

Tunable Laser Source Model 4200



Low Noise, High Speed, Versatile, Low Cost

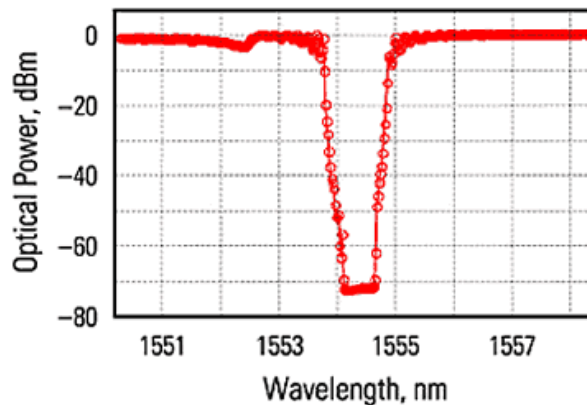
The 4200 Tunable Laser Source (TLS) is a fast, low-noise tunable source designed as a reliable high-performance workhorse for a variety of applications. For passive optical component testing, the Model 4200 TLS and either the dBm Model 2004 Component Spectrum Analyzer[®] (CSA) or the 4500 IL/PDL/ORL Swept Spectrometer[®] are designed to work hand-in-hand for fast, high accuracy characterization of Insertion Loss, PDL, and Return Loss (ORL).

Low STSE to Characterize Deep Wells

The figure below plots optical power transmission through two matched, narrow-notch filter fiber Bragg grating reflectors measured with the dBm Optics Model 4200. The ratio of the signal power to the total integrated ASE background power outside the 0.8 nm filter width is > 70 dB.

Summary

- Tuning range: Coverage from 1260-1680 nm
- Special wavelength: 980 nm
- Standard sweep rates to 100 nm/second; fast sweeping at 1000 nm/second with the 680 series
- > 50-65 dB STSE for characterizing deep well devices
- Options include built-in in polarization control, attenuation, power monitoring, wavelength measurement to ± 1 pm with mode-hop detection and correction
- High reliability



Rugged and Reliable

The 4200 is one of the most reliable tunable laser sources available. Our experience in designing and developing production-line-worthy tunable lasers, has helped make the Model 4200 one of the most reliable TLS's available. Shock and vibration are fully specified to rigorous standards.

