



# OZ Optics

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## V-GROOVE ASSEMBLIES

USA Patent: 7058275

### Features:

- Up to 96 fiber V-Groove arrays
- Hermetic feedthru versions with glass or metal solder are available
- Singlemode, multimode or polarization maintaining fibers
- High polarization extinction ratios up to 30 dB available
- Ribbon or individual fibers, lensed/tapered fibers, mechanically cleaved, laser cleaved or polished endcapped fibers
- Assemblies with bare fiber or 900 μm jacketing, and with or without connectors
- Standard 900 μm jacketed breakouts available, up to 2 meters in length
- Custom configurations possible for OEM applications
- Designed to meet Telcordia specifications (GR 1221-core, GR 326-core)

### Applications:

- Arrayed Waveguide (AWG) devices
- Planar Lightwave Chips (PLC)
- Dense Wavelength Division Multiplexers (DWDM)
- MEMS devices
- Miniaturized or integrated fiber optic components

### Product Description:

OZ Optics V-Groove array assemblies assist in developing next generation photonic devices. The arrays are manufactured using precision silicon wafer V-Groove technology or Pyrex V-Groove in conjunction with a Pyrex lid, enabling sub-micron alignment accuracy with UV cure attachment capabilities. OZ Optics also offers pyrex V-Groove substrates.

OZ Optics V-Groove array assemblies are available with singlemode, multimode or PANDA type Polarization Maintaining (PM) fibers. Customization can even include different types of fibers assembled into a single array. PM fibers offer a means to control the polarization of optical signals throughout the system thus minimizing Polarization Dependant Losses (PDL) and Polarization Mode Dispersion (PMD) effects. This control is crucial in developing high speed 40 Gb/s to next generation 100 Gb/s coherent detection systems.

In general, OZ Optics uses polarization maintaining fibers based on the PANDA fiber structure when building polarization maintaining components and patchcords. However, OZ Optics can construct devices using other PM fiber structures. We do carry some alternative fiber types in stock, so please contact our sales department for availability. If necessary, we are willing to use customer supplied fibers to build devices.

Standard PANDA style PM arrays are manufactured with the polarization axis (stress rods) aligned vertical to the V-Groove base within 3°. High grade assemblies with one to eight channels can be provided with the stress rods aligned to 1°. Arrays can also be provided with the fibers aligned parallel to the base, alternating axes or at custom angles. When supplied with a breakout and connectors, the alignment of the connector is also to the slow axis, within 3° for standard connectors or available to within 1.5° for high grade connectors.

V-Groove array assemblies can be manufactured with a hermetic feedthrough attached. This enables the development of multichannel photonic devices capable of meeting Telcordia requirements. Fiber breakouts can also be added, to convert ribbonized fibers into separated fibers, capable of being connectorized.



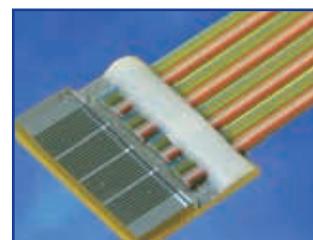
Hermetic Feedthru V-Groove Assemblies for Coherent Detection Systems



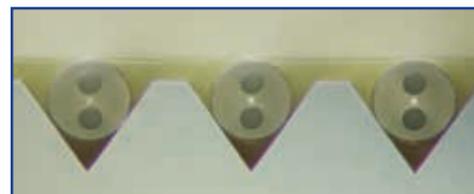
8 Channel PM Fiber Pigtailed V-Groove Array



