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A multistage free-space optical interconnect for backplane applications: implementation issues

A.G. Kirk, F.K. Lacroix, M.H. Ayliffe, E. Bernier, D. F-Brosseau, M. Chateauneuf, B.Robertson[1], F.A.P. Tooley[2], D.V. Plant
Photonics Systems Group, Department of Electrical and Computer Engineering, McGill University
3480 University Street, Montréal, Canada, Tel: (514) 398-2531, E-mail: akirk@photonics.ece.mcgill.ca
[1] Now with the Department of Engineering, University of Cambridge, UK.
[2] Now with the Department of Physics, Heriot-Watt University, UK.

1 Introduction

Free-space optical interconnects represent a possible solution to the interconnection bottleneck encountered at the backplane level of high performance electronic systems [1,2]. One of the critical challenges in this field is the development of robust, misalignment tolerant, field serviceable micro-optical hardware. Here we describe the implementation of the micro-optical modules required for a multistage 256 channel optical interconnect.

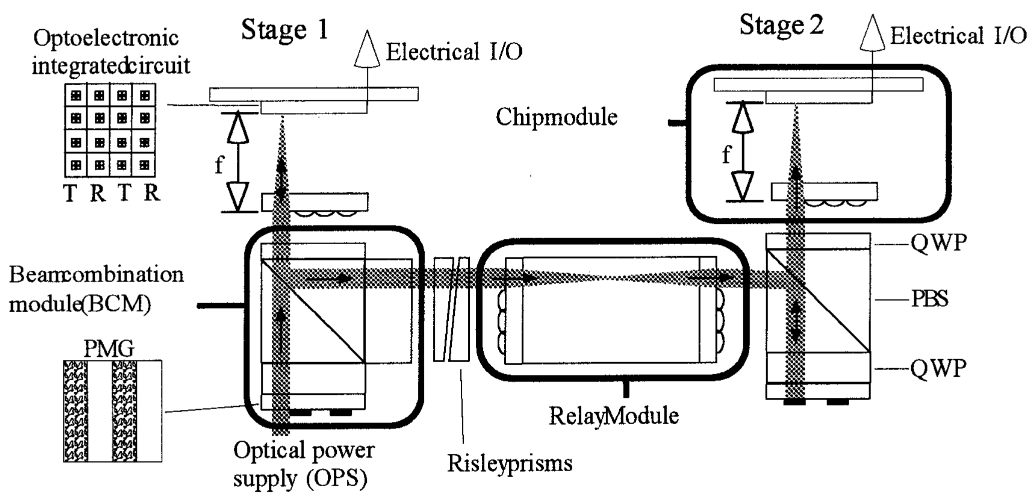

Figure 1. Optical layout for two stages of the multistage interconnect (abbreviations given in text)

2 Design

Fig. 1 shows the layout of two stages of a multistage optical interconnect, based on a design recently described by Robertson [3]. The optoelectronic integrated circuits (OEIC), situated at stages 1 and 2 contain alternate clusters of 4 x 4 GaAs quantum confined stark effect (QCSE) modulators and detectors (in a dual rail configuration). The devices are placed on a 90 μm pitch whilst the clusters are placed on an 800 μm pitch. The modulators are illuminated via an optical power supply (OPS) which generates the required array of 512 spots [4]. Polarizing optics (comprising of two quarter wave plates (QWP) and a polarizing beam splitter (PBS)) are used to combine the CW spot array and the optical data transmitted from the previous stage onto each OEIC whilst allowing optical output from the OEIC to be transmitted to the next stage. Light is relayed in clusters between OEICs via diffractive minilens arrays. An alignment tolerance analysis of this design [3,5] indicates that the optical components should be assembled into the modules shown on Fig. 1 (i.e. beam combination module (BCM), relay module and chip module [6]). Each module can then be inserted into the system using passive alignment techniques.

3 Implementation

Fig. 2 shows the relay module, which consists of two diffractive optical lens arrays separated by a block of high index glass. The lens arrays are aligned via an interferometric technique [7]. Four low efficiency

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Fresnel lenses are positioned in the corners of the relay lens substrates and are used to generate interference fringes. This permits a lateral alignment accuracy of ±5 μm and a rotational accuracy of 0.1°. Optical cement is used to fix the components in place. Tilt and axial alignment tolerances are assured from the specifications of the planarity and dimensions of the glass spacer. A similar technique is used to assemble the beam combination module shown in Fig. 3. Once the modules have been assembled using active alignment techniques they are integrated by passive insertion into a slotted baseplate. Fig. 4 shows the 512 spot array which is generated at the OEIC plane after transmission through the beam combination module and onto the chip module. The transmission efficiency from the input to the optical power supply module to the modulator array was found to be 34% (not including intrinsic fan-out losses) and the spot uniformity within a cluster was ±1%.

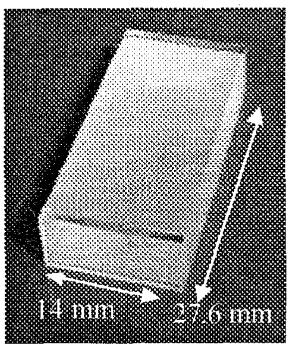

Figure 2. Relay module

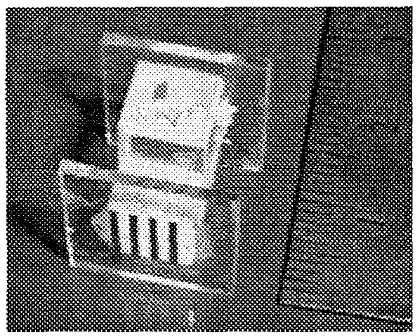
Figure 3. Beam combination module

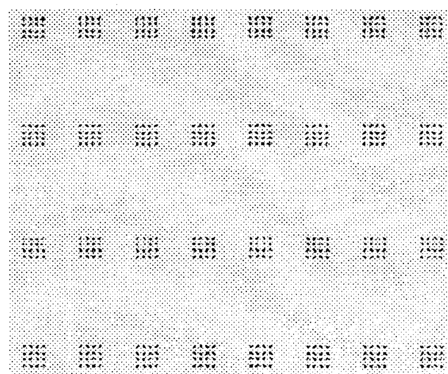
Figure 4. Spot array at OEIC plane

4 Conclusions

Careful optical system design permits a modular construction technique for free-space optical interconnects. Module assembly requires accurate active alignment techniques but greatly simplifies system integration. Further details of optical system performance will be presented.

Acknowledgments

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