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).

Summary

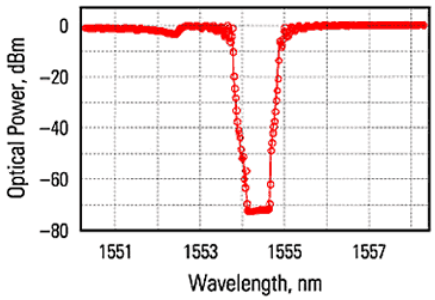
- Tuning range: Coverage from 1260 to 1680 nm
- Special wavelengths at 840 and 980
- Standard sweep rates to 100nm/sec; our 680 series has fast sweeping at 2000 nm/second
- > 50-65 dB STSE for characterizing deep well devices
- Options include built-in in polarization control, attenuation, power monitoring, wavelength measurement to 1 pm with mode-hop detection and correction
- High reliability

Wide Tuning Range

Our Model 4200 can cover both edges of the O, E, S, C, L and U bands.

Low STSE to Characterize Deep Wells

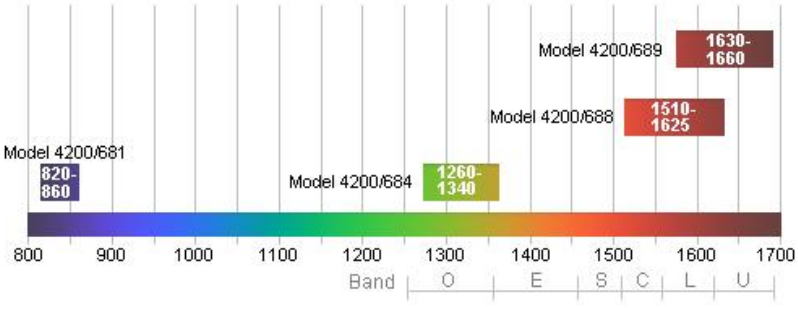
The figure (right) plots optical power transmission through two matched, narrow-notch filter fiber Bragg grating reflectors measured with the dBm Optics Model 4200. The ratio of the signal power to the total integrated ASE background power outside the 0.8 nm filter width is > 70 dB.



Rugged & 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 4200 one of the most reliable TLS available. Shock and vibration are fully specified to rigorous standards.

Fast Sweep, Stable, Affordable



Overview
Tunable Laser Source (Model 4200)

Easy to use from the front panel, ethernet or GPIB

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

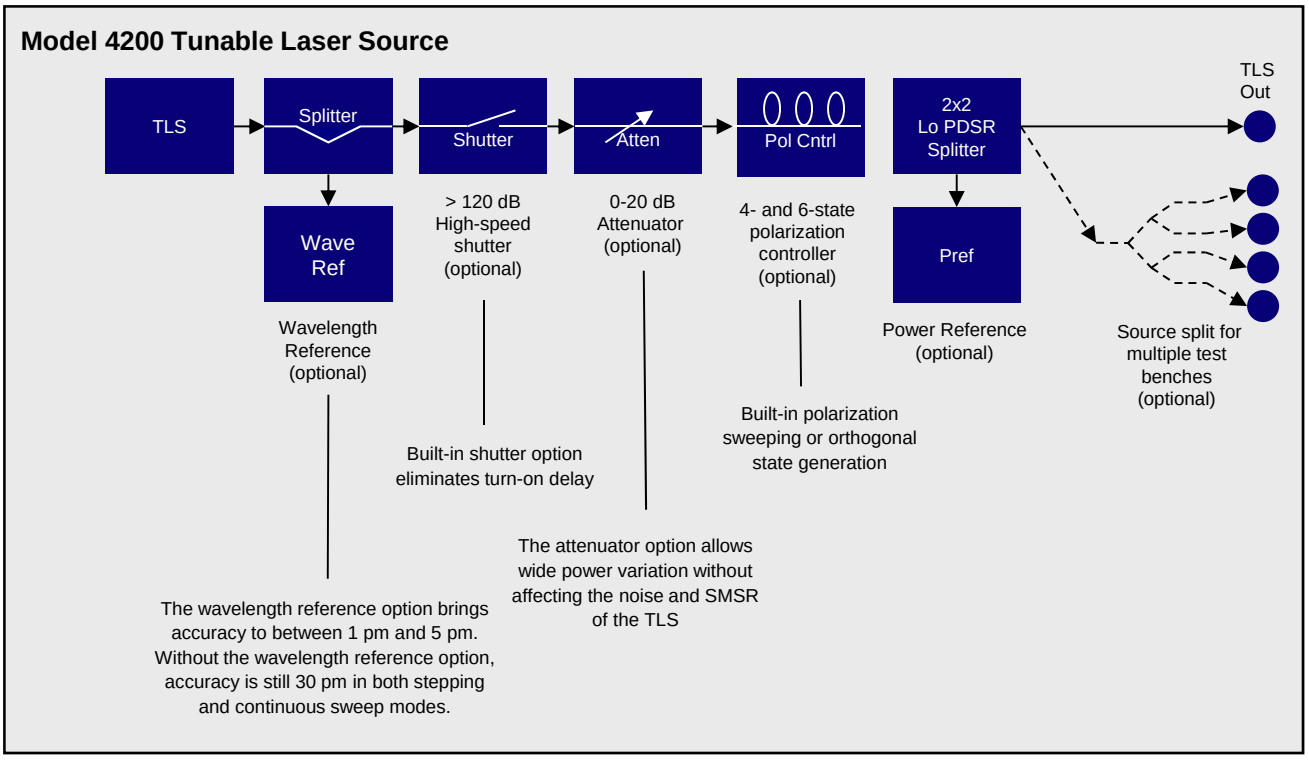
Continuous sweep at 1-100 nm/second with a typical sweep of 100 nm/second, characterization of full C+L band components in less than 1 second.

