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1 – Description

The Variable Optical Delay Line (VODL) is a device that enables a very precise and stable control of an optical path length up to **12ns**.
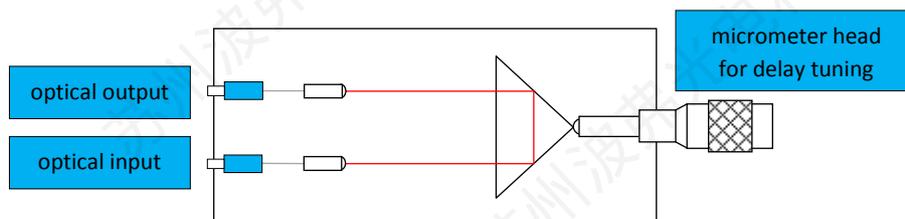
The product has one input and one output. The optical delay can continuously be tuned thanks to a micrometer head (manual option) or a motorized actuator (piloted option).

Our VODL products are athermal and don't need any external control to stabilize the optical path delay.

VODL 300ps or 600ps packaging

2 – Block diagram

Block diagram: VODL

3 – Absolute maximum ratings

Parameter	Symbol	Min	Typ.	Max	Unit	Remarks/Conditions
Maximal optical input power	OpIn			300	mW	
Storage temperature range	STR	-10		40	°C	
Humidity	RH	5		85	%	Non condensing

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4 – Operating conditions

Parameter	Symbol	Min	Typ.	Max	Unit	Remarks/Conditions
Operating wavelength	OWR	1520		1625	nm	
Operating temperature range	OTR	10		35	°C	

5 – Specifications

We propose three VODL product ranges:

- With 100ps optical delay range. This product is only available with manual version.
- With 300ps or 600ps optical delay range. These products are available with manual (micrometer head) or piloted (motorized actuator) versions.
- With 3ns, 6ns, 9ns or 12ns optical delay range. This product is only available with a motorized actuator.

Parameter			Symbol	Min	Typ.	Max	Unit	Remarks/Conditions
Insertion Losses[1]	100ps	SM	IL		0.5	1.0	dB	Over full delay range
	300ps and 600ps	SM			0.5	1.0		
		PM			0.8	1.5		
	3ns, 6ns, 9ns or 12ns	SM			1.5	2.0		
		PM			2.0	2.5		
IL uniformity[1]			ΔIL			0.5	dB	Over full delay range
Polarization Dependant Losses[1,2]			PDL			0.3	dB	Over full delay range
Polarization Extinction Ratio[1,3]			PER	20			dB	
Optical Return Loss			ORL	35			dB	
Manual VODL sensitivity	100ps					1.3	ps/turn	
	300ps					15	fs	
	600ps					30		
Motorized VODL	Minimum incremental motion	300ps				3	fs	
		600ps				6		
		3ns				10		
		12ns				40		
	Relative accuracy	300ps				150	fs	The relative accuracy of the VODL is the degree to which a given displacement conforms to an agreed upon standard.
		600ps				300		
		3ns				250		
		12ns				1000		
	Unidirectional repeatability	300ps				30	fs	The unidirectional repeatability is the ability of the VODL to achieve a commanded position over many attempts when approach from the same direction.
		600ps				60		
		3ns				30		
		12ns				120		
	Bidirectional repeatability	300ps				40	fs	The bidirectional repeatability is the ability of the VODL to achieve a commanded position over many attempts when approach from either direction.
		600ps				60		
		3ns				150		
		12ns				600		
Reference Insertion Losses[1]			RIL		0.3	0.5	dB	
Reference position accuracy[4]					0.5	1.0	ps	
Variable Optical Attenuation[5]			VOA	60			dB	
VOA sensitivity[5]					0.05	0.1	dB	
Packaging size[6]	100ps			100 x 32 x 28			mm³	
	300ps			216 x 92 x 40				
	600ps			216 x 92 x 40				
	3ns to 12ns			750 x 400 x 129				

[1] measured over OTR and OWR for all states of polarization
[2] for Single Mode VODL
[3] for long free space delay option
[4] for VODL option
[5] for VOA option
[6] excluding micrometer head or piloted actuator

6 – Piloted versions: motorized actuator or linear stage

For 300ps and 600ps VODL, the piloted version uses a motorized actuator driven by a controller. The controller is compatible with the NEWPORT NSTRUCT Instrument Manager platform, simple and intuitive to use and conveniently accessible via USB.

