

UNIVERSITI TEKNOLOGI MARA

**PLASTIC OPTICAL FIBER COUPLERS FOR
PORTABLE OPTICAL ACCESS-CARD SYSTEM**

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Thesis submitted in fulfilment of the requirements
for the degree of

Doctor of Philosophy

Faculty of Applied Science


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Candidate'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 other degree or qualification.

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Abstract

A code generating device using 1xN asymmetric POF coupler has been designed and fabricated. This code generating device is part of a novel portable optical access-card system. In this project, 1x2 Y-branch, 1x2 and 1x4 asymmetric couplers were developed. The design of the 1x2 asymmetric POF coupler utilized a simple tap off ratio (TOFR) design technique to tap off optical power from the main bus line. This asymmetric design was achieved by varying the size of the tap line while the bus line was fixed at 1 mm size. The device modeling was done using non-sequential ray tracing utilizing a metal-based hollow waveguide structure. The 1x2 Y-branch coupler device model shows a simple 3 dB device characteristics. The designed TOFR for the 1x2 asymmetric coupler varies from 33% to 50% for tap line width of 500 μm to 1000 μm . The simulated TOFR however varies from 18.8% to 50% for the same tap line width ranges. These couplers were fabricated using hollow waveguide structure with metal and acrylic-based mold inserts where designs were engraved onto the mold inserts using CNC machine. After engraving, short POF fibers were inserted into the input and output ports of the engraved slots and a top block was then placed on top of the mold insert and secured. The fabricated metal-based 1x2 Y-branch showed a minimum excess loss of 3 dB. The fabricated metal and acrylic-based 1x2 asymmetric couplers showed TOFR variation between 10.7% to 47.7% and 10.3% to 50% respectively. The insertion loss for the metal-based 1x2 asymmetric coupler at the tap line varies from 12.7 dB to 21.2 dB whereas for the bus line, the insertion loss was about 12 dB. The insertion loss for the 1x4 asymmetric coupler at the output ports varied from 17.3 dB to 27.7 dB. The high insertion loss of the metal-based devices was due to air gaps between the top block and the bottom mold insert, because of the non-flatness of the metal surfaces and causes light rays to escape from the hollow region. This work has enabled us to develop low cost optical code generating devices for a novel portable optical access-card system.

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