NanoSpeed™ Fiber Optical Phase Modulator/Switch

(Bidirectional, Polarization Insensitive, All Wavelengths)

DATASHEET

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Features

- High Reliability
- High Speed
- Low loss
- Compact

Applications

- Sensor
- Phase shift/delay
- Data process
- Instrumentation

RoHS COMPLIANT

The NS Series fiber optical phase modulator/switch is a device based on a patented electro-optical configuration, featuring low optical loss and wide temperature operation with built-in compensation. The device is a bidirectional two-port equipment in which the input and output ports are interchangeable. The device dynamically controls the optical phase of the transmitting light, meeting the most demanding requirements of continuous operations over 25 years and non-mechanical ultra-high reliability (passed Telcordia and space qualifications). The switch is intrinsically bidirectional and selectable for polarization-independent or polarization-maintain by the fiber type.

For high-frequency resonance configuration, the device has an integrated circuit inside that only requires a 5V AC input signal matching the resonance frequency. For lower frequency, this device can be mounted on specially designed electronic drivers of both analog and digital switching drivers using a 5V analog or TTL control signal and a 12V power supply (wall pluggable), respectively.

The rise/fall time is intrinsically related to the crystal properties, and the repetition rate is associated with the driver. There are poor frequency response sections due to the device resonances. The NS devices are shipped mounted on a tuned driver.

The NS series switches respond to a control signal at any arbitrary time, with a frequency from DC up to MHz. The switch is usually mounted on a tuned driver before shipping. The electrical power consumption is related to the repetition rate at which the switch is operated.

Specifications

Parameter		Min	Typical	Max	Unit
Insertion Loss [1]	1900-2200nm		0.8	1.8	dB
	1260~1650nm		0.6	1.0	dB
	960~1100nm		0.8	1.3	dB
	780-960nm		1.2	1.5	dB
	520 – 680nm		1.5	2.3	dB
IL Temperature Dependency		60	0.25	0.5	dB
Durability		10^{14}			cycles
Polarization Dependent Loss (SM version)			0.15	0.3	dB
Polarization Mode Dispersion (SM version)			0.1	0.3	ps
Polarization extinction ratio (PM version)		18			dB
Return Loss		45	50		dB
Phase Change [2]		0	180	360	Degree
Analog Modulation rate		DC	50	200	kHz
Digital Switching Rate [3]		10	20	100	MHz
Resonance Modulation Rate					
Optic power	Normal power version		300		mW
Handling [4]	High power version			5	W
Operating Temperature	Standard	-5		75	°C
	Special version	-30		85	
Storage Temperature		-40		100	°C

Notes:
[1] Measured without connectors. Wavelength with red color can be implemented in the special version with a long lead time.
[2] The phase change is proportionally to the 0-5V control signal with NVDR driver. Regular is 180 degree, 360 degree is special order.
[3] Fixed at a predetermined phase change degree.
[4] For 1310nm/1550nm. For the shorter wavelength, the handling power is significantly reduced. High power version should be ordered to increase the damage threshold.

