

Optical InterLinks LLC (OIL)-----

GuideLink™ Polymer Waveguide Products

***Multichannel Monolithic Data Network
Monitoring Taps***

Using OIL's Polymer Waveguide (PWG) Splitters

OIL's PWG Data Monitoring Taps

Data Centers are increasingly adopting optical transmission:

The Goal: To overcome thermal, power and cross talk issues associated with electronic signal transmission at 10GB/s per channel or higher

Optical Signal Monitoring Required: Fused optical fiber (FBT) splitters are initially being used to provide signal monitoring taps for Data Center optical transmission networks

OIL's PWG monitor tap arrays offer unique advantages:

- extremely compact multichannel units using interleaved multimode splitters,
- all I/O ports are on 250 micron spacing
- low optical loss with nominally +/- 0.3 dB,
- controlled balanced splitting nominally within 3% for 50/50 and 70/30 ratios; other ratios available
- compatible with low to high mode fill using internal scramblers that produce stable splitting and alignment position tolerance,
- potential for low cost manufacture

OIL's PWG Data Monitoring Taps

To date OIL's PWG arrays of interleaved alternating multimode splitter directions provide extremely compact units with uniform I/O spacing on each side of 250 microns for ease of connection/assembly and manufacturability:

- **8 channel** --- 4 splitters in each direction or 8 splitters with 12 I/O ports on each side of the PWG unit
- **12 channels** --- 6 alternating direction splitters or 12 splitters with 18 I/O ports per each side of the PWG unit
- **20 channels**--- 10 alternating direction splitters or 20 splitters with 30 I/O ports per each side of the PWG unit
- All current PWG units use a generic master waveguide unit exposed with 30 I/O ports on each side. There are 20 alternating splitters from which specific devices can be made. The final packaged optical fibers initially have been connected using silicon V groove mount interfaces (as described in this review) that define the specific device I/O. **Alternative connection options are under development eliminating the need for silicon V grooves.**

OIL's PWG Data Monitoring Taps

PWG units are photomask exposed and processed in large film sheets using OIL's unique self development process. Multiple units are created in the film sheet that are separately precisely cut out, evaluated and processed for assembly.

Below, the insets show 50/50 split ratios on the left; and 70/30 split ratios on the right including the very sharp splitting junctions inherent with OIL's process.

50/50



70/30

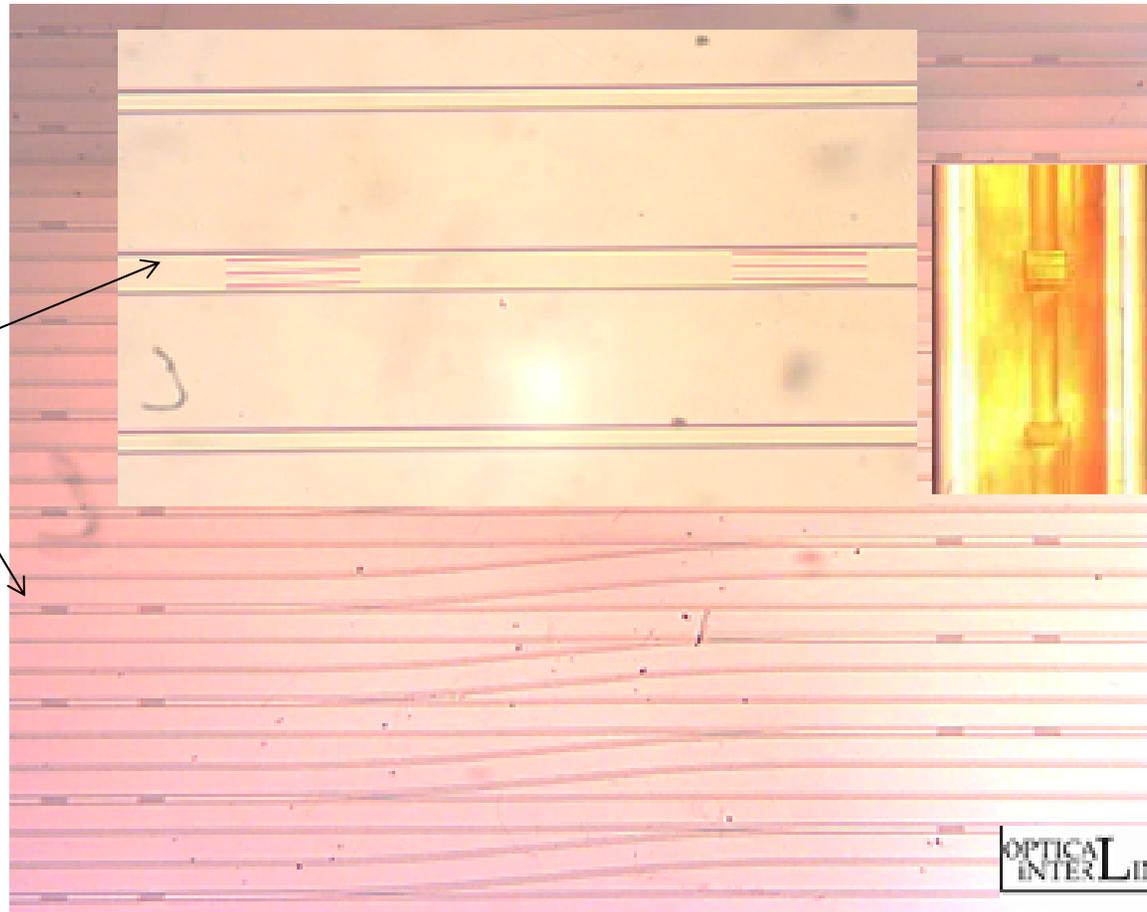


OIL's PWG Data Monitoring Taps

Each PWG input has scrambler units that are internally imaged during waveguide exposure. They deflect lower angle low mode input to higher propagating angles or mode fill operation. This enables balanced, stable multimode splitting with minimal excess loss and also increases alignment position tolerance.

