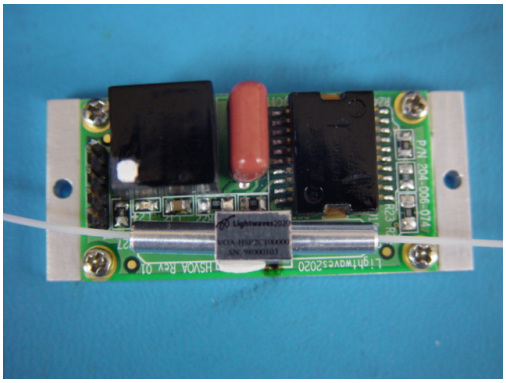
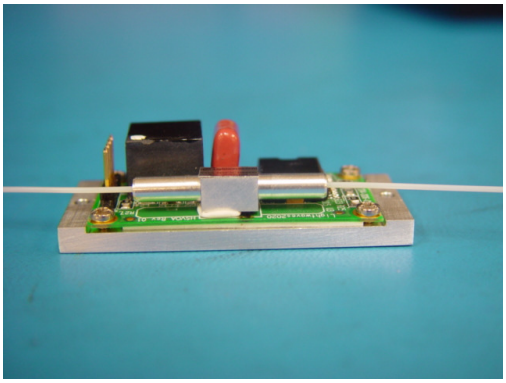
High-Speed Variable Optical Attenuator

Application Note

9/26/2008





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1. Product Outline and Specification

1.1 Product Outline

Lightwaves2020's high-speed Variable Optical Attenuator (VOA) is based on Electro-Optical effect of a novel optical material when an electrical field is applied. It offers fast response in *μs*, in contrast with the conventional LC-based VOA with speed in *ms*. The dramatic increase in response time enables the new VOA to meet what 40Gbs application requires.

A driver-PCB, on which the VOA is installed, is optional. The device is driven by 0-5 VDC voltages to perform optical power attenuation and switching.

Features:

- High-speed (μs) attenuation control.
- Broadband wavelength ranges.
- No moving parts and continuous tuning.
- Low insertion loss.
- Low PDL over wavelength range.
- Solid state technology.

Applications:

- Channel balance in DWDM systems.
- Power equalization in optical add/drop module and optical cross-connects.
- Gain-tilt and power adjustment in EDFA.
- Receiver protection.

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1.2 Product Specification

Optical Specification

Parameters	Unit	Performance		
Operating Wavelength Range	nm	1550nm-band (C+L-band)	1310nm-band (O-band)	1310/1550nm (Dual-band)
Insertion Loss	dB	<0.9	<1.2	
Attenuation	dB	Option 0: >28 Option 1: >32 Option 2: >38		
PDL @ λc^2 at 15dB Attenuation	dB	<0.3		
Response Time	µs	<10		
Return Loss	dB	>55		
PMD	ps	<0.1		
Operating Temperature Range	°C	0 to 65		
Storage Temperature Range	°C	-40 to 85		
Operating Relative Humidity (Non-Condensing)	%RH	95		
Storage Relative Humidity (Non-Condensing)	%RH	95		
Maximum Optical Power	mW	500		
Maximum Power Consumption[3] @65°C	W	<0.2		
Driving Voltage with Driver	V	0 to 5		
Driving Voltage without Driver	V	0 to 350		

Note: 1. All specification referred without connectors.
2. Measurement wavelength: C+L-band ➔ 1550nm
O-band ➔ 1310nm
3. Component only. (without driver)

Mechanical and Package Specification

Parameters	Unit	Specifications
Dimension	mm	30x6x6
Driver PCB Dimension	mm	46x24x13.8
Fiber Length (from module to connector end)	m	1.0 –1.2
Fiber Type	-	SMF-28e or equivalent
Fiber Jacket	-	900µm loose tube, UL94-V1 Compliance
Color Code	-	NA
Optical Connector	-	FC/UPC, Optional