The 3ns to 12ns VODLs use a motorized linear stage which is driven by a stepper motor controller/driver. Communication with the controller/driver is via an integrated RS-232-C interface, or a USB port.

All piloted VODL are delivered with a controller, a USB cable and a power supply.

7 – Optical Reference Path (ORP) option

The optical reference path option enables to precisely control the **difference** between two optical paths and eventually take it down to zero.

Let us call ODR the optical delay range of the VODL (ODR can be 300ps, 600ps, 3ns, 6ns, 9ns or 10ns) and t_0 the optical delay of the reference arm. By default the reference arm is set such as the optical delay of the variable arm can be adjusted in the range [t_0; t_0+ODR]. However, upon customer request, the reference arm can be set such as the variable arm can be tuned in the range [t_0-ODR; t_0] or [t_0-ODR/2; t_0+ODR/2] or any other set up.
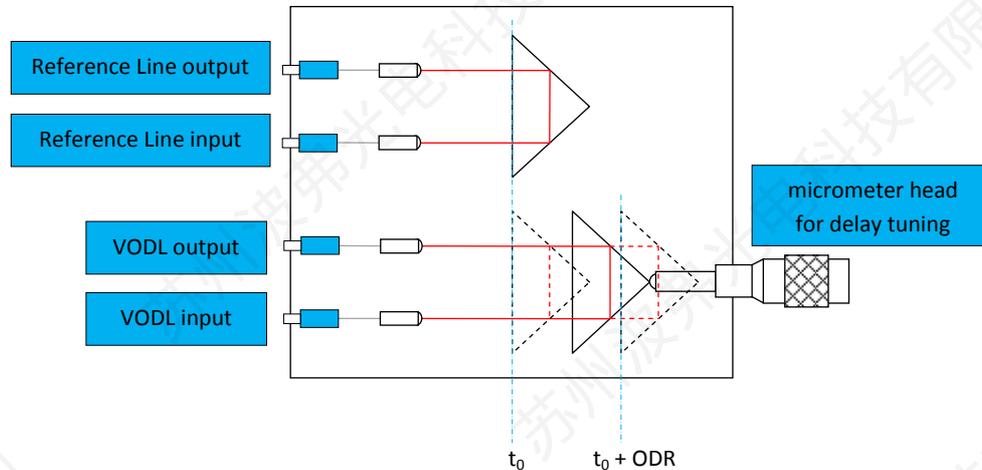
*VODL with ORP option, [t_0; t_0 + ORD] version*

The reference position accuracy corresponds to the delay difference between the VODL and the reference arm when the VODL is set to t_0. This parameter is better than 1ps.

8 – Variable Optical Attenuation (VOA) option

We propose to add a VOA (Variable Optical Attenuator) on our VODL product.

