Daughter Board to Backplane Bi-directional Optical Interconnectivity

Optical CrossLinks has developed a feasibility demonstration for optical multimode waveguide array backplane/mother board to daughter board connectivity. The 90 degree connection demonstrates the principle for two guiding layers enabling a bi-directional connection from the daughter board going both directions on the backplane/mother board. The design concept is amenable to versatile practical configurations, additional guide layers, extremely high density, non-standard or standard sized ferrules based on the MT pin ferrule designs. Yet to be configured are spring loaded housings to assure that both electrical and optical connections are compatible and compressive forces are compensated. The approach capitalizes on unique technology attributes enabling:

1) a compatible ferrule dimension footprint relative to an electronic board connector,
2) extremely high density within commercial sized MT ferrules including multiple waveguide array layers for bi-directional connectivity and up to 500 densely packed waveguides within the ferrule face,
3) blind mate connectivity using housing tracks combined with MT pins,
4) optical losses to be of the order 0.5 dB per right angle connection from the plane of the daughter board to that of the backplane or mother board including the guide to guide interface in adjoining MT style ferrules,
5) all ferrules to be mounted on the board surface with no through holes in the backplane / mother board being required.

The basic design concept is depicted schematically in Figure 1 where a robust flexible film containing an array of waveguides is bent 90 degrees with a 5mm ROC from the backplane to a precise guide aligning face plate.

This is further embellished by the schematic shown in Figure 2 where two guide layers from each side of the ferrule on the backplane/mother board are bent as shown and aligned in the face plate MT interface. The adjoining daughter board with matching guide arrays in an edge mounted modified MT is shown at the top.

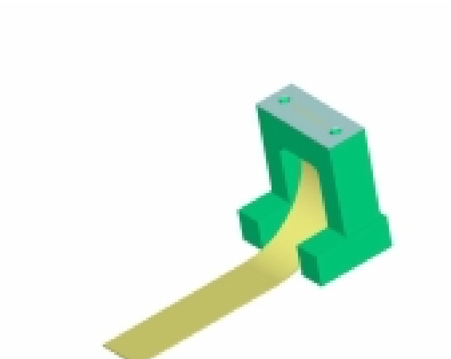


Figure 1. Right angle connector schematic

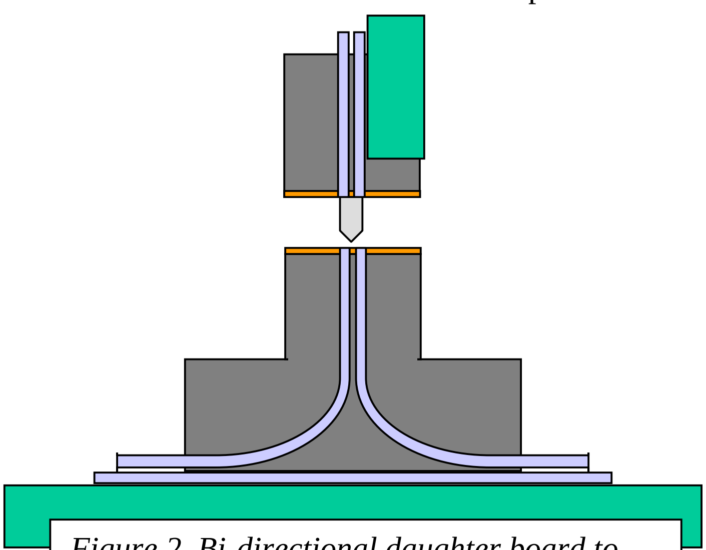


Figure 2. Bi-directional daughter board to backplane connector

The two waveguides in light blue are coupled across the MT interface each bending in opposite directions onto the backplane/mother board. The ferrules are gray and the boards are green. The aligning face plate is in orange. Another guide is shown underneath the 90 degree ferrule to depict optical circuitry remaining on the backplane to connect to other adjoining boards.

As a representative example to demonstrate the concept actual waveguides are shown in Figure 3 where MT ferrules are connected on the two guide arrays coming out of the back plane right angle bend ferrule. This configuration is ready for board attachment. The daughter board MT ferrule, which is plugged into the backplane ferrule, has the cut down MT ferrule for board edge mounting as was depicted in Figure 2. For this demo the MT ferrules on the backplane are also machined for board edge mounting. Longer waveguide runs in real applications are expected. The vertical waveguide film is actually two vertical waveguide array layers with 45 degree I/O mirrors at the top.