16 Channel Pyrex V-Groove Assembly



Silicon 32 Channel V-Groove Assembly



PM Fiber V-Groove Assembly Endface



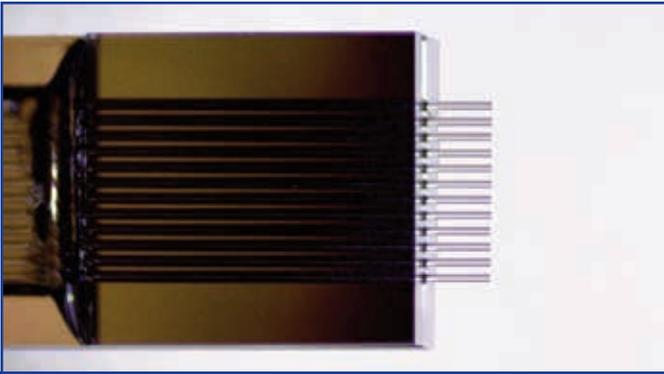
Hermetic V-Groove Assembly



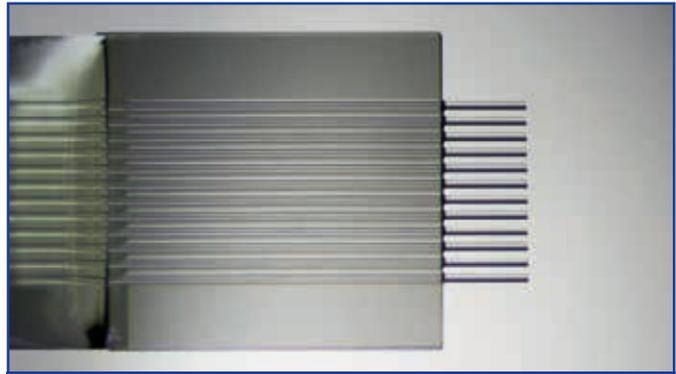
V-Groove Assembly With 900 Micron OD Breakout And Connectors

**NEW! V-groove assemblies with tapered/lensed/polished/cleaved fibers.**

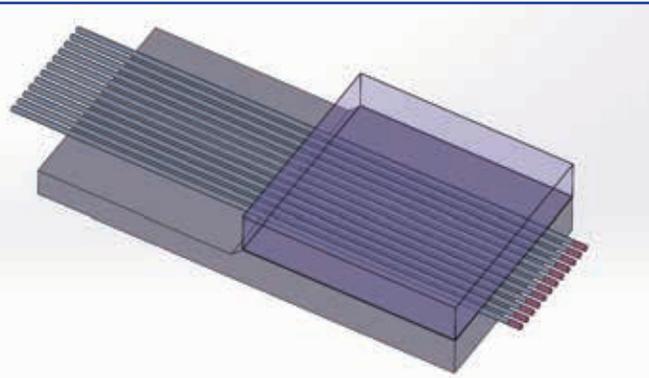
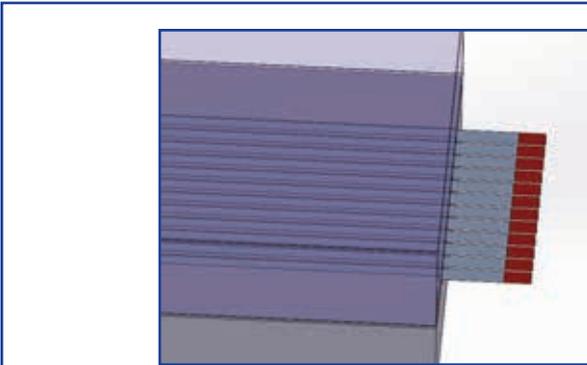
**NEW! V-groove assemblies with endcapped fibers for high power applications.**



**V-groove Assembly with polished/cleaved fibers with glass v-groove substrate**



**V-groove Assembly with polished/cleaved fibers with a Silicon v-groove substrate**



**V-groove Assembly with endcapped fibers for high power application**

### **Dual Fiber Polarization Maintaining Patchcords:**

A common requirement in polarizing devices is a fiber optic patchcord assembly where two or more polarization maintaining fibers are terminated in a single ferrule, to be attached to a lens or other optical assembly. Great care must be taken when assembling such devices, to ensure that the polarization axes of both fibers are precisely aligned with respect to each other.

