

A review on Barrel Shifter

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Abstract—Barrel Shifter is an important building block in the RISC processor for optimizing. Mainly used for rotation and shifting of the data either in left or right direction. This type of shifter is useful in signal processing ICs. The arithmetic and logical shifter are itself a type of barrel shifter. Here the main objective of this paper is to present the review on different design methods of barrel shifter.

Index Terms— Barrel Shifter, CMOS, MUX, Reversible logic, Power consumption, Time delay

I. INTRODUCTION

Barrel shifter is an important computational block, it is often used to shift and rotate n-bits in advance microprocessors, within a single clock cycle. In RISC processor Arithmetic Logical Unit performs arithmetic operations like addition, subtraction and intelligent operations like shifting. The RISC processor contains register documents used to store the operand in store directions. The point of control unit is to give a control flag that controls the operation of the processor which tells the small scale building design which operation is done at which time.

Barrel shifter performs 3 type of shifting operations circular shift, logical shift, arithmetic shift and the amount of shift (typically 1 to n-1 bits). The logical shifter is used to shift the bit in either left or right direction; the empty places are filled by zeros. In Arithmetic shifter the procedure for left shifting is same as logical but in case of right shifting the empty place is filled by signed bit. Barrel shifter carries out the rotation of bits in left or right direction; in this the empty place is filled by the shifted bit. Circuit diagram of 4-bit barrel shifter is shown below which can shift up to 4-bits places in one clock cycle.

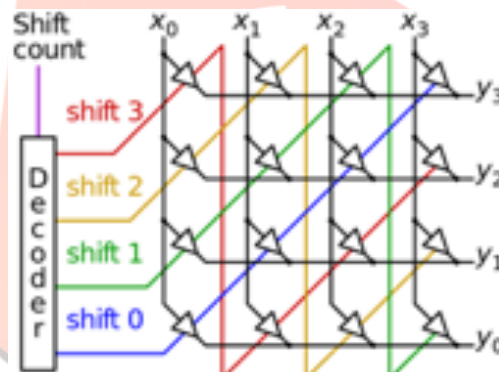


Fig 1. Circuit diagram of 4-bit barrel shifter. A barrel shifter is a combinational circuit that shifts a data word by a specified number of bits in one clock cycle. A barrel shifter can be implemented as a tree of multiplexers (mux), and in such an implementation the output of one mux is connected to the input of the next mux.

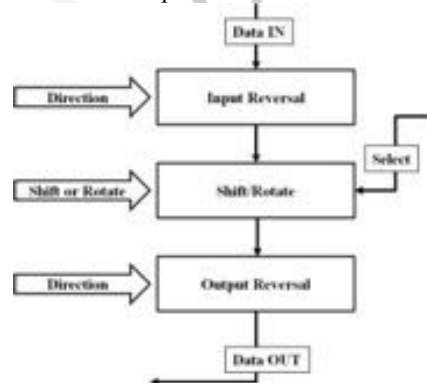


Fig 2. Block Diagram of barrel shifter.

Block diagram of barrel shifter is given, in fig.2, which represents different operation performed by it. Barrel shifter can be used to perform different operations. In rotate operation the data can be rotated either in right or left direction. For example 101110001 after rotating right by one bit the data is shifted in right direction by one bit and the output is 1101110000. Similarly if rotate the same data in right direction by 6 bit then the output obtained is 1000111011. Similarly for the next input 011111110 the shifting of data is shown in left direction, firstly the input is shifted in left direction by one bit the output is 111111100, in left shift the shifted data is removed and empty spaces are replaced by zeros. In rotating data left the input is

101111110, firstly the data is rotated by one bit output is 011111101, secondly the data is rotated by two bit output is 111111010.

Barrel shifter is of two types :(1) Mask based and (2) Multiplexer based . In barrel shifter which is implemented using multiplexer, select lines are used for shifting controls [1].

II. LITERATURE REVIEW

There are different types of design to implement barrel shifter. This section will discuss about different designs of barrel shifter and their merits.

A .Reversible Universal Bidirectional Shifter

A reversible universal bidirectional shifter is capable of performing logical left and right shift, left and right rotate, and left and right arithmetic shift operation. The design from the (n,k) reversible universal right shifter can be explained as : The chain of n/2 Fredkin gates controlled by the control signal left are added at the inputs and outputs of the (n,k) reversible universal right shifter as illustrated in Fig.3. As can be seen in Fig. 3 there is an additional Fredkin gate after the (n,k) reversible universal right shifter that is to preserve the sign bit in case of arithmetic left shift operation when the value of control signal sla is 1.

To copy the sign bit of the input data for arithmetic right shift an additional Feynman gate is used as shown in Fig. 3.