The inset show the low index pattern imaged thru the waveguide

Array of alternating direction splitters with mode scramblers ----- for signal monitoring



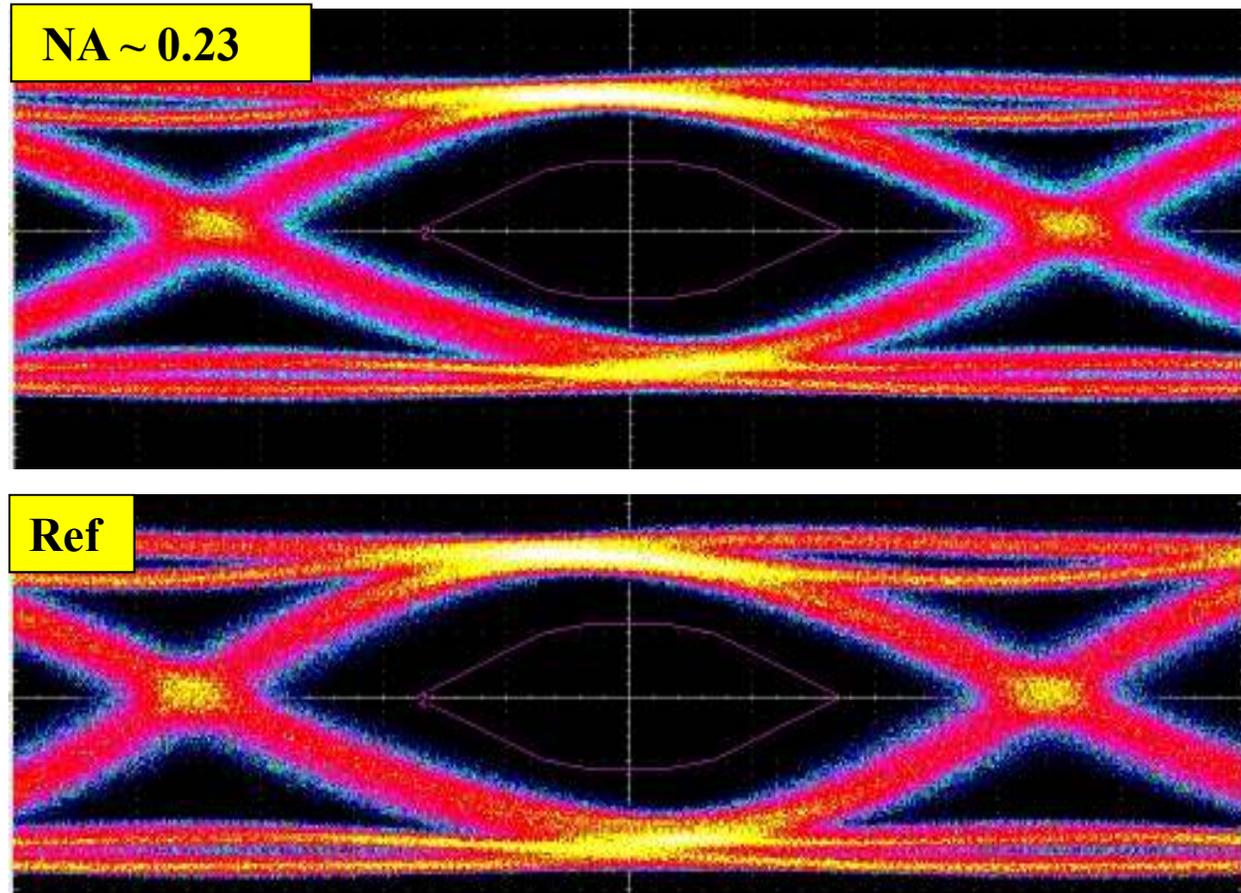
OIL's PWG Data Monitoring Taps

Currently Data Centers use 10GB/s per channel. This result demonstrates OIL's PWG performs well at this data rate. Testing for 20 to 30 GB/s is underway

Open Eye Diagrams
Measured by Cisco
using 5 cm pigtailed
PWG's at 850 nm
operation at 10Gb/s.

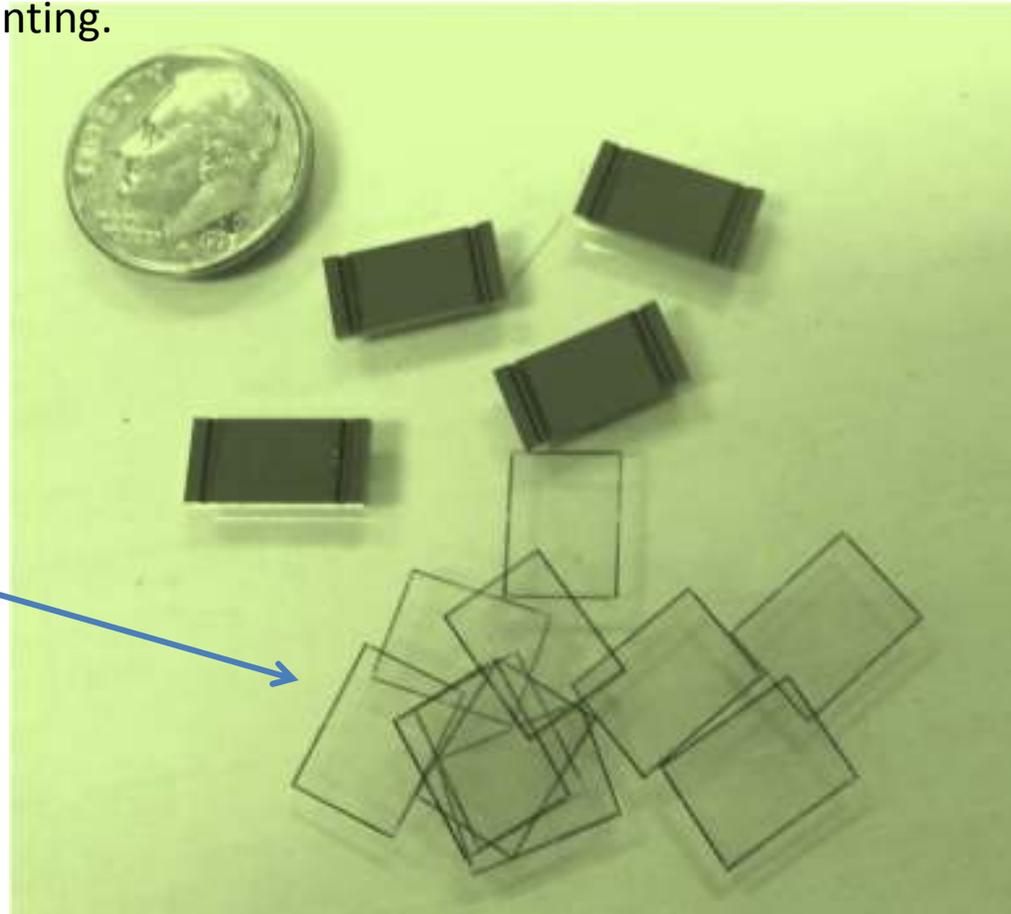
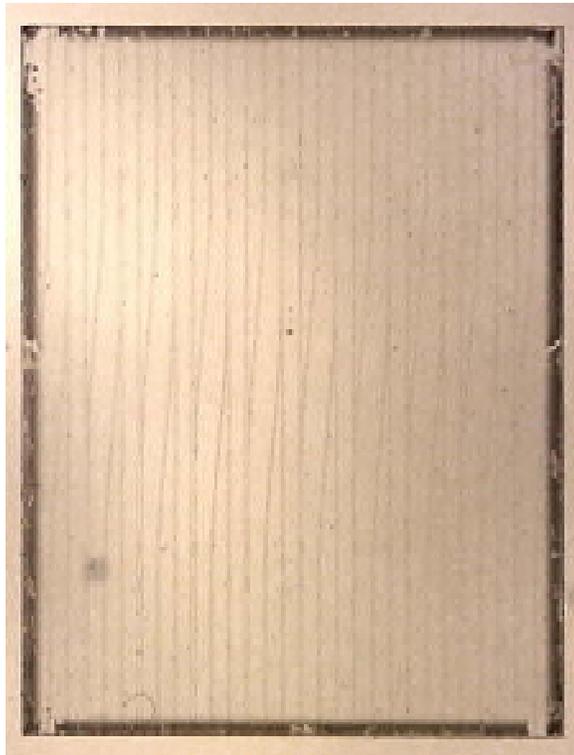
Top: PWG with NA
compatible with
50 μ m GI core OM3
and OM4 OF input
and output

