UNIVERSITI TEKNOLOGI MARA

1×N SYMMETRICAL AND ASYMMETRICAL OPTICAL PLANAR WAVEGUIDES COUPLERS

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

1×N symmetrical and asymmetrical couplers based-on highly multimode planar waveguide have been designed, simulated, fabricated and characterized. Highly multimode waveguide has wide potential application in home-network applications, automotive wiring such as entertainment devices in car and sensors application. In this research work, 1×2 and 1×4 symmetrical waveguide coupler were utilized symmetry Y-junction design to obtain symmetric splitting ratio. Meanwhile, 1×2 asymmetrical waveguide coupler were developed using different technique to obtain asymmetrical ratios. The transmission characteristics were simulated using non-sequential ray-tracing technique. The devices have cross-section area of 1 mm ×1 mm were fabricated on transparent acrylic substrates. Two different waveguides have been used as a core that is highly transparent adhesive polymer and hollow metal-based waveguide. The hollow waveguide structure was coated with 60-nm-thick reflective layer to enhance reflectivity in the waveguide channel. The design of 1×2 tap-off Y-junction waveguide coupler utilized changing the width of the branching waveguides to obtain asymmetric branching ratios. The simulation result gives excess loss from 0.223 dB to 0.528 dB with various tap-width of 0.05 mm to 0.95 mm with 0.05 mm interval. The output coupling ratios have been designed in the range of 1% to 99%. A novel design of asymmetric hollow shift-port Y-junction waveguide coupler was proposed. This Y-junction simply utilizes the technique of shifting the axis of the arm of the output port so that the required power-splitting ratio can be obtained. The waveguide splits the output power asymmetrically in the range of 93% to 7% with ±3% splitting-ratio accuracy. The measured insertion loss at the shift-port has a minimum value of 4.00 to a maximum of 15.62 dB for 0.00 to 0.90 mm shifting of the axis respectively. While the measured optical excess loss at the shift-port varies from 2.06 to 4.32 dB. Another new asymmetrical waveguide coupler design which is hollow shift-axis has been presented. The structure with a series of patterns having shifted axis (Δx) from 0.1 mm to 0.9 mm have been designed. The center axis of the taper waveguide and the branching output arm were adjusted in a straight line to obtain an asymmetrical branching ratio. By shifting Δx from 0.1 to 0.9 mm, the branching ratio can be obtained in the range from 1% to 99% by experiment. The measured insertion loss at the shift-axis has a minimum value of 5.21 dB to a maximum of 27.36 dB for 0.1 to 0.9 mm shifting of the axis respectively. While the measured optical excess loss at the shift-axis varies from 5.18 to 10.58 dB.

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