Making Light Work Lighter

General Photonics
C o r p o r a t i o n

VDL-004

Miniature Manual
Variable Optical Delay Line

User Guide

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SAFETY CONSIDERATIONS

The following safety precautions must be observed during operation of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the product. General Photonics assumes no liability for customers' failure to comply with these requirements.

Before operation, the user should inspect the product and review the manual carefully.

Follow environmental guidelines in terms of temperature, humidity, and risk of fire or shock. Avoid exposure to liquids or water condensation.

Operate the product on a stable surface. Avoid excess vibration.

Standard laser safety procedures should be followed during operation.

> *Never look into the light source fiber connector when the light source is turned on. THE OUTPUT LIGHT FROM A HIGH POWER LASER IS HARMFUL TO HUMAN EYES. Follow industry standard procedures when operating a high power laser source.*

Section 1.0   Overview

The VDL-004 is a miniature variable optical delay line designed specifically for OEM applications. It provides continuous control with high precision, zero backlash, and good thermal stability. An internal mirror can be installed to cause light to double pass the device, doubling the delay range. A locking mechanism is provided for locking the delay at a permanent position. The VDL-004 generally comes with single mode or PM fiber pigtails per customer requirement. With a footprint of only 78×22×15 mm for a delay range of 130 ps (40 mm), the device can be easily integrated into larger instruments or assemblies for precision optical path length control or timing alignment. Convenient mounting brackets allow mounting in any orientation, as well as easy integration of multiple units on a base plate to form an array.

Figure 1 shows the VDL-004. The optical input and output fiber pigtails are on the left. The adjustment dial is on the right.

Figure 1 VDL-004 manual delay line

Section 2.0   Features

2.1 Optical Features

The standard (single-pass) VDL-004 has a free-space adjustable delay path and two input/output fiber ports. Unless specified, the two fiber ports are symmetrical and therefore interchangeable. If the double-pass option is chosen, the output fiber port is replaced with a Faraday mirror, and both the input and output signals travel on the remaining pigtail.

For double pass devices, because the input and output signals travel on the same pigtail, additional components may be needed to separate the input and output signals. A circulator (for SM input) or PBS (for PM input) can be used for this purpose. In an SM input setup, port 1 of the circulator should be connected to the input, port 2 of the circulator to the VDL, and port 3 of the circulator is the output. In a PM input system, one of the single-polarization ports of the PBS should be connected to the input, and the other to the output. The common port should be connected to the VDL.

VDLs with polarization maintaining (PM) fiber connections are designed for use with slow axis-aligned inputs. Connector keys are aligned to the slow axis of the PM fiber.
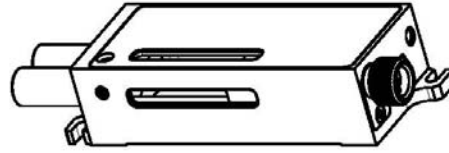
2.2 Mechanical Dimensions
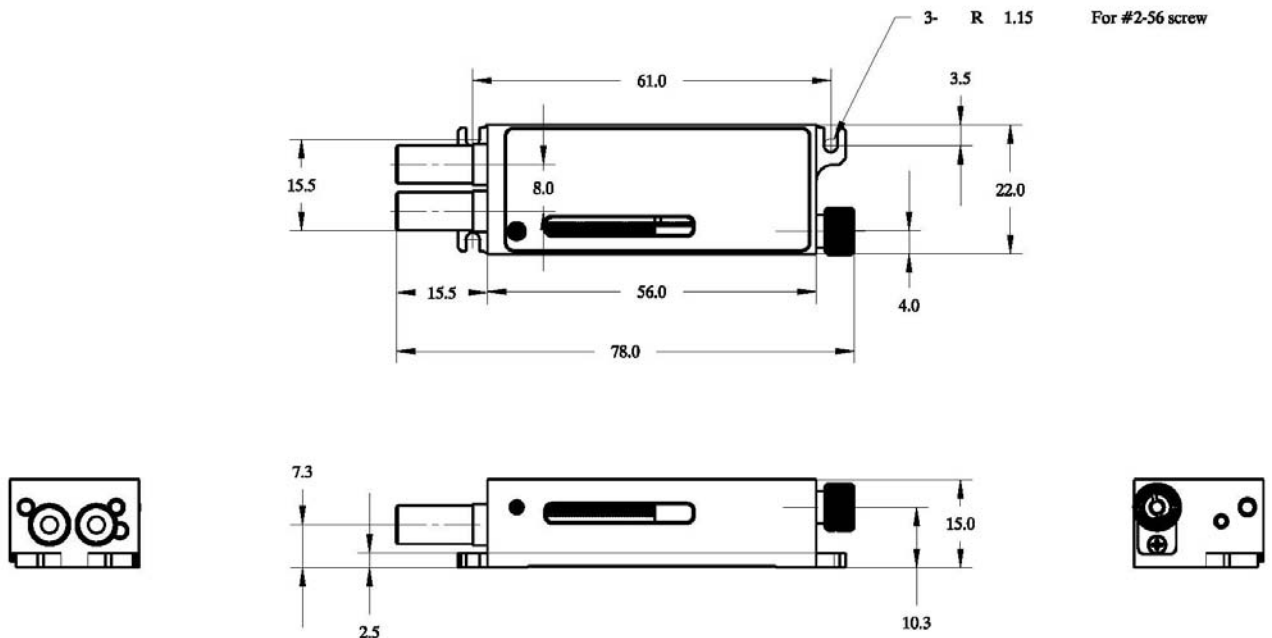
Figure 2 Mechanical Dimensions (in mm)