Bottom: reference
input signal



OIL's PWG Data Monitoring Taps

PWG tap monitor units are cut out from exposed film sheets. The black border is debris from the laser ablation micromachining that is cut and polished off during assembly. Each is a master waveguide unit with 30 I/O ports (20 interleaved splitters) is used for all current applications. Multiple pieces are on the right with the silicon / pin V groove for mounting.



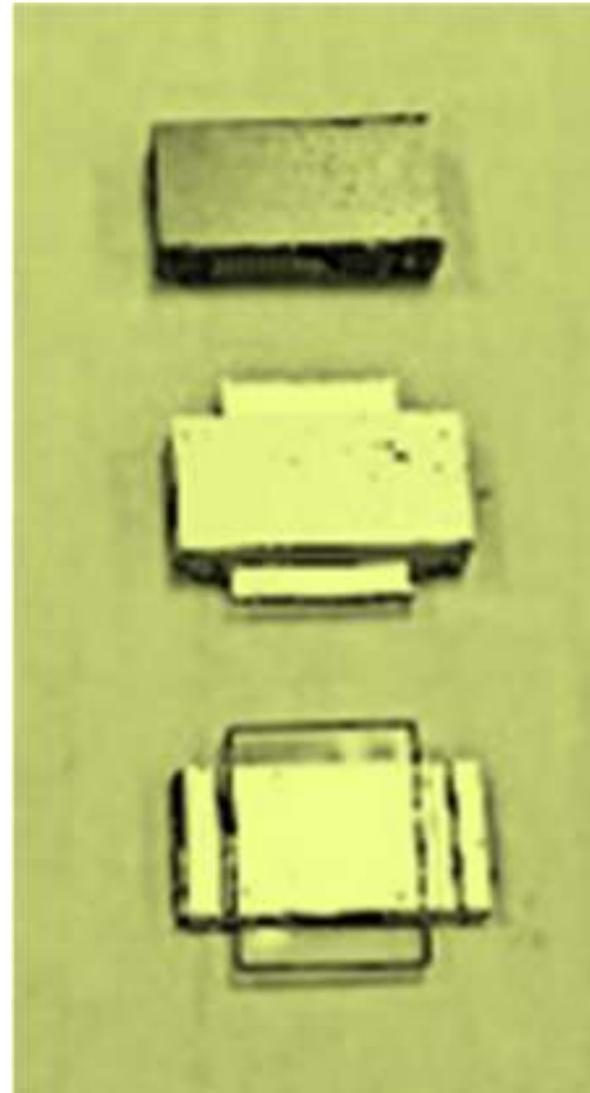
OIL's PWG Data Monitoring Taps

Assembly of the PWG units.

Top: The over hanging PWG array is cut and polished at the silicon mount edges. Final QC is made. PWG final length is 6 mm for each of the 20 splitters and 7.5 mm wide centered between the pin holes