Table 1. Operations on (n,k) reversible universal bidirectional shifter

<i>left</i>	<i>sra</i>	<i>rotate</i>	<i>Operation Performed</i>
0	1	0	Reversible arithmetic right shift
0	0	1	Reversible right rotation
0	0	0	Reversible logical right shift
1	0	0	Reversible arithmetic left shift
1	0	1	Reversible left rotation
1	0	0	Reversible logical left shift

All the operations that can be performed by a (n,k) reversible universal bidirectional shifter are shown in Table 1. For left = 1, the (n,k) reversible universal bidirectional shifter will perform all type of left shifts such as logical left shift or arithmetic left shift or left rotate operation. When left = 0 the (n,k) reversible universal bidirectional shifter will work as (n,k) reversible universal right shifter that can perform the operation such as logical right shift or arithmetic right shift or right rotate operation.

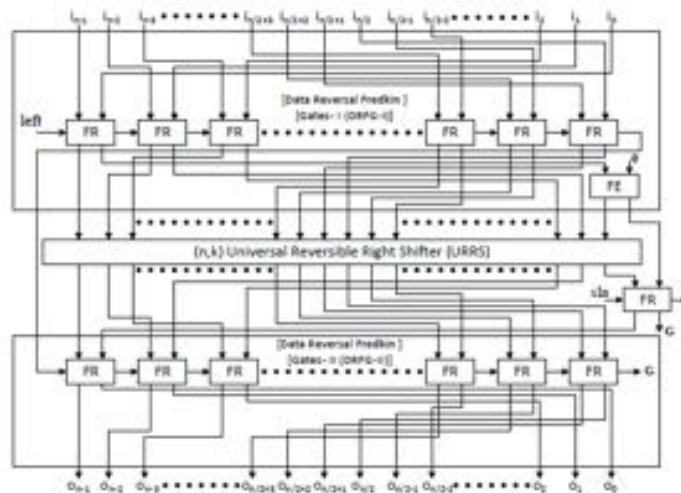


Fig.3 Circuit diagram of barrel shifter using reversible logic gates

B.2x2 Barrel Shifter using MUX [3]:

The fig.2 shows the multiplexer implementation of 2x2 barrel shifter which is performing a left rotation of two bit if i0 i0 i1 i1 is taken as input then the output will be in the sequence i1 i1 i0 i0. Input sequence is shifted by two bit to the left and LSB is filled by the shifted bits. Thus the rotation of two bits from left side is accomplished. This can be explained by taking an example, input 1100011011 is taken now the shift and rotate logic is as shown below:

Input	1	1	0	0	0	1	1	0	1	1
Rotate right 1	1	1	1	0	0	0	1	1	0	1

Rotate right 5	1	1	0	1	1	1	1	0	0	0
Input	1	1	0	0	0	1	1	0	1	1
Rotate left 1	1	0	0	0	1	1	0	1	1	1
Rotate left 5	1	1	0	1	1	1	1	0	0	0
Input	1	1	0	0	0	1	1	0	1	1
Shift right 1	0	1	1	0	0	0	1	1	0	1
Shift right 5	0	0	0	0	0	1	1	0	0	0
Input	1	1	0	0	0	1	1	0	1	1
Rotate left 1	1	0	0	0	1	1	0	1	1	1
Rotate left 5	1	1	0	1	1	1	1	0	0	0

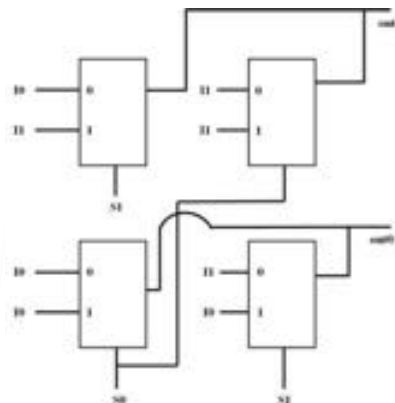


Fig. 4 Barrel Shifter using 2:1 Mux

Table 1 shows the comparison of 2-bit barrel shifter using conventional CMOS and barrel shifter using 2:1 MUX.

Table.1 Comparison Table[3]

Parameters	Conventional CMOS	Using Mux	Percentage Reduced
Power consumption (watt)	0.0435nW	0.01029nW	76.37%
Delay (sec)	0.0512ns	0.004ns	91.77%
Transistor Count	56	24	57.14%

From the above table it is clear that overall performance of barrel shifter is improved using mux. In VLSI area, delay and power consumption are most important parameters, these parameters value should be reduced for better performance. from the above table it is very clear that area is reduced by 57.14% that is very efficient.

C. Barrel shifter using conventional CMOS logic

Here barrel shifter is designed by using conventional CMOS logic as well as transmission gate CMOS. Table 2 shows the different parameters that are calculated by simulation of barrel shifter that are implemented using conventional CMOS logic as well as transmission gate CMOS.

Table.2 Comparison of Conventional CMOS and Transmission gate CMOS

Parameters	Conventional CMOS	Transmission Gate CMOS
Propagation Delay (ns)	4.95	4.85
Average Power at 20MHz (mW)	1.328	1.428
Peak power (mW)	37.28	278.43
Leakage Power (nW)	41.39	24.07
Transistor Count	2042	2050

III. CONCLUSION

This paper explains different designs for designing of barrel shifter; it can be implemented by conventional CMOS, transmission gate, mux and using reversible logic gates.

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