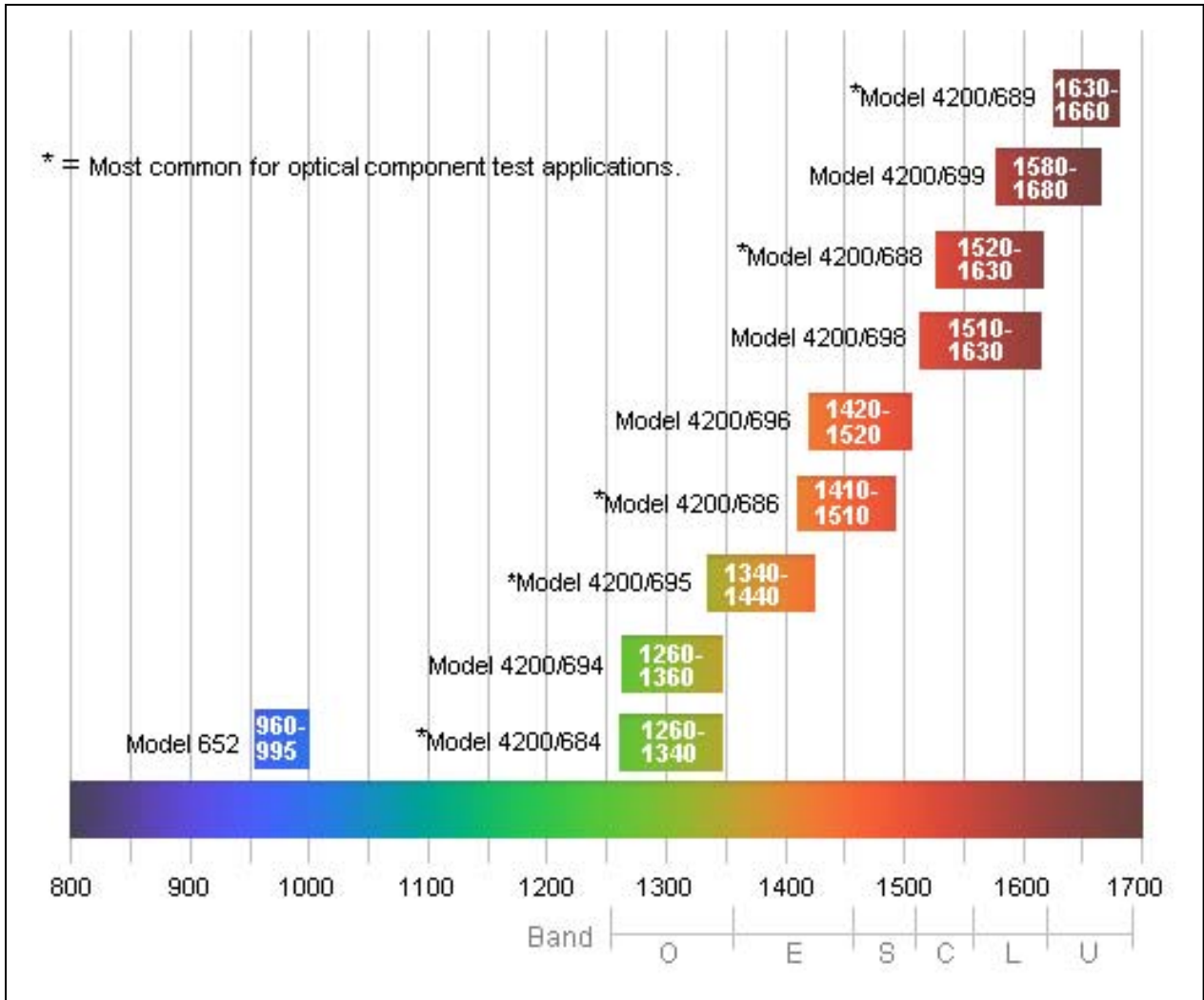
Fast Sweep, Stable, Affordable



Tunable Laser Source: Model 4200

Wide Tuning Range

The Model 4200 can cover the O, E, S, C, L and U bands.



Tunable Laser Source: Model 4200 Overview

Output power is very stable. Real-time power reference (Option 301) eliminates uncertainty due to output power variation.

Continuous sweep at 2-1000 nm/second with a typical sweep of 100 nm/second, characterization of full C+L band components in less than 1 second.

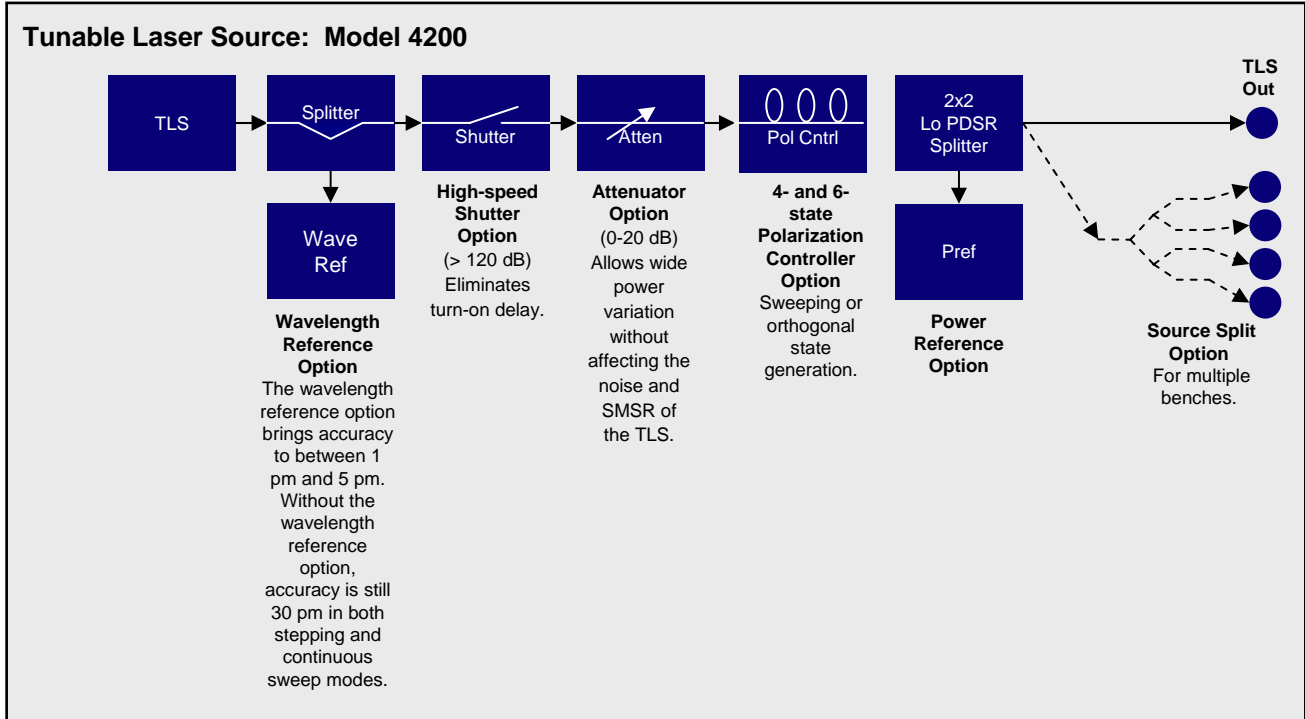
Easy to use from the front panel, ethernet or GPIB