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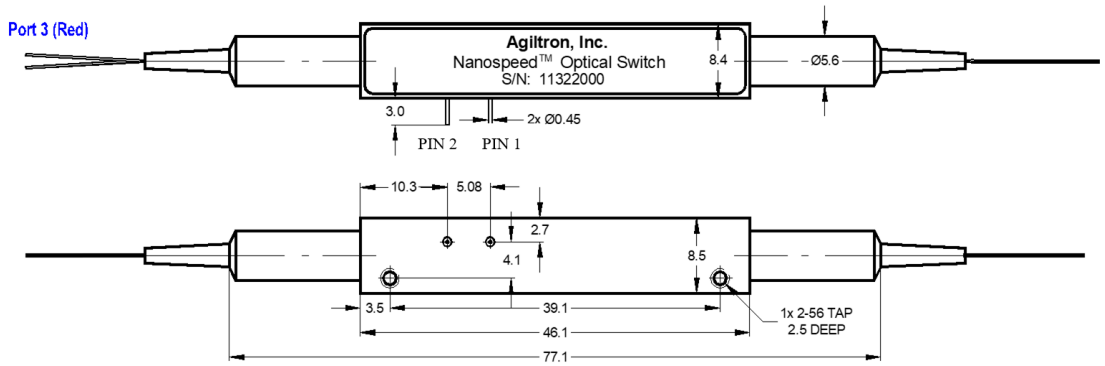
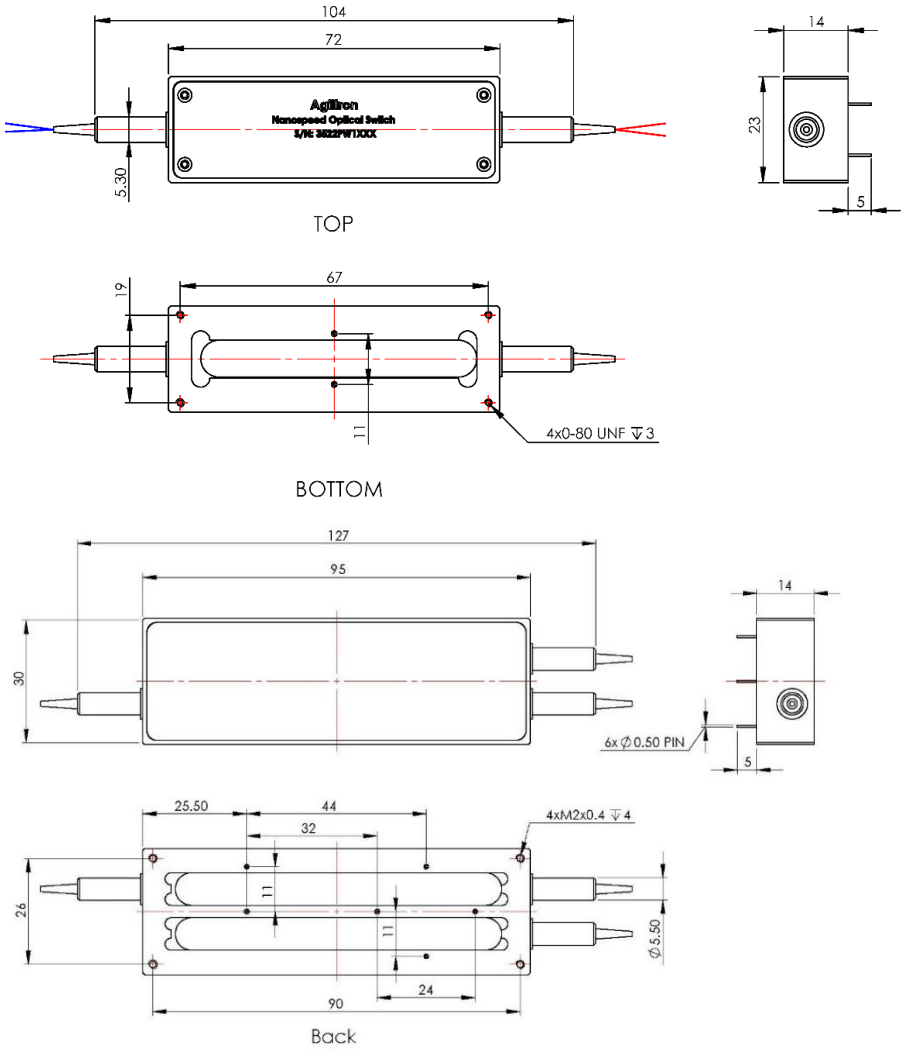
Mechanical Dimensions (Unit: mm) 850-2300nm, DC-200kHz



Mechanical Dimensions (Unit: mm) 550-2300nm, DC-800kHz



*Product dimensions may change without notice. This is sometimes required for non-standard specifications.

