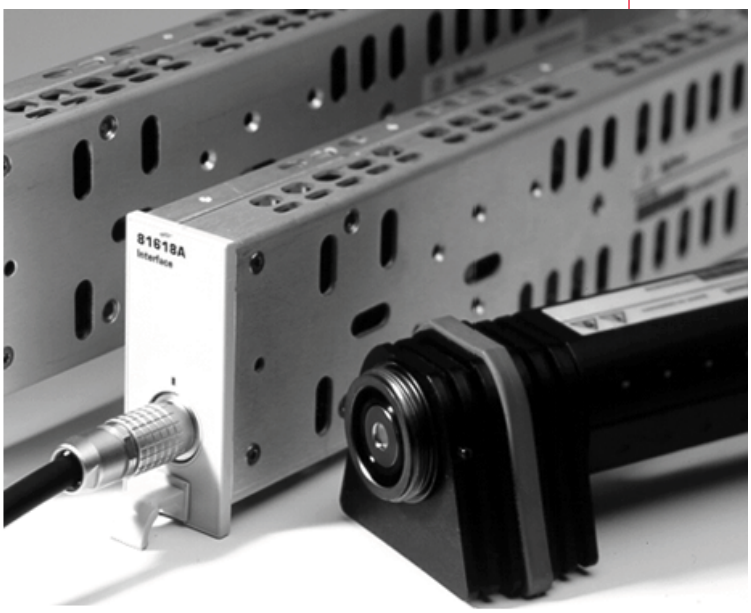
Keysight Technologies
Power Sensor Modules
Optical Heads
Return Loss Modules

Data Sheet



KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

Optical power measurement modules

The Keysight Technologies optical power measurement modules provide high performance functionality to the Keysight Lightwave Measurement platform. These modules can be used with the mainframes 8163B, 8164B or 8166B as well as the earlier 816xA models.

Power sensor modules

Power sensor modules provide a front panel optical input that accepts various 81000xI connector interfaces for popular fiber connector types or bare fibers. Besides giving optical power in units of W or dBm or dB referred to a reference, calibrated for any wavelength in the available range, these advanced instruments provide high speed data logging of up to 20 k (100 k for the 81636B) values, triggered internally or externally. The min-max function keeps the maximum and minimum values continuously or over a chosen number of samples for simple determination of power variations. Averaging times can be set from 10 s down to 100 µs (25 µs for the 81636B).

Optical heads

Optical heads provide a 5 mm diameter detector area and allow flexible placement of the power meter which is then connected to the 81618A or 81619A interface module in the mainframe.
The functionality is the same as for the sensor modules and a choice of adapters allows input from popular connector types, bare fibers or open beams.
The simple geometry and high quality detectors allows the heads to offer the highest accuracy measurements. Special calibrations, especially to the 81624B provide metrology lab reference quality. The magnetic D-shaped adapters 81624DD (included) allow rapid removal and replacement on the head without twisting attached fibers. It is used for the dust cap or other threaded-mount adapters and can be removed by loosening the set screws to replace with other D-shaped adapters.

Return loss modules

Return loss modules use two power sensors and fiber couplers to provide a direct measurement of the optical return loss. One sensor measures the optical power reflected back to the instrument while the other monitors the optical power output from the instrument. The ratio provides the return loss. These modules can use an external light source and can also be provided with internal Fabry-Perot lasers for very stable measurements. Full calibration functions are available and especially supported by a built-in application of the 8163B. Using remote programming, these can also be configured to log up to 20 k values from each sensor, synchronized with a tunable laser attached to the external input for making wavelength dependent measurements.

As with the complete Lightwave Measurement platform, remote programming is available with SCPI commands and especially convenient using the 816x VXIPlug&Play driver. This driver especially simplifies power logging and coordinated measurements with tunable lasers, especially with multiple power meters. The instruments are also supported for programming with Keysight Command Expert.

Selection guidance

- 81635A: dual-channel sensor, lowest price
- 81634B: most accurate sensor, high sensitivity
- 81636B: fast power sensor, 100 k points, 25 µs, high dynamic range
- 81630B: high power sensor
- 81620B: Si head, 450-1020 nm
- 81623B: Ge head, general purpose, also 850 nm specifications
- 81624B: InGaAs head, highest accuracy
- 81626B: InGaAs head, high power
- 81628B: InGaAs head with integrating sphere, highest power and accuracy at high power

www.keysight.com/find/oct

For connector adapters, see
www.keysight.com/find/octaccessories

Specifications

Generally, specifications are valid after warm-up, after zeroing, in auto-range mode (if not differently stated) and at the stated operating conditions and measurement settings.

