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OPTICAL DELAY LINES

Features

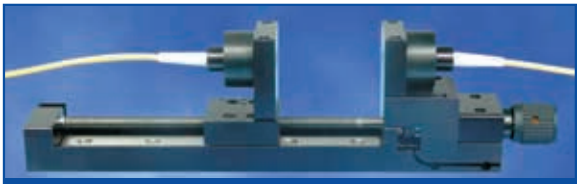
- Low insertion loss
- Sub-picosecond resolution
- Wide wavelength range
- **New: Over 1200 psec delay range**
- Polarization insensitive
- Singlemode and polarization maintaining fiber versions
- Electrically controlled versions available
- Miniature style version
- 400–2000 nm wavelength range

Applications

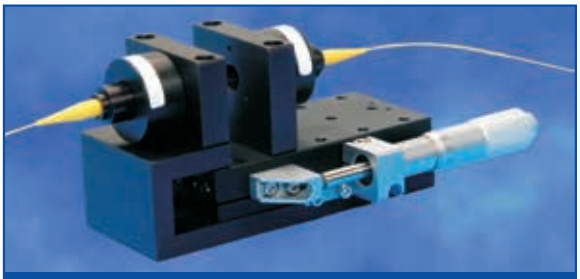
- PMD compensation in high speed communications networks
- Interferometric sensors
- Coherent telecommunications
- Spectrum analyzers
- OCT systems

Product Description

Fiber Optic Delay Lines (ODL) consist of an input and output fiber collimator to project the light into free space and collect it again into a fiber. The distance the light travels in free space is precisely controlled, either by controlling the separation between the input and output optics, or by reflecting the light off a movable reflector. In either case, by varying the distance the light travels, one can control the delay time through the device.



Delay Line with Manual Lead Screw (ODL-100)



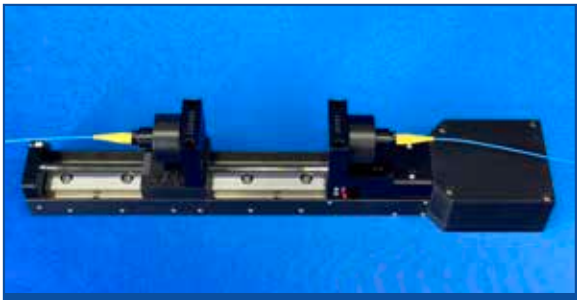
Delay Line with Micrometer (ODL-200)



Miniature Delay Line (ODL-700)



Extended (330 ps or 600 ps) Manual Reflector Style Delay Line (ODL-600)



Delay Line with Motorized Lead Screw (ODL-300)



Extended (330 ps, 600 ps or 1200 ps) Reflector Style Delay Line with Servo Motor (ODL-650)



Reflector Style Delay Line with Manual Lead Screw (ODL-600) - 167 ps

OZ Optics reserves the right to change any specifications without prior notice.

Delay lines are offered using singlemode, multimode or Polarization Maintaining (PM) fibers. 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.

Delay lines are offered in both manual or electrically controlled versions. Manual delay lines utilize either a lead screw or a micrometer to adjust the spacing. Electrically controlled versions utilize a servo motor with encoders to monitor the motion. With this device submicron resolution (<0.003 ps) is achieved. The delay line is easily controlled by a computer via an RS-232 interface or manually using some simple TTL input signals. These devices are calibrated to provide the delay in picoseconds. Home and end position sensors prevent accidental damage to the device.

A miniature style delay line provides up to 13 picoseconds delay in a miniature package. The unit takes up little more space than an ordinary patchcord connection, and is easily adjustable and lockable.