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2. Product Performance

2.1 Attenuation Curve vs. Driving Voltage

(A) Normal-on Case

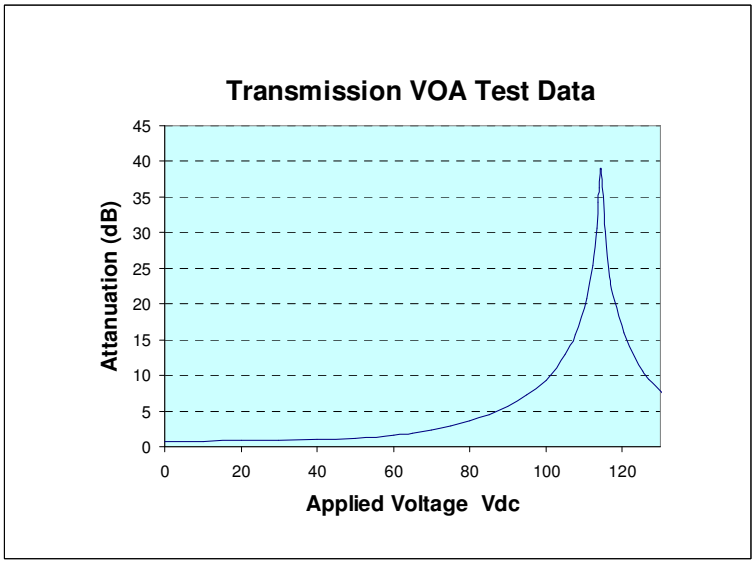

Fig 1: Attenuation Curve vs. Applied DC Voltage at room temperature

(B) Normal-off Case