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Analog Driving Board Selection

Maximum Repetition Rate	Part Number (P/N)
100kHz (dual stage)	NVDR-SP2210121
200kHz (single stage)	NVDR-SP2210121
800kHz (single stage)	NVDR-SPH210121

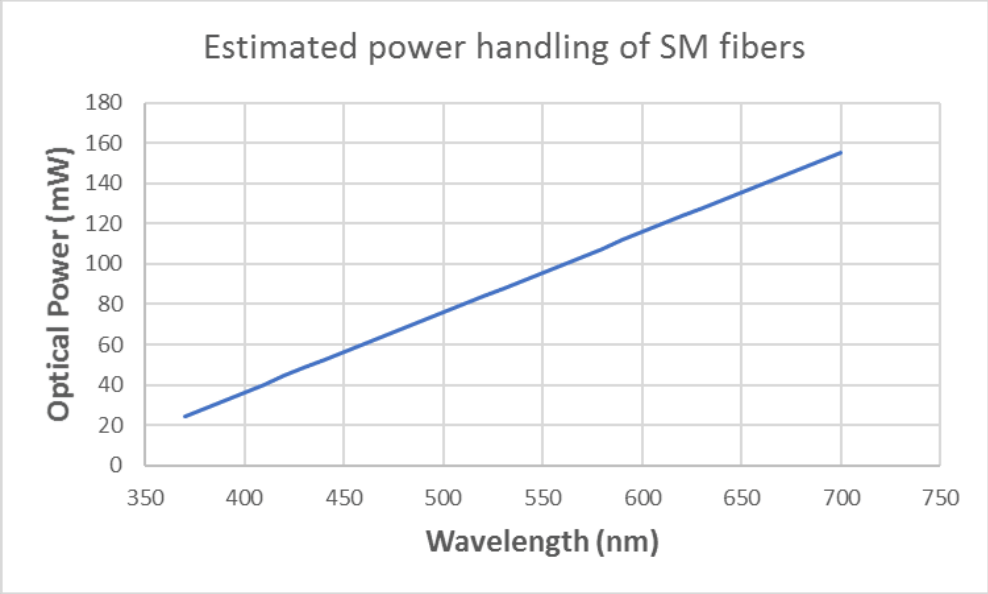
Digital Driving Board Selection

	☐☐	☐☐	☐	☐	☐	1	1
Prefix	**Switch Type**	**Configuration[1]**	**Repeat Rate**	**Switch QTY**	**Channel # [3]**	**Control Mode**	**Power Supply**
NSDR-	single stage = 1P dual stage [2] = 2P	1x1 = 1a 1x2, 2x1 = 2a 1x4, 4x1 = 4a ... 1xN, Nx1 = Na Special=00	200kHz = M 500kHz/50ns = P[3] 1MHz/50ns = H[3] 1MHz/10ns = F[3] Special = 0	Single = 1 Multiple = G	Single Channel = 1 N parallel channel = N Special = 0	TTL=1	12VDC =1 Special =0

Resonance Driving Board (inside the device)

The resonant modulator can be driven by a function generator tuned to the device's resonant frequency.

Optical Power Handling vs Wavelength For Single-Mode Fibers



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Ordering Information

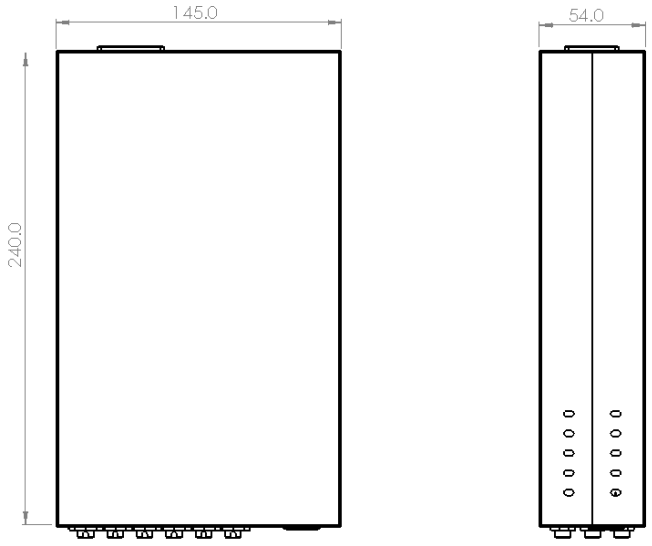
	☐	☐	☐	☐	☐	☐	☐	☐	☐
Prefix	**Type**	**Wavelength**	**Phase Change**	**Repetition Rate**	**Fiber Type**	**Fiber Cover**	**Fiber Length**	**Connector**	**Benchtop [1]**
NSPM-	Standard = 1 High Power [1] = 2	1060 = 1 2000 [1] = 2 1310 = 3 1550 = 5 1625 = 6 850 = 8 780 = 7 650 = E 550 = F Special = 0	180 = 1 360 = 2	Digital 100kHz = 1 Digital 200kHz = 2 Digital 800kHz = 3 Analog 100kHz = A Analog 200kHz = B Analog 800KHz = C Resonance 5MHz = D Resonance 10MHz = E Resonance 20MHz = F Resonance 50MHz = G Resonance 80MHz = H Special = 0	SMF-28 = 1 HI1060 = 2 HI780 = 3 PM1550 = 5 PM980 = 9 Special = 0	0.9mm tube = 3 Special = 0	0.5m = 2 1.0 m = 3 Special = 0	None = 1 FC/PC = 2 FC/APC = 3 LC/PC = 7 E2000 PC = 8 E2000 APC = 9 Special = 0	Non = 1 Yes = 2