Typical 100 nm tuning range

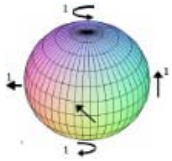
Mode-hop free performance

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

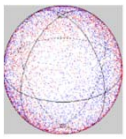


Your TLS Becomes a Fully Controlled and Characterized Optical Source



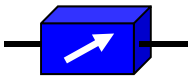
Polarization State Control

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.



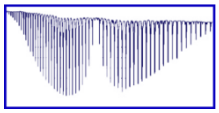
Polarization Scrambling

With our internal polarization scrambler option, you can turn on and off high-speed polarization scrambling, turning your TLS output into a randomized polarization signal. This eliminates the effects of birefringence in your 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.

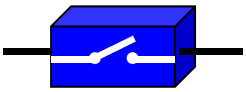


Wavelength Referencing

Add our wavelength reference module (Option 401) or our precision power meter module (Option 410) and get real-time calibration of wavelength accuracy. By connecting through GPIB or Ethernet (or using 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 < 1.8 pm (Option 401 with gas cell) or < 5 pm (Option 401).

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.

Model 4200: Tunable Laser Source
Options and Ordering Information

Option	Description	684	688
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	✓	✓

Model 4200: Tunable Laser Source
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 ºC to 35 ºC (50 ºF to 95 ºF). Contact factory for 0 ºC to 40 ºC (32 ºF to 104 ºF).
Storage temperature	-40 ºC to +70 ºC (-40 ºF to 158 ºF).
Humidity	< 95% non-condensing 0 ºC to 35 ºC
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

Power Meter Modules
Option 201, Option 202, Option 221, Option 222, Option 210, Option 301
Specifications *(Page 1 of 2)*

Sensitivity and Noise

Range	Fixed Range	Measurement		Measurement Resolution [1]		Precision Power Meter Module (Option 202, Option 222 [11]) Noise RMS [2]						Power Meter Module (Option 201, Option 221 [11]) Noise RMS [2]					
						5 secs [7]		100 ms [8]		10 µs (full speed) [9]		5 secs [7]		100 ms [8]		10 µs (full speed) [9]	
		W	dBm	W	dBm	±W	±dBm	±W	±dBm	±W	±dBm	±W	±dBm	±W	dBm	±W	±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 µW	100 µW	-10	2 nW	-57	2 nW	-57	2 nW	-57	8 nW	-51	4 nW	-54	4 nW	-54	16 nW	-48
Fast 100 µW	100 µW	100 µW	-10	2 nW	-57	1 nW	-60	1 nW	-60	4 nW	-54	4 nW	-54	4 nW	-54	16 nW	-48
	10 µW	10 µW	-20	200 pW	-67	30 pW	-75	40 pW	-74	800 pW	-61	400 pW	-64	400 pW	-64	4 nW	-54
	1 µW	1 µW	-30	20 pW	-77	20 pW	-77	20 pW	-77	300 pW	-65	200 pW	-67	200 pW	-67	2 nW	-57
Fast 1 µW	1 µW	1 µW	-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

