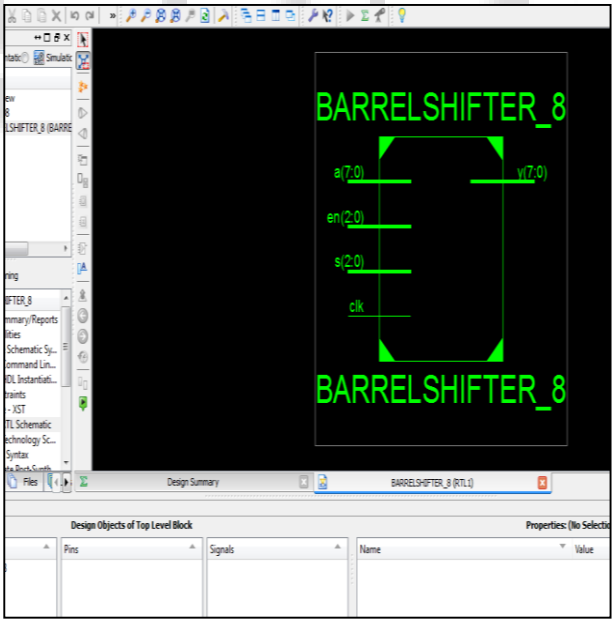


Fig. 4: RTL view of 8 bit barrel shifter

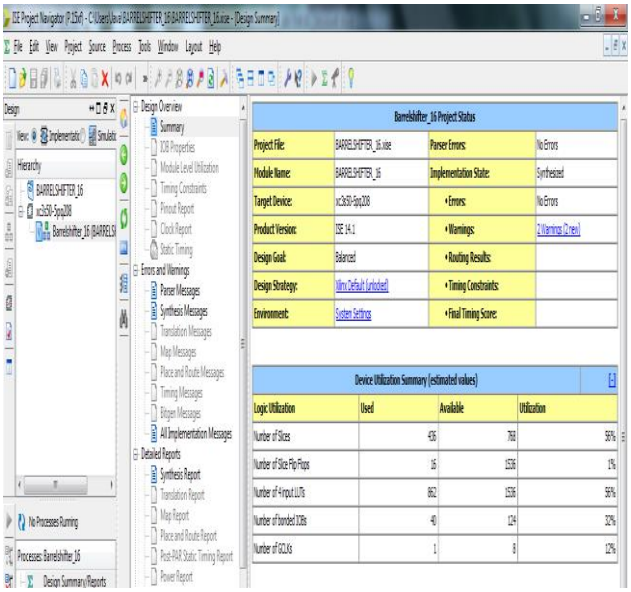


Fig. 5: Design summary of 8 bit barrel shifter

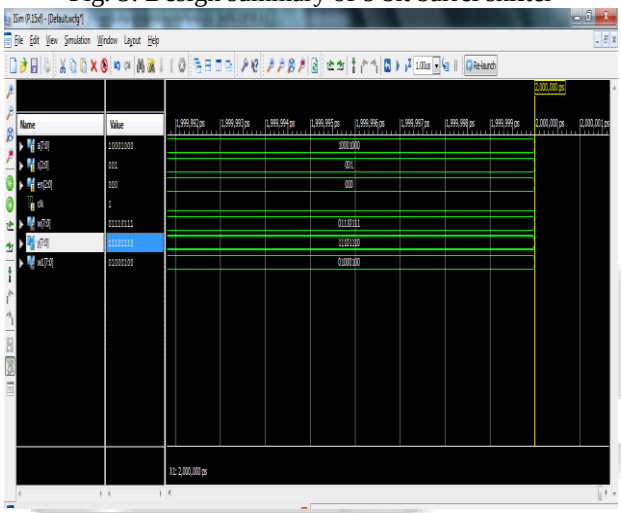


Fig. 6: Simulation of 8 bit barrel shifter

III. COMPARATIVE RESULT

Maximum Combinational Path Delay (in ns) for different Barrel Shifter at 8 bit level		
[5]	[1]	Proposed
12.638	22	10.689
Maximum Combinational Path Delay (in ns) for different Barrel Shifter at 16 bit level		
[5]	[1]	Proposed
	40	17.072

Table 1:

IV. CONCLUSION

In this dissertation work a thorough analysis and study work has been done on Barrel shifter we have found that Proposed Barrel shifter provides much better outcome than commercially available Barrel shifter. So we have used this Barrel shifter to perform all shifting operations being used in various operations of Arithmetic Execution Unit those are square and multiplication unit. After synthesis and simulation work for proper validations has been performed on this Barrel shifter to have reliability on our proposed designed module.

V. FUTURE WORK

This proposed Barrel shifter Unit can be used at commercial level where high speed calculation is required for digital signal processors. It can also be used in Defense, Medical areas and safety critical operations where Speed is more crucial in comparison to other parameters.

We have worked upon the Gate level design and for this design we have used XILINX ISE 14.1, this proposed module can also be designed at low level/switch level using TANNER EDA tool, to work upon more parameters, to achieve more optimized module

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