Typical 100 nm tuning range

Mode-hop free performance

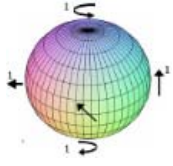
Output power of +10 to -3 dBm with low noise gives sufficient power with the CSA or Swept Spectrometer to characterize even the deepest components—even with the TLS power split to several test benches.

Wavelength resolution of 0.08 pm to precisely characterize narrow-band DWDM components



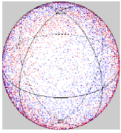
Tunable Laser Source: Model 4200

Turn Your TLS Into a Fully-controlled and Characterized Optical Source



Polarization State Control

The 953I 4- and 6-state polarization controller enables deterministic control over the output state of the signal. The 953I provides 4 and 6 orthogonal states for use in polarization analysis—all in a low cost, fully integrated package. Another choice is to use an external Agilent 8169 polarization controller under direct control of the TLS.



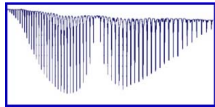
Polarization Scrambling

With the internal polarization scrambler option, turn on and off high-speed polarization scrambling to turn the TLS output into a randomized polarization signal. This eliminates the effects of birefringence in the optical path.



Attenuation

With the internal variable attenuator (Option 921), 0 to 20 dB of attenuation can be added and controlled from either the front panel or remotely.



Wavelength Referencing

Option 410, the precision wavelength reference module, and Option 402, the wavelength reference module, provide real-time calibration of wavelength accuracy. By connecting through GPIB, Ethernet, or the USB flash memory card, it is possible to obtain an accurate indication of the wavelength of the laser to < 1 pm (Option 410) or < 5 pm (Option 402).

Output Power Characterization

Add real-time power reference (Option 301) to the Model 4200 TLS and get a full characterization of the output power at every wavelength.



Output Shutter

Add a shutter (Option 310) for fast stabilization power control of any tunable laser. The base laser can be turned on and off, but all TLS's take some time to stabilize after current is applied to the laser. Using the shutter eliminates the time it takes to stabilize after turn-on.

Tunable Laser Source: Model 4200

Options and Ordering Information

Option	Description	684	686	688	689	694	695	696	698	699
4200	Tunable laser source mainframe	✓	✓	✓	✓	✓	✓	✓	✓	✓
301	Internal real-time power reference	✓	✓	✓	✓					
310	Internal optical shutter/automatic dark calibration	✓	✓	✓	✓					
402Q	Wavelength reference module (extended range); 1260-1640 nm; 5 pm accuracy		✓	✓	✓					
402T	Wavelength reference module; 1510-1648 nm; 5 pm accuracy			✓	✓					
410Q	Precision wavelength reference module (extended range); 1260-1640 nm; 1 pm accuracy		✓	✓	✓					
410T	Precision wavelength reference module; 1510-1648 nm; 1 pm accuracy			✓	✓					
705	Rack ears	✓	✓	✓	✓	✓	✓	✓	✓	✓
921	Internal variable optical attenuator; 0-20 dB	✓	✓	✓	✓					
953I-13	Internal automatic matrix method PDL/IL measurement (4- and 6-state polarization controller; 1310 nm version)	✓	✓							
953I-15	Internal automatic matrix method PDL/IL measurement (4- and 6-state polarization controller; 1550 nm version)		✓	✓	✓					
957I	Internal polarization scrambler	✓	✓	✓	✓					