		Reading Time with Averaging of:		
Auto-Range Mode	Full Measurement Range	1 Reading	2,000 Readings	500,000 Readings
Fast 10 mW - 2 nW	10 dBm to -57 dBm	10 µs	20 ms	5.00 s
Fast 100 µW - 20 pW	-10 dBm to -77 dBm	10 µs	20 ms	5.00 s
Fast 1 µW - 200 fW	-30 dBm to -97 dBm	10 µs	20 ms	5.00 s
Fast 10 nW - 2 fW	-50 dBm to -107 dBm	10 µs	20 ms	5.00 s
Fast 1 nW - 0.5 fW	-60 dBm to -117 dBm	10 µs	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)

Power Meter Modules
Option 201, Option 202, Option 221, Option 222, Option 210, Option 301
Specifications *(Page 2 of 2)*

Polarization Uncertainty of Measurement

< ±0.0015 dB typical; 0.0035 dB guaranteed for precision power meter module (Option 202, Option 301)
< ±0.0050 dB for power meter module (Option 201, Option 210, Option 221, Option 222)

Return Loss

> 55 dB

Remote Power Meter Module, 800-1700 nm (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
Cable length: 1 meter standard; call factory for additional lengths

Precision Power Meter Module, 800-1700 nm (Option 221)

Analog output: 0-2V (4V max)
Output impedience: 600 ohms typical
Maximum input voltage: ±10V
Bandwidth: DC up to 7.5 kHz depending on range

Precision Power Meter Module, Analog Output*, 800-1700 nm (Option 222)

Analog output: 0-2V (4V max)
Output impedience: 600 ohms typical
Maximum input voltage: ±10V
Bandwidth: DC up to 7.5 kHz depending on range

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[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 ± 2C, 1.1 mm diameter beam, 30 µW

[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 ± for 4 measurements, filter on

[8] Maximum variation ± for 50 measurements, filter on

[9] Maximum variation ± for 10,000 measurements, filter on

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

[11] Measurement noise may be higher with analog output due to conducted noise from devices and cables connected to the analog output connection.

Wavelength Reference Module Options (Internal)
Options 410Q, 410T, 410THR, 402Q, 402T
Specifications

	410THR*	410Q	410T	402Q	402T
Description	Precision wavelength reference module (high resolution)	Precision wavelength reference module (extended range)	Precision wavelength reference module	Wavelength reference module (extended range)	Wavelength reference module
Absolute wavelength accuracy	< 0.6 pm typical; < 1 pm guaranteed under enhanced accuracy conditions*	< ±1 pm +1 pm per mode hop	< ±1 pm +1 pm per mode hop	< ±5 pm +1 pm per mode hop	< ±5 pm +1 pm per mode hop
Repeatability	< 0.08 pm at one standard deviation typical under enhanced accuracy conditions*	< ±1 pm	< ±1 pm	< ±5 pm	< ±5 pm
Wavelength range	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	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; 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	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 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.	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.
Optical input power	+3 dB to -3 dB	> -15 dBm into "TLS IN" PORT typical			
Minimum sweep rate	20 nm/second for full specifications.				
Maximum sweep rate	100 nm/second guaranteed; 120 nm/second typical.				
Mode hop correction	Automatic: Finds, characterizes and corrects for single or up to 15 mode hops encountered during the sweep. Mode hops must be at least 1 nm apart and not be at the beginning 1nm of the sweep.				
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. TLS must sweep forward monotonically.				
Data available	Wavelength axis automatically corrected when wavelength correction is enabled. Data trace showing wavelength correction applied (TLS wavelength error) may be displayed.				