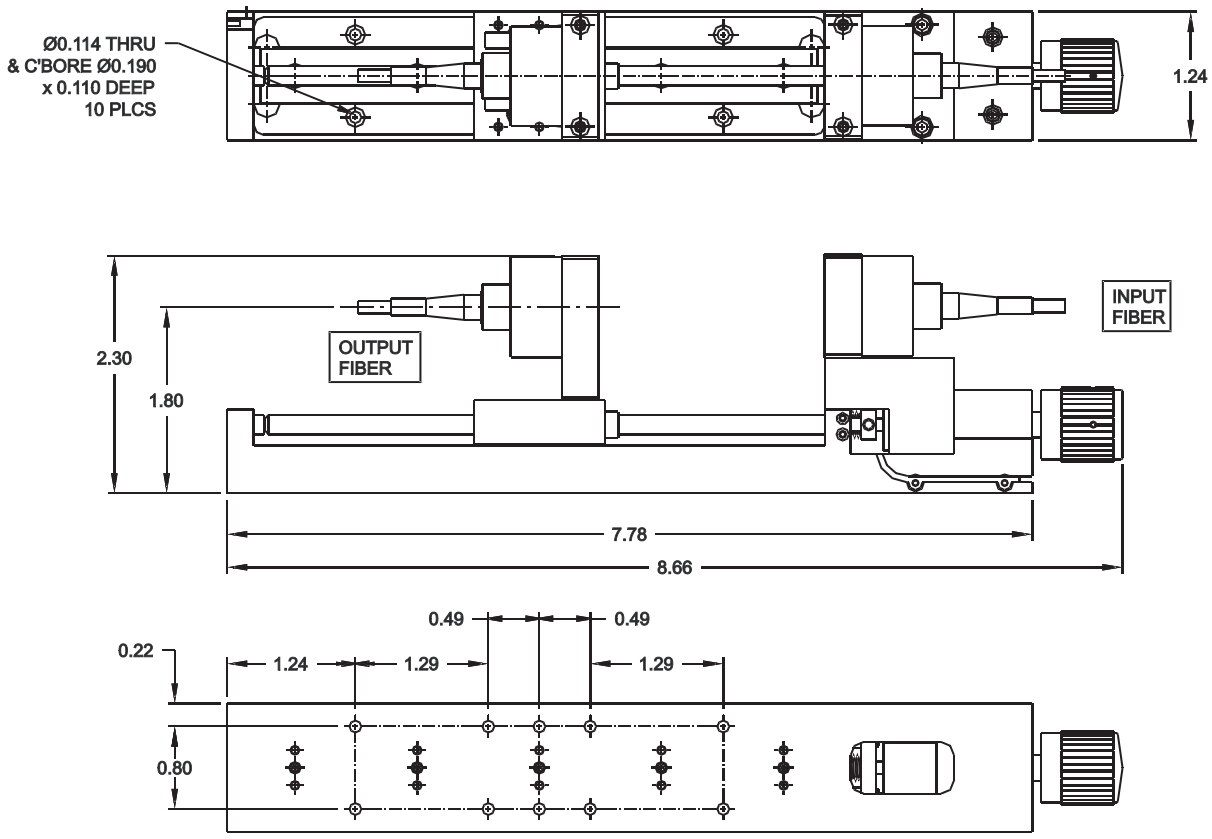


Figure 1: Dimensions of ODL-100 Model **Units are in inches.**

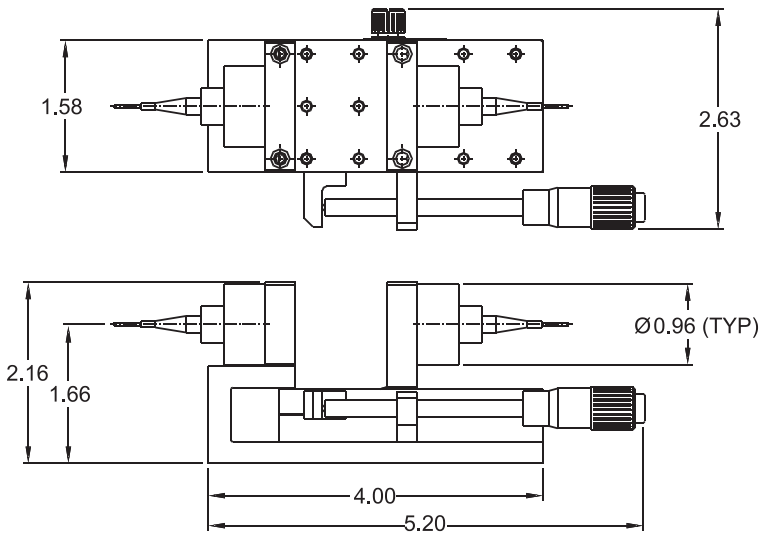


Figure 2: Dimensions of ODL-200 Model **Units are in inches.**

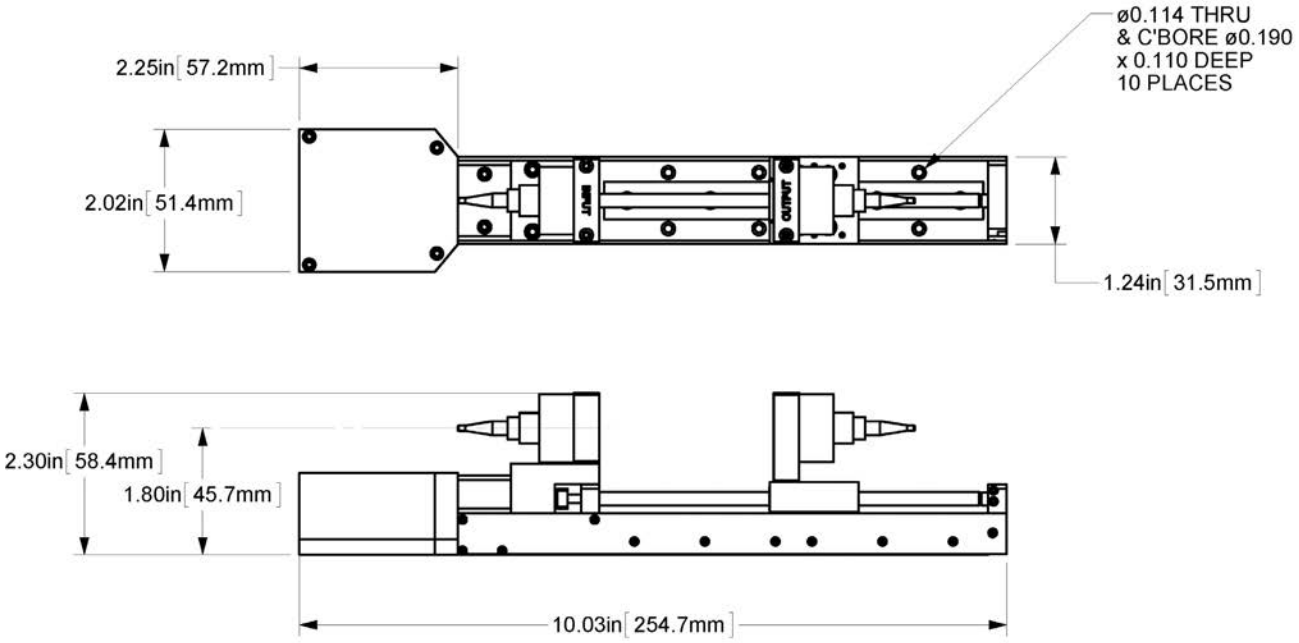