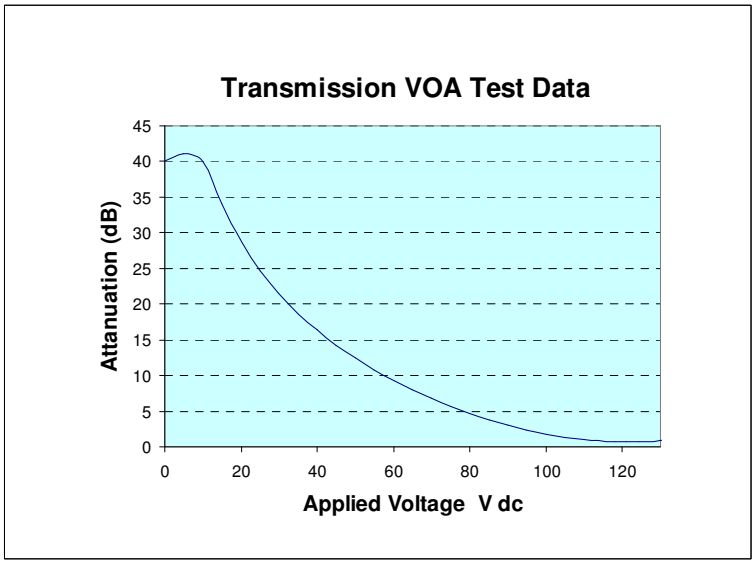

Fig 2: Attenuation Curve vs. Applied DC Voltage at room temperature

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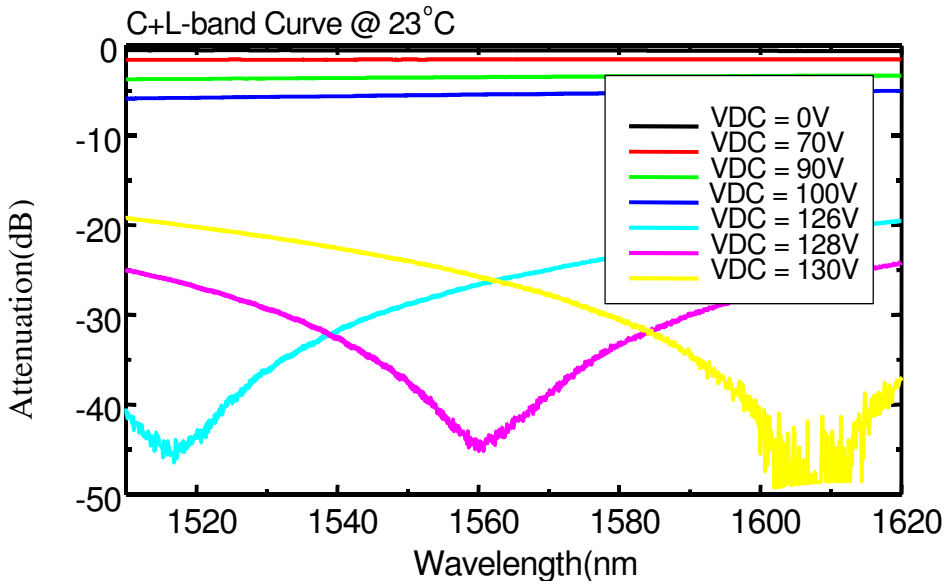
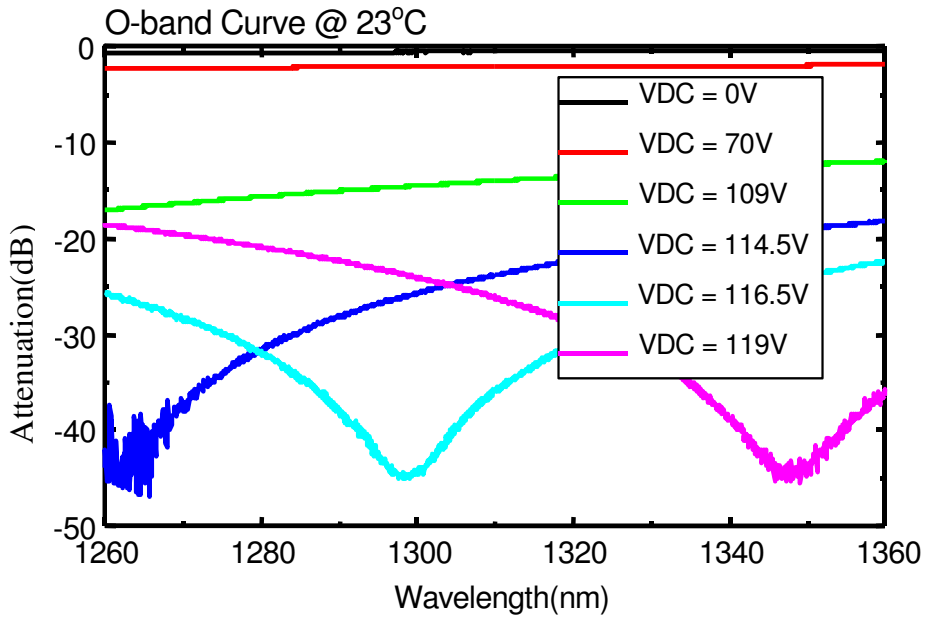
2.2 Attenuation Curve vs. Wavelength (dual-band sample)