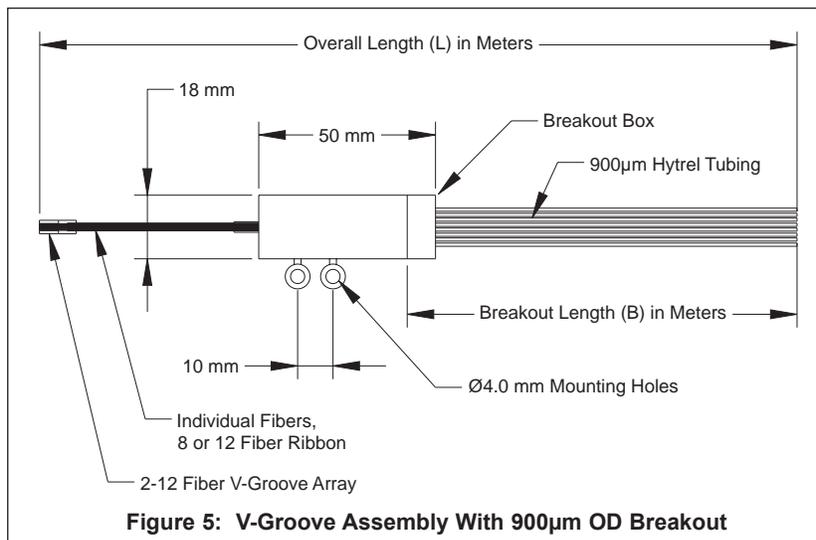
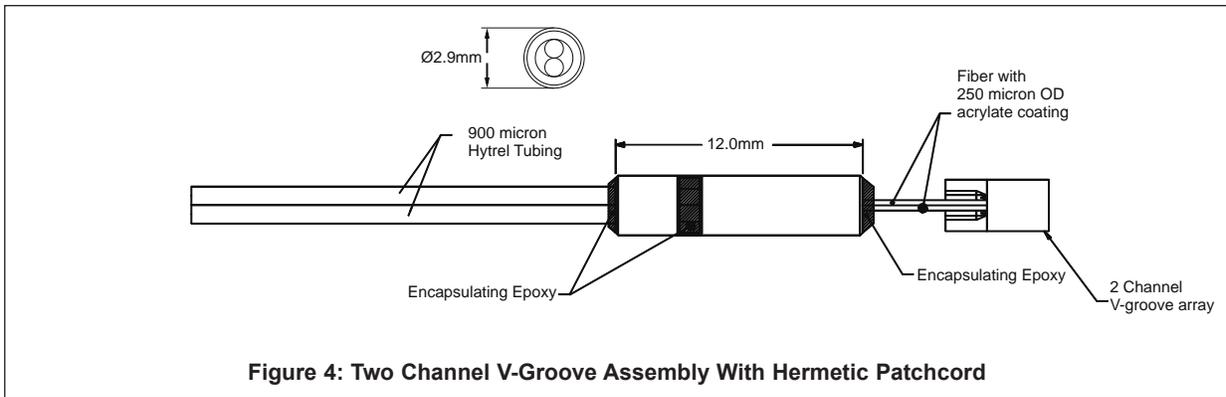
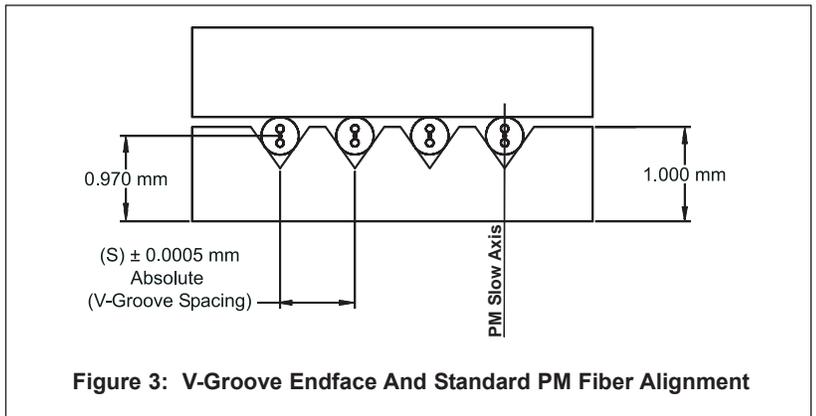
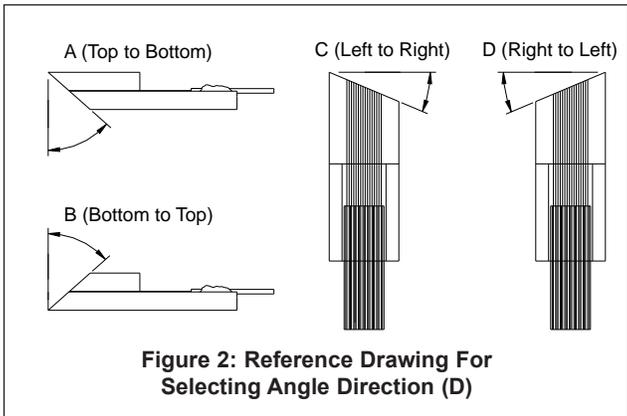
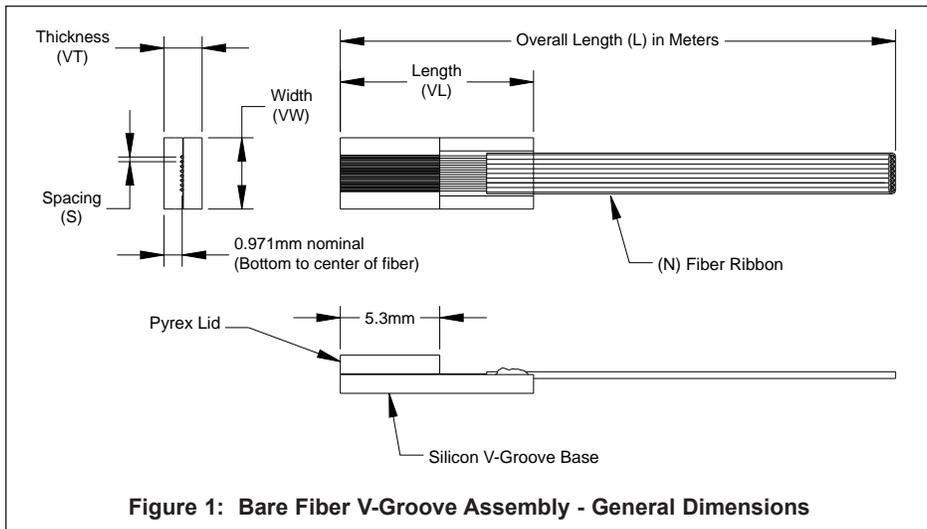
OZ Optics has the capacity to manufacture dual fiber ferrule assemblies with high precision. The polarization axis of each fiber can be independently aligned, with the slow axes of the fibers aligned either parallel or perpendicular to each other. The end face of the ferrule can be flat or angle polished, to any desired orientation. Contact OZ Optics for details. For assemblies with more than two fibers, OZ Optics offers V-Groove assemblies. Please refer to the data sheet titled *V-groove Assemblies* for detailed information.