Figure 3: Dimensions of ODL-300 Model **Units are in inches.**

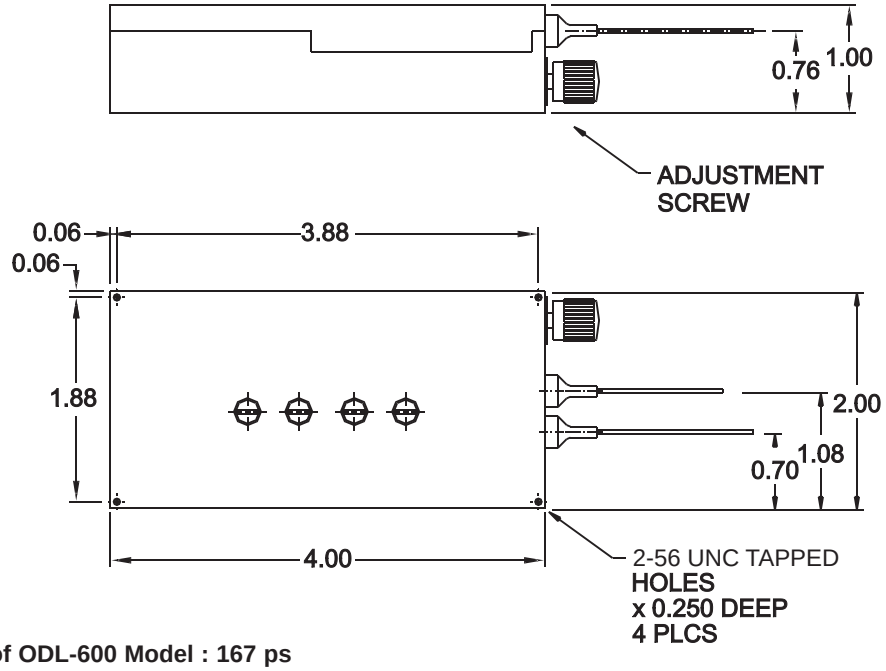


Figure 4: Dimensions of ODL-600 Model : 167 ps **Units are in inches.**

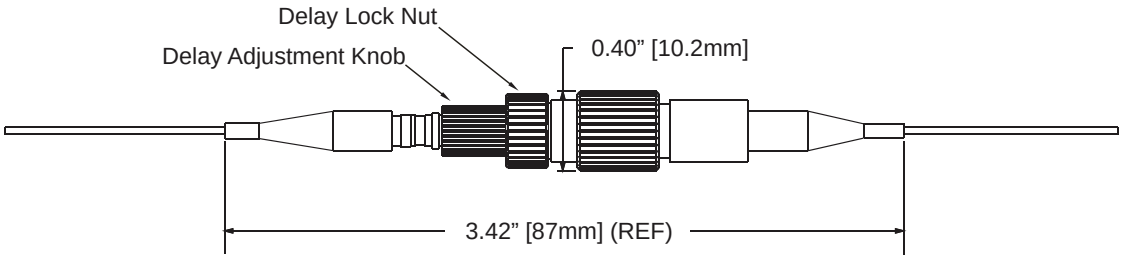


Figure 5: Dimensions of ODL-700 Model **Units are in inches.**