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2.3 Power Consumption

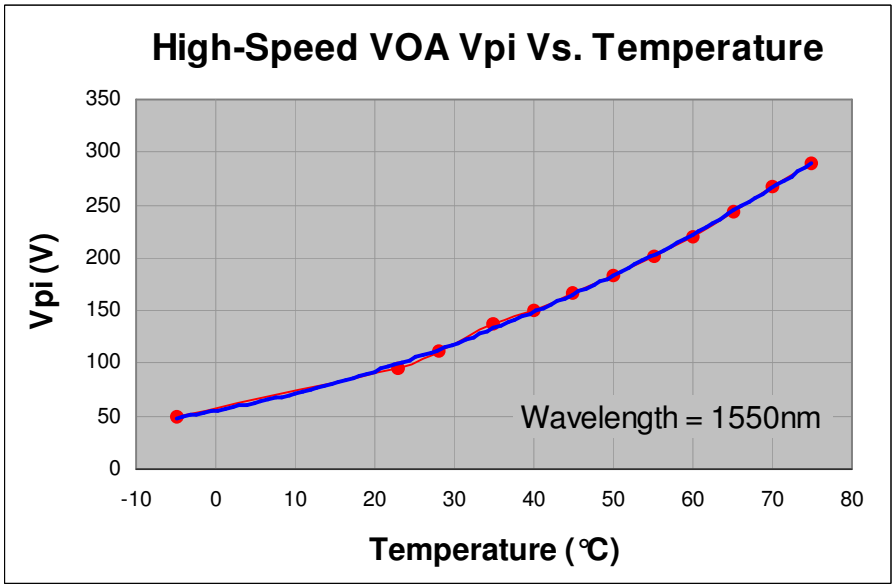
(Room Temperature)

Input voltage	*Output voltage to HS-VOA*	*Supply current (w/o load)*	*Supply current (w/ load)*
0V	*0V*	*0.176A*	*0.216A*
1V	*60.6V*	*0.181A*	*0.235A*
2V	*122.4V*	*0.188A*	*0.265A*
3V	*182.9V*	*0.196A*	*0.284A*
4V	*243.4V*	*0.205A*	*0.316A*
5V	*302.8V*	*0.224A*	*0.356A*

As can be seen from the above data, the total power consumption with driver is < 2.0W.

2.4 Vπ vs. Temperature

Vπ is defined as the voltage to obtain the maximum attenuation value for a specific wavelength. Vπ is increased with temperature:



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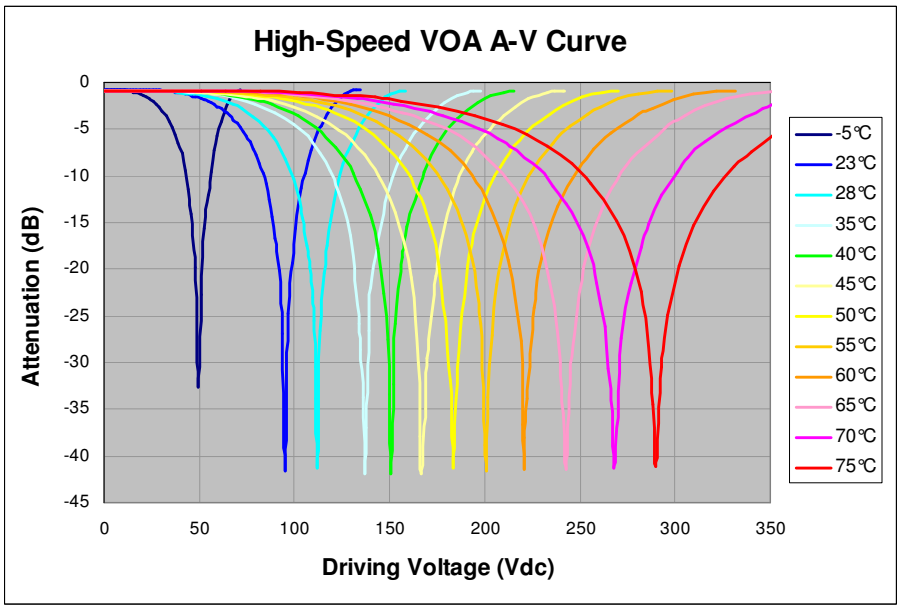
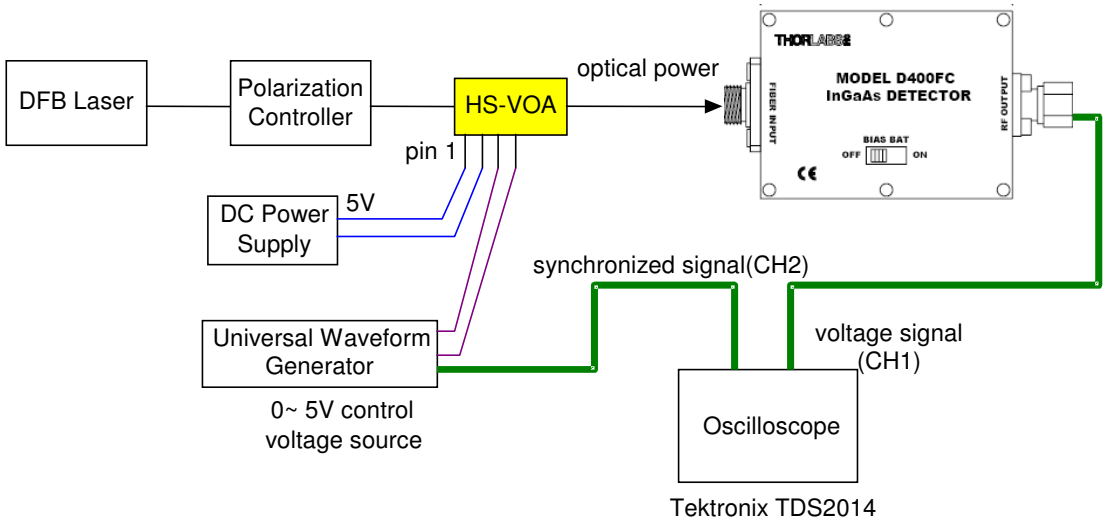
Lightwaves2020's driver can amplify the input control voltage of 0 ~ 5V, linearly to 0 ~ 350V output voltage. Therefore, it covers all Vπ range for operating temperature from 0 to 65°C.