Tunable Laser Source: Model 4200

Mainframe Specifications

System transmit speed	Transmitting to host with Ethernet is 3 Mbytes/second (dedicated link). Transmitting to host with GPIB is 1.7 Mbytes/second into a PC.
Trigger latency ¹	< 40 ns latency; < 40 ns jitter
Display	4" x 6" graphical display; VGA (800 x 600); TFT LCD color
Data storage	Memory for > 100K readings per channel on all channels real-time storage.
Triggering	Software synchronous trigger or two selectable external trigger inputs
Interfaces	IEEE-488, 100-BaseT Ethernet standard
Command set	IEEE-488.2 compliant (SCPI-like)
Power	90-265 VAC; 175 VA max; 47-63 Hz. No switch or fuse change required.
Ambient temperature	10 °C to 35 °C (50 °F to 95 °F). Contact factory for 0 °C to 40 °C (32 °F to 104 °F).
Storage temperature	-40 °C to +70 °C (-40 °F to 158 °F).
Humidity	< 95% non-condensing 0 °C to 35 °C
Warm-up time	60 minutes to full specifications; useable immediately after turn on
Recalibration period	1 year; certificate of calibration included
Warranty period	Standard warranty is 4 years; Options 402, 410, 953I and tunable laser modules (680 Series and 690 Series) carry a one-year warranty.
Size	16.8" w x 16.4" d x 5.25" h (42.6 cm x 41 cm x 10.5 cm)
Weight	15 lbs (6.8 kg)
Mounting	Benchtop or rack mount

¹ Trigger latency defined as total time from trigger edge to initiation of measurement

Tunable Laser Source: Model 4200

Real-time Power Reference; Shutter/Dark Calibration

Options 301, 310

Specifications

Sensitivity and Noise				Precision Power Meter Module (Option 202) Noise RMS ²						Power Meter Module (Option 201) Noise RMS ²							
Range	Fixed Range	Measurement		Measurement Resolution ¹		5 secs ⁷		100 ms ⁸		10 μ s (full speed) ⁹		5 secs ⁷		100 ms ⁸		10 μ s (full speed) ⁹	
		W	dBm	W	dBm	\pm W	\pm dBm	\pm W	\pm dBm	\pm W	\pm dBm	\pm W	\pm dBm	\pm W	\pm dBm	\pm W	\pm dBm
Fast 10 mW	10 mW	10 mW	10	200 nW	-37	50 nW	-43	100 nW	-41	400 nW	-34	100 nW	-41	200 nW	-37	800 nW	-31
	1 mW	1 mW	0	20 nW	-47	8 nW	-51	20 nW	-50	40 nW	-44	20 nW	-47	40 nW	-44	80 nW	-41
	100 μ W	100 μ W	-10	2 nW	-57	2 nW	-57	2 nW	-57	8 nW	-51	4 nW	-54	4 nW	-54	16 nW	-48
Fast 100 μ W	100 μ W	100 μ W	-10	2 nW	-57	1 nW	-60	1 nW	-60	4 nW	-54	4 nW	-54	4 nW	-54	16 nW	-48
	10 μ W	10 μ W	-20	200 pW	-67	30 pW	-75	40 pW	-74	800 pW	-61	400 pW	-64	400 pW	-64	4 nW	-54
	1 μ W	1 μ W	-30	20 pW	-77	20 pW	-77	20 pW	-77	300 pW	-65	200 pW	-67	200 pW	-67	2 nW	-57
Fast 1 μ W	1 μ W	1 μ W	-30	20 pW	-77	10 pW	-80	6 pW	-82	100 pW	-70	50 pW	-73	50 pW	-73	500 pW	-63
	100 nW	100 nW	-40	2 pW	-87	2 pW	-87	3 pW	-85	40 pW	-74	20 pW	-77	50 pW	-73	500 pW	-63
	10 nW	10 nW	-50	0.2 pW	-97	1 pW	-90	2 pW	-87	40 pW	-74	20 pW	-77	50 pW	-73	500 pW	-63
Fast 10 nW	10 nW	10 nW	-50	0.2 pW	-97	1 pW	-90	2 pW	-87	4 pW	-84	20 pW	-77	50 pW	-73	500 pW	-63
	1 nW	1 nW	-60	0.02 pW	-107	1 pW	-90	2 pW	-87	3 pW	-85	20 pW	-77	50 pW	-73	500 pW	-63
	100 pW	100 pW	-70	2 fW	-117	1 pW	-90	2 pW	-87	2 pW	-87	20 pW	-77	50 pW	-73	500 pW	-63
Fast 100 pW	100 pW	100 pW	-70	2 fW	-117	300 fW	-95	300 fW	-95	300 fW	-95	20 pW	-77	50 pW	-73	500 pW	-63