Dim.	330 ps	600 ps	1200 ps
A	4.12	6.12	9.70
B	5.22	7.22	10.80
C	4.06	6.06	9.64

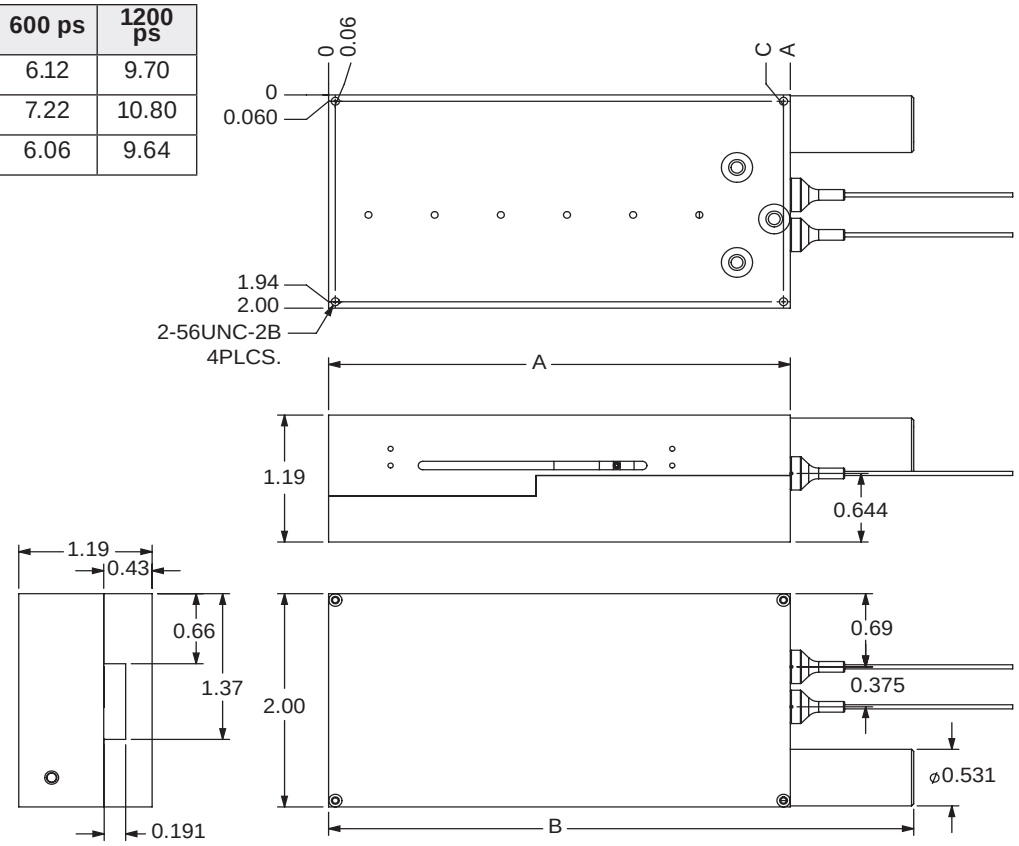


Figure 6: Dimensions of ODL-650 Model: Extended range 330 ps, 600 ps and 1200 ps **Units are in inches.**