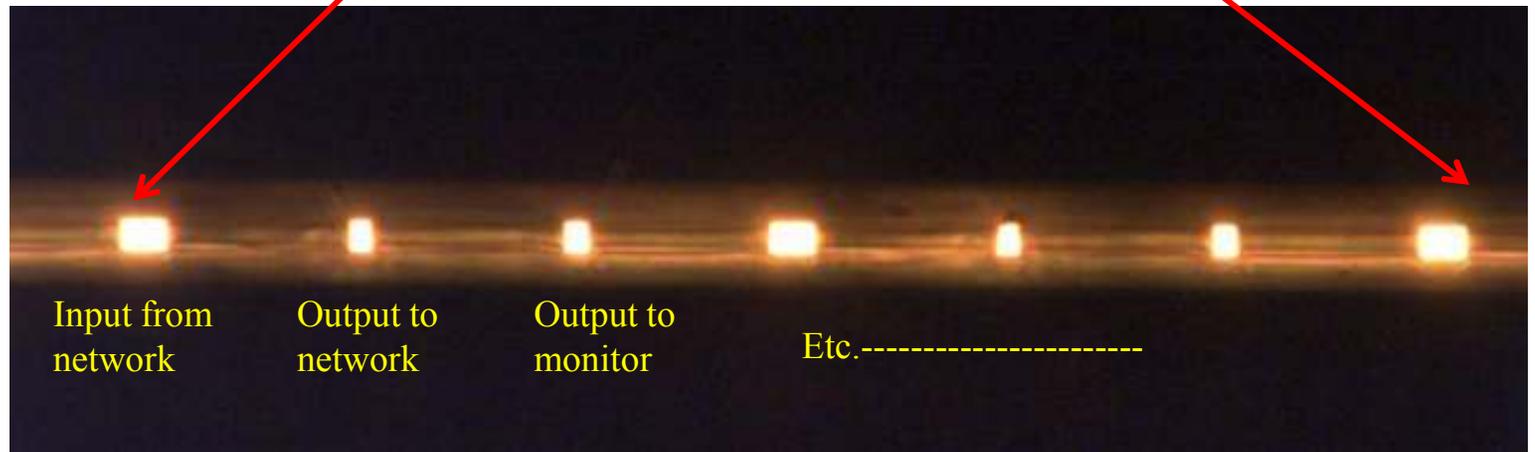
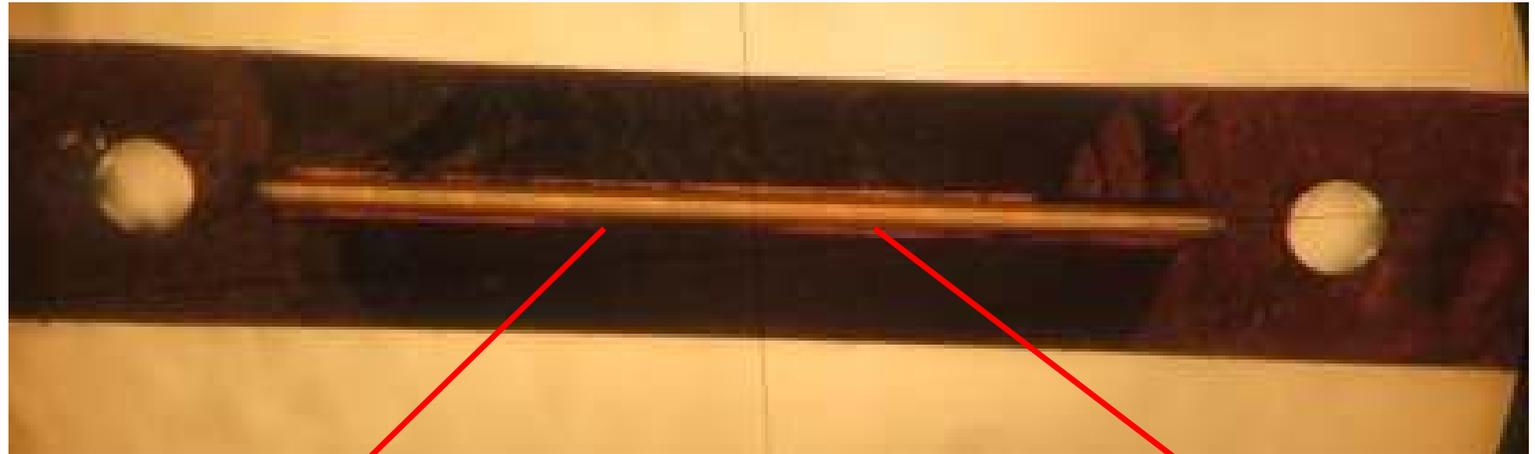
Middle: top silicon mount is positioned. Following precision alignment between the pin holes the PWG is epoxied in place.

Bottom: PWB is positioned on lower silicon/pin V groove mount



OIL's PWG Data Monitoring Taps

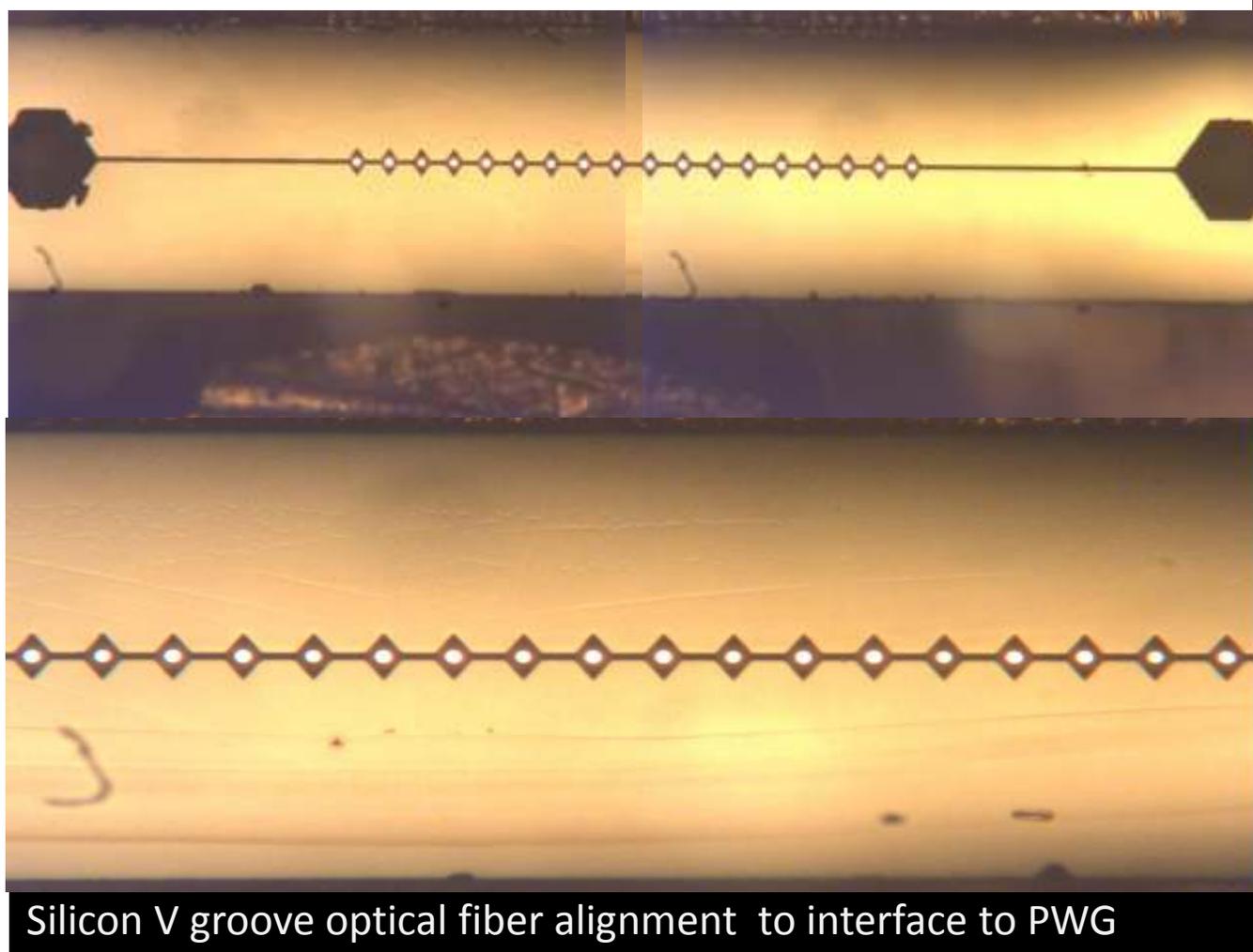
Top: End view of the silicon encapsulated PWG with 30 I/O ports and alignment pin holes