Accuracy^{1, 6}

Absolute uncertainty at reference conditions ⁴ : 2.5% Absolute operational uncertainty ⁵ : 5% Relative uncertainty: <1% + noise (per table above)

Measurement Speed

Auto-Range Mode	Full Measurement Range	Reading Time with Averaging of:		
		1 Reading	2,000 Readings	500,000 Readings
Fast 10 mW - 2 nW	10 dBm to -57 dBm	10 μ s	20 ms	5.00 s
Fast 100 μ W - 20 pW	-10 dBm to -77 dBm	10 μ s	20 ms	5.00 s
Fast 1 μ W - 200 fW	-30 dBm to -97 dBm	10 μ s	20 ms	5.00 s
Fast 10 nW - 2 fW	-50 dBm to -107 dBm	10 μ s	20 ms	5.00 s
Fast 1 nW - 0.5 fW	-60 dBm to -117 dBm	10 μ s	20 ms	5.00 s
Med 10 mW - 20 pW	10 dBm to -77 dBm	1 ms	21 ms	5.00 s
Med 10 mW - 200 fW	10 dBm to -97 dBm	10 ms	30 ms	5.01 s
Slow 10 mW - 2 fW	10 dBm to -107 dBm	1.5 s	1.52 s	6.52 s
Slow 10 mW - 0.5 fW	10 dBm to -117 dBm	5 s	5.02 s	10.02 s

Connections*

Model	Description
1.5 UNIV	Universal 1.5 mm ferrule interface
2.5 UNIV	Universal 2.5 mm ferrule interface
BF	Bare fiber interface
FC	FC connector interface
LC	LC connector interface
MU	MU connector interface
SC	SC connector interface
ST	ST connector interface
SMA	SMA connector interface

*Select when ordering. Additional connectors may be available. Input connection can be changed in the field.

(Continued)

Tunable Laser Source: Model 4200

Real-time Power Reference; Shutter/Dark Calibration

Options 301, 310

Specifications

Analog Output

Analog output available (Option 222)

Polarization Uncertainty of Measurement

< ±0.0015 dB typical; 0.0035 dB guaranteed for precision power meter module (Option 202) < ±0.0050 dB for power meter module (Option 201)
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Return Loss

> 55 dB

Remote Power Meter Module (Option 210)

Input configurations: 3 mm free space; 1 mm free space; FC, SC, ST, UC Universal connector or BF (bare fiber)

Input orientation: End (axial) entry or side entry
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Cable length: 1 meter standard; call factory for additional lengths

¹ From 1500 to 1620 nm. For 1400-1635, add 3 dBm; for 800 nm-1650 nm, add 10 dB noise and resolution specs (or multiply to W by 10). Assume automatic or manual dark calibration performed.

² Peak noise is typically 3 to 3.5 times the RMS figure. Noise figures are typical performance.