Dim.	330 ps	600 ps
A	4.12	6.12
B	4.80	6.80
C	4.06	6.06

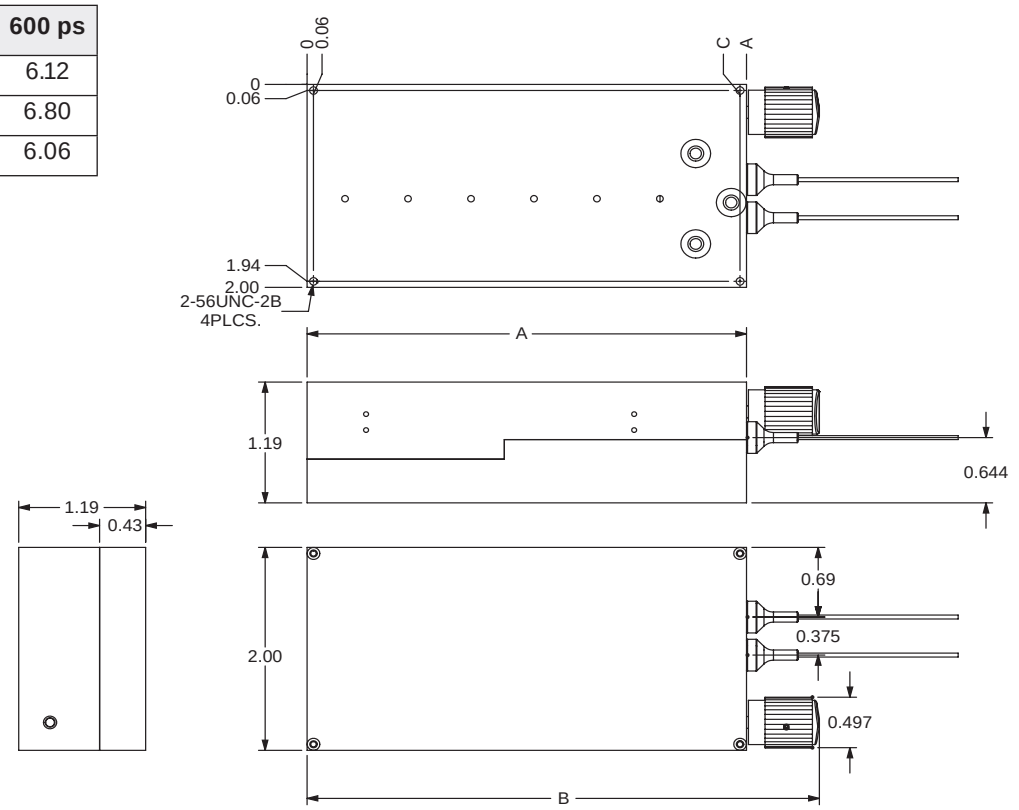


Figure 7: Dimensions of ODL-600 Model: Extended range 330 ps and 600 ps **Units are in inches.**

Ordering Information For Standard Parts

For more standard parts, please see our Online Catalog https ://shop.ozoptics.com/

Bar Code	Part Number	Description
9432	ODL-100-11-1550-9/125-S-60-3A3A-3-1	Variable Fiber Optic Delay Line for 1550 nm, with manual lead screw and 60 dB return loss. Pigtails are 1 meter long, 3 mm OD PVC cabled 9/125 SM fibers, FC/APC connectors.
13421	ODL-100-11-1550-8/125-P-60-3A3A-3-1	Variable Fiber Optic Delay Line for 1550 nm, with manual lead screw and 60 dB return loss. Pigtails are 1 meter long, 3 mm OD PVC cabled 8/125 SM fibers, FC/APC connectors.
10468	ODL-200-11-1550-8/125-P-60-3A3A-1-1	Variable Fiber Optic Delay Line for 1550 nm, with manual lead screw and 60 dB return loss. Pigtails are 1 meter long, 8/125 PM fibers, protected with 0.9 mm OD hytrel tubing, and with FC/APC connectors.
14645	ODL-600-11-1550-9/125-S-60-3A3A-1-1	Reflector Style Variable Fiber Optic Delay Line for 1550 nm, with manual lead screw and 60 dB return loss. Pigtails are 1 meter long, 0.9 mm OD tight buffered 9/125 SM fibers, FC/APC connectors.
13755	ODL-600-11-1550-8/125-P-60-3A3A-1-1	Reflector Style Variable Fiber Optic Delay Line for 1550 nm, with manual lead screw and 60 dB return loss. Pigtails are 1 meter long, 8/125 PM fibers, protected with 0.9 mm OD hytrel tubing, and with FC/APC connectors.
60818	ODL-650-11-1550-9/125-S-60-3A3A-1-1-MC/RS232-330	Extended 330 ps Electrically Controlled Reflector Style Variable Fiber Optic Delay Line for 1550 nm, and 60 dB return loss. Pigtails are 1 meter long, 9/125 um SM28e+ SM fibers, protected with 0.9 mm OD loose tube hytrel tubing, terminatedwith FC/APC connector on both ends, RS232 Interface.
59617	ODL-650-11-1550-8/125-P-60-3A3A-1-1-MC/RS232-330	Electrically controlled reflector style variable fiber Optic Delay Line for 1550 nm, with 60 dB return loss. Pigtails are 1 meter long, 8/125 PM fibers, protected with 0.9 mm OD hytrel tubing, terminated with FC/APC connectors with the key aligned and locked along the fiber slow axis with ER>20 dB. RS232 Interface. Extended range, 330 ps

Ordering Example For Standard Parts:

A customer is building a polarization mode dispersion compensator using a polarization maintaining electrically controlled delay line and computer interface. The delays in their system are 50 picoseconds or less. His system is sensitive to both insertion losses and return losses, so a low return loss device is needed.