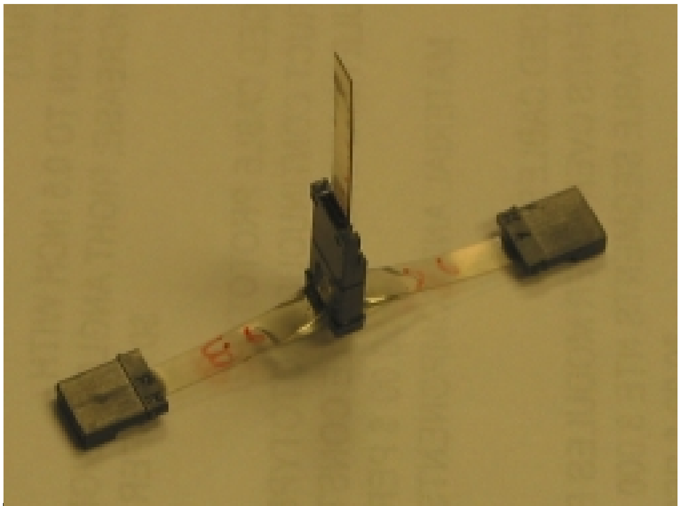
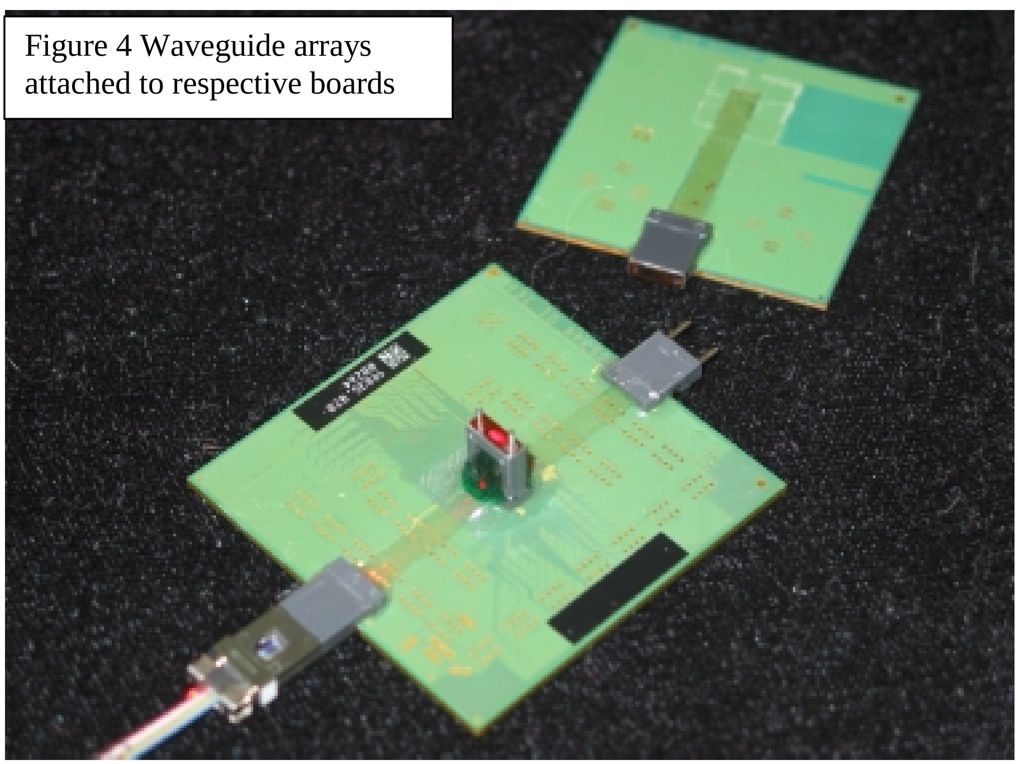


Figure 3 Waveguide array films with coupled MT connectors before board attachment.

This waveguide array configuration is attached to a representative backplane/ mother board as shown in Figure 4. Here the daughter board is separate from the backplane board. As noted all three MT's in this configuration have been machined for board edge mounting. Red light (633nm) can be seen coming up from the backplane right angle ferrule which shows light from one of the two layers of waveguides directed through the guide array from the fiber ribbon MT onto the simulated backplane.

Figure 4 Waveguide arrays attached to respective boards



In Figure 5 the two boards are coupled through MT ferrule interfaces and guided light is observable from one I/O mirror.