Specifications describe a guaranteed product performance that is valid under the specified conditions. Specifications are based on a coverage factor of 2 (unless otherwise stated), corresponding to a level of confidence of > 95%.

Typical values describe product performance that is usually met but not guaranteed.

Technical Specifications

Power sensor module	81635A	81634B
Sensor element	InGaAs (dual)	InGaAs
Wavelength range	800 nm to 1650 nm	800 nm to 1700 nm
Power range	–80 dBm to +10 dBm	–110 dBm to +10 dBm
Applicable fiber type	Standard SM and MM up to 62.5 µm core size, NA ≤0.24	Standard SM and MM up to 100 µm core size, NA ≤0.3
Uncertainty (accuracy) at reference conditions [1]	±3% (1200 nm to 1630 nm) typ. < ±3.5% [10] (800 nm to 1200 nm)	±2.5% (1000 nm to 1630 nm)
Total uncertainty [2]	±5% ±20 pW [8,9] (1200 nm to 1630 nm) typ. ±5.5% ±200 pW [9,11] (800 nm to 1200 nm)	±4.5% ±0.5 pW (1000 nm to 1630 nm)
Relative uncertainty:		
- due to polarization [3]	typ. < ±0.015 dB	< ±0.005 dB
- spectral ripple (due to interference) [4]	typ. < ±0.015 dB	< ±0.005 dB
Linearity (power): [5]	CW –60 dBm to +10 dBm	CW –90 dBm to +10 dBm
- at 23 °C ±5 °C	< ±0.02 dB [9] (1200 nm to 1630 nm) typ. < ±0.02 dB [9] (800 nm to 1200 nm)	< ±0.015 dB (1000 nm to 1630 nm)
- at operating temp. range	< ±0.06 dB [9] (1200 nm to 1630 nm) typ. < ±0.06 dB [9] (800 nm to 1200 nm)	< ±0.05 dB (1000 nm to 1630 nm)
Return loss [7]	> 40 dB	> 55 dB
Noise (peak to peak) [6]	< 20 pW (1200 nm to 1630 nm) typ. < 200 pW (800 nm to 1200 nm)	< 0.2 pW (1200 nm to 1630 nm)
Averaging time (minimal)	100 µs	
Maximum safe input power	+16 dBm	
Analog Output	None	Included
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")	
Weight	0.5 kg	
Recommended recalibration period	2 years	
Operating temperature	+10 °C to +40 °C	0 °C to +45 °C
Humidity	Non-condensing	
Warm-up time	20 min	

1. Reference Conditions:
   - Power level 10 µW (-20 dBm), continuous wave (CW)
   - Fiber 50 µm graded-index, NA=0.2
   - Ambient temperature 23 °C ±5 °C
   - On day of calibration (add ±0.3% for aging over one year, add ±0.6% over two years)
   - Spectral width of source < 10 nm (FWHM)
   - Wavelength setting at power sensor must correspond to source wavelength ≤ ±0.4 nm
2. Operating Conditions:
   - Fiber ≤50 µm, NA ≤0.2
   - 81634B only: connectors with 2.5 mm ferrule with flat face (fiber tip offset not more than 0.3 mm from 2.5 mm cross-section) with straight or angled polish
   - 81635A only: for LC connector use 81000LI adapter, not 81002LI; for MU connector use 81000MI, not 81002MI
   - Averaging time 1 s
   - Only Keysight 81635A: For fiber 62.5 µm graded-index (NA=0.24): add ±2%
   - Within one year after calibration; add 0.3% for second year
   - Operating temperature range as specified, humidity: non-condensing
3. All states of polarization at constant wavelength (1550 nm ±30 nm) and constant power, straight connector, T = 23 °C ±5 °C. For angled connector (8 °) add ±0.01 dB typ.
4. Conditions:
   - Wavelength 1550 nm ±30 nm, fixed state of polarization, constant power
   - Temperature 23 °C ±5 °C
   - Linewidth of source ≥ 100 MHz,
   - Angled connector 8 °.
5. Does not include noise
6. Averaging time 1 s, T = 23 °C ±5 °C, ΔT ±1 °C, observation time 300 s.
7. Conditions:
   - Wavelengths 1310 nm ±30 nm and 1550 nm ±30 nm
   - Standard single mode fiber, angled connector min 8 °
   - T = 23 °C ±5 °C
8. For wavelengths > 1600 nm add ±0.06%/nm.
9. For input power > 2 mW add ±0.02 dB.
10. Add ±1% for wavelength 900 nm to 950 nm.
11. Add ±3.5% for wavelength 900 nm to 950 nm.

