

# Optical Component Analyzer N7788B



# Introduction

Keysight Technologies, Inc. pushes the limits of component measurements with the N7788B component analyzer. Its proprietary technology is comparable with the well-known Jones-Matrix-Eigenanalysis (JME) which is the standard method for measuring polarization mode dispersion (PMD) or differential group delay (DGD) of optical devices.

For spectral measurements of polarization dependent loss and dispersion, the N7788B is combined with a Keysight swept-wavelength tunable laser, such as the 81600B or 81960A (not included) and the Polarization Navigator software application for single-scan measurements. Compared to the JME, Keysight's powerful single scan technology offers a range of advantages:

A complete set of parameters:

- DGD/PMD
- PDL
- Power/loss
- TE/TM-loss
- Jones matrices
- Mueller matrices
- 2nd-order PMD (depolarization + PCD)

## Key benefits

- Highest accuracy in a single sweep: No averaging over multiple sweeps required.
- High measurement speed: Complete measurement across C/L-band in less than 10 seconds (no need to wait for many averages).
- Robustness against fiber movement/vibration and drift: Fixing fibers with sticky tape on the table or even operation on isolated optical table is not required! The single-scan measurement fully characterizes each wavelength point in 0.3 ms rather than after multiple sweeps over many seconds.
- No limitation on optical path length of component.
- The internal referencing scheme guarantees reliable and accurate measurements.

## Applications

- Fiber characterization: SMF, PMF, DCF.
- Passive component testing: filters, isolators, circulators.
- Dynamic component/module testing: OADM/ROADM.
- Active component testing: EDFAs, SOAs, VOAs.
- Link test: In-channel measurements across amplifiers.

## Designed for the manufacturing floor

### High throughput

A complete analysis across the C and the L band is performed in less than 10 seconds!

### Software drivers

A range of software drivers is available for external control of the system. This allows easy integration in common ERP systems.

### Remote control

The N7788B has USB and GPIB interfaces and can be programmed directly or operated manually or automatically via the included Polarization Navigator software.

### Report generation

Generating PDF reports is supported. The content including layout is configurable by the user.

### Real time power readout

High throughput measurement of non-connectorized components is supported by providing a real time power readout which enables fiber coupling of the new device.

### Barcode scanner

Barcode scanning is supported for quick transfer of the DUT serial number.

## Keysight N7788B instrument setup and application examples

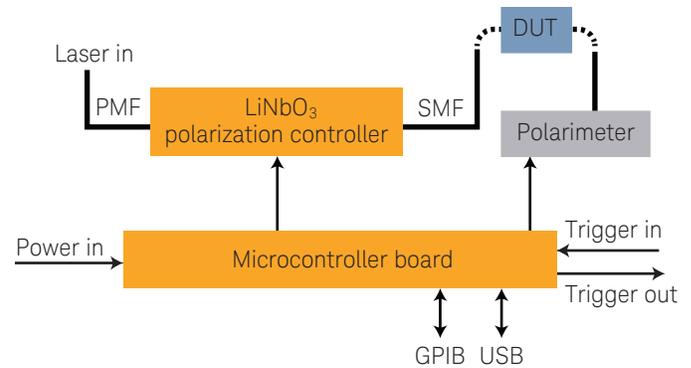


Figure 1. N7788B instrument setup.

The instrument setup is shown in the Figure 1. A  $\text{LiNbO}_3$  polarization controller deterministically varies the input polarization to the DUT. As the tunable laser source sweeps over the desired wavelength range, a polarimeter analyzes the output state of polarization while the input polarization is being modified. The result is a highly accurate device characterization with respect to DGD/PDL/loss, etc. Furthermore, the internal optical switch provides continuous self calibration for excellent repeatability.

## Resolving TE/TM insertion loss

The TE/TM-function allows accurate determination of the minimum and maximum loss of the DUT at each wavelength and permits determination of the polarization-dependent frequency Pdf of filter passbands.

Due to birefringence, optical filters tend to show different transmission functions depending on the polarization state. As shown in Figure 2, these functions are typically shifted in wavelength depending on the amount of birefringence.

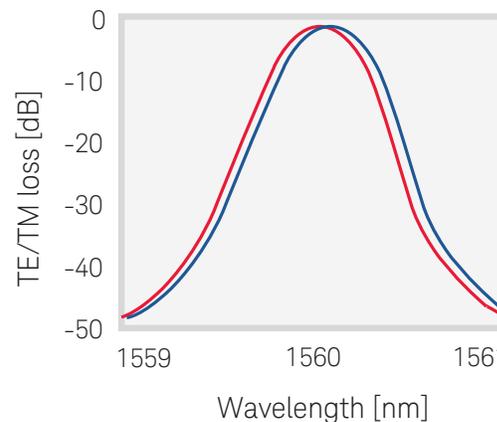


Figure 2. Polarization-dependent wavelength shift (PD- $\lambda$ ) of a filter.

