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Comparison of Conservative Reversible Gates

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***Abstract*-There are several logic gates which perform their operations only in irreversible manner. Reversible gates perform their operations in reversible manner. These gates are developing in recent years due to its less heat dissipating capacity. Whereas other logic gates will lose some information during bit transmission in form of heat. Such loses can be avoided in reversible logic gates. Reversible logic gates are used to construct low loss and low computational structures. Reversible gates are used in future emerging technologies such as quantum computing, optical computing, quantum cellular automata and in ultra low power VLSI circuits. This paper presents the comparison of several reversible logic gates.**

1. INTRODUCTION

Conservative logic is a logic family that exhibits the Property that there are an equal number of 1s in the outputs as there are in the inputs. Conservative logic can be reversible in nature or may not be reversible in nature. Reversibility is the property of circuits in which there is one to-one mapping between the inputs and the output vectors that is for each input vector there is a unique output vector and vice-versa.

Researchers have proved that if the computation is performed in an irreversible manner, each bit of information lost will produce KTln2 Joules of heat energy. From a thermodynamic point of view, it is also proved that kTln2 energy dissipation would not occur, if a computation is carried out in reversible way.

Reversible logic imposes many design constraints that need to be either ensured or optimized for implementing any particular Boolean functions[2]. Moore's law predicts exponential growth of heat generated due to information loss which will be an intolerable amount in the next decade. This heat dissipation dramatically reduces the performance and lifetime of the circuits.

The solution is to use revolutionary technology which enables extremely low power consumption and heat dissipation in computing. Bennett showed that if a computation is carried out in Reversible logic zero energy dissipation is possible, as the amount of energy dissipated in a system is directly related to the number of bits erased during computation. The design that does not result in information loss is irreversible. A set of reversible gates are needed to design reversible circuit[2]. Several such gates are proposed over the past decades. More formally, a reversible logic gate is a *k*-input, *k*-output (denoted *k***k*) device that maps each possible input pattern into a unique output pattern.

2. REVERSIBLE LOGIC GATES

In this section several reversible logic gates are compared and analysed.

2.1 NOT GATE

1*1 NOT gate is the simplest among all the reversible gates where the gate has only one input (A) and one output(B) such that B=A'

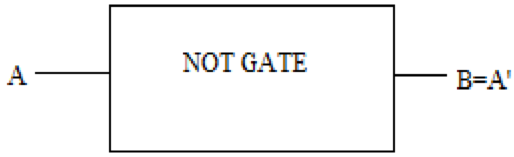

Figure 2.1 NOT Gate

2.2 Feynman Gate

Let Iv and Ov be the input and output vector of a 2*2 Feynman gate (FG) respectively[4], where $Iv=(A,B)$ *and* $Ov=(P=A,\ Q=A\oplus B)$. The block diagram for 2*2 Feynman gate is shown in figure 2.2

Figure 2.2 Feynman Gate

2.3 Toffoli Gate

Let Iv and Ov be the input and output vector of a 3*3 Toffoli Gate (TG) respectively[5], where Iv = (A, B, C) *and* $Ov= (P=A,\ Q=B,\ R=AB\oplus C)$. Figure 2.3 shows the 3*3 Toffoli gate.

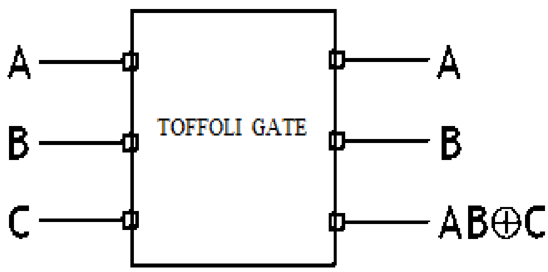

Figure 2.3 Toffoli Gate

2.4 Fredkin Gate

Let Iv and Ov be the input and output vector of a 3*3 Fredkin Gate respectively[5], where $Iv=(A,B,C)$ *and* $Ov=(P=A, Q=A'B \oplus AC, R=A'C \oplus AB)$. Figure 2.4 shows the block diagram of 3*3 Fredkin gate.

