

Logic Gate Optical Coupler Logic Analysis



AI Overview

Optical couplers can implement all-optical logic gates such as OR, AND, and NIMPLY by exploiting linear or nonlinear coupling of light between waveguides, enabling ultrafast, low-power logic operations without electronic conversion. Principles of Optical Coupler Logic Gates Optical couplers use light propagation and interference between adjacent waveguides or fiber cores to perform logic operations. In a linear three-core fiber coupler, the geometry and coupling coefficients determine how input pulses combine at the output, allowing the realization of gates like a 3-input OR or a configurable AND/NIMPLY gate. These devices operate with low-power amplitude-modulated pulses and do not require nonlinear materials, relying solely on coupled-mode theory and precise core spacing for logical discrimination. Nonlinear couplers, such as slot-waveguide couplers, exploit intensity-dependent refractive index changes to achieve logic functions like NOT, OR, and AND. These designs can be polarization-dependent or independent and often require full-vector finite-element simulations to optimize performance.

Types of All-Optical Logic Gates All-optical logic gates (AO-LGs) include the standard Boolean operations: AND, OR, NOT, XOR, XNOR, NAND, and NOR. They can be categorized based on:

- Reconfigurability: Gates that can switch between logic functions using control signals.
- Simultaneous operation: Gates capable of processing multiple inputs concurrently.
- Modulation-based designs: Gates optimized for specific pulse formats or data rates.
- Reversible logic gates: Designs that minimize energy loss and allow backward computation.

Performance Metrics and Analysis Key metrics for evaluating optical logic gates include:

- Contrast ratio (CR): Measures the distinction between logical '1' and '0' outputs.
- Response time: Determines the speed of logic operation, often in picoseconds.
- Power consumption: Low-power operation is critical for integration into photonic circuits.
- Compactness and integration: Simpler structures favor integration into larger optical integrated circuit...

Article Content

A review on construction of logic gates by using soliton in all-optical ...

Logic gates are an extremely important structural component for logical operations and high-speed data transmission now-a-days. Initially, logic gates were functioning with electrical

Analysis of an optical logic gate using a symmetric coupler operating ...

In this paper we propose the operation of an all-optical logical gate based in a symmetric nonlinear directional coupler (NLDC) operating with a pulse

Optoelectronics: Optocouplers

Optocouplers, sometimes referred to as opto-isolators or photo-couplers, are semiconductor devices that isolate unwanted signals by physically separating high-voltage circuits

All-Optical Logic Gates Based on Nonlinear Slot Waveguide Couplers

A novel design of all-optical logic gates based on nonlinear slot-waveguide couplers is proposed. NOT, OR, and AND logic gates can be realized by a simple single optical-directional

All-optical 3-input OR and 2-input AND/NIMPLY logic gates in a linear ...

In this work, we present the numerical modeling of two all-optical logic gates based on a fully linear, dispersion-free planar symmetric three-core optical fiber coupler. The devices operate with low

Review on all-optical logic gates: design techniques and ...

Abstract and Figures All-optical logic gates (AO-LGs) are the key elements that play a pivotal role in the development of future all-optical networks and all-optical computing.

All-in-one, all-optical logic gates using liquid metal plasmon ...

In this work, we exploit the plasmon-enhanced TONL of liquid-metal GNAs to demonstrate a reconfigurable all-in-one AOLG based on dynamic and programmable manipulation

Design and analysis of an all-optical NAND logic gate using a photonic ...

Abstract In this study, a high-speed all-optical NAND logic gate (AO-NAND-LG) was designed and numerically simulated. The simulation was performed using the photonic crystal

Numerical analysis in triangular and planar three-core nonlinear ...

Request PDF | Numerical analysis in triangular and planar three-core nonlinear optical fiber couplers (TNLDC) operating logical gates | In this paper, we investigate the switching process in ...

The design, analysis, and simulation of an optimized all-optical AND ...

All-optical logic gates have proven their significance in the digital world for the implementation of high-speed computations. We propose herein a novel structure for an all-optical

Optical XOR logic gate design in two dimensional photonic ...

In this paper, we present an all-optical XOR gate based on two-dimensional photonic crystals (PCs). The proposed gate is designed to be used in optical computing and all-optical logic...

Ultracompact, high-extinction ratio XOR, OR, and Feynman logic

First, a 3 dB directional coupler based on metal-insulator-metal waveguides is presented and its operation principles are investigated using the coupled mode theory method. Then, XOR and OR

[2512.20024] All-optical 3-input OR and 2-input AND/NIMPLY logic

In this work, we present the numerical modeling of two all-optical logic gates based on a fully linear, dispersion-free planar symmetric three-core optical fiber coupler.

Logic gates based in two

OMELG is defined as a function of the extinction ratio of the gate outputs. Comparing the same gates of the three and two-core NLDC we observe that the logical gates of the three-core TNLDC ...

From Light to Logic: Recent Advances in Optoelectronic

This review delves into the advancements in optoelectronic logic gate (OELG) devices, emphasizing their transformative potential in computational technology

Ultra-Compact All-Optical NAND Logic Gates Based on 4×4 MMI Coupler ...

In this paper, we present a new scheme for realizing an all-optical logic NAND gate structure based on only one 4×4 MMI cascaded with a 2×2 MMI coupler on HPWGs. The device

A Comparative Study of Various All-Optical Logic Gates

Many researchers have demonstrated basic logic gates with the help of optics to enhance the working performance of digital circuits. All-optical logic units are basic structure to implement

Simple and reconfigurable all-optical logic gate

To our knowledge, this is the first report of an optical logic gate that is capable of switching between all the six basic logical operations by adjusting only one system parameter.

Fully Integrated AND and OR Optical Logic Gates

We propose two novel designs of compact, linear, and all-optical OR and AND logic gates based on photonic crystal architecture. The proposed devices are formed by the combination of the

All-optical logic gates via PT-symmetric soliton dynamics in ...

We present a numerical study of a PT-symmetric nonlinear directional coupler designed for femtosecond soliton-based optical switching and logic operations. The system is modeled using a

(PDF) Logic gates based in two

In this paper we did a study of logic gates obtained in the operation of a three-core non linear directional coupler (TNLDC) and an asymmetric two-core coupler (DNLDC) operating in the

All optical logic gates based on an asymmetric nonlinear directional ...

Many interesting applications of these devices have been proposed , and all optical switching in the nonlinear directional coupler and cascaded nonlinear couplers have been

Performance analysis of all-optical logical gate using artificial ...

Even though the two mentioned neural networks models can be used to model all-optical 3-input XOR gates appropriately, results show that MLP NN using the most relevant features

Demonstration of All-Optical NAND Logic Gate Using Photonic

Many approaches have been proposed to achieve all-optical logic functions, based on the nonlinear effects either in optical fiber or in semiconductor material. In the present work we propose a novel

A novel method of high-speed all-optical logic gate based on metalens

Overall, these results demonstrate a successful balance between contrast and transmission speed when utilizing metalens to realize all-optical logic gates. From the results, the

Contact Us

For more information, pricing, or custom solutions, please contact us:

Website: <https://www.dknconsulting.co.za>

Email: info@dknconsulting.co.za

Phone: +31 6 2948 7351

Address: Herengracht 123, 1015 BT Amsterdam, Netherlands

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