Bar Code	Part Number	Description
61776	ODL-650-11-1550-8/125-P-60-3A3A-1-1-MC/RS232-600	Electrically controlled reflector style variable fiber Optic Delay Line for 1550 nm, with 60 dB return loss. Pigtails are 1 meter long, 8/125 PM fibers, protected with 0.9 mm OD hytrel tubing, terminated with FC/APC connectors with the key aligned and locked along the fiber slow axis with ER>20 dB. RS232 Interface. Extended range, 600 ps

Standard Product Specifications

Table 1. Manual delay line

Model	ODL-100	ODL-200	ODL-600			ODL-700
Travel Mechanism	Manual Lead Screw	Manual Micrometer	Manual Lead Screw, Mirror			Manual Adjustment Screw
Travel Range (mm)	100	25	25x2=50	50x2 =100	100x2= 200	4
Resolution (microns)[1]	318 per turn	10 per division	635 per turn			210 per turn
Delay Range (psec)	330	83	167	330	600	13
Delay Resolution[1]	1 psec per turn	0.033 psec per division	2 psec per turn			0.67 psec per turn
Max. Insertion Loss (dB)[2,3]	<1.5	<1.0	<1.0	<1.1	<1.8	<1.5
Loss Variation over travel range (typical) (dB)[3]	0.5	0.1	0.15		0.6	0.5
Size (LxWxH) (mm)	230x30x60	145x60x55	102x51x25	132.5x50.8x30.2	172.7x50.8x30.2	87x10.2 (Diameter)
Return Loss [5] (dB)	-35 for multimode fiber versions, -40, -60 for singlemode fiber versions					-50

Table 2. Motorized delay line

Model	ODL-300	ODL-650		
Travel Mechanism	Servo Motor	Servo Motor, Mirror		
Travel Range (mm)	100	50x2=100	100x2=200	200x2=400
Resolution (microns)[1]	0.7 per encoder pulse	0.4 per encoder pulse		
Delay Range (psec)	330	330	600	1200
Delay Resolution[1]	2.4 fs per encoder pulse	1 fs		
Max. Insertion Loss (dB)[2,3]	<1.5	<1.1	<1.8	<1.8
Loss Variation over travel range (typical) (dB)[3]	0.5	0.15	<0.6	<0.6
Size (LxWxH) (mm)	242x30x60	132.5x50.8x30.2	183.4x50.8x30.2	
Return Loss[5] (dB)	-35 for multimode fiber versions, -40, -60 for singlemode fiber versions			
Speed[4] (mm/sec)	3.8	50		
Input Supply Voltage	7–12 V			
Input Supply Current (typical)	400 mA	200 mA		

Note:

1. Theoretical, based on thread pitch and motor/encoder resolution. The MC/RS232 versions of the ODL-300 and ODL-650 can generate twocounts per encoder pulse, effectively doubling the resolution.
2. Includes variation of insertion loss over the entire travel range.
3. For 1550 nm wavelengths singlemode or PM fibers, at room temperature.
4. This is the maximum speed for ODL-650. The speed may be programmed to a lower value by the user.
5. Multimode version not available on reflective style delay line (ODL-600 and ODL-650)

Environmental Specification For Singlemode Or PM ODL-650 Systems At 1550 nm

Operating Temperature (°C)	-10°C to +60°C
Temperature Dependent Loss (Measured over the Entire Scanning Range)	<1 dB from +10°C to +40°C <2 dB from -10°C to +60°C
Operating Lifetime	Over 5000 hours, continuous operation

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 1 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. What Delay Range (in psec or mm) do you need?
2. What Resolution (in psec or mm) do you need?
3. Do you need a readout of the position?
4. Do you need electrical control?
5. Do you need computer control? What Interface will you use?
6. Do you intend to make your own drive circuit?
7. What wavelength will you be using?
8. What fiber type are you using? Singlemode, Multimode or Polarization Maintaining?
9. What is the worst acceptable return loss?
10. What kind of fiber connectors are you using?