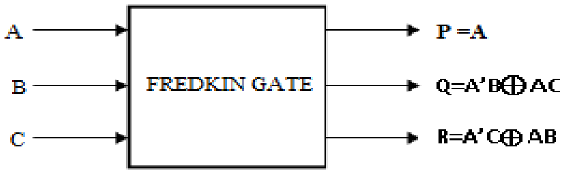

Figure 2.4 Fredkin Gate

2.5 New Gate

A 3*3 New Gate (NG) can be defined as $Iv=(A, B, C)$ *and* $Ov=(P=A, Q=AB \oplus C, R=A'C' \oplus B')$, where Iv and Ov are the input and output vector respectively. The block diagram of a NEW GATE is shown in Figure 2.5

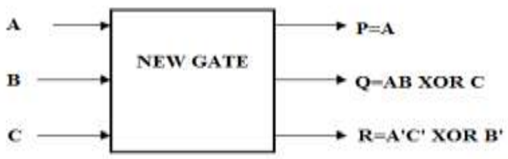

Figure 2.5 New Gate

2.6 Perers Gate

3*3 Peres Gate is another important gate which has a low quantum cost as compared to other gates. A single Peres gate can give generate and propagate outputs when the third input C = 0. Two Peres gates can be combined to form a full adder. Block diagram of PERES gate is shown in figure 2.6

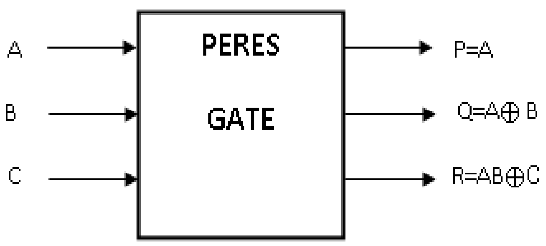

Figure 2.6 PERES Gate

2.7 Tr Gate

TR GATE is another important gate which has a low quantum cost. A single TR GATE can give generate and propagate outputs.TR gate has $Iv=(A, B, C)$ *and* $Ov=(P=A, Q=A \oplus B, R=(AB') \oplus C')$ where Iv and Ov are the input and output vector respectively block diagram of TR gate is shown in figure 2.7

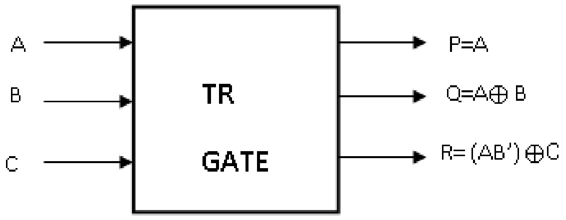

Figure 2.7 TR Gate

2.8 Dpg Gate

4*4 DPG GATE is a combination of two 3x3 PERES GATE. As we know that the Peres Gate has a low quantum cost as compared to other gates, so the combination of it provide more useful Double Peres Gate. This gate can singly work as many combinational circuits as FULL ADDER & FULL SUBTRACTOR. Block diagram of DPG gate is shown in figure 2.8

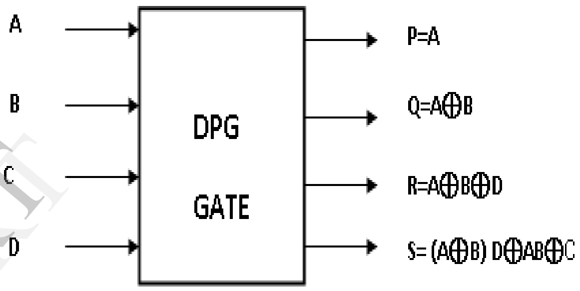

Figure 2.8 DPG Gate

2.9 Dkg Gate

4*4 DKG GATE can also singly work as many combinational circuits as FULL ADDER & FULL SUBTRACTOR. This gate has four input vectors $Iv=(A, B, C,D)$ *and* output vector $Ov(P,Q,R,S)$ block diagram of DKG gate is shown in figure 2.9

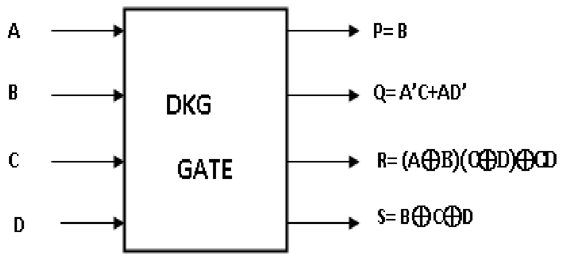

Figure 2.9 Dkg Gate

3.APPLICATIONS

Reversible logic gates are used in several applications like quantum computing, optical computing, quantum cellular automato, nano computing, bio molecular computations, space craft, implanted medical devices etc.,

4. CONCLUSION

This paper presents all reversible gates and application, benefits of these logic gates. Reversible gats can reduce heat dissipation due to its reversibility property and further it can be used in several applications. Among these reversible gate FREDKIN GATE is one of the most comfortable gate which can be used to develop several sequential circuits. Where other gates like DKG and DPG gates can be act as full adder and full subtractor which can develop only a combinational level applications. Other such gates can also used in several other functionalities to reduces the complexity and power dissipation. Thus by using FREDKIN GATE we can develop LATCHES and FLIP FLOPS with that design further other designs can be developed and analysed in future work.

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