Figure 2 shows the mechanical dimensions of the VDL-004, including the size and locations of mounting holes. The VDL-004 has 3 mounting holes located at the corners. 2-56 screws can be used to mount it to a surface or a base plate.
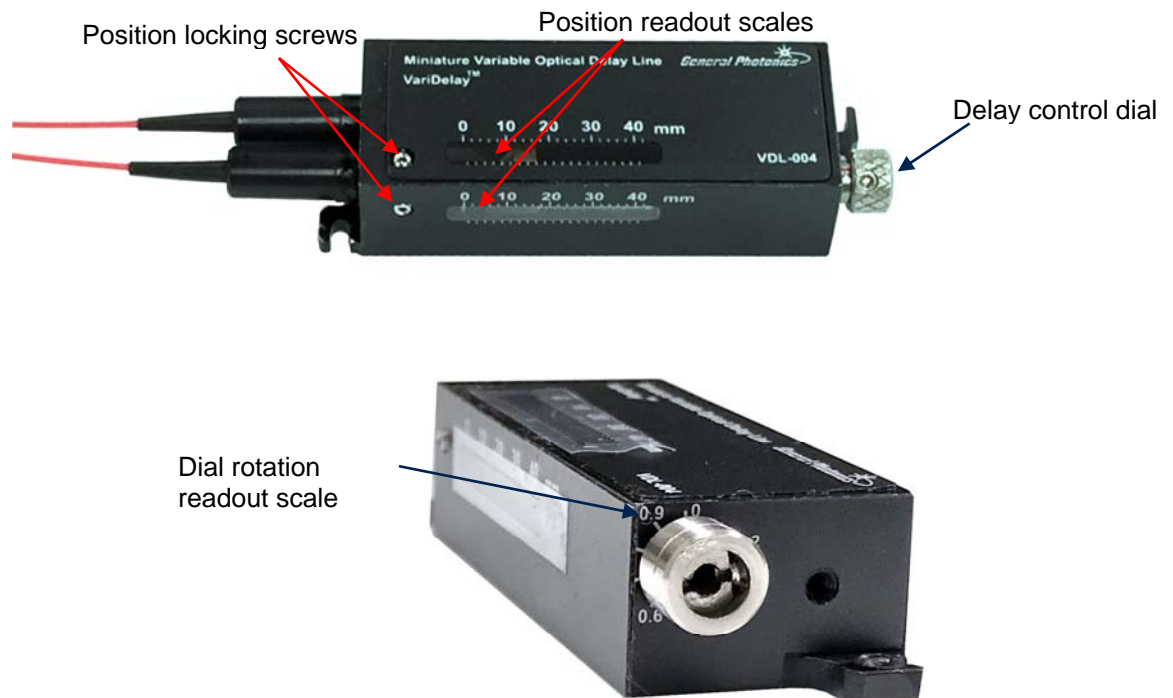
2.3 Delay Control and Readout

Figure 3 Delay controls and position readouts

The VDL-004 has an optical delay adjustment range of 130 ps (40mm). The delay setting can be changed by turning the dial on the side of the VDL. There is a rotation scale for the dial with division markings for tenths of a rotation. A full rotation corresponds to an optical delay change of 1mm (3.34 ps).