ODL-*A*-11-*W*-*a/b*-*F*-*LB*-*XY*-*JD*-*L*(-*I*)(-*R*)

A = Version:
100 = Standard Style, with lead screw
200 = Standard Style, with micrometer
300 = Standard Style, with DC servo motor
600 = Reflector Style, with lead screw*
650 = Reflector Style, with Servo motor*
700 = Miniature Style

W = Wavelength:
Specify in nanometers
(Example: 1550 for 1550 nm)

a/b = Fiber core/cladding sizes, in microns
9/125 for 1300/1550 nm SM fiber
See Tables 1 to 5 in the *Standard Tables*
https://www.ozoptics.com/ALLNEW_PDF/DTS0079.pdf
for other standard fiber sizes

F = Fiber type:
M = Multimode
S = Singlemode
P = Polarization maintaining

LB = Backreflection level:
40 dB for wavelength outside 1300–1550 nm.
60 dB for 1300 and 1550 nm only. Multimode devices are only available with 35 dB.

R = Delay range in ps (600 and 650 models only)
No entry = 167 ps (ODL - 600 - Only)
330 = 330 ps option
600 = 600 ps option
1200 = 1200 ps option

I = Interface (ODL-300 & 650 models only)
MC/RS232 for Intelligent RS232 Interface with built-in manual TTL control lines PC for direct connections to the motor, encoder and limit switches (no driver).

L= Fiber length, in meters, on each side of the device

Example: To order 1 meter of fiber at the input and 7 meters at the output, replace the L with 1,7

JD = Fiber Jacket type:
1 = 900 micron OD hytrel jacket
3 = 3 mm OD kevlar reinforced PVC cable
See Table 7 in the *Standard Tables*
https://www.ozoptics.com/ALLNEW_PDF/DTS0079.pdf
for other jacket sizes

X,Y = Input & Output Connector Codes:
X = No connector
3S = Super NTT-FC/PC
3U = Ultra NTT-FC/PC
3A = Angled NTT-FC/PC
8 = AT&T-ST
SC = SC
SCA = Angled SC
LC = LC
LCA = Angled LC
MU = MUfor other connectors

Ordering Example For Custom Parts

A customer building an interferometer needs a motorized reflector style delay line for 1300 nm, using singlemode fiber. He needs pigtails 1 meter long on one side, and 10 meters long on the other side, and does not need connectors. Because he is fusion splicing, he prefers uncabled fiber. He needs as long a travel range as possible at least 250 psecond. Return losses do need to be as low as possible, to prevent additional interference effects. He will control with RS232 commands.

Part Number	Description
ODL-650-11-1300-9/125-S-60-XX-1-1,10 -MC/RS232-330	Electrically controlled reflector style variable fiber optic delay line 1300 nm with 60 dB return lass. Pigtails are 1 meter long on the input and 10 m long on the output 0.9 mm OD hytrel jacketed 9/125 singlemode fibers, no connectors. Unit comes with a RS232 interface, 330 psec delay range.

Application Notes

Example Application: Polarization mode dispersion (PMD) is an important issue in the quest to build high speed (10GBs, 40GBs, and higher) communication networks. An input signal travelling along a single mode fiber normally has some distortion, due to polarization mode dispersion. The signal effectively has been split into two arbitrary, yet orthogonal polarizations, and one polarization is leading the other. A delay line is a crucial element in building compensators for PMD.

The figure below shows how to use a delay line to compensate for polarization modes dispersion. The light from the singlemode input is split into two using a polarizing beam splitter. A polarization controller installed just before the splitter is used to convert the arbitrary polarizations that the signal has been split into S and P polarization. The faster S polarization is routed through the delay line while the slower P polarization is sent straight into the combiner. The combined signals then reach the receiver. A control system monitors the quality of the signal at the receiver, and dynamically adjusts the polarization and the delay to get the two signals to match up again. Thus the PMD is in the system can be corrected in real time.