³ Per "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results;" NIST Technical Note #1297

⁴ Wavelength = 1310, 1520-1625 nm, $T_{(ambient)} = 23C \pm 2C$, 1.1 mm diameter beam, 30 μ W

⁵ Wavelength = 800-1650 nm, $T_{(ambient)} = 10$ to 35C, Fiber with N.A. <0.3, -70 dBm to +3 dBm (total wavelength range 800 nm-1700 nm)

⁶ Above 5 dBm, accuracy is typical

⁷ Maximum variation \pm for 4 measurements, filter on

⁸ Maximum variation \pm for 50 measurements, filter on

⁹ Maximum variation \pm for 10,000 measurements, filter on

¹⁰ Includes the time to change range and take readings. All readings equally spaced.

Tunable Laser Source: Model 4200

Wavelength Reference Module Options (Internal)

Options 410Q, 410T, 402Q, 402T

Specifications

	410Q	410T	402Q	402T
Description	Precision wavelength reference module (extended range)	Precision wavelength reference module	Wavelength reference module (extended range)	Wavelength reference module
Absolute wavelength accuracy	< ±1 pm	< ±1 pm	< ±5 pm	< ±5 pm
Repeatability	< ±1 pm	< ±1 pm	< ±5 pm	< ±5 pm
Wavelength range	1260-1640 nm	1510-1648 nm full accuracy; wider wavelength range at reduced accuracy	1260-1640 nm	1510-1648 nm full accuracy; wider wavelength range at reduced accuracy
Minimum sweep range	1 nm from: 1520-1532; 1536-1550; 1561-1573; 1575-1594; 1595-1608; 1610-1638; 10 nm for other wavelengths	1 nm from: 1520-1532; 1536-1550; 1561-1573; 1575-1594; 1595-1608; 1610-1638; 5 nm for other wavelengths	1 nm from: 1520-1532; 1536-1550; 1561-1573; 1575-1594; 1595-1608; 1610-1638; 10 nm for other wavelengths	1 nm from: 1520-1532; 1536-1550; 1561-1573; 1575-1594; 1595-1608; 1610-1638; 5 nm for other wavelengths
Maximum wavelength error that can be corrected	The "Wavelength Offset Wizard" corrects beginning-of-sweep wavelength errors up to 5 nm. The error in any 10 nm span of the sweep may not exceed 200 pm.	The "Wavelength Offset Wizard" corrects beginning-of-sweep wavelength errors up to 5 nm. The error in any 5 nm span of the sweep may not exceed 200 pm.	The "Wavelength Offset Wizard" corrects beginning-of-sweep wavelength errors up to 5 nm. The error in any 10 nm span of the sweep may not exceed 200 pm.	The "Wavelength Offset Wizard" corrects beginning-of-sweep wavelength errors up to 5 nm. The error in any 5 nm span of the sweep may not exceed 200 pm.
Maximum sweep rate	100 nm/second guaranteed; 120 nm/second typical			
Mode hop correction	Automatic: Finds, characterizes and corrects for single or multiple mode hops encountered during the sweep.			
Optical input power	> -15 dBm into "TLS IN" PORT typical			
Wavelength resolution	0.01 pm			
Wavelength correction	Each power/IL/ORL/PDL measurement point wavelength is automatically connected to the actual wavelength			
Wavelength sweep rate	Full specifications generally apply to TLS at its maximum sweep rate. At slower rates, some TLS become unstable and can even sweep backwards for short periods of time.			
Data available	Wavelength axis automatically corrected when wavelength correction is enabled. Data trace showing wavelength correction applied (TLS wavelength error) may be displayed.			