Technical Specifications (continued)

High power sensor module	81630B
Sensor element	InGaAs
Wavelength range	970 nm to 1650 nm
Power range	–70 dBm to +28 dBm
Applicable fiber type	Standard SM and MM up to 100 µm core size, NA ≤0.3
Uncertainty (accuracy) at reference conditions [1]	±3.0% for 1255 nm to 1630 nm at 980 nm ±3.5% (add ±0.5% per nm if 980 nm is not the center wavelength) at 1060 nm ±4.0% (add ±0.6% per nm if 1060 nm is not the center wavelength),
Total uncertainty [2,8]	±5% ±1.2 nW (1255 nm to 1630 nm) at 980 nm ±5.5% ±1.2 nW (add ±0.5% per nm if 980 nm is not the center wavelength) at 1060 nm ±6.0% ±1.2 nW (add ±0.6% per nm if 1060 nm is not the center wavelength)
Relative uncertainty:	
- due to polarization [3]	< ±0.01 dB
- spectral ripple (due to interference) [4]	< ±0.005 dB
Linearity (power): [5]	CW – 50 dBm to + 28 dBm (970 nm – 1630 nm)
- at 23 °C ± 5 °C	≤±0.05 dB [8]
- at operating temp. range	≤±0.15 dB [8]
Return loss [7]	> 55 dB
Noise (peak to peak) [6]	< 1.2 nW (1255 nm – 1630 nm)
Averaging time (minimal)	100 µs
Maximum safe input power	+28.5 dBm
Analog Output	Included
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")
Weight	0.6 kg
Recommended recalibration period	2 years
Operating temperature	0 °C to +35 °C [9]
Humidity	Non-condensing
Warm-up time	20 min

1. Reference Conditions:
   - Power level 80 µW, continuous wave (CW)
   - SM Fiber; 9 µm; NA = 0.1
   - Ambient temperature 23 °C ±5 °C
   - On day of calibration (add ±0.3% for aging over one year, add ±0.6% over two years)
   - Spectral width of source < 10 nm (FWHM)
   - Wavelength setting at power sensor must correspond to source wavelength ≤ ±0.4 nm
2. Operating Conditions:
   - Fiber ≤50 µm, NA ≤0.2
   - Connectors with 2.5 mm ferrule with flat face (fiber tip offset not more than 0.3 mm from 2.5 mm cross-section) with straight or angled polish
   - Averaging time 1 s
   - Within one year after calibration; add 0.3% for second year
   - Operating temperature range as specified, humidity: non-condensing
3. All states of polarization at constant wavelength (1550 nm ±30 nm) and constant power, straight connector, T = 23 °C ±5 °C. For angled connector (8 °) add ±0.01 dB typ.
4. Conditions:
   - Wavelength 1550 nm ±30 nm, fixed state of polarization, constant power
   - Temperature 23 °C ±5 °C
   - Linewidth of source ≥ 100 MHz
   - Angled connector 8 °
5. Does not include noise
6. Averaging time 1 s, T = 23 °C ±5 °C, ΔT ±1 °C, observation time 300 s.
7. Conditions:
   - Wavelengths 1310 nm ±30 nm and 1550 nm ±30 nm
   - Standard single mode fiber
   - Angled connector min 8 °
   - T = 23 °C ±5 °C
8. For input power > +10 mW add: typ. ±0.0012 dB/mW. In case of negative power change > 50 dB allow additional recovery time of 3 min
9. 30 °C for > +20 dBm input power

Technical Specifications (continued)

Fast power sensor module	81636B
Sensor element	InGaAs
Wavelength range	1250 nm to 1640 nm
Power range	–80 dBm to +10 dBm
Applicable fiber type	Standard SM and MM up to 62.5 µm core size, NA ≤0.24
Uncertainty (accuracy) at reference conditions [1]	±3% (1260 nm to 1630 nm)
Total uncertainty [2, 8, 9]	±5% ±20 pW (1260 nm to 1630 nm)
Relative uncertainty: - due to polarization [3] - spectral ripple (due to interference) [4]	 typ. ±0.015 dB typ. ±0.015 dB
Linearity (power) [5,9] - at 23 °C ±5 °C - at operating temperature range	CW –60 dBm to +10 dBm, (1260 nm to 1630 nm) < ±0.02 dB < ±0.06 dB
Return loss [7]	>40 dB
Noise (peak to peak) [6]	< 20 pW (1260 nm – 1630nm)
Averaging time (minimal)	25 µs
Dynamic Range at manual range mode [10] - at +10 dBm-range - at ±0 dBm-range - at –10 dBm-range - at –20 dBm-range	 typ. >55 dB typ. >55 dB typ. >52 dB typ. >45 dB
Noise at manual range mode (peak to peak): [10] - at +10 dBm-range - at ±0 dBm-range - at –10 dBm-range - at –20 dBm-range	CW –60 dBm to +10 dBm, 1260 nm to 1630 nm < 50 nW < 5 nW < 1 nW < 500 pW
Analog Output	Included
Maximum safe input power	+16 dBm
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")
Weight	0.5 kg
Recommended recalibration period	2 years
Operating temperature	+10 °C to +40 °C
Humidity	Non-condensing
Warm-up time	20 min

