Conversion of Binary to Gray Code Using Opti FDTD Designer

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Abstract: Design of an all-optical binary to gray code converter using Opti FDTD. This device consists of a Mach-Zehnder interferometer as a switching element, switching the light from one port to another port at an ultra-fast rate. The performance parameters of these extension ratios and insertion ratios are obtained as 20.59 dB and 0.951 dB respectively.

KEYWORDS: All-optical, plasmonics Mach-Zehnder Interferometer, Gray code, error detection.

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INTRODUCTION

In optical communication systems, sometimes it is necessary to convert the information into optical form using code converters. Few code converters like binary to octal, octal to binary, decoders and encoders, etc. already being proposed optical. To extend the work some other devices such as binary code to gray code converter as well as the counter can be implemented.

Binary to gray code converter using logic gates

Gray is the code in which one bit is changed when one represents the next code in the sequence, due to this code is known as unit distance code. It is also known as reflected code. Binary inputs are applied as input and produce corresponding gray code as output. Further BTG is implemented optically.

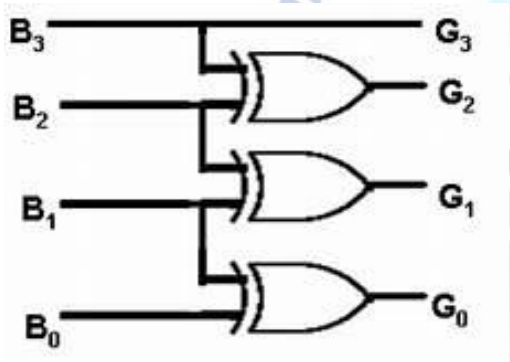


Fig. 1: Binary to gray code generator using logic gates

Natural-binary code				Gray code			
B3	B2	B1	B0	G3	G2	G1	G0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	0	0	0	1	1
0	0	1	1	0	0	1	0
0	1	0	0	0	1	1	0
0	1	0	1	0	1	1	1
0	1	1	0	0	1	0	1
0	1	1	1	0	1	0	0
1	0	0	0	1	1	0	0
1	0	0	1	1	1	0	1
1	0	1	0	1	1	1	1
1	0	1	1	1	1	1	0
1	1	0	0	1	0	1	0
1	1	0	1	1	0	1	1
1	1	1	0	1	0	0	1
1	1	1	1	1	0	0	0

Table 1: Truth table for BTG code converter

Binary to Gray Code Converter using Opti FDTD

A Four-bit BTG code converter is proposed these binary data bits $B3B2B1B0$ are applied at MZI1, MZI2, MZI3, MZI4 at the respective ports and gray code outputs $G3G2G1G0$ are obtained output ports of coupler 1, MZI5, MZI6, MZI7 respectively (shown in Fig. 2). The data is consider as logic 1 with high-intensity input optical signal as compared to the logic 0 levels. The intensity levels for logic 1 and logic 0are $5.46 * e9$ and $4.46 * e8$ W/m respectively. The low-intensity optical signal (logic 0) emerges the optical signal at the second output port. Schematic of BTG code converter.

The device is designed using the cascading of the plasmonic-based MZIs (P-MZI). Mach-Zehnder interferometer is able to transfer input optical power to either output port i.e. works as switching element. The coming optical beam is traveling through the medium having non-linear material, is refracted.

The proposed structure is simulated using the FDTD method and results are given. The low-intensity optical signal is applied at the second, first, first and second in put terminals of MZI, MZI2, MZI3, and MZI4 respectively. Bit $B3 = 0$, a lowintensity optical signal is applied at the first input port of MZI1, and output is obtained at the first output port i.e. $G3 = 0$.

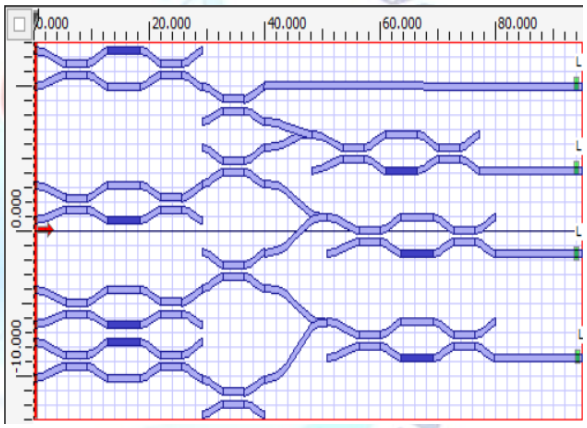
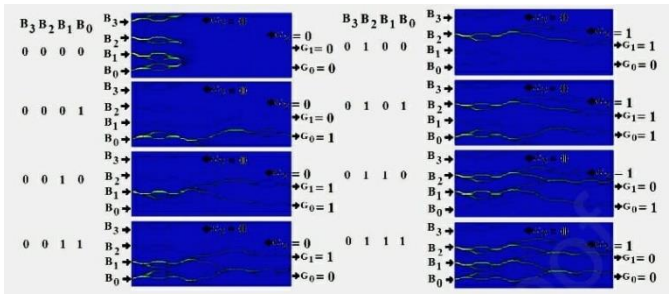


Fig .2 Binary to gray code using Opti FDTD Designer

RESULT AND DISCUSSION

The design is simulated using the FDTD. Design is operated with a continuous wave (CW) optical signal of 1.55μm. The magnitude of the optical signal is considered as $5.46 * e$ 9 and $4.46 * e8$ W/m for logic 1 and 0 respectively.



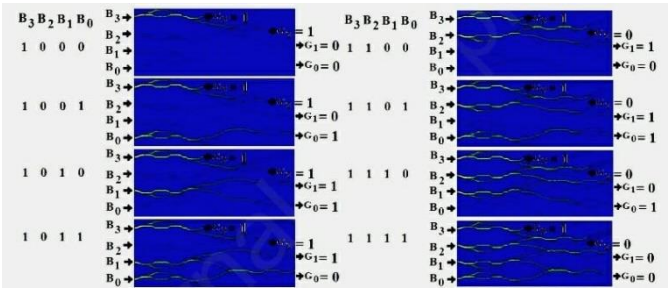


Fig .3 Outputs of the Binary to Gray using Opti FDTD

CONCLUSION

All-optical binary to gray code converter device is presented and the functionality of the device is analyzed. A design is proposed using P-MZI based switch which is smaller in size w.r.t electro-optic effect based MZI, and footprint is the order of $94.10 * 26\mu m2$. It is suitable for error detection in the coded data, and it has the advantage of optical data processing like fast data rate, secure data transmission, and immune to atmospheric interference. The performance is analyzed and few parameters like ER and IL are obtained 20.59 dB and 0.951 dB respectively which are promising data for the validation of the device.

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