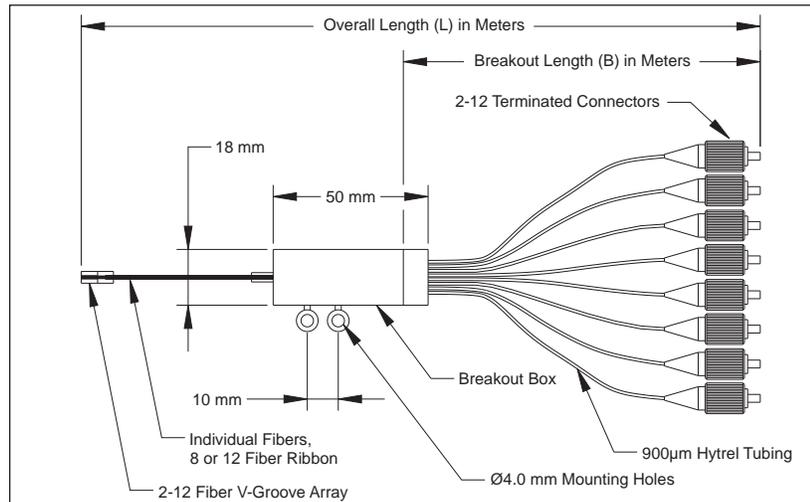
**Dual Fiber PM Patchcord Assembly**



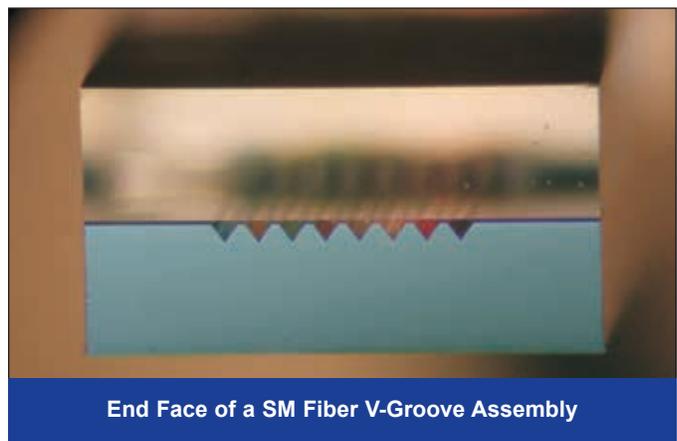
**End Face Of Dual Fiber Assembly Showing Stress Rod Alignment**



Note: For V-Groove Assemblies with more than 12 fibers, multiple breakout boxes can be used, one for every 8 fibers.



**Figure 6: V-Groove Assembly With 900µm OD Breakout And Connectors**



**Ordering Examples For Standard Parts:**

A customer needs to connect standard singlemode fiber to a planar waveguide device which has an 8 output positions at 250 µm spacing and is polished at 8° to reduce backreflection problems. The device will be spliced in place, so no connectors or breakouts are required.

**General Specifications:**

Polish angle:	0°, 8° ± 0.3° Custom angles available up to 50°
Insertion loss:	<0.5 dB per fiber
Fiber spacing:	127 and 250 µm fiber to fiber. Other spacings available upon request 500 µm gap between each 8 fiber ribbon (for 16 fiber count and higher)
V-Groove spacing accuracy:	±0.5 micron absolute (See application notes)
Fiber types:	Singlemode SMF-28 ribbon fiber (9/125) Multimode ribbon fiber (50/125 or 62.5/125) Polarization maintaining (PANDA Type) fiber (individual) Others custom fibers available (individual) Tapered/Lensed. Please refer to datasheet DTS0080 and choose type indicating fiber type, spot size, working distance, fiber length, etc. Endcapped fibers. Please provide details: Fiber type, endcap length and tolerance. Polished or cleaved fibers. Please provide details: Fiber type, angle and tolerance.
Breakout:	Breakout length up to 2 meters Breakout tube is white (singlemode or multimode) or blue (PM) 900 micron Hytrel. Other colors and material is also available upon request.
Connectors available:	SC, FC, ST, LC, MU, other

## PM Fiber Pigtailed V-Groove Assembly Specifications:

Polarization extinction ratio	One to eight channels: >20 dB. Twelve or more channels: >17 dB. >30 dB versions can be made for one or two channels
PM fiber orientation	Standard alignment is with the stress rods vertical. Other alignment angles are available. Each fiber can be individually aligned and monitored to ensure good extinction ratios
Angle alignment accuracy of stress rods	$\pm 3^\circ$ (Standard Grade) or $1^\circ$ (Premium Grade, one to eight channels only)

### Ordering Information For Custom Parts:

OZ Optics welcomes the opportunity to provide custom designed products to meet your application needs. As with most manufacturers, customized products do take additional effort so please expect some differences in the pricing compared to our standard parts list. In particular, we will need additional time to prepare a comprehensive quotation, and lead times will be longer than normal. In most cases non-recurring engineering (NRE) charges, lot charges, and a 50 piece minimum order will be necessary. These points will be carefully explained in your quotation, so your decision will be as well-informed as possible. We strongly recommend buying our standard products.