Bottom: End view of illuminated PWG's. Inputs are 50 microns wide and splitter outputs are 25 microns wide for optimum coupling to/from OM3/OM4 OF

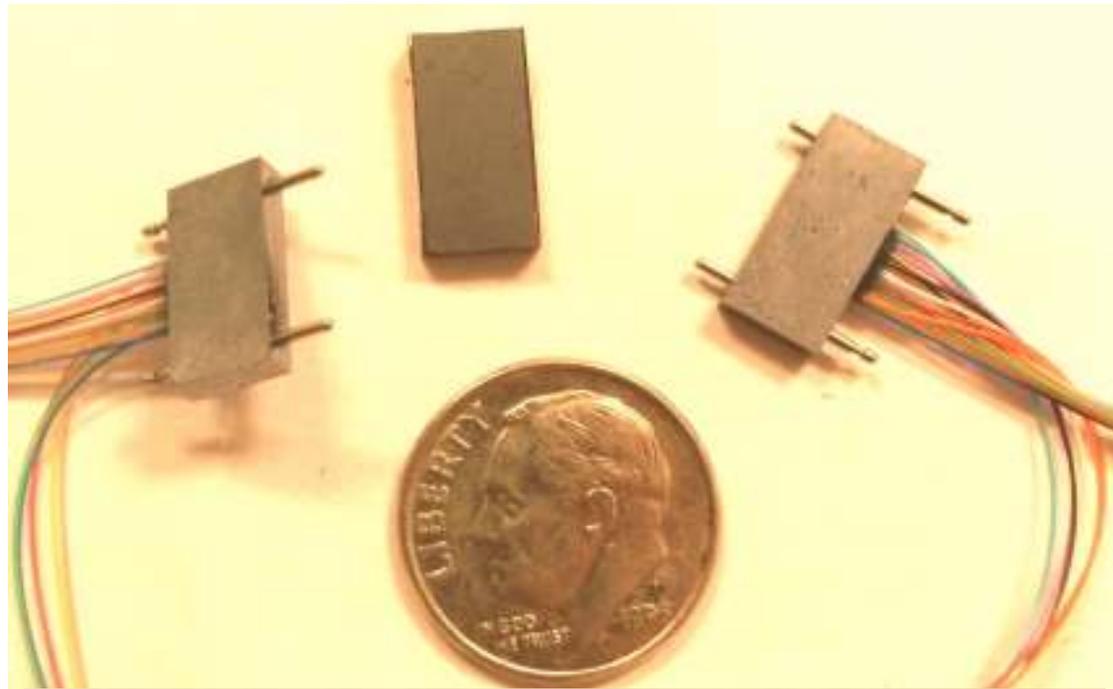
OIL's PWG Data Monitoring Taps

Optical fiber silicon mount with 18 fibers for coupling to PWG constructing the 12 channel unit-- 6 interleaved tap monitors.

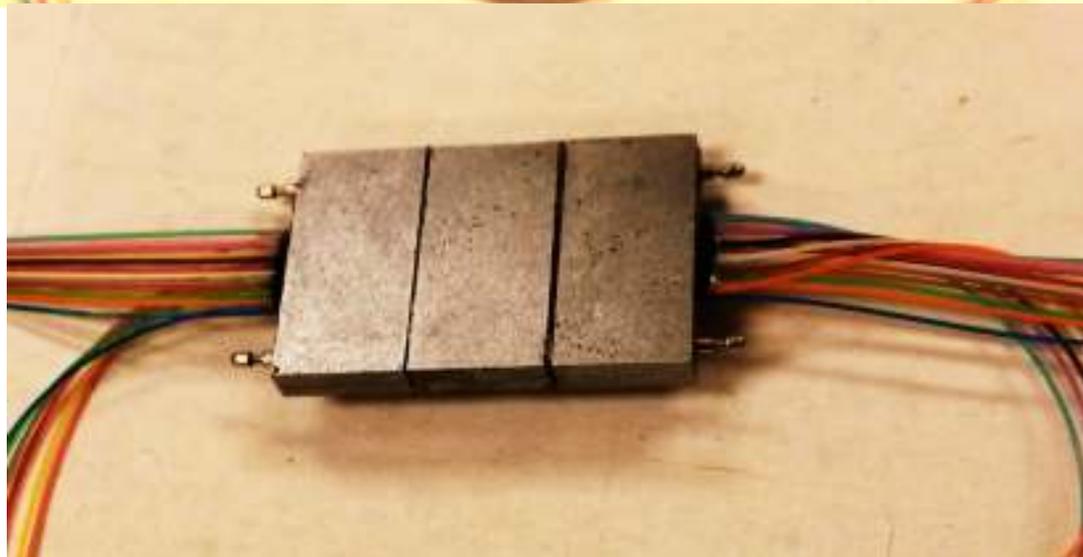


OIL's PWG Data Monitoring Taps

Top: Optical fiber silicon mounts with fiber harnesses attached and the PWG encapsulated silicon. Alternative connectorization under development eliminating silicon.