The capability of performing quick PMD-measurements makes this measurement system well-suited to collecting long-term PMD data. The PC software allows continuous collection and saving of spectral PMD data. The data can then be visualized as a pseudo-color plot (see Figure 3).

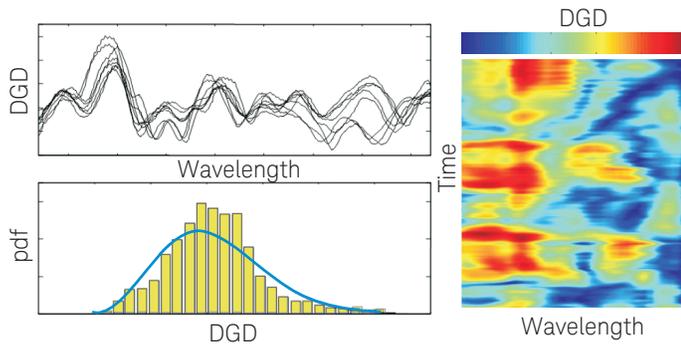


Figure 3. Long term DGD measurements.

The internal reference path allows measurement of insertion loss spectra with excellent accuracy, further minimizing the influence of environmental disturbance to the results.

### Configuration for swept-wavelength measurements

The N7788B is configured so that a polarized source like a tunable laser can be input and the polarization-controlled signal is then output to the front panel. It can then be applied to a DUT and the DUT output signal is then returned to the polarization analyzer input of the instrument. Internal switching for automatic referencing is also included. This setup is especially used for measuring wavelength dependent differential group delay, DGD and PMD, together with PDL and IL with a single wavelength sweep. The Polarization Navigator is the user interface for the N778x-series polarization instruments and includes an application engine for this setup. This has now been integrated into the N7700A suite and is free. Installation requires the N7700A Main package and the Polarization Navigator package.

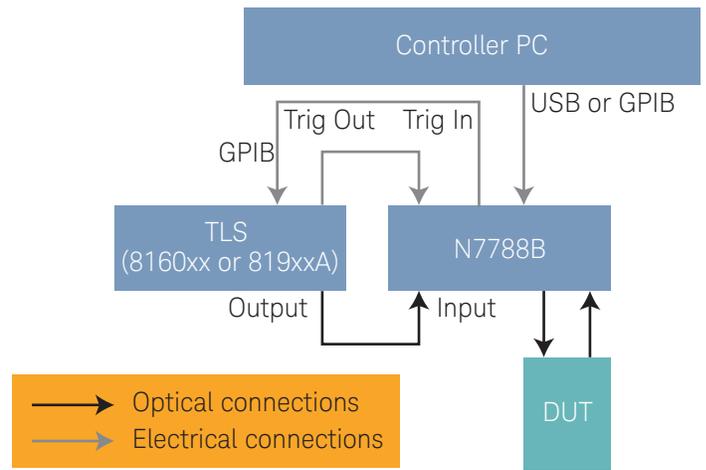


Figure 4. Schematic instrument configuration for swept-wavelength DGD/PMD, PDL and IL measurements using the N7788B.

Due to the excellent spectral resolution, the Keysight N7788B is best suited for intra-channel DGD/PDL characterization.

The all-parameter-JME algorithm allows flexible adjustments of the wavelength resolution without the need to repeat the measurement. This allows the user to easily find the optimum trade-off between PDL/DGD accuracy and wavelength resolution.

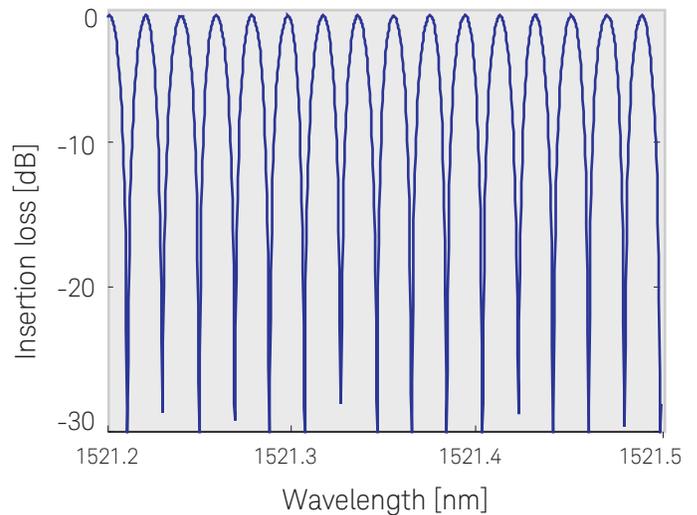


Figure 5. Loss curve of a DPSK demodulator.