### Questionnaire For Custom Parts:

1. How many fibers do you need?
2. What fiber spacing is needed for your application? (250  $\mu\text{m}$  standard)
3. Do you need the endface polished at an angle? (8° angle standard)
4. What type of fiber do you need (singlemode, multimode, PANDA type polarization maintaining)
5. Do you need connectors for the assembly?
6. How long of an assembly do you need?

### VGA-N-S-A-D-VL-VW-VT-F-W-a/b-X-JD-L-B

**N** = Number of V-Grooves  
1,2,4,8,12,16,24,32, or 48

**S** = V-Groove Spacing (in microns)  
127, 250, 400 or 500  
250 is standard

**A** = Angle of Polish  
0, 8 degrees standard

**D** = Direction of angle  
A,B,C,D (see Figure 2)  
X for flat polish ( $0^\circ$ )

**VL** = Length (in millimeters)  
10.3 is standard

**VW** = Width (in millimeters) See standard specifications for standard chip dimensions

**VT** = Thickness (in millimeters)  
2.03 is standard

**F** = Fiber Type  
S = Singlemode  
P = Polarization Maintaining  
M = Multimode

**W** = Wavelength of operation

**a/b** = Fiber Core/Cladding Diameter  
9/125 for Corning SMF-28 SM fiber  
6/125 for Corning Flexcore 1060 SM fiber  
7/125 for 1300 nm PANDA PM fiber  
8/125 for 1550 nm PANDA PM fiber

**B** = Breakout length (in meters)  
2 meter maximum, 0.5 meter is typical

**L** = Overall Length (in meters)  
Standard length is 1-2 meters

**JD** = Jacket Diameter  
0.25 = bare fiber, 250  $\mu\text{m}$  coated and ribbon fiber  
0.40 = PM fiber with 400  $\mu\text{m}$  coating (500  $\mu\text{m}$  spacing only)  
1 = 900  $\mu\text{m}$  jacketed (Hytel)

**X** = Connector Code  
Note: Standard Assemblies have the same connectors on all fibers  
3S = Super FC/PC (<-40dB RL)  
3U = Ultra FC/PC (<-50dB RL)  
3A = Angled FC/PC (<-60dB RL)  
8 = ST  
SC = SC (<-40dB RL)  
SCU = Ultra SC (<-50dB RL)  
SCA = Angled SC (<-60dB RL)  
LC = LC  
LCA = Angled LC  
MU = MU  
X = No Connector

### Ordering Examples For Custom Parts:

A customer needs to connect to 1550 nm PANDA style PM fiber to a planer waveguide device which has an four output positions at 250  $\mu$ m spacing and is polished at 8 degrees to reduce backreflection problems. The device is going to be used with equipment which has angled FC/PC receptacles. To an overall fiber length of one meter is required with 0.5 m split out for the connectors

Part Number	Description
VGA-4-250-8-A-10.3-3.8-2.03-P-1550-8/125-3A-1-1-0.5	1 meter long, 0.25 mm OD Jacketed 8/125 $\mu$ m 1550 nm Polarization Maintaining fiber pigtailed 4 channel V-Groove assembly with 250 $\mu$ m spacing and 8° angle polish top to bottom with a 0.5 meter long 0.9 mm OD breakout and angled FC/PC connectors on each end

### Assembly Variations (Bold/Underline Letters)

**X** = Connector Code

3S = Super FC/PC (<-40 dB RL)

3U = Ultra FC/PC (<-50 dB RL)

3A = Angled FC/PC (<-60 dB RL)

8 = ST

SC = Super SC (<-40 dB RL)

SCU = Ultra SC (<-50 dB RL)

SCA = Angled SC (<-60 dB RL)