* The 410THR operates like the 410T in all respects except that accuracy and repeatability are enhanced with the 410THR. To obtain these enhanced results, the sweep should be configured as follows: 1) sweep rate 40 nm/second; 2) sweep start and sweep end in one of the following wavelength ranges: 1523 nm to 1530 nm, 1538 nm to 1550 nm, 1563 nm to 1571 nm, 1578 nm to 1588 nm, 1599 nm to 1605 nm, 1615 nm to 1623 nm; 3) analog filtering off 4) TLS models: Agilent model 81600B, New Focus model 6500, dBm Optics model 4200. Note: Accuracy is improved over the 410 outside these conditions, but performance may vary.

Tunable Laser Sources (Internal)
680 Series*
Specifications

	681	684		688	
	HP	LN	HP	LN	HP
Tuning range	835-850 nm	1265-1345 nm		1520-1630 nm	
Tuning range, mode-hop free	835-850 nm	1265-1345 nm		1510-1620 nm	1520-1630 nm
Output power	+6 dBm	0 dBm	+6 dBm	0 dBm	+8 dBm
Signal to source spontaneous emission ratio (SSE) [5,7]	> 40 dB	> 70 dB	> 40 dB	70 dB	>45 dB (1540-1630) > 40 dB
Signal to total source spontaneous emission ratio (STSE) [6,7]	> 15 dB	> 55 dB	> 15 dB	> 60 dB (1540-1625) > 55 dB	15 dB
Tuning speed	2 to 1000 nm/s (±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) < ±30 pm in fixed wavelength mode < ±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	< 50 MHz				
Side mode suppression (SMSR)	> 50 dBc typical				
Optical shutter	> 80 dB extinction available with integrated optical shutter/automatic dark calibration (Option 310)				
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 ºC to +32 ºC (+55 ºF to +90 ºF); < 80% RH non-condensing				
Environmental: Storage	-20 ºC to +70 ºC (-4 ºF to +158 ºF); < 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 ºC (±2 ºC).
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

Variable Attenuator (Internal)
Option 921
Specifications

Parameter	Specification
Attenuation range	> 20 dB
Wavelength range	1525-1610 nm
Accuracy	0.3 dB
Excess loss	1.5 dB typical; 1.8 dB max

Polarization Controller (Internal)
Options 953I-13, 953I-15
Specifications

Parameter	953I-13	953I-15
	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

Parameter	Specifications
Insertion loss	0.05 dB
Output degree of polarization	< 5%
Insertion los variation	< 0.01 dB
Center wavelength	980, 1060, 1310, 1480, 1550, 1600
Wavelength range	100 nm centered on wavelength above
DOP	5%
ORL	65 dB
Scrambling bandwidth	DC to 700 kHz

Miscellaneous Option Specifications and Descriptions

Note: Each model/unit has an Options and Ordering Information sheet. Refer to this sheet to determine option availability.

Option	Description	Specifications
310	Optical shutter/automatic dark calibration	"Off" blocking: > 100 dB Wavelength range: 700-1700 nm
501	Bare fiber adapter, low stress, easy alignment	N/A
502	Bare fiber to FC adapter	N/A
692	Laser diode source module. Select one laser diode. (Up to 5 total laser diode sources; order additional sources using 692X-wwww.)	N/A
692X	Additional laser diodes for 692-wwww. Includes switch. Select up to 4.	N/A
705	Rack ears (4000 Series)	N/A
740	Internal GPIB controller (required to automatically control external TLS or external polarization controller)	Allows control of external TLS or external polarization controller
940	Internal optical return loss (ORL) module	ORL measurement range dependent on test system configuration: > 55 dB under most conditions; > 70 dB with optimal configurations. (See Application Note 2004-014A.)
956	Automated matrix method PDL/IL measurement	Works in conjunction with customer's Agilent/HP 8169A polarization controller. Requires Option 740.
972	Built-in source split with switches for 2 DUTs	Additional PDL: +0.015 PDL
973	Built-in source split with switches for 3 DUTs	Additional PDL: +0.040 PDL
974	Built-in source switch for 2 external lasers	N/A
974-PM	Built-in PM source switch for 2 external lasers	N/A
975	Built-in source switch for 3 external lasers	N/A
976	Built-in source switch for 4 external lasers	N/A
982	Built-in source split for 2 DUTs	Additional PDL: +0.015 PDL
983	Built-in source split for 3 DUTs	Additional PDL: +0.040 PDL

* Contact the factory for extended specification, custom-designed, and OEM products or specials.
* Technical data subject to change.