1. Reference Conditions:
   - Power level 10 µW (-20 dBm), continuous wave (CW)
   - Fiber 50 µm graded-index, NA = 0.2
   - Ambient temperature 23 °C ±5 °C
   - On day of calibration (add ±0.3% for aging over one year, add ±0.6% over two years)
   - Spectral width of source < 10 nm (FWHM)
   - Wavelength setting at power sensor must correspond to source wavelength ≤ ±0.4 nm
2. Operating Conditions:
   - Fiber ≤50 µm, NA ≤0.2
   - For LC connector use 81000LI adapter, not 81002LI; for MU connector use 81000MI, not 81002MI
   - Averaging time 1 s
   - Within one year after calibration, add 0.3% for second year
   - Operating temperature range as specified, humidity: non-condensing
3. All states of polarization at constant wavelength (1550 nm ±30 nm) and constant power, straight connector, T = 23 °C ±5 °C. For angled connector (8 °) add ±0.01 dB typ.
4. Conditions:
   - Wavelength 1550 nm ±30 nm, fixed state of polarization, constant power,
   - Temperature 23 °C ±5 °C
   - Linewidth of source ≥ 100 MHz
   - Angled connector 8 °
5. Does not include noise
6. Averaging time 1s, T = 23 °C ±5 °C, ΔT ±1 °C, observation time 300 s.
7. Conditions:
   - Wavelengths 1310 nm ±30 nm and 1550 nm ±30 nm
   - Standard single mode fiber
   - Angled connector min 8 °
   - T = 23 °C ±5 °C
8. For wavelengths > 1600 nm add ±0.06%/nm
9. For input power > 2 mW add ±0.02 dB
10. Conditions:
    - Averaging time 25 µs, T = 23 °C ±5 °C
    - Observation time 2.5 s
    - ΔT ±1 °C

Technical Specifications (continued)

All optical heads have to be operated with the single (Keysight 81618A) or dual (Keysight 81619A) Interface Modules.

Silicon optical head	**81620B**
Sensor element	Si, Ø 5 mm
Wavelength range	450 nm to 1020 nm
Power range	–90 dBm to +10 dBm
Applicable fiber type Open beam	Standard SM and MM max 100 µm core size, NA ≤0.3 Parallel beam max Ø 4 mm
Uncertainty (accuracy) at reference conditions [1]	±2.2% (600 nm to 1020 nm)
Total uncertainty [2]	±4.0% ±0.5 pW (600 nm to 1020 nm)
Linearity (power): [3,5] at 23 °C ±5 °C at operating temp. range	(CW –70 dBm to +10 dBm) < ±0.04 dB < ±0.15 dB
Noise (peak to peak) [4]	< 0.5 pW (700 nm to 900 nm)
Averaging time (minimal)	100 µs
Analog output	Included
Maximum safe input power	+16 dBm
Dimensions (H x W x D)	57 mm x 66 mm x 156 mm
Weight	0.5 kg
Recommended recalibration period	2 years
Operating temperature	0 °C to 40 °C
Humidity	Non-condensing
Warm-up time	40 min

1. Reference Conditions:
   - Power level 10 µW (-20 dBm), continuous wave (CW)
   - Parallel beam, 3 mm spot diameter on the center of the detector
   - Ambient temperature 23 °C ±5 °C
   - On day of calibration (add ±0.3% for aging over one year, add ±0.6% over two years)
   - Spectral width of source <10 nm (FWHM)
   - Wavelength setting at power sensor corresponding to source wavelength ≤ ±0.4 nm
2. Operating Conditions:
   - Parallel beam, 3 mm spot diameter on the center of the detector or connectorized fiber with NA ≤0.2 (straight connector)
   - For NA > 0.2 add 1%
   - Averaging time 1 s
   - Within one year after calibration; add 0.3% for second year
   - Spectral width of source <10 nm (FWHM)
   - Wavelength setting at power sensor corresponding to source wavelength ±0.4 nm
3. Does not include noise; zeroing required; for wavelength <1000 nm applies for –50 dBm to +10 dBm
4. Averaging time 1 s, T = 23 °C ±5 °C, ΔT ±1 °C, observation time 300 s
5. For input power > 2 mW add ±0.004 dB/mW; zeroing required

Technical Specifications (continued)

All optical heads have to be operated with the single (Keysight 81618A) or dual (Keysight 81619A) Interface Modules.