LC = LC

LCA = Angled LC

MU = MU

X = No Connector

Note: Standard Assemblies have all one type of connector

**L** = Overall Length

Note: Standard overall lengths are 2.0 meters and shorter

**B** = Breakout Length (breakout box to end of fiber/connector)

Note: Standard Breakout Lengths are 1.0 meter and shorter

## Frequently Asked Questions (FAQs):

**Q:** What are the standard materials used?

**A:** Silicon for the V-Groove base, Pyrex for the lid.

**Q:** Is the fiber core above or below the surface of the silicon V-Groove chip?

**A:** Nominally the center of the core is located approximately 30 microns below the surface of the chip.

**Q:** Can UV cure adhesives be used to attach the V-Groove assembly to a device?

**A:** Yes, The Pyrex lid allows UV curing of the assembly for attachment.

**Q:** What is the difference between alignment of the stress rods and alignment of the polarization axis for PM fibers?

**A:** The stress rods in PM fiber create a stress across the fiber core, producing the high birefringence that gives PANDA fiber the ability to maintain polarization. However this stress is not perfect throughout the fiber. In addition, the V-Groove production process causes some stress of its own, disturbing the stress profile. These stress variations cause the fiber polarization axis to vary from the stress rod alignment by one or two degrees. Because the stress rods are monitored during alignment, they are specified to a tighter tolerance than the polarization axis.

**Q:** What is the breakout box for?

**A:** The breakout box is used to protect the transition from ribbon fiber to 900 $\mu$ m jacketing. The breakout box is required for assemblies that are to be supplied with connectors.

**Q:** Does the breakout box add any attenuation to the V-Groove assembly?

**A:** No, the breakout box provides a means to separate and jacket the fibers without adding additional attenuation.

**Q:** Can the breakout leads have differing lengths or connectors?

**A:** Yes, OZ Optics can manufacture the breakout to custom specifications, including connector options or individual lengths.

**Q:** How close can the breakout box be to the V-Groove chip?

**A:** The minimum standard distance is 0.25 meters.

**Q:** Can test data be supplied with the fiber array's?

**A:** Yes. If specified prior to ordering, OZ Optics can supply a test report for each V-Groove array or a sampling of the lot being ordered. Please note that this may effect the lead time and price of the assemblies being ordered.

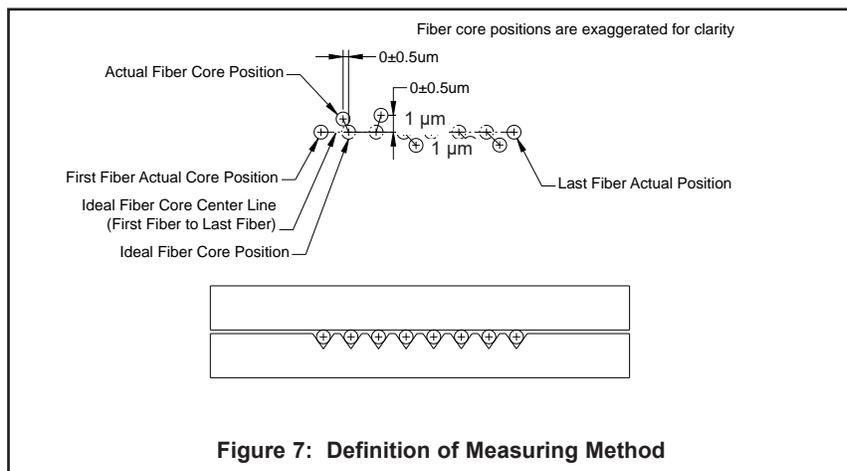
## Application Notes:

### General use of V-Groove array Products

The most common use of the V-Groove assemblies is for connection to and from planar waveguide devices. The design of the V-Groove arrays offered by OZ Optics allows for up to 48 fibers to be connected at one time, maintaining the appropriate fiber spacing to achieve good light coupling, using either UV or heat cured optical epoxy. The most common method for connection is to actively align the V-Groove array utilizing a 3 or 6 axis micro-stage, optimizing the coupling for the first and last fibers of the array. A slight air gap should be maintained during the alignment process to eliminate damage to the fibers and device. Upon achieving the maximum coupling of the outside fibers, the optical adhesive is applied to the interface of the V-Groove chip and the device. Since the OZ Optics V-Groove array is manufactured with an optically clear Pyrex lid, UV curing can be used to get a fast bonding time, then post cured later if necessary. It is critical to choose an adhesive that allows transmission of the wavelength to be used for the device, as the adhesive will be in the path of the light.