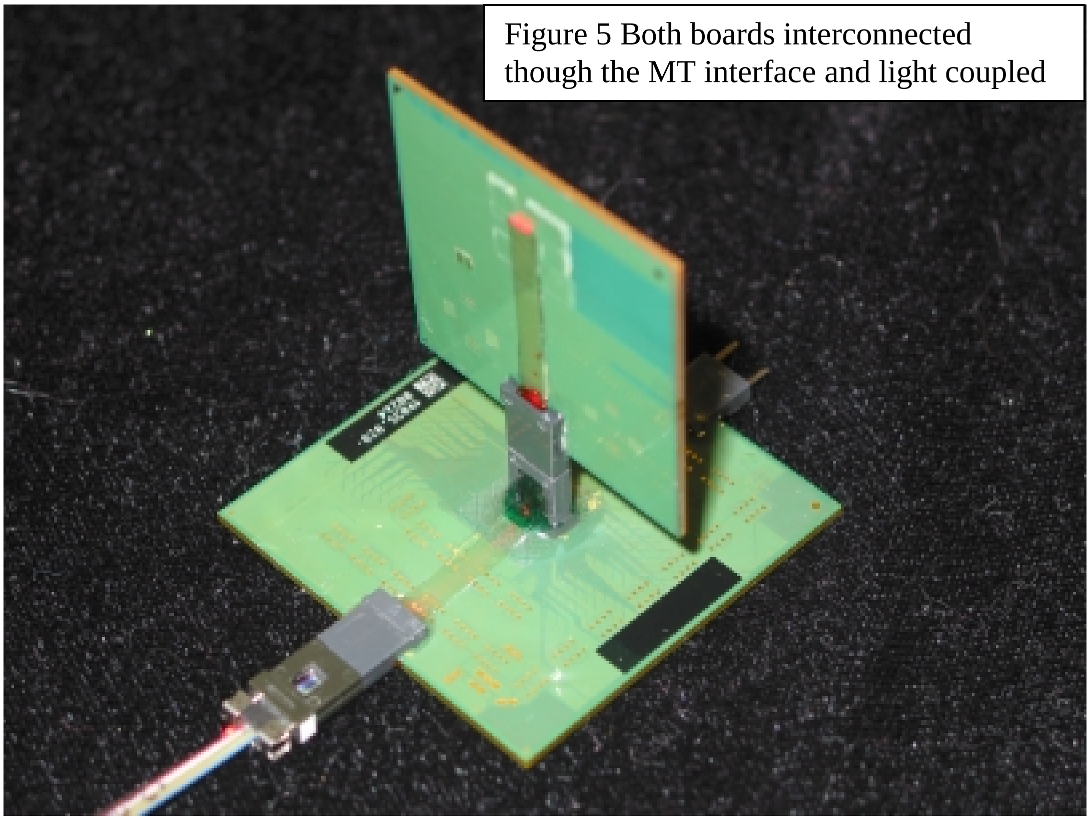
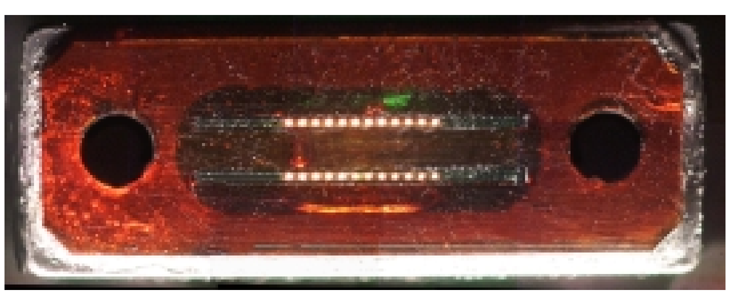


Figure 5 Both boards interconnected though the MT interface and light coupled

Illumination of 24 waveguides at the MT right angle bend ferrule face is shown in Figure 7 where both guide layers can be seen. Close stacking of guides on 50 micron centers within layers and 100 micron layer to layer enables several hundred guides to be coupled. At this interface there are 44 guides but not all are light coupled. The MT guide pin holes are the standard 700 microns diameter and 4.6 mm apart. The guides are 35 microns square with an NA of 0.3 which enables the 5mm ROC right angle bend to sustain minimal loss of only a few tenths of dB or less. As note the total loss for the bend and MT coupling interface is approximately 0.5 dB. Guide loss at 850nm range is 0.08 dB/cm.

Figure 7. Backplane/mother board right angle bend MT interface showing guides and alignment pin holes.



The unique attributes of the technology that enable versatile the right angle board to board coupling include:

1) Stand alone films with symmetrically placed embedded guides that are robustly packaged with low CTE and high Tg materials for stability without being substrate bonded.
2) Precision micro machining that centers the guides in the strip facilitating alignment in precisely machined structures.
3) Flexible films with low optical loss for 4mm ROC or less.
4) Custom MT style ferrule designs can be configured with even higher numbers and density of coupled guide arrays then achievable with standard size ferrules.

Summary

We have demonstrated the capability for a practical bi-directional backplane to daughter board optical connectivity that is cost effective and versatile. Guides can also pass under the connector to connect to other daughter boards if needed. In addition this design does not require punching holes into the backplane. If there are only polymer waveguides to interconnect and interface to lasers or detectors the guides can be spaced extremely close with 10 micron gaps between guides and roughly 50micron center to center. For interfacing to optical fiber the guides need to fan out to the usual 250 micron center-to-center spacing. Utilizing another OXL waveguide design capability we have demonstrated crossing guides with internal guiding structures that enable routing or non parallel guide arrays with extremely low optical loss of less than 0.1 dB per crossover such that dense guide arrays from board to board interconnects can be redistributed easily on the separate boards.

Developments yet to be demonstrated are the design of housings containing the MT ferrules with spring loading for mounting on the daughter board to enable electronic and optical interfaces to connect as a relief for compressive forces since the electronic and optical connection may seat differently. In addition, this flexibility will also provide some freedom of movement for improved self alignment during board insertion. To achieve this we intend to utilize if need be the flexibility and stand alone robustness of OXL's guide film structures.

BLBooth 6/14/04