Tunable Laser Source: Model 4200

680 Series*

Specifications

	684		686		688		689	
	LN	HP	LN	HP	LN	HP	LN	HP
Tuning range	1260-1340 nm		1410-1510 nm		1520-1630 nm		1630-1660 nm	
Tuning range, mode-hop free	1260-1340 nm		1410-1510 nm		1510-1620	1520-1630	1630-1660 nm	
Output power	0 dBm	+6 dBm	0 dBm	+6 dBm	0 dBm	+8 dBm	0 dBm	+4 dBm
Signal to source spontaneous emission ratio (SSE) ^{5,7}	> 70 dB	> 40 dB	> 70 dB	> 40 dB	70 dB	> 40 dB	> 70 dB	> 40 dB
Signal to total source spontaneous emission ratio (STSE) ^{6,7}	> 55 dB	> 15 dB	> 55 dB	> 15 dB	> 55 dB	15 dB	> 55 dB	> 15 dB
Tuning speed	2 to 1000 nm/s ($\pm 1\%$)							
Wavelength resolution ²	0.08 pm (10 MHz)							
Absolute wavelength accuracy ¹	< ± 1 pm with precision wavelength reference (Option 410) < ± 5 pm with wavelength reference (Option 402) < ± 30 pm in fixed wavelength mode < ± 1 nm in swept mode without wavelength reference							
Wavelength repeatability ²	< ± 1 pm with precision wavelength reference (Option 410) < ± 5 pm with wavelength reference (Option 402) < ± 100 pm in swept mode without wavelength reference							
Wavelength resolution	0.1 pm							
Wavelength stability ³	< ± 2.5 pm							
Tuning linearity ¹	< ± 1 pm in swept mode with precision wavelength reference (Option 410) < ± 5 pm in swept mode with wavelength reference (Option 402) < ± 80 nm in swept mode without wavelength reference							
Linewidth	< 100 kHz (30 kHz chirp) instantaneous							
Side mode suppression (SMSR) ^{4,7}	> 50 dBc typical							
Optical shutter	> 80 dB extinction available with integrated optical shutter/automatic dark calibration							
RIN	-140 dBc (0.1 GHz to 1.0 GHz); -150 dBc/Hz (1 GHz to 2.5 GHz) typical							
Connector	FC/APC standard; FC/APC-PM available							
Trigger output	+5 volt trigger at beginning of continuous sweep							
Remote interfaces	GPIB (IEEE 488); Ethernet; USB Flash Drive							
Power	90-240 VAC							
Environmental: Operating	+10 °C to +32 °C (+55 °F to +90 °F); < 80% RH non-condensing							
Environmental: Storage	-20 °C to +70 °C (-4 °F to +158 °F); < 80% RH non-condensing							
Size	16.8" width x 16.4" depth x 5.25" height (42.6 cm x 41 cm x 10.5 cm)							
Weight	6 lbs (2.7 kg)							
Shock/vibration	ISTB Procedure 2B; 100G non-operating							
Laser safety	Class 3B (FDA 21 CFR 1040.10); Class 3A (IEC 825-1; 1993)							

* Most common for optical component test applications.

NOTE: All specifications measured with one-hour warm up and constant temperature 23 °C (± 2 °C).

CAUTION: Viewing the laser output with certain optical instruments (e.g., eye loupes, magnifiers, microscopes) within a distance of 100 mm may pose an eye hazard.

¹ Using installed wavelength correction option if noted, see Option 402 for specifications or Option 410 for operating parameters