### Core Position Measurement method

OZ Optics relies on an automated measurement system to determine the actual core positions and tolerances of the assemblies. The following figure details the measurement process. The measurement system illuminates the fibers with a white light to determine the actual position of the light being transmitted through the fiber (true core position). The illuminated fiber array is then measured using a highly accurate automated video measurement system which finds the center of the first and last illuminated fiber. A reference plane is then created between these two points as the ideal centerline of the array (y axis). Measurements are then taken along this centerline to determine the actual illuminated fiber centers, and values are calculated against the location of the ideal fiber core positions. This measurement method most closely emulates the actual usage of the V-Groove array products.



### LIMITATIONS ON THE LOCATIONS OF THE FIBER CORES:

OZ Optics has taken extensive measures to ensure that the geometry of the V-Grooves are as exact as possible. However another source of fiber core offsets are from the fiber itself. Variations in the fiber core/cladding geometry may also cause offset errors. Therefore while OZ Optics can measure the actual fiber core positions, a specification for the tolerances of the fiber core positions cannot be explicitly specified. As an example, Standard Corning SMF-28 fiber has a core-cladding concentricity tolerance of <math><0.5</math> microns. One can therefore reasonably expect less than one micron positional (V-Groove tolerance & core/cladding concentricity) errors in the fiber core positions using SMF-28 fiber. Results with other fibers will vary.

### Ribbon Fiber Hermetic Patchcords

There have been several issues trying to hermetically seal more than one fiber at a time into a package. The traditional method of using a metalized fiber construction to accomplish this task has some inherent manufacturability problems, including the cost of individually metalizing fibers and then handling them to create a consistent seal, ensuring even metalization between ribbon fibers, and adhesion problems of the metal to the fibers including flaking, blisters and cracking of the metalization. The OZ Optics hermetic patchcords with glass solder for ribbon fibers eliminates these issues by providing a fully assembled hermetic seal directly onto the bare glass. The glass solder material is processed in such a manner that a consistent seal is created between the ribbon fibers and a hermetic seal tube. The seal tube can then be hermetically sealed into a package using industry standard sealing solders, using standard temperatures and techniques. These assemblies relieve the concern about damaging the fibers during the sealing process, having to handle many individual fibers at once, and having inconsistent hermetic sealing around the fibers. The hermetic patchcords with glass solder for ribbon fiber can be provided on a V-Groove array assembly, ready to attach and package.

OZ Optics can also provide V-Groove array assemblies with metalized ribbon, individually metalized fibers or with a Hermetic seal tube assembled onto the ribbon if needed for your application. When supplied as a hermetic patchcord, the assemblies will be tested to ensure hermeticity and are ready to be attached and sealed in place using industry standard sealing solders.

### PM V-Groove Array ER Measurements

OZ Optics ER Meter for PM V-Groove arrays provides fast and accurate extinction ratio measurements of V-Groove assemblies manufactured with PM fiber. The semi-automated system is computer controlled for hassle free control and measurements. The system consists of a polarized light source, a 3 axis measurement micro-stage with one axis motorized, an extinction ratio display set and PC software to control the system. The stage and meter display are connected to a PC using RS-232 cables. The system is capable of measuring extinction ratios up to 40dB with an angular accuracy of  $1.5^\circ$ .

### Operating The PM V-Groove Array ER Measurement System

The system works by first setting the software configurations for the appropriate V-Groove size and spacing. The V-Groove chip is then attached to the mounting stage and the opposite end of the fiber is attached to the polarized source. After adjusting the stage to roughly align the fiber to the meter, the software starts to take the ER measurement and automatically moves the array to the next fiber position. Manual recording of the measured ER and angle is required at this point. Optional software is available to log the measurements for later use. At the software prompt, the user must connect the fiber to the polarized source so the next measurement can be taken.