Ge optical head	**81623B**	**81623B Calibration option C85**	**81623B Calibration option C01**
Sensor element		Ge, Ø 5 mm	
Wavelength range		750 nm to 1800 nm	
Power range		– 80 dBm to +10 dBm	
Applicable fiber type Open beam		Standard SM and MM max 100 µm core size, NA ≤0.3 Parallel beam max Ø 4 mm	
Uncertainty (accuracy) at reference conditions [1]	±2.2% (1000 nm to 1650 nm) ±3.0% typ. (800 nm to 1000 nm)	±2.2% (1000 nm to 1650 nm) ±2.5% (800 nm to 1000 nm)	±1.7% (1000 nm to 1650 nm) ±3.0% typ. (800 nm to 1000 nm)
Total uncertainty [2, 9]	±3.5% ±100 pW (1000 nm to 1650 nm) ±4.0% typ. ±250 pW (800 nm to 1000 nm)	±3.5% ±100 pW (1000 nm to 1650 nm) ±3.7% ±250 pW (800 nm to 1000 nm)	±3.0% ±100 pW (1000 nm to 1650 nm) ±4.0% typ. ±250 pW (800 nm to 1000 nm)
Relative uncertainty: - due to polarization [3] - spectral ripple (due to interference) [4]		< ±0.01 dB [10] (typ. < ±0.005 dB) < ±0.006 dB (typ. < ±0.003 dB)	
Linearity (power): [5] at 23 °C ±5 °C at operating temp. range		(CW – 60 dBm to +10 dBm) [9] < ±0.025 dB < ±0.05 dB	
Return loss [7]	> 50 dB, typ. > 55 dB [8]		> 56 dB
Noise (peak to peak) [6]		< 100 pW (1200 nm to 1630 nm) < 400 pW (800 nm to 1200 nm)	
Averaging time (minimal)		100 µs	
Analog Output		Included	
Maximum safe input power		+16 dBm	
Dimensions (H x W x D)		57 mm x 66 mm x 156 mm	
Weight		0.5 kg	
Recommended recalibration period		2 years	
Operating temperature		0 °C to 40 °C	
Humidity		Non-condensing	
Warm-up time		40 min	

1. Reference Conditions:
   - Power level 10 µW (-20 dBm), continuous wave (CW)
   - Parallel beam, 3 mm spot diameter on the center of the detector
   - Ambient temperature 23 °C ±5 °C
   - On day of calibration (add ±0.3% for aging over one year, add ±0.6% over two years)
   - Spectral width of source <10 nm (FWHM)
   - Wavelength setting at power sensor corresponding to source wavelength ≤ ±0.4 nm
2. Operating Conditions:
   - Parallel beam, 3 mm spot diameter on the center of the detector or connectorized fiber with NA ≤0.2 (straight connector; option C01 also with angled connector ≤8 °)
   - For NA >0.2 add 1%
   - Averaging time 1 s
   - Within one year after calibration; add 0.3% for second year
   - Spectral width of source < 10 nm (FWHM)
   - Wavelength setting at power sensor corresponding to source wavelength ±0.4 nm
3. All states of polarization at constant wavelength (1550 nm ±30 nm) and constant power, straight connector, T = 23 °C ±5 °C. For angled connector (8 °) add ±0.01 dB typ.
4. Conditions:
   - Wavelength 1550 nm ±30 nm, fixed state of polarization, constant power,
   - Temperature 23 °C ±5 °C
   - Linewidth of source ≥100 MHz
   - Angled connector 8 °
5. Does not include noise; for wavelength < 1000 nm applies for –50 dBm to +10 dBm
6. Averaging time 1 s, T = 23 °C ±5 °C, ΔT ±1 °C, observation time 300 s.
7. Conditions:
   - Wavelength 1550 nm ±30 nm
   - Standard single mode fiber
   - Angled connector min 8 °
8. With D-shape adapter 81001xx return loss > 60 dB typical
9. For input power > 2 mW add ±0.004 dB/mW (not for C01); zeroing required
10. Specification valid for optical heads with S/N starting with “DE413...” and higher (shipping began April 1, 2001)