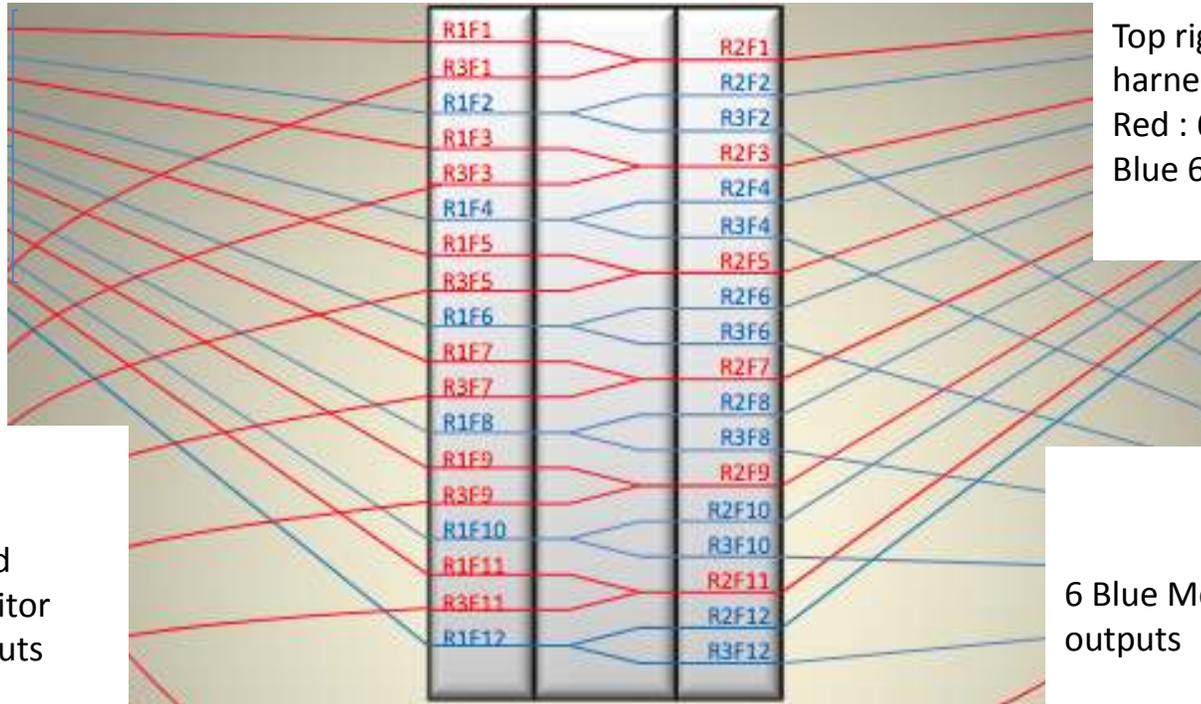
Bottom: Pin aligned final assembly. The 3 pieces are locked with optical epoxy as a permanent unit.



OIL's PWG Data Monitoring Taps

Fiber harness layout for 12 channel (6 interleaved splitter units with 6 inputs and 12 outputs each side).

Top left Network harness:
Red : 6 outputs
Blue: 6 inputs



Top right Network harness:
Red : 6 inputs
Blue 6 outputs

6 Red Monitor outputs

6 Blue Monitor outputs

Generated by Mimatrix Technologies

Center section is the simulated splitter unit interfacing the two fiber harness mounts.

OIL's PWG Data Monitoring Taps

Current encapsulating package for all units.

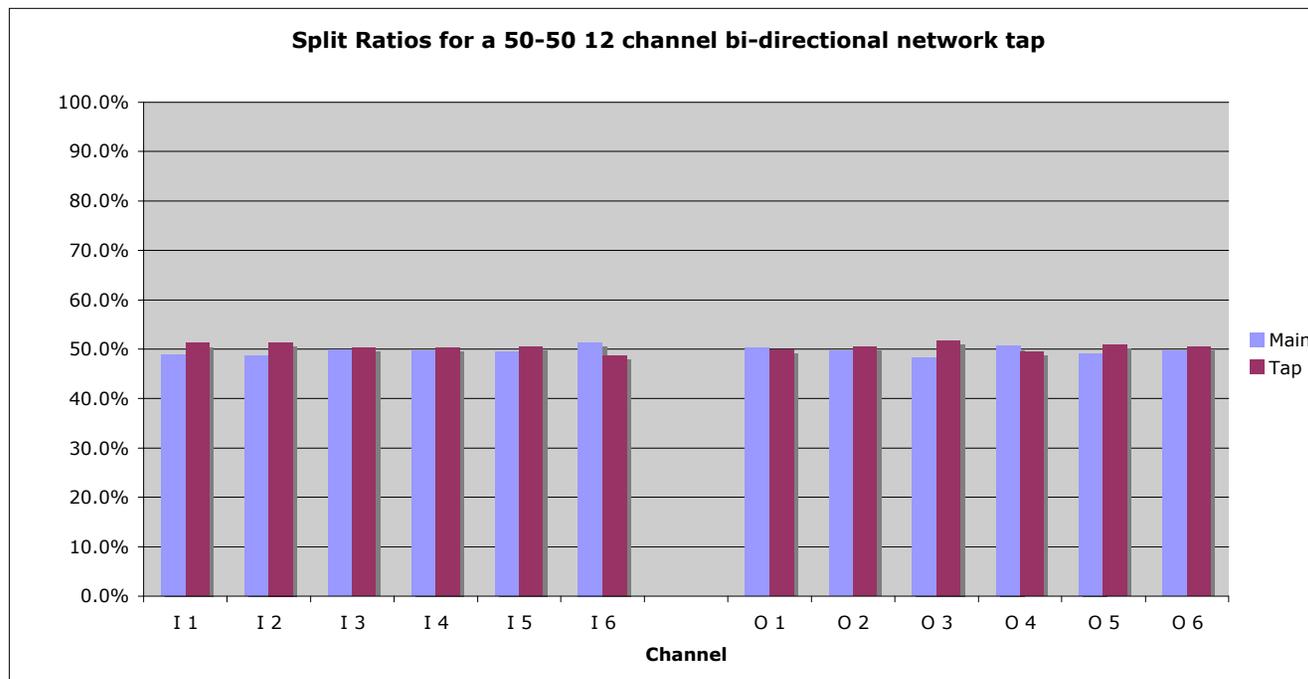
Dimensions are: 5 cm long, 3.4 cm wide, and 0.6 cm high



OIL's PWG Data Monitoring Taps

Split ratios for packaged 12 channel* 50/50 bi directional devices are within 3%. Network channels are in blue and monitor tap channels are in red.

