WAVESHAPER® 1000B/4000B

1000B Programmable Optical Filter
4000B Programmable Optical Processor

Full flexibility for Filtering and Switching operations in optical communications

The WaveShaper 1000B Programmable Optical Filter and the 4000B Programmable Optical Processor allow arbitrary optical filtering of attenuation and phase across the Super C-Band or the entire C+L band. The 4000B allows wavelength selective optical switching using the 1 x 4 optical port configuration and in addition it provides a high resolution mode of operation in which the optical signal passes twice through the grating based monochromator. This high resolution mode ensures narrow channel shapes in combination with steep filter slopes of more than 700 dB/nm. This instrument family is broadly used in Research, Development and Manufacturing applications.

FEATURES

- Product versions available for:
  - Super C-Band
  - C+L Band
- Arbitrary control of attenuation and phase
- Filter update rate of more than 10 Hz
- High resolution: bandwidth down to 14 GHz (FWHM)
- Power splitting (4000B)
- Webserver included

APPLICATIONS

- DWDM System Test
- Network Simulation
- Transceiver test
- Pulse shaping
- Optical comb generation
- Quantum optics

COHERENT

The WaveShaper is based on Coherent's proprietary Liquid Crystal on Silicon (LCoS) technology which enables a filter update rate of more than 10 Hz. Fast switching and rapidly scanning filter applications are supported – allowing high throughput testing as required for example in system test or manufacturing where fast uploading of different filter shapes is required.

Control and Programming

The WaveShaper B Series instruments can be controlled in a number of ways:

- From a Win 10 system using the WaveShaper App Graphical User Interface (GUI) package.
- From a Web-Browser using the WaveShaper-internal Web-Server. This Web-Server provides full control without installing software on the user computers. Control from any platform (Windows, Linux, Android, iOS etc) is provided.
- A RESTful http based Application Programming Interface (API) provides control of the WaveShaper from other programming environments. Programming examples are available for LabView, Matlab, Python, Octave, Visual Basic and C#.

WaveSketch

WaveSketch enables users of the WaveShaper 1000B and 4000B to manually create filter shapes using a 'drag and drop' graphical interface. As both the loss and phase of the filter curve are manipulated on screen, the WaveShaper transfer function is updated in real time thus allowing, for example, continuous adjustments to eliminate drift in system test applications.

Network Simulation

The network simulation capability allows simulating the characteristics of optical networks including the impact of cascaded filtering components like ROADMs, amplifiers etc.

Power Splitting and Broadcasting

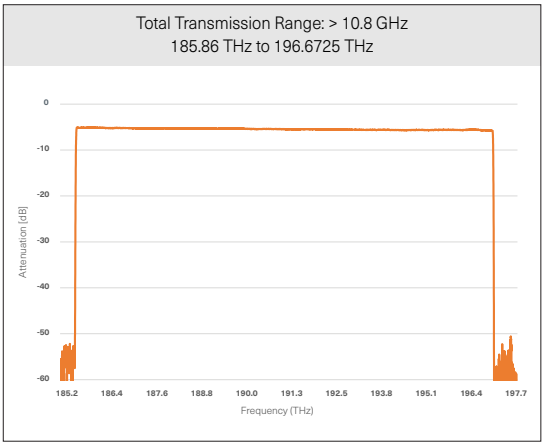
The WaveShaper 4000B has the ability to split an input signal between multiple output ports. Simple structures like wavelength-dependent couplers and splitters (Figure 1) can be created with user defined coupling ratios and frequency dependencies.

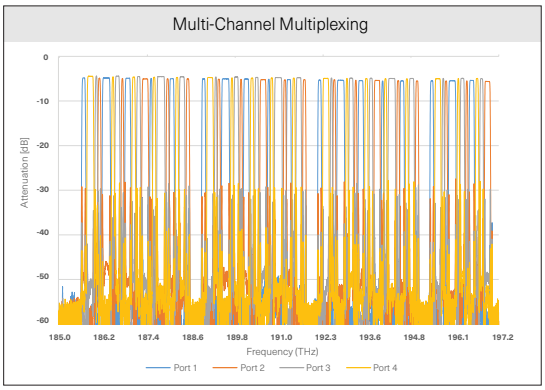
The phase of signals in the different ports can also be adjusted, enabling more complex structures like delay line interferometers (e.g. DPSK-Demodulator – shown in Figure 2) or DQPSK-Demodulators with a variable, easily-programmable, optical transfer function.

