Design of a 3 bit Wallace Tree Multipler

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Abstract-

Multiplication process is often used in digital signal processing systems, microprocessors designs, communication systems, and other application specific integrated circuits. Multipliers are complex units and play an important role in deciding the overall area, speed and power consumption of digital designs. A Wallace multiplier is a hardware implementation of a binary multiplier, a digital circuit that multiplies two integers. It uses a selection of full and half adders (the Wallace tree or Wallace reduction) to sum partial products in stages until two numbers are left.Compared to naively adding partial products with regular adders, the benefit of the Wallace tree is its faster speed. It has reduction layers, but each layer has only propagation delay. A naive addition of partial products would require time. As making the partial products is and the final addition is , the total multiplication is , not much slower than addition.

Reference Circiut-
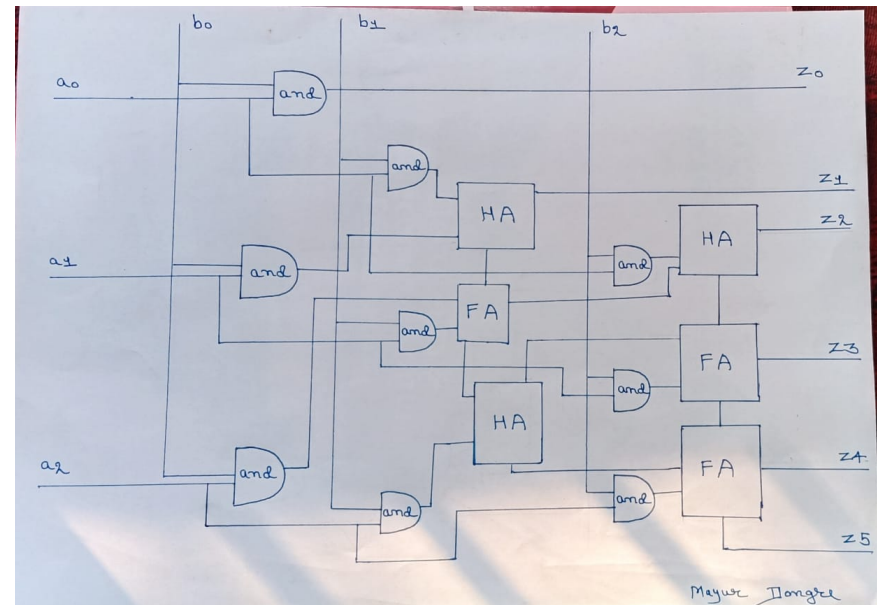
3-bit Wallace Multiplier

Reference Circuit's Waveforms-
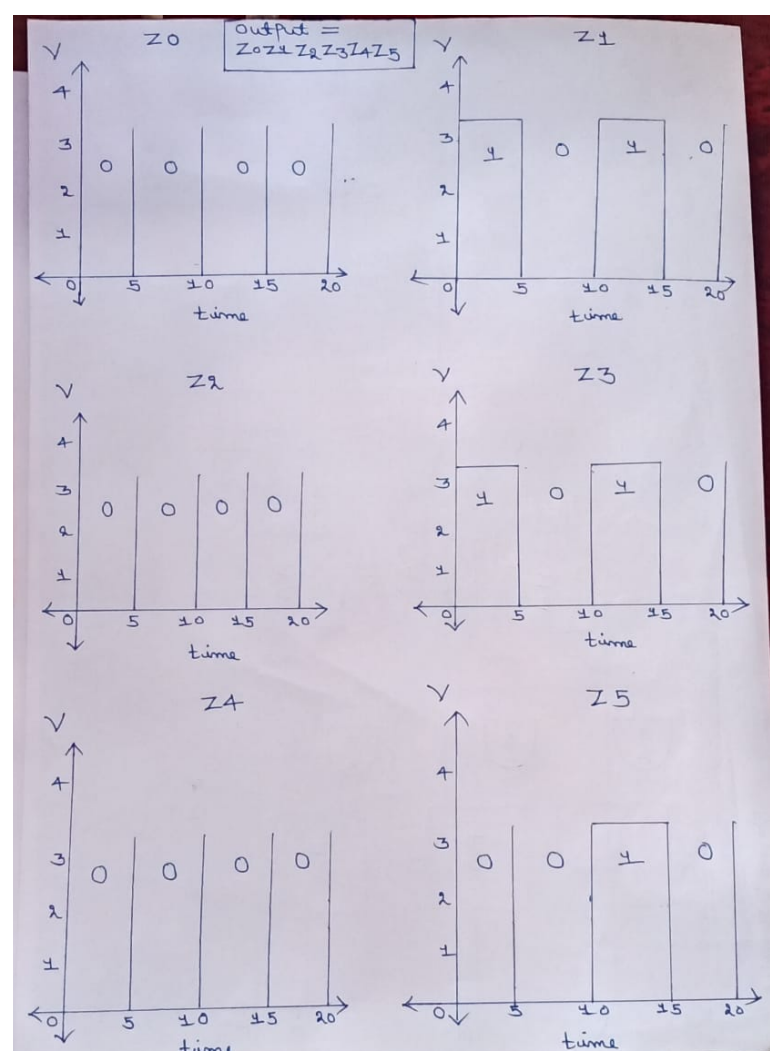
Waveforms

Reference Circuit Details -

The Wallace tree has three steps:

1)Multiply each bit of one of the arguments, by each bit of the other.

2)Reduce the number of partial products to two by layers of full and half adders.

3)Group the wires in two numbers, and add them with a conventional adder.

The input is 3-bit numbers which will be multiplied using the Wallace tree algorithm and it will produce a 6-bit product. This structure is implemented using half adders, full adders and AND gates. Initially, every bit is multiplied with every bit of the other number, then these partial products which have weight equal to the product of its factors are further reduced to obtain the respective weights by using half adders or full adders based on the size. The final result is calculated by the sum of all these partial products.

References :
1) https://en.wikipedia.org/wiki/Wallace_tree

2)Youtube Video -https://www.youtube.com/watch?v=lcPIMvI57dM&t=114s

3)PriyankaMishraandSeemaNayak.AStudyon Wallace Tree Multiplier. https://www.researchgate.net/publication/32720922