2.5 Attenuation curve vs. driving voltage for different temperature



2.6 Response Time

The test setup for response time measurement is shown below:



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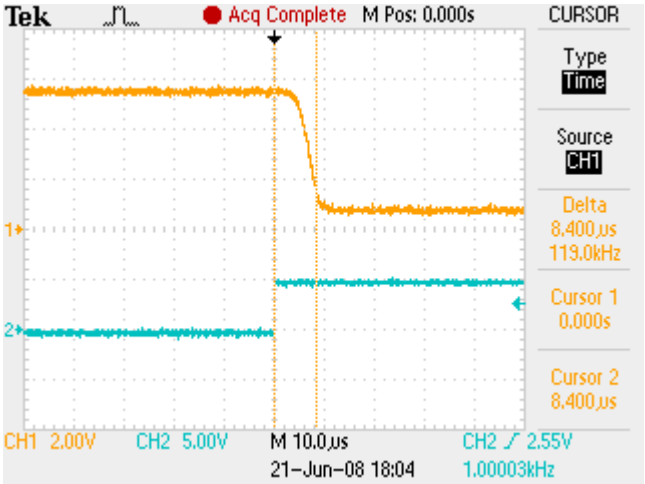
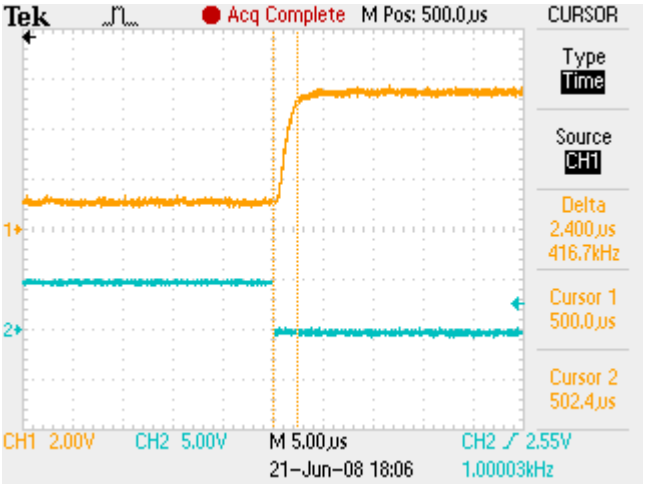
The specification for the response time is < 10µs. Below are the general results using 1kHz control signal for the testing. The main speed limitation comes from the driver. With better driver design, the response time can be < 1µs.