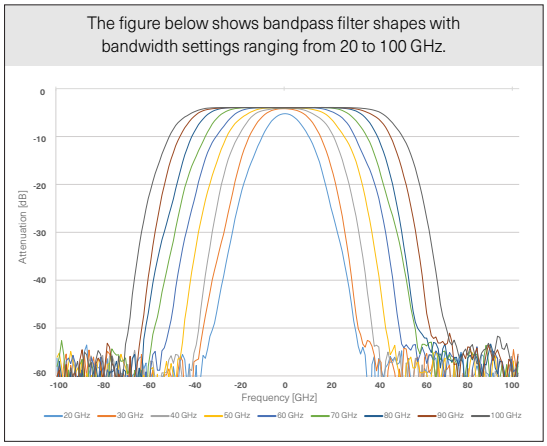
Figure 1: Splitter

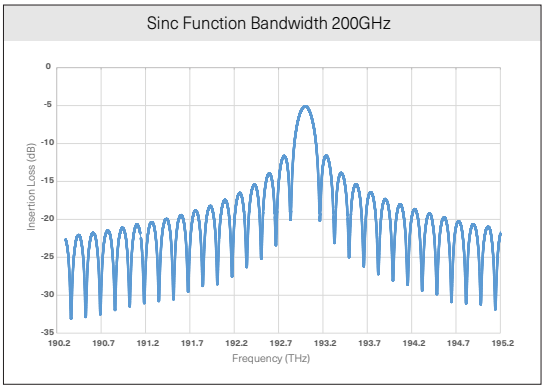
Figure 2: Variable Delay Line Interferometer

Measurements of sample filter shapes generated with a WaveShaper 4000B/X









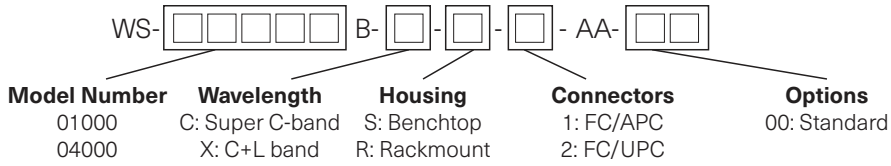
Specifications

The device will meet all specifications following a warm-up period of 10 minutes from a temperature within the Operating Temperature range. Specifications may change without notice.

Model		1000B	4000B	1000B/X	4000B/X
Transmission Band		Super C-band		C+L band	
Optical Ports	Port Configurations	1x1	1x4	1x1	1x4
Filter Control	Operating Frequency Range	190.55 THz to 196.775 THz (1523.53 nm to 1573.301 nm)		185.85 THz to 197.000 THz (1521.79 nm to 1613.08 nm)	
	Filter Bandwidth	10 GHz to full range 8 GHz to full range (1)		18 GHz to full range 14 GHz to full range (1)	
	Filter Shape	Arbitrary Attenuation and Arbitrary Phase			
	Frequency Setting Resolution	±0.1 GHz (±0.8 pm)			
	Frequency Setting Accuracy	±2.5 GHz (±20 pm)		±5 GHz (±40 pm)	
	Bandwidth Setting Resolution	±0.1 GHz (±0.8 pm)			
	Bandwidth Setting Accuracy	±5 GHz (±40 pm)		±10 GHz (±80 pm)	
	Bandwidth Setting Repeatability	±2.5 GHz (±20 pm)		±5 GHz (±40 pm)	
	Group Delay Control Range	±25 ps		±15 ps	
	Attenuation Control Range	0 to 40 dB			
	Attenuation Setting Resolution	0.01 dB			
	Attenuation Setting Accuracy	±1 dB for 0.01 to 10 dB ±10% for 10.01 to 25 dB ±15% dB for 25.01 to 30 dB			
	Settling Time (Filter update rate)	<0.1 s (>10 Hz)			
Loss and Dispersion	Insertion Loss	5 dB (2)	5 dB (2) 11 dB (1,2)	6.5 dB (3)	6.5 dB (3) 12 dB (1, 3)
	Insertion Loss Non-Uniformity	0.8 dB			
	Polarization Dependent Loss (PDL)	0.4 dB		0.6 dB	
	Differential Group Delay (DGD)	0.6 ps		0.5 ps	
	Return Loss	25 dB		30 dB	
Optical Power (4)	Max Total Input Optical Power	27 dBm			
	Max Optical Power per 50 GHz channel	13 dBm			
Environment	Operating Temperature	10 to 35 °C			
	Operating Humidity	10% to 90% non condensing			
Electrical	Communications Interface	USB 2.0, Ethernet (GbE)			
	Power Consumption	< 50 W			
Mechanical	Connector Interface	FC/APC, FC/UPC			
	Dimensions, weight	Bench-top: 241 mm x 88 mm x 316 mm, 3.8 kg			

Notes:
(1) Valid for port 1 when selecting “High Resolution” mode
(2) Valid for Filter Bandwidth settings of 15 GHz and larger. For Filter Bandwidth settings below 15 GHz an additional loss of up to 2 dB may apply.
(3) Valid for Filter Bandwidth settings of 25 GHz and larger. For Filter Bandwidth settings below 25 GHz an additional loss of up to 2 dB may apply.
(4) Optical signals with spectral components below 600 nm must be avoided.