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9 – Application note

Using a VODL with ORP and VOA options will help to adjust the skew and the IL uniformity in a DPSK experimental setup:
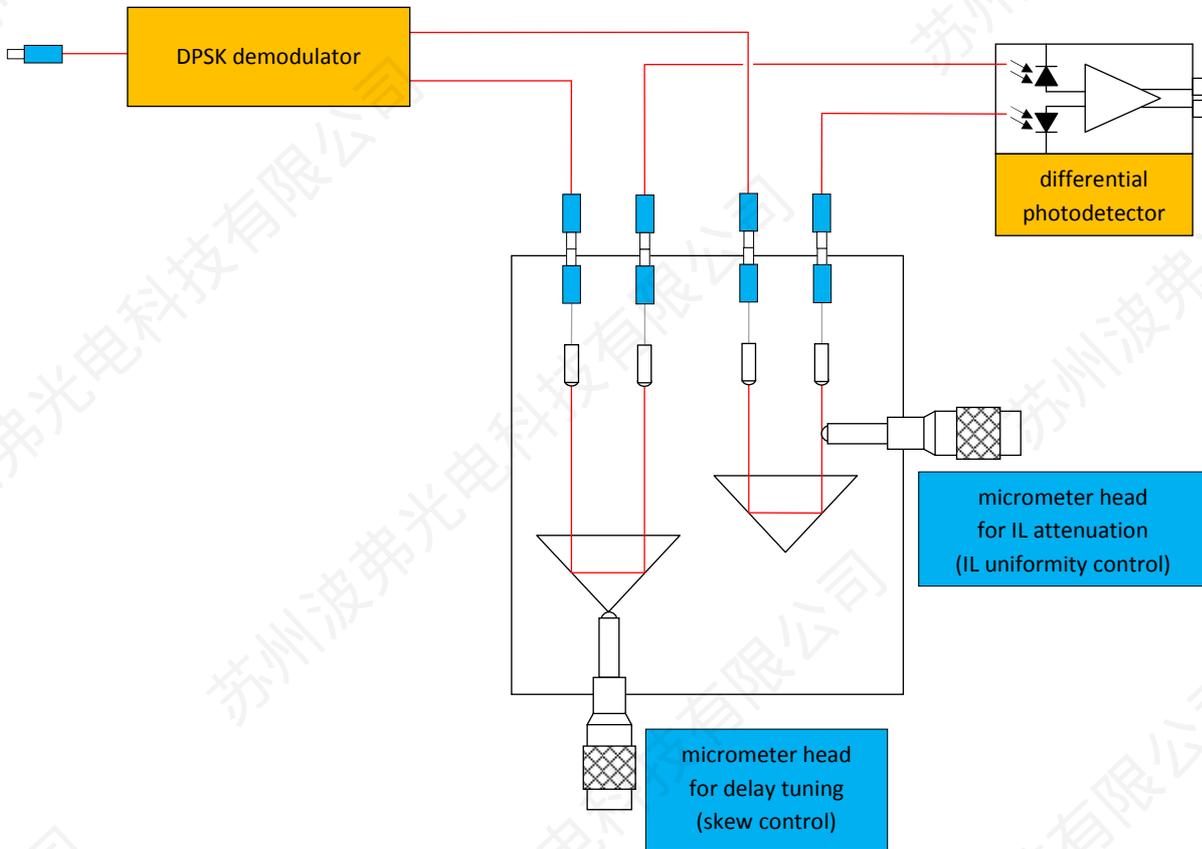
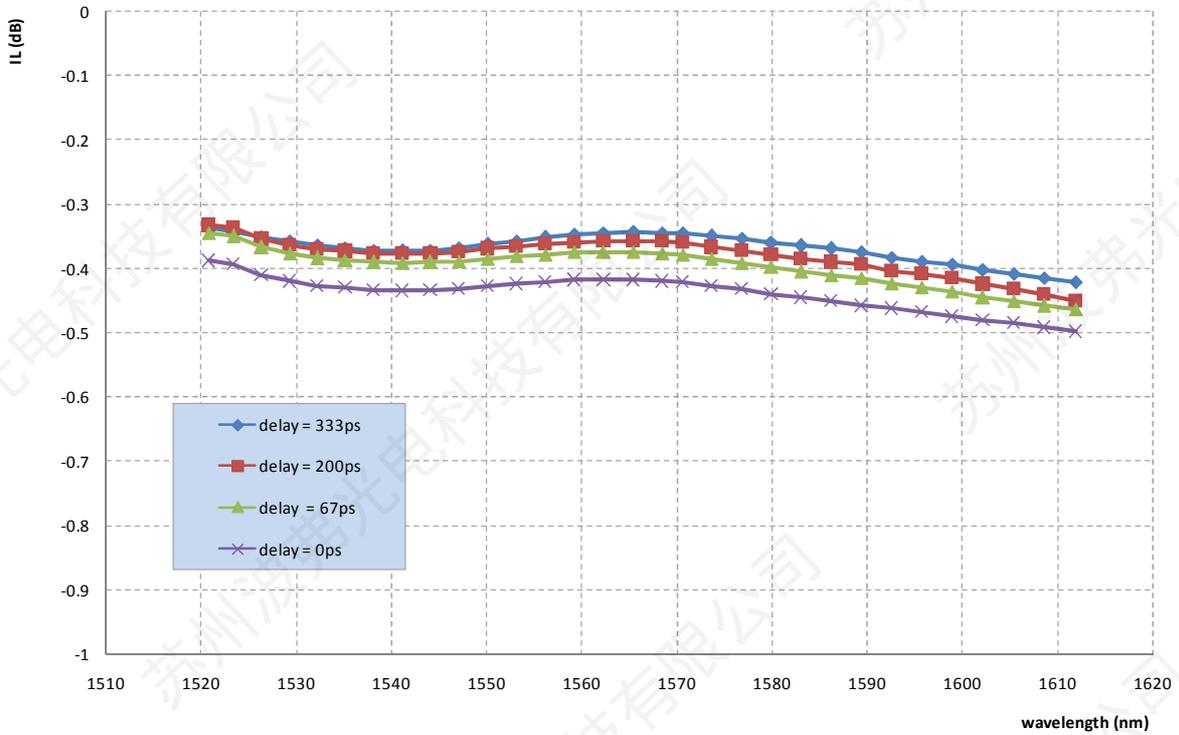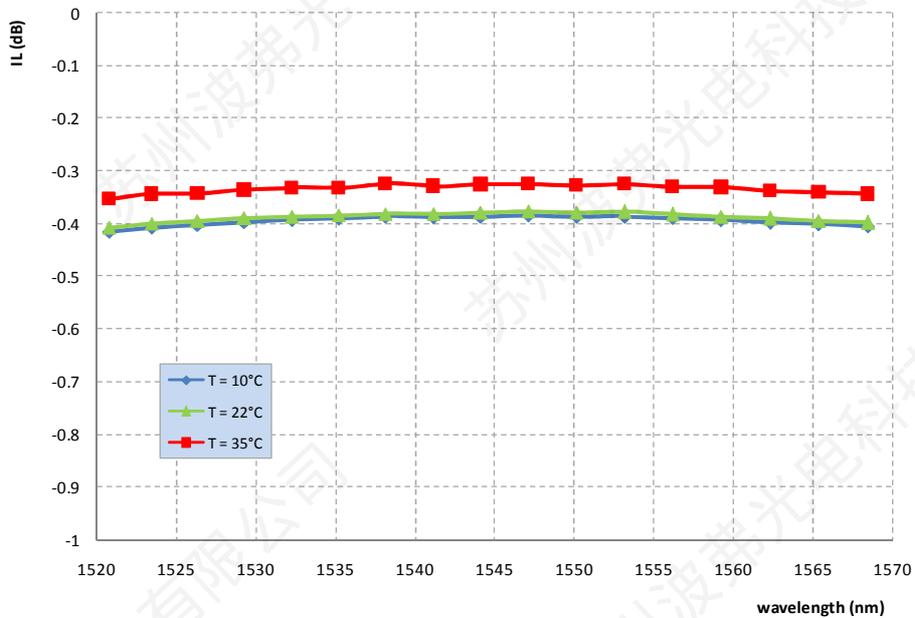*VODL with ORP and VOA options application*