Technical Specifications (continued)

All optical heads have to be operated with the single (Keysight 81618A) or dual (Keysight 81619A) Interface Modules

High performance and high power optical heads	81624B	81624B Calibration option C01	81626B	81626B Calibration option C01
Sensor element	InGaAs, Ø 5 mm			
Wavelength range	800 nm to 1700 nm		850 nm to 1650 nm	
Power range	–90 dBm to +10 dBm		–70 dBm to +27 dBm (1250 nm to 1650 nm) –70 dBm to +23 dBm (850 nm to 1650 nm)	
Applicable fiber type Open beam	Standard SM and MM max 100 µm core size, NA ≤0.3 Parallel beam max Ø 4 mm			
Uncertainty (accuracy) at reference conditions [1]	±2.2% (1000 nm to 1630 nm)	±1.5% (970 nm to 1630 nm)	±3.0% (950 nm to 1630 nm)	±2.5% (950 nm to 1630 nm)
Total uncertainty [2]	±3.5% ±5 pW (1000 nm to 1630 nm)	±2.8% ±5 pW (970 nm to 1630 nm)	±5.0% ±500 pW [8] (950 nm to 1630 nm)	±4.5% ±500 pW [8] (950 to 1250 nm max +23 dBm) (1250 to 1630 nm max +27 dBm)
Relative uncertainty: - due to polarization [3] - spectral ripple (due to interference) [4]	≤±0.005 dB (typ. ≤ ±0.002 dB) ≤±0.005 dB (typ. ≤ ±0.002 dB)		≤±0.005 dB (typ. ≤ ±0.002 dB) ≤±0.005 dB (typ. ≤ ±0.002 dB)	
Linearity (power): [5] - at 23 °C ±5 °C - at operat. temp. range	CW –70 dBm to +10 dBm, 1000 nm to 1630 nm < ±0.02 dB < ±0.05 dB		CW – 50 dBm to + 27dBm, 950 nm to 1630 nm < ±0.04 dB [8] < ±0.15 dB [8]	
Return loss	typ. 60 dB [7]		> 45 dB	> 47 dB
Noise (peak to peak) [6]	< 5 pW		< 500 pW	
Averaging time (min.)	100 µs			
Analog Output	Included			
Maximum safe input power	+16 dBm		+23.5 dBm (850 nm to 1650 nm) +27.5 dBm (1250 nm to 1650 nm)	
Dimensions (H x W x D)	57 mm x 66 mm x 156 mm			
Weight	0.5 kg			
Recommended recalibration period	2 years			
Operating temperature	0 °C to 40 °C		0 °C to +35 °C [9]	
Humidity	Non-condensing			
Warm-up time	40 min			

1. Reference Conditions:
   - Power level 10 µW (-20 dBm), continuous wave (CW)
   - Parallel beam, 3 mm spot diameter on the center of the detector
   - Ambient temperature 23 °C ±5 °C
   - On day of calibration (add ±0.3% for aging over one year, add ±0.6% over two years)
   - Spectral width of source ≤10 nm (FWHM)
   - Wavelength setting at power sensor corresponding to source wavelength ≤ ±0.4 nm
2. Operating Conditions:
   - Parallel beam, 3mm spot diameter on the center of the detector or connectorized fiber with NA ≤0.2 (straight connector, option C01 also with angled connector ≤8 °)
   - For NA > 0.2 add 1%.
   - Averaging time 1 s
   - Within one year after calibration, add 0.3% for second year
   - Zeroing required
3. All states of polarization at constant wavelength (1550 nm ±30 nm) and constant power, straight connector, T = 23 °C ±5 °C. For angled connector (8 °) add ±0.01 dB typ.
4. Conditions:
   - Wavelength 1550 nm ±30 nm, fixed state of polarization, constant power
   - Temperature 23 °C ±5 °C
   - Linewidth of source ≥100 MHz
   - Angled connector 8 °
5. Does not include noise; zeroing required
6. Averaging time 1 s, T = 23 °C ±5 °C, ΔT ±1 °C, observation time 300 s. Wavelength range 1200 nm to 1630 nm
7. Conditions:
   - Wavelengths 1550 nm ±30 nm
   - Standard single mode fiber, angled connector min 8 °
   - With D-shape adapter 81001xx return loss > 60 dB typical
8. For input power >10 mW:
   - Add typ. ±0.0016 dB/mW, or in case of option C01 for wavelength ≤1550 nm add ±0.0006 dB/mW (guaranteed) using adaptor 81000AF.
   - In case of decreasing power, allow time for stabilization of the reading (about 5 s per dB change).
   - In case of decreasing power by more than 50 dB, allow recovery time of 3 minutes.
9. Max 30 °C above + 20 dBm input power