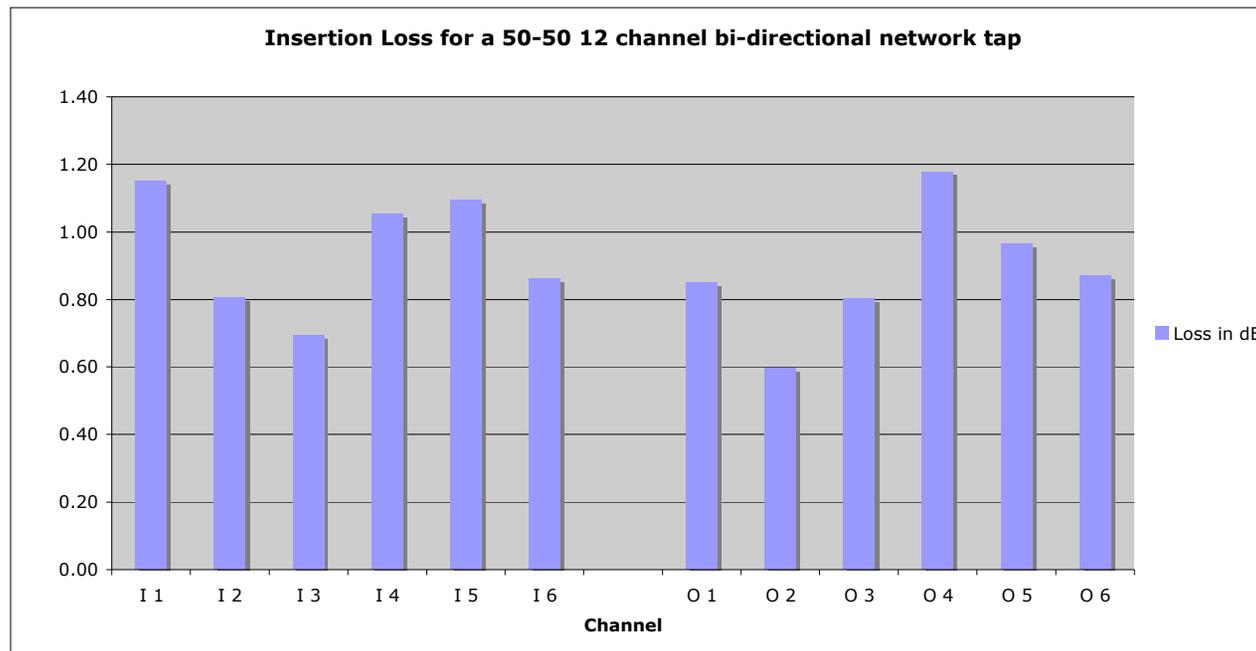
The group on the left is arbitrarily labeled for discussion purposes Input side I - 1 thru 6 and on the right labeled Output O - 1 thru 6.



* Data reported in this review covers only 12 channel devices for brevity. OIL is currently also delivering 8 and 20 channel devices.

OIL's PWG Data Monitoring Taps

Optical loss for each of the two outputs (from a single splitter) from each side for a packaged 12 channel 50/50 bi directional device are within +/- 0.3 dB as shown below. Current goal spec was less than 1.5 dB not including 3 dB split loss.

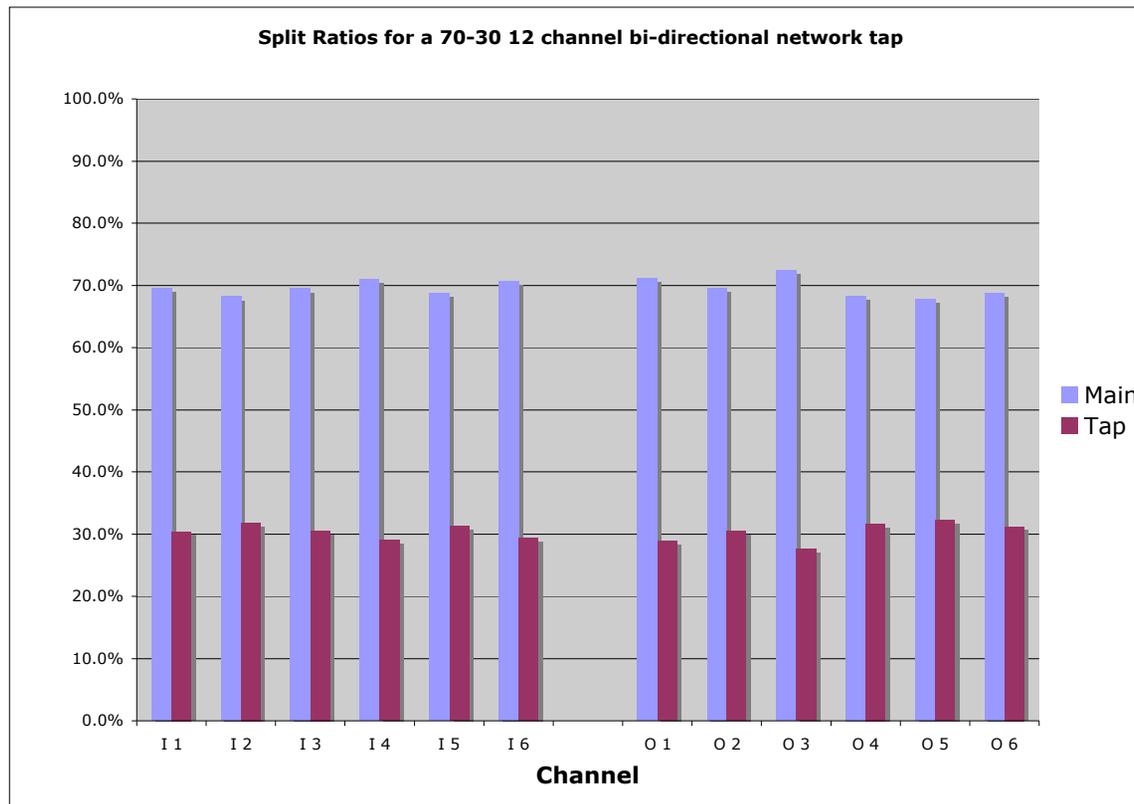


Plot show dB loss versus each splitter output for the arbitrarily labeled I and O sides of the symmetrical device.