² 1 pm in step mode

³ In fixed wavelength mode

⁴ 0.1 nm bandwidth; signal to max ASE; 1-3 nm from carrier

⁵ 0.2 nm bandwidth; signal to max ASE; > 5 nm from carrier

⁶ Signal to total ASE > 0.5 nm from carrier

⁷ Measurement taken at maximum rated power

Tunable Laser Source: Model 4200

690 Series

Specifications

	694		695		696		698		699	
	LN	HP	LN	HP	LN	HP	LN	HP	LN	HP
Tuning range	1260-1360 nm		1340-1440 nm		1420-1520 nm		1510-1630 nm		1580-1680 nm	
Tuning range, mode-hop free	1260-1360 nm		1340-1440 nm		1420-1520 nm		1510-1630 nm		1580-1680 nm	
Output power (across range)	> -4 dBm	> +7 dBm	> -4 dBm	> +7 dBm	> -4 dBm	> +7 dBm	> -4 dBm	> +7 dBm	> -4 dBm	> +7 dBm
Output power (peak)	> -2 dBm	> +10 dBm	> -2 dBm	> +10 dBm	> -2 dBm	> +10 dBm	> -2 dBm	> +10 dBm	> -2 dBm	> +10 dBm
Signal to total source spontaneous emission ratio ^{*3} (STSE)	> 65 dB	> 35 dB	> 65 dB	> 35 dB	> 65 dB	> 35 dB	> 65 dB	> 35 dB	> 65 dB	> 35 dB
Signal to source spontaneous emission ratio ^{*4} (SSE)	> 70 dB	> 45 dB	> 70 dB	> 45 dB	> 70 dB	> 45 dB	> 70 dB	> 45 dB	> 70 dB	> 45 dB
Tuning speed	Up to 100 nm/s									
Wavelength resolution	5 pm (< 1 pm with fine tuning) fixed wavelength									
Absolute wavelength accuracy	< ±5 pm ^{*1} with models -HP/HA, and -LN/HA < ±100 pm with models -HP and -LN									
Wavelength repeatability	< ±2 pm with models -HP/HA, and -LN/HA < ±10 pm with models -HP and -LN									
Wavelength stability ^{*2}	< ± 5 pm with models -HP and -LN < ± 1 pm with models -HP/HA and -LN/HA									
Tuning linearity	N/A									
Linewidth	> 160 MHz with coherence control ON (typical); < 1 MHz with coherence control OFF (typical)									
Side Mode Suppression (SMSR)	> 45 dB (typical)									
Optical shutter	Included									
Connector	FC/APC standard; FC/APC-PM available									
Environmental: Operating	+15 °C to +35 °C (+59 °F to +95 °F); < 80% RH non-condensing									
Environmental: Storage	-20 °C to +70 °C (-4 °F to +158 °F); < 80% RH non-condensing									
Weight	8 lbs (3.6 kg)									
Shock/vibration	Packaged drop 80 cm (40G) 2 drop per face, 6 faces. Unpackaged side drop 25 mm 1 drop per side, 4 sides. Unpackaged corner drop 25 mm 1 drop per corner, 4 corners. Vibration 10 to 55 Hz amplitude 0.3 mm, 3 tests, 10 cycles each.									
Laser safety	Class 3B (FDA 21 CFR 1040.10); Class 3A (IEC 825-1; 1993)									

NOTE: All specifications are quoted after 1-hour warm-up period. ^{*1}: < ±8 for wavelengths < 1270 nm. ^{*2}: For period of 1 hour. Within ±0.5 °C. ^{*3}: Ratio of signal to power to total spontaneous emission power within ±15 nm of the signal wavelength (typical value). ^{*4}: Ratio of signal power to maximum spontaneous emission power in a 1 nm band within a ±3 nm band around the signal wavelength (typical value).

CAUTION: Viewing the laser output with certain optical instruments (e.g., eye loupes, magnifiers, microscopes) within a distance of 100 mm may pose an eye hazard.

Tunable Laser Source: Model 4200

Variable Attenuator, Polarization, Polarization Scrambler

Options 953I-13, 953I-15, 957-I

Variable Attenuator (Internal)

Option 921

Specifications

Attenuation range	> 20 dB
Wavelength range	1260-1360 and 1510-1630
Accuracy	Call factory
Excess loss	< 0.5 dB typical; < 0.7 dB max

Polarization Controller (Internal)

Options 953I-13, 953I-15

Specifications

	953I-13	953I-15
Description	Internal 4- and 6-state polarization controller; 1310 nm version	Internal 4- and 6-state polarization controller; 1550 nm version
Insertion loss	1.0 dB typical	1.0 dB typical
Insertion loss variation	0.1 dB max for all SOP states	0.1 dB max for all SOP states
Wavelength dependent loss	< 0.6 dB 1260-1360 nm	< 0.6 dB 1530-1565 nm
Return loss	55 dB min	55 dB min
SOP repeatability	±0.1 degrees on Poincaré sphere	±0.1 degrees on Poincaré sphere
Rotation angle wavelength dependence	-0.068 degrees/nm	-0.068 degrees/nm
SOP switching speed	250 µs max	250 µs max
States generated	-45, 0, 45, 90, RHC, LHC	-45, 0, 45, 90, RHC, LHC
Maximum optical power	300 mW min	300 mW min
Wavelength	1260-1360 nm	1480-1620 nm

Polarization Scrambler (Internal)

Option 957-I

Specifications

Description	Internal polarization scrambler
Insertion loss	< 0.05 dB
Output degree of polarization	< 5%
Insertion loss variation	< 0.01 dB
Scrambling base frequency	700 KHz



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