Technical Specifications (continued)

All optical heads have to be operated with the single (81618A) or dual (81619A) Interface Modules

High power optical head	**81628B with integrating sphere**
Sensor element	InGaAs
Wavelength range	800 nm to 1700 nm
Power range	–60 dBm to +40 dBm (800 nm to 1700 nm) For operation higher than +34 dBm see safety note
Damage Power	+40.5 dBm
Applicable fiber type Open beam	Single mode NA ≤0.2, Multimode NA ≤0.4 Ø ≤3 mm center of sphere
Uncertainty (accuracy) at reference conditions [1,8]	±3.0% (970 nm to 1630 nm)
Total uncertainty [2,8] ≤10 dBm >10 dBm to ≤20 dBm >20 dBm to ≤38 dBm	(970 nm to 1630 nm) ±4.0% ± 5 nW ±4.5% ±5%
Relative uncertainty: - due to polarization [3] - due to speckle noise at source linewidth: [4] 0.1 pm to 100 pm >100 pm	 typ. ≤ ±0.006 dB typ. ≤ ±0.02 dB typ. ≤ ±0.002 dB
Linearity (power): [5,8] ≤10 dBm >10 dBm to ≤20 dBm >20 dBm to ≤37 dBm >37 dBm to ≤38 dBm	(CW –40 dBm to + 38 dBm, 970 nm to 1630 nm) ≤ ±0.03 dB ≤ ±0.06 dB ≤ ±0.09 dB ≤ ±0.10 dB at 23 °C ±5 °C, for operating temperature range add ±0.03 dB
Return loss	typ. > 75 dB
Noise (peak to peak) [6]	< 5 nW
Averaging time (minimal)	100 µs
Analog Output	Included
Dimensions (H x W x D)	55 mm x 80 mm x 250 mm
Weight	0.9 kg (without heat sink)
Recommended recalibration period	2 years
Operating temperature [7]	0 °C to +40 °C
Humidity	Non-condensing
Warm-up time	40 min

Safety Note:

For optical power higher than +34 dBm the attached heat sink MUST be used!

For continuous optical power or average optical power higher than +38 dBm the connector adapters will get warmer than permitted according to the safety standard IEC 61010-1.

The 81628B Optical Head can handle optical power up to +40 dBm, however, operation above +38 dBm is at the operators own risk.

Keysight Technologies Deutschland GmbH will not be liable for any damages caused by an operation above +38 dBm.

1. Reference Conditions:
   - Power level 10 µW (-20 dBm), continuous wave (CW)
   - Averaging time 1 s
   - Parallel beam, 3 mm, center of sphere input
   - Ambient temperature 23 °C ±5 °C
   - On day of calibration (add ±0.3% for aging over one year, add ±0.6% over two years)
   - Spectral width of source < 10 nm (FWHM)
   - Wavelength setting at power sensor must correspond to source wavelength ≤ ±0.4 nm
   - Humidity 50% ±10%
2. Operating Conditions:
   - Parallel beam, Ø 3 mm, center of sphere input, or connectorized fiber with NA ≤0.2 (straight connector)
   - For NA > 0.2: add 1%
   - Within one year after calibration, add ±0.3% for second year
   - Operating temperature range as specified, humidity < 80% and non-condensing
   - Zeroing required
3. All states of polarization at constant wavelength (1550 nm ±30 nm) and constant power.
4. Conditions:
   - Wavelength 1550 nm ±30 nm, fixed state of polarization, constant power
   - Temperature 23 °C ±5 °C
   - Measurement time ≤ 3 min
5. Does not include noise; zeroing required
6. Averaging time 1 s, T = 23 °C ±5 °C, ΔT ±1 °C, observation time 300 s, wavelength range 970 nm to 1630 nm; thermal drift at +38 dBm, exposure time 30 min:
   Recovery time 10 min: ≤30 nW
   30 min: ≤10 nW
7. For input power > 30 dBm the maximal operating temperature is limited to 35 °C
8. Wavelength must not be equal to any water absorption line

Technical Specifications (continued)

All return loss modules require angled contact (8 °) at input and output connectors