VODL with ORP and VOA options

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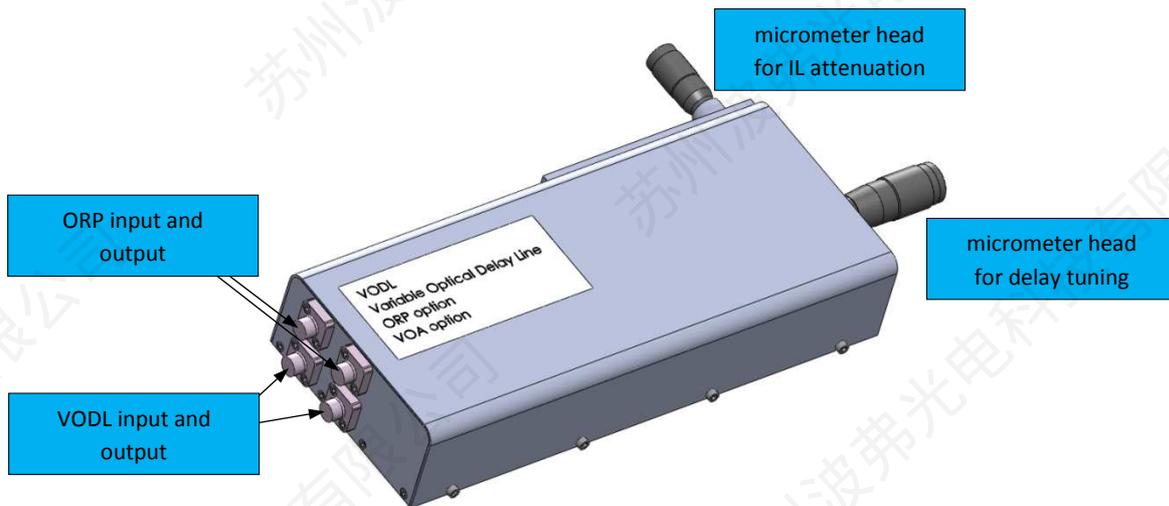
10 – IL uniformity measurements

Here are the IL measurements for a 300ps VODL over the wavelength range for different delays and temperatures.

Graph: IL vs wavelength for different delay ranges

Graph: IL vs wavelength for different temperatures

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11 – Fiber type and connectors

Every VODL can be proposed either with SM or PM fiber.

The devices can be proposed with any kind of connectors (FP/UPC, FC/APC, SC/PC, SC/APC, LC/PC, E2000/PC, E2000/APC, etc…).

12 – Wavelength range

VODL can be proposed at different wavelength range, from the visible to the IR. The device will be operational on a wavelength range of a tens of nanometers centered on the wavelength required by customer. VODL at 1300nm, 1064nm and 800nm have already successfully been manufactured.
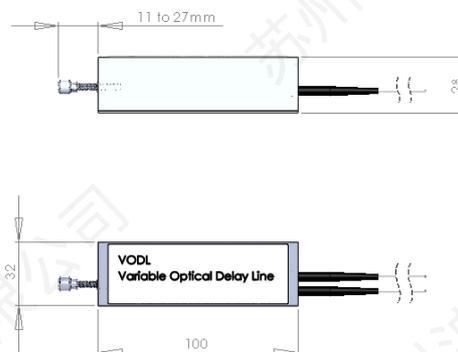
13 – Custom products

Thanks to our free-space technology we can easily customize most of our product and so it is for the VODL. Customer can feel free to ask for any customization they need. We will examine the request and do our best to have a positive answer.

14 – Package layout
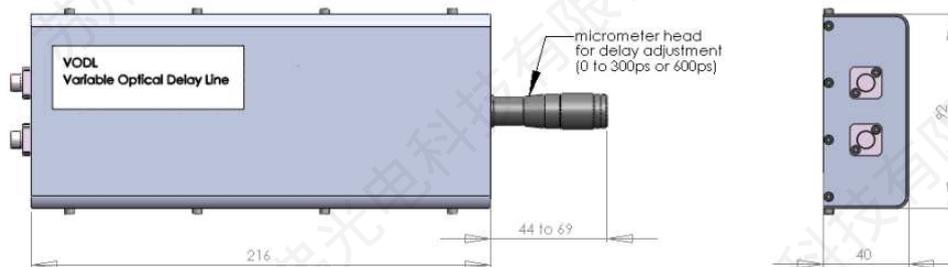
Manual VODL 300ps and 600ps packaging

Manual VODL 100ps packaging

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15 – Revision

date	version	Object
February 21, 2013	VODL V1.0	Creation
May 28, 2014	VODL V1.1	Added VODL 100ps
February 3rd, 2015	VODL V1.2	Added VODL 6ns, 9ns and 12ns

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