The following photos show the rise time and fall time of light with a square waveform voltage applied.





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2.7 Polarization Dependent Loss (dual-band sample)

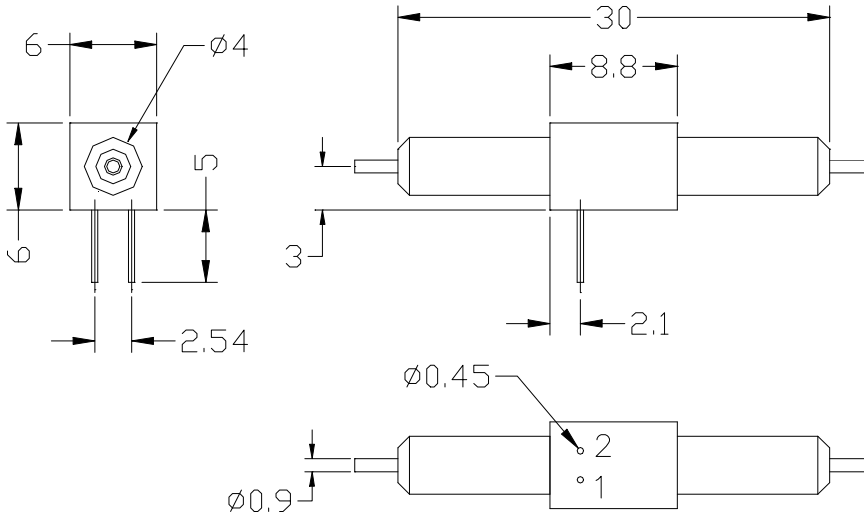
Data @ 1310nm	
ATT(dB)	**PDL(dB)**
0.70	0.045
5.00	0.033
10.00	0.099
15.00	**0.127**
20.00	0.181
25.00	0.313
30.00	0.488
35.00	0.854
40.00	1.315

Data @ 1550nm	
ATT(dB)	**PDL(dB)**
0.62	0.062
5.00	0.083
10.00	0.089
15.00	**0.083**
20.00	0.098
25.00	0.134
30.00	0.362
35.00	0.637
40.00	1.164

In order to get the accurate PDL data, the driver voltage and environment temperature should be very stable. The above test data was obtained under the test condition with the optical power variation < 0.08dB, attenuation < 25dB, within 1minute.

3. Mechanical Drawing and Pin Assignment

3.1 Mechanical Drawing



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3.2 High Speed VOA Pin Assignment