Return loss module	**81610A**	
Source	External input only [1]	
Sensor element	InGaAs	
Fiber type	Standard single-mode 9/125 µm	
External input	Max input power: +10 dBm Min input power: 0 dBm Damage input power: +16 dBm	
Wavelength range for external input	1250 nm to 1640 nm	
Dynamic range	70 dB	
Relative uncertainty of [2] Return Loss (RL)	with broadband source	with Keysight FP sources
RL ≤55 dB	< ±0.25 dB	typ. < ±0.5 dB
RL ≤60 dB	< ±0.3 dB	typ. < ±1.0 dB
RL ≤65 dB	< ±0.65 dB	typ. < ±2.0 dB
RL ≤70 dB	< ±1.7 dB	
Total uncertainty	add ±0.2 dB	add typ. ±0.2 dB
Maximum safe input power	+16 dBm	
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")	
Weight	0.6 kg	
Recommended Recalibration period	2 years	
Operating temperature	10 °C to 40 °C	
Humidity	Non-condensing	
Warm-up time [3]	20 minutes	

1. Insertion Loss is in the range of 7 dB.
2.
   - Averaging time 1 s
   - Calibration prior to measurement
   - Constant temperature
   - Broadband source: 83438A
   - FP Sources: 81650A, 81651A, 81654A with active Coherence Control
   - Reference Cable 81610CC used for total uncertainty
   - Length of measurement patch cord ≤2m, angled connector in optimal optical condition
3. Warm-up time 60 min, if previously not stored at the same temperature.

Reference Cable Specification

To connect to Return Loss Modules the cable requires connector Interface 81000SI DIN47256/4108

	81610CC Reference cable
Return loss	as printed on cable
Return loss uncertainty [1]	±0.2 dB
Wavelengths	1310 nm and 1550 nm ±15 nm

1. Clean reference reflector in perfect optical condition
   (Do not use with contact-type connectors)

Technical Specifications (continued)

(When used with external sources the specifications of 81610A return loss module apply)
All return loss modules require angled contact (8 °) at input and output connectors

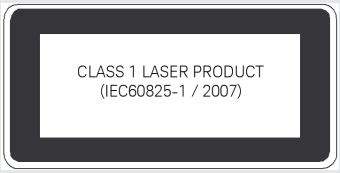
Return loss module with internal source	**81613A**	
Source	Fabry-Perot Laser (internal)	
Output Power	typ. –4 dBm ±1.0 dB typ.	
Center wavelength [1]	1310 nm /1550 nm ±20 nm typ.	
Sensor Element	InGaAs	
Fiber Type	Standard single-mode 9 / 125 µm	
Dynamic Range	75 dB	
Relative uncertainty of Return Loss (RL)	User calibration [2]	Plug and play [3]
RL ≤55 dB	< ±0.5 dB (typ. < ±0.3 dB)	typ. < ±0.6 dB
RL ≤60 dB	< ±0.6 dB (typ. < ±0.4 dB)	typ. < ±1.5 dB
RL ≤65 dB	< ±0.8 dB (typ. < ±0.5 dB)	
RL ≤70 dB	< ±1.9 dB (typ. < ±0.8 dB) [4]	
RL ≤75 dB	typ. < ±2.0 dB [4]	
Total uncertainty	Add ±0.2 dB	Add typ. ±0.2 dB
Maximum safe input power	+16 dBm	
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")	
Weight	0.6 kg	
Recommended Recalibration period	2 years	
Operating temperature	10 °C to 40 °C	
Humidity	Non-condensing	
Warm-up time [5]	20 minutes	

1. At 25 °C constant temperature, coherence control on, warm-up time after laser turn on > 5 min
2.
   - Averaging time 1 s
   - Calibration prior to measurement
   - Constant temperature
   - Coherence control on
   - Warm-up time after laser turn on > 5 min
   - Length of measurement patch cord ≤2 m
   - Angled connector in optimal optical condition
   - Reference Cable 81610CC used for total uncertainty
3. Use default settings (no user calibration necessary): length of measurement patch cord ≤2 m, return loss of connectors ≥70 dB.
4. For measurements performed immediately after calibration.
5. Warm-up time 60 min, if previously not stored at the same temperature.

Laser Safety Information

The above products are classified as Class 1 according to IEC 60825-1 (2007).

All laser sources comply with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50, dated 2007-June-24.



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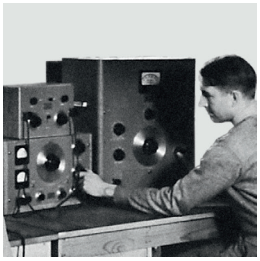
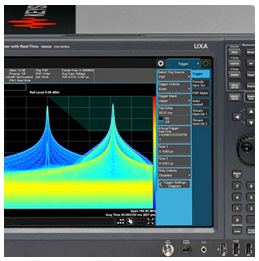


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