[1]. The benchtop integrates the modulator, driver, and power supply. Front Panel: SMA 0-5V electrical control input port for precise modulation. Fiber input and output ports with standard FC/APC connectors. Back Panel: 100-240 VAC power input for global compatibility and a Power switch for easy on/off control.
This all-in-one design simplifies setup and operation

Note:

- **PM1550** fiber works well for **1310nm**

Benchtop Box Mechanical Dimension



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Q & A

Q: Does NS device drift over time and temperature?

A: NS devices are based on electro-optical crystal materials that can be influenced to a certain range by the environmental variations. The insertion loss of the device is only affected by the thermal expansion induced miss-alignment. For extended temperature operation, we offer special packaging to -40 -100 ^{0}C. The extinction or cross-talk value is affected by many EO material characters, including temperature-dependent birefringence, Vp, temperature gradient, optical power, at resonance points (electronic). However, the devices are designed to meet the minimum extinction/cross-talk stated on the spec sheets. It is important to avoid a temperature gradient along the device length.

Q: What is the actual applying voltage on the device?

A: 100 to 400V depending on the version.

Q: How does the device work?

A: NS devices are not based on Mach-Zander Interference, rather birefringence crystal's nature beam displacement, in which the crystal creates two different paths for beams with different polarization orientations.

Q: What is the limitation for faster operation?

A: NS devices have been tested to have an optical response of about 300 ps. However, practical implementation limits the response speeds. It is possible to achieve a much faster response when operated at partial extinction value. We also offer resonance devices over 20MHz with low electrical power consumption.

Q: I assume that "Analog" means we provide a continuously varying voltage to the input port, proportional to the desired phase shift. Does "Digital" mean that a protocol is used to transmit the desired phase shift, something like a command string containing a designed phase shift value encoded in binary or ASCII? Or does it mean that there are only two voltage levels (essentially TTL) and the EOM switches between two phase shifts only?

A: It changes between two values, no voltage and Vpi. Analog or digital response

Q: How many EOMs can be installed in a benchtop box?

A: Up to 2

Q: What is Vpi for the EOM (or driver if paired with the EOM)?

A: Depend on specific, 200-450V

Operation Manual

1. Connect a control signal to the SMA connector on the PCB.
2. Attach the accompanied power supply (typically a wall-pluggable unit).
3. The device should then function properly.

Note: Do not alter device factory settings.

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Application Notes

Fiber Core Alignment
Note that the minimum attenuation for these devices depends on excellent core-to-core alignment when the connectors are mated. This is crucial for shorter wavelengths with smaller fiber core diameters that can increase the loss of many decibels above the specification if they are not perfectly aligned. Different vendors' connectors may not mate well with each other, especially for angled APC.

Fiber Cleanliness
Fibers with smaller core diameters (<5 μm) must be kept extremely clean, contamination at fiber-fiber interfaces, combined with the high optical power density, can lead to significant optical damage. This type of damage usually requires re-polishing or replacement of the connector.

Maximum Optical Input Power
Due to their small fiber core diameters for short wavelength and high photon energies, the damage thresholds for device is substantially reduced than the common 1550nm fiber. To avoid damage to the exposed fiber end faces and internal components, the optical input power should never exceed 20 mW for wavelengths shorter 650nm. We produce a special version to increase the how handling by expanding the core side at the fiber ends.