Pin	Function	Pin	Function
1	Control Voltage (+)	2	GND

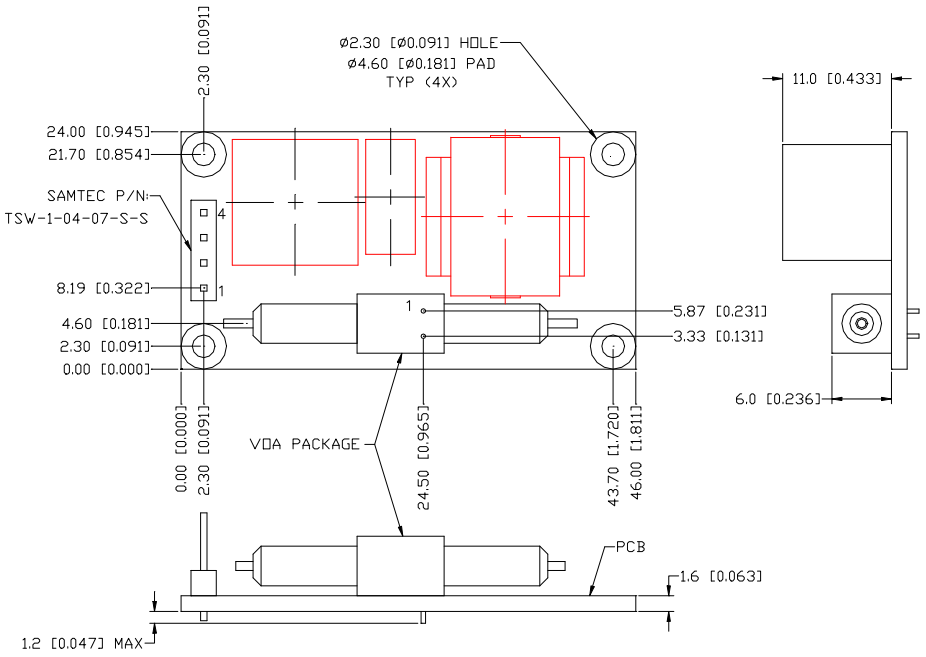
3.3 Driver Pin Assignment

a. Output Voltage: 300VDC
b. Response Time: <10µs
c. Input setting voltage: 0-5VDC

Power Consumption: <2.0W @ 65°C

1	+5VDC	2	GND
3	GND	4	Control Voltage 0 to +5VDC

3.4 Driver and VOA Assembly Dimension



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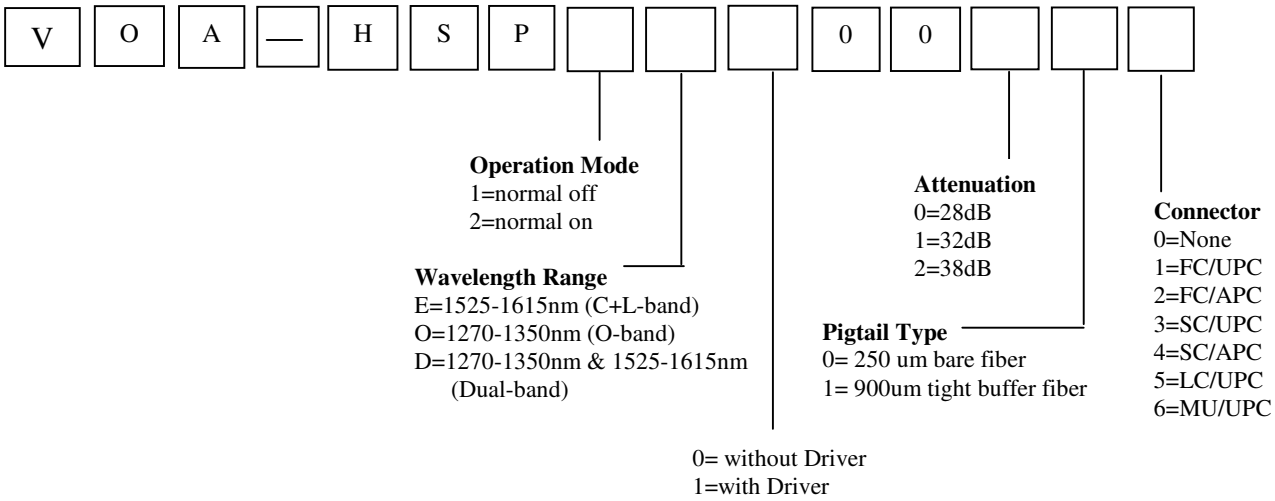
4. Conclusion

In general, Lightwaves2020's High-speed Variable Optical Attenuator has excellent performance in insertion loss, response time, attenuation range, and etc.. Since this device is sensitive to temperature and driving voltage, it is recommended that thermoelectric cooler (TEC) be used along with this device to achieve the best performance.

5. Ordering Information



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