Order Code Key



Model	Order Code	Description	Wavelength Band	Housing Type	Fiber Type	Connection Type
WaveShaper 1000B	WS-01000B-C-S-1-AA-00	Programmable Optical Filter	Super C	Benchtop	Single-mode	FC/APC
	WS-01000B-C-S-2-AA-00	Programmable Optical Filter	Super C	Benchtop	Single-mode	FC/UPC
	WS-01000B-C-R-1-AA-00	Programmable Optical Filter	Super C	Rackmount	Single-mode	FC/APC
	WS-01000B-X-S-1-AA-00	Programmable Optical Filter	C+L	Benchtop	Single-mode	FC/APC
	WS-01000B-X-S-2-AA-00	Programmable Optical Filter	C+L	Benchtop	Single-mode	FC/UPC
	WS-01000B-X-R-1-AA-00	Programmable Optical Filter	C+L	Rackmount	Single-mode	FC/APC
WaveShaper 4000B	WS-04000B-C-S-1-AA-00	Programmable Optical Processor	Super C	Benchtop	Single-mode	FC/APC
	WS-04000B-C-S-2-AA-00	Programmable Optical Processor	Super C	Benchtop	Single-mode	FC/UPC
	WS-04000B-C-R-1-AA-00	Programmable Optical Processor	Super C	Rackmount	Single-mode	FC/APC
	WS-04000B-X-S-1-AA-00	Programmable Optical Processor	C+L	Benchtop	Single-mode	FC/APC
	WS-04000B-X-S-2-AA-00	Programmable Optical Processor	C+L	Benchtop	Single-mode	FC/UPC
	WS-04000B-X-R-1-AA-00	Programmable Optical Processor	C+L	Rackmount	Single-mode	FC/APC
	WS-04000B-X-R-2-AA-00	Programmable Optical Processor	C+L	Rackmount	Single-mode	FC/UPC

Additional Resources

Visit https://ii-vi.com/instruments for the latest product information, news and software for the WaveShaper and WaveAnalyzer product families.

Knowledge Base

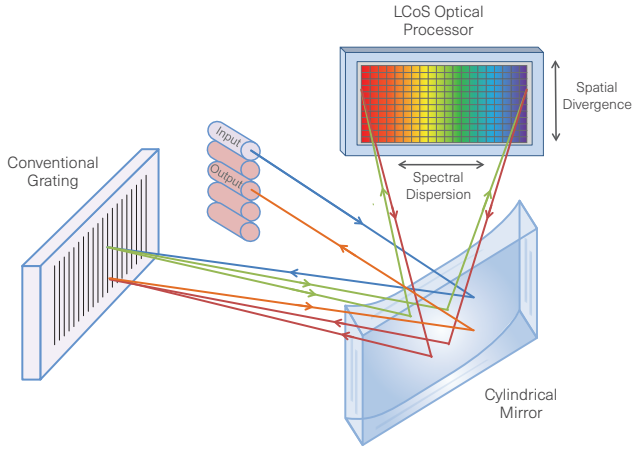
Obtain further application and technical information about the Optical Instrumentation portfolio by visiting: https://ii-vi.com/waveshaper-and-waveanalyzer-knowledgebase

Product Demonstration Videos

Watch product demos at: https://www.youtube.com/user/iiviincorporated

Technology - How does it work?

The WaveShaper family is based on advanced Liquid Crystal on Silicon (LCoS) technology. As shown schematically in the figure below, the input signal is dispersed by a conventional grating before its spectral components hit the LCoS optical processor. This LCoS processor consists of a matrix of reflective liquid crystal elements. By applying voltages to these matrix elements, they can add individual phase shifts to the reflected signals which allows beam steering of the signal components hitting the LCoS processor. As the wavelengths are separated on the LCoS chip, the control of each wavelength is independent of all others and can be switched or filtered without interfering with other wavelengths. As a result, the structure offers spectral attenuation, dispersion and optical switching capabilities which are available in the WaveShaper family.



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