OIL's PWG Data Monitoring Taps

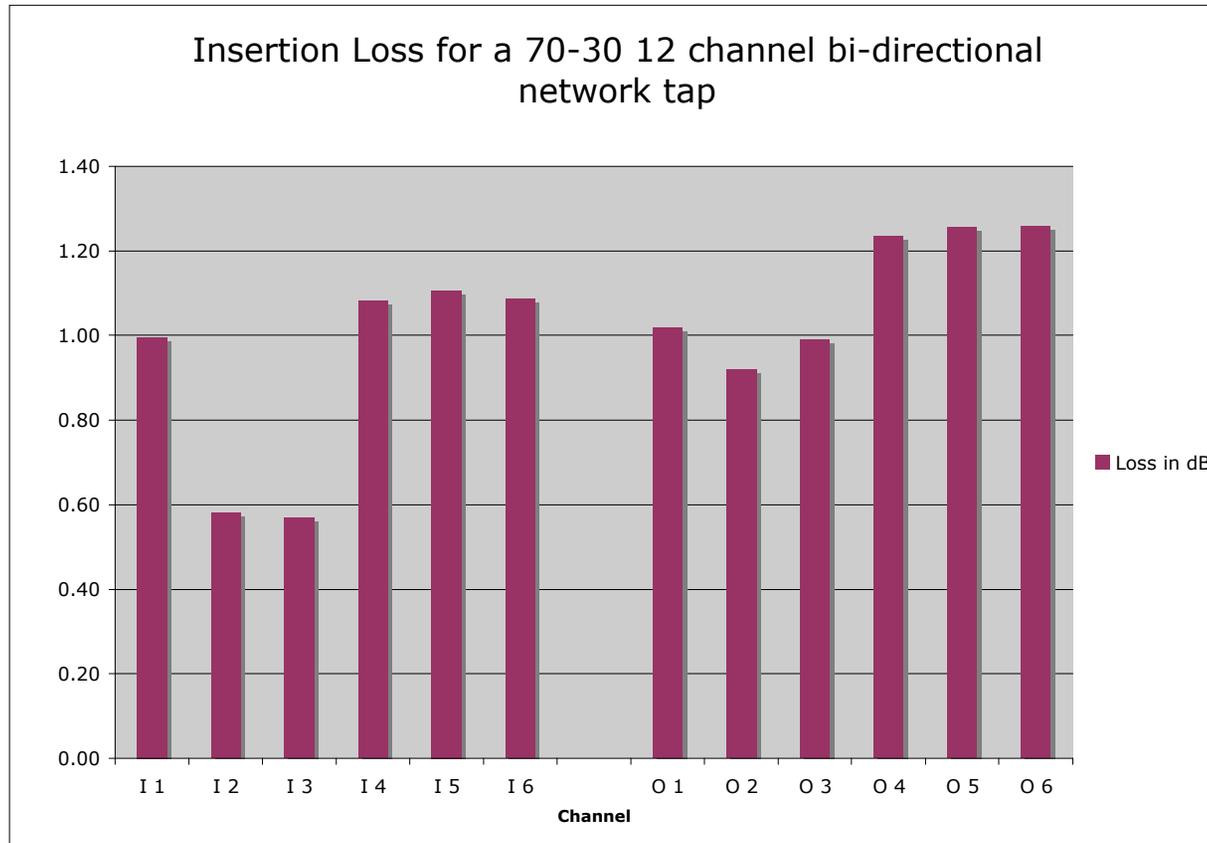
Split ratios for packaged 12 channel 70/30 bi directional device are within 3% of spec. Network channels are in blue and monitor tap channels are in red.

The group on the left is arbitrarily labeled for discussion purposes Input side I - 1 thru 6 and on the right labeled Output O - 1 thru 6.



OIL's PWG Data Monitoring Taps

Optical loss for each of the two outputs (from a single splitter) from each side for a packaged 12 channel 70/30 bi directional device are less than +/- 0.3 dB as shown below. Current goal spec was less than 1.5 dB not including split loss.



Plot show dB loss versus each splitter output for the arbitrarily labeled I and O sides of the symmetrical device.

OIL's PWG Data Monitoring Taps

Summary of OIL data monitoring device features :

- All I/O ports are on 250 micron centers with one input followed by 2 splitter outputs, one to the network the other as the monitor channel, repeating along each side of the unit. Exposures are made for a generic unit with a total of 30 waveguides on each side from which specific devices can be created.
- All splitting ratios have output channels that are currently nominally 50/50 or 70 network and 30 monitoring. Other ratio options are available.
- All input channels are nominally 50 microns wide and 35 microns high for efficient input coupling from 50 micron GI fibers,
- All input waveguides have OIL's unique internally imaged mode scramblers to assure balanced stable splitting for low to high multimode input and greater input alignment tolerance for manufacturability.
- All output channels are nominally 25 microns wide and 35 microns high to provide optimum coupling into 50 micron GI fiber cores (OM3/OM4 fibers)
- OIL's PWG splitters are interleaved with alternating directions to compress the waveguide unit and with equally spaced fiber interconnection.

OIL's PWG Data Monitoring Taps

Path Forward:

Continue to optimize the process, layout designs, and assembly operations in preparation for volume production scale up

Farm out critical fiber harness components to reduce costs

Develop market opportunities and new design modifications to meet industry needs

Requests for information and inquiries can be directed to :

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