# Specifications <sup>1</sup> N7788B Optical Component Analyzer

<b>Wavelength</b>		
Specification wavelength range	1270 nm to 1375 nm (Opt. 300, O-Band)	
	1270 nm to 1375 nm, 1460 nm to 1620 nm (Opt. 400, O/C/L-Band)	
	1460 nm to 1620 nm (Opt. 500, C/L-Band)	
Operating wavelength range <sup>2</sup>	1260 nm to 1640 nm	
<b>Differential group delay</b>		
DGD uncertainty <sup>3</sup>	Resolution 2.0 nm	± (30 fs + 0.3% * DGD)
	Resolution 0.1 nm	± (30 fs + 3.0% * DGD)
DGD measurement range <sup>3</sup>	0 ps to 1000 ps	
PMD uncertainty <sup>4</sup>	± (30 fs + 2.0% * DGD)	
PMD repeatability (typical)	± 3 fs	
PMD measurement range <sup>4</sup>	0 ps to 300 ps	
<b>Loss</b>		
PDL uncertainty <sup>5</sup>	C-Band	± (0.05 dB + 4% * PDL)
	O-Band	± (0.10 dB + 4% * PDL)
PDL repeatability (typical)	± 0.005 dB	
Insertion loss uncertainty (typical) <sup>3</sup>	C/L-Band	± 0.03 dB
	O-Band	± 0.07 dB
Insertion loss dynamic range (typical) <sup>3</sup>	> 41 dB (for higher TLS power levels, increase value accordingly)	
<b>Polarization analysis</b>		
SOP uncertainty (typical) <sup>6,7</sup>	1.5°	
DOP uncertainty <sup>6</sup>	± 2.0 %	
DOP uncertainty after user calibration (typical) <sup>6,8</sup>	± 0.5 %	
Maximum sampling rate	1 MHz	
<b>Optical power measurement</b>		
Relative power uncertainty <sup>6</sup>	C/L-Band: ± 0.03 dB (± 0.02 dB typical)	
	O-Band: ± 0.07 dB (± 0.04 dB typical)	
Input power range	-50 dBm to +7 dBm	
Maximum safe optical input power	+12 dBm	
<b>Polarization control</b>		
SOP switching time	< 10 μs	
PDL (typical)	C/L-Band	< 0.2 dB
	O-Band	< 0.5 dB
Insertion loss	< 3.5 dB (< 3 dB, typical)	
Maximum safe input power	+20 dBm	

1. Ambient temperature change max ± 0.5 °C since normalization. Valid for 81600B Tunable Laser Source Family. TLS power set to -6 dBm. Sweep over specification wavelength range. Specification does not include instability in test device. Specified loss ranges include loss of test device and any additional switches or connections in the optical path. Specification valid on day of calibration.
2. SOP/DOP measurements are only possible outside the specification wavelength range if the user performs a manual calibration.
3. DUT properties: Insertion loss < 30 dB, PDL < 1 dB, DGD < 150 ps. Specification is typical for DGD > 150 ps.
4. DUT properties: Insertion loss < 41 dB, PDL < 3 dB, PMD < 50 ps. Applies for highly mode-coupled devices such as single mode fibers. Specification applies for PMD being averaged DGD over a wavelength span of 100 nm. Specification is typical for PMD > 50 ps.
5. DUT properties: Insertion loss < 25 dB, PDL < 6 dB. Note: DUT connectors are considered as being part of the DUT. Thus, angled connectors will add to the device PDL.
6. Input power > -30 dBm.
7. DOP > 95%.
8. User calibration requires a source with 100% DOP and is valid for a fixed wavelength.

# Specifications <sup>1</sup> N7788B Optical Component Analyzer (Continued)

## Ordering instructions

Optical connector options for laser input port	
N7788B-021	Straight contact connector
N7788B-022	Angled contact connector
Optical connector options for DUT ports	
N7788B-031	Straight contact connector
N7788B-032	Angled contact connector
Wavelength options	
N7788B-300	1270 to 1375 nm
N7788B-400	1270 to 1375 nm and 1460 to 1620 nm
N7788B-500	1460 to 1620 nm
Connector interface	
The N7788B should usually be ordered with three 81000xl connector interfaces, depending on desired connector type (not included).	
Accessories	
5063-9240	Rack mount kit for 1 unit with filler panel
5063-9212 + 5061-9694	Rack mount parts for 2 units side-by-side
General characteristics	
Dimensions (D x W x H)	380 mm x 213 mm x 88 mm (excluding front and back rubber cushions and handle)
Weight	Approx. 4 kg
Recommended recalibration period	24 months
Operating temperature	+5 °C to +40 °C
Operating humidity	0% to 80%, non-condensing
Altitude	The maximum operating altitude is 2000 m
Pollution protection	Pollution degree 2
Warm-up time	20 minutes
Interfaces	The instruments can be controlled via USB or GPIB interfaces
Power consumption	Line power: AC 100 to 240 V ± 10%, 50/60 Hz, 60 VA max

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