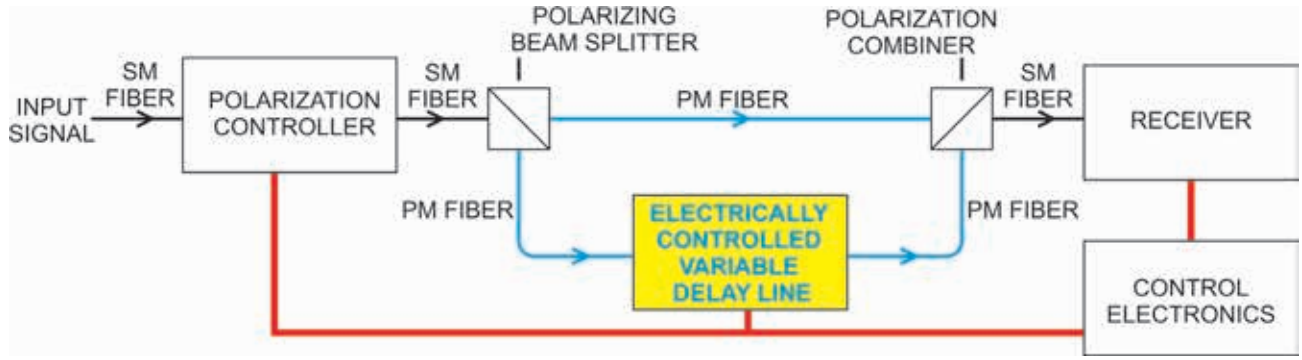
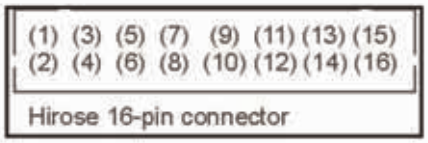


Figure 9. PMD Compensation System Using a Variable Delay Line

Mounting: The base of the delay lines have mounting holes for attachment to a rack or printed circuit board. For best results, the mounting surface should be rigid and free of vibration. Do not over-tighten the mounting screws and use screws that thread in no more than 2 mm. Tightening the mounting screws too much will warp the base and potentially increase losses either temporarily or permanently.

Electrical Connections: The ODL-650 unit has a Hirose DF11-16P-2DS16-pin connector. The pin designations are given below:

Pin	Name	Function	Comment
1	GND	Common Ground	
2	GND	Common Ground	
3	Select	Select TTL interface	For TTL interface, Input Active Low
4	Vin	Input DC supply voltage; (Min +7 V Max +12 V)	For ODL-300 Typ. 400 mA For ODL-650 Typ. 200 mA
5	Reverse	Move the motor in reveres	For TTL interface, Input Active Low
6	Rx	RS232- Receive input line	
7	Forward	Move the motor forward	For TTL interface, Input Active low
8	Tx	RS232- Transmit output line	
9	N/A	Do not connect	Factory use
10	N/A	Do not connect	Factory use
11	Reset	Hardware Reset line	Active Low, Min 100 mS
12	N/A	Do not connect	Factory use
13	End	End limit switch	TTL output, active low
14	N/A	Do not connect	Factory use
15	Home	Home limit switch	TTL output, active low
16	N/A	Do not connect	Factory use



When you first connect the wire harness to the 16-pin port, make sure that the power is off. Before turning the power on, make sure that your connections have the correct voltage levels and polarity (given above). If you have ordered an RS-232 interface, the harness comes terminated with a DB9 connector that plugs directly into your computer's serial port. For special applications, the harness is left without a connector and must be terminated by the user for the communications type of their choice.

Frequently Asked Questions (FAQs)

Q: How do I convert travel in mm to delays in picoseconds?

A: The delay is equal to the distance divided by the speed of light in air. 1 mm corresponds to 3.33 psec of delay. Note that in the ODL-600 and ODL-650 models, the light travels the distance twice, so the delay is twice the motion of the optics.

Q: Is the minimum delay zero picoseconds?

A: No, there is a minimum delay, due to the minimum separation between the optics, and the length of the attached fibers. A one meter long fiber produces a 4.9 nsec delay. The minimum separation of the optics induces between 30 psec and 150 psec delay, depending on the model. The delay range specified in the tables is for relative delay.

Q: Are the units calibrated?

A: No, there is a minimum delay, due to the minimum separation readout of the motion, in mm. The ODL-300 with controller and ODL-650 also give a readout of the delay in picoseconds. The other models do not have any calibration. Note that these are relative readouts, not absolute (see the previous question).

Q: What are the advantages and disadvantages of the inline version versus the reflector style?

A: Generally the inline version gives the largest travel ranges versus the reflector style, and thus can produce the greatest delays. However the reflector style unit has the advantage that the fibers themselves do not move. This makes the reflector style the best choice for commercial applications as opposed to lab use.

Q: Do I need special software to run the ODL-300 or ODL-650 delay lines?

A: Both units are operated with simple text commands that can be sent via terminal programs such as Windows™ Hyperterminal™. Active X™ control and Labview™ driver, as well as a direct Windows interface program are also provided.

Q: What voltages and currents do the motor driven delay lines use?

A: The ODL-300 requires an input voltage between 7 to 12 Volts, and can draw on the order of 400 mA of current when the motor is turning. The ODL-650 also requires 7 to 12 Volts, and can draw on the order of 200 mA of current when operating. If you have special requirements please contact OZ Optics.