There are delay readout scales on the top and side surfaces of the VDL. The ruler scale reads optical delay in mm. The corresponding delay time change can be calculated from

$$\Delta t = \frac{\Delta L}{c}$$

where ΔL is the length change on the ruler and $c=3\times10^8$ m/sec is the speed of light in vacuum. For higher accuracy, the user should consult a physical constant table for a more precise value for the speed of light, and consider the refractive index of air in the calculation.

Warning: Applying excessive force to overextend the delay range may result in damage to the VDL. Please leave 1-2 millimeters at the end of the range to protect the device from excessive travel damage.

Once the delay is set, the position can be locked by tightening one or both of the two 2-56 set screws on the top and side of the device (see Figure 3).

2.4 Wavelength and Polarization Properties

The VDL-004 employs free space optics to adjust optical path length; therefore, changing the delay setting will not change the polarization of the signal. However, single mode input/output fibers may transform the polarization state between input and output.

Single-pass VDLs are also available with PM fiber pigtails. PM VDLs are designed for use with a single linear input polarization state aligned to the slow or fast axis of the PM fiber. Connector keys are generally aligned to the slow axis of the PM fiber.

1310/1550nm SM pigtailed single-pass VDLs are dual window. They will function over 1260-1650nm but will perform best over 1310±50 and 1550±50nm.

840 or 1060nm SM VDLs, all PM pigtailed VDLs, or double-pass VDLs are single window devices that operate over λ_c±50nm, where λ_c is the center operating wavelength.

Section 3.0   Operation Instructions

3.1 Unpacking

Inspect VDL-004 for any physical damage due to shipping and transportation. Contact carrier if any damage is found. Check the packing list to see if any parts or accessories are missing.

Be careful when removing the product from the packing material and when handling the fiber pigtails. Do not apply any stress to the fiber or allow any sharp bends or kinks. Do not drop the connectors or allow them to hang, unsupported, from the pigtails.

Packing List

Item #	Description
1	VDL-004
2	User guide

3.2 Operation

1. If applicable, mount VDL to optical table, board, or base plate using 2-56 screws (see Figure 2).
2. Connect input/output optical pigtails. Make sure connectors are clean before making connections. For best results, fix fibers in place during operation.
3. Use the dial to adjust the delay setting. Delay adjustment is continuous. The amount of delay change can be monitored using the position scales on the top and side of the device and the dial rotation scale at the dial.
4. The position can be locked by tightening one or both of the position locking set screws (see Figure 3).

Section 4.0   Specifications

Optical

Operating Wavelength range[2]	SM: 840±50nm, 1060±50nm, or 1260-1650 nm PM: 840, 1060, 1310 or 1550 ± 50 nm
Optical Delay Range	0 ~ 130 ps (40mm) continuous
Optical Delay Resolution	Continuous 3.34 ps (1 mm) per full turn
Delay Temperature Stability	(0.52+0.008*delay) μm/°C where "delay" = optical delay in mm
Delay Repeatability[3]	<20μm
Zero Point Delay Offset[4]	230 ps
Insertion Loss[1]	<0.8 dB
Insertion Loss Variation[1]	<0.4 dB over entire range
PDL[1]	0.1 dB for single mode fiber
Return Loss[1]	55 dB
Extinction Ratio	>20 dB for PM model
Optical Damage Power Threshold	300 mW

Physical and Environmental

Operating Temperature	−15 °C to 55 °C
Storage Temperature	−40 °C to 80 °C
Fiber Type	840nm: HI780 or PM Panda 1060nm: HI1060 or PM Panda 1310 and/or 1550nm: SMF-28 or PM Panda
Position locking	2-56 3/32" flat tip set screws (x2)
Dimensions	78 (L) × 22 (W) × 15 (H) mm

Notes:
1. Specifications in table apply for a single-pass device without connectors, measured over 1310 ± 50 nm or 1550 ± 50 nm at 23±5°C. The output pigtail can also be replaced with a Faraday mirror to create a double pass device with a total range of 260 ps. Specifications may be different for double pass devices or for wavelengths other than 1310 or 1550nm.
2. Other wavelengths available upon request. Contact General Photonics for details.
3. Optical delay variation after rotating the dial 2 full turns in one direction, then returning to original position.
4. Absolute delay at 0ps setting, excluding fiber.