

# N4377A Lightwave Detector

## Electro-optical measurements on optical transmitters

### E-to-O Amplitude and Phase Measurements up to 43.5 GHz or 70 GHz

The N4377A Lightwave Detector is a USB-powered, DC-coupled optical-electrical converter with built-in optical power meter capability. It enables frequency domain applications in photonics if used with a vector network analyzer or a spectrum analyzer.

### S21 measurements, laser linewidth and modulation spectra

With amplitude and phase response correction data stored on board the device, vector network analyzers (such as PNA, PNA-X) can de-embed the converter from optical transmitter or modulator measurements, enabling accurate S21-parameter measurements in the photonic domain.

Electrical spectrum analyzers benefit from the converter's low intrinsic noise and high bandwidth when performing laser linewidth and modulation spectrum measurements.

Calibration and re-calibration are independent from the electronic instrument the converter is used with.



The N4377A is a USB-powered extension to instruments performing frequency-domain measurements. Calibration data are accessible in S2P file format via USB. SCPI remote programming is possible via USBTMC.



Figure 1: N4377A Lightwave Detector

### Built-in optical power meter

A calibrated optical power meter provides average power measurements and enables insertion loss measurements, e.g. on optical modulators. A bar-graph display on the converter not only helps detect bent or broken fibers, bad connectors or missing signal, but also helps stay within the detector's linear optical power range.

## Single-mode and multimode fiber versions

The N4377A Lightwave Detector is available for single-mode fiber with 43.5 GHz and 70 GHz bandwidth with calibration wavelengths at 1310 nm and 1550 nm, as well as for multimode fiber with 43.5 GHz bandwidth and calibration at 850 nm.

The single mode fiber versions operate across and beyond the entire CWDM range, starting at 1260 nm and reaching to 1650 nm.

The 43.5 GHz version for multimode fiber offers calibrated measurements at 850 nm but can also be operated at SWDM wavelengths and wavelengths as long as 1600 nm. An option adds calibration wavelengths at 1310 nm and 1550 nm.

## Target Test Devices

Mach-Zehnder modulators (MZM), electro-absorption modulators (EAM), directly modulated lasers and transmitter optical subassemblies (TOSA) represent the most common optical transmitters. They are typically tested for their frequency response over a range of operating currents and ambient temperatures. The N4377A's built-in optical power meter allows to check the operating power, but also gives an indication of a bent fiber or a bad connection. Dual-drive optical modulators can be characterized with 4-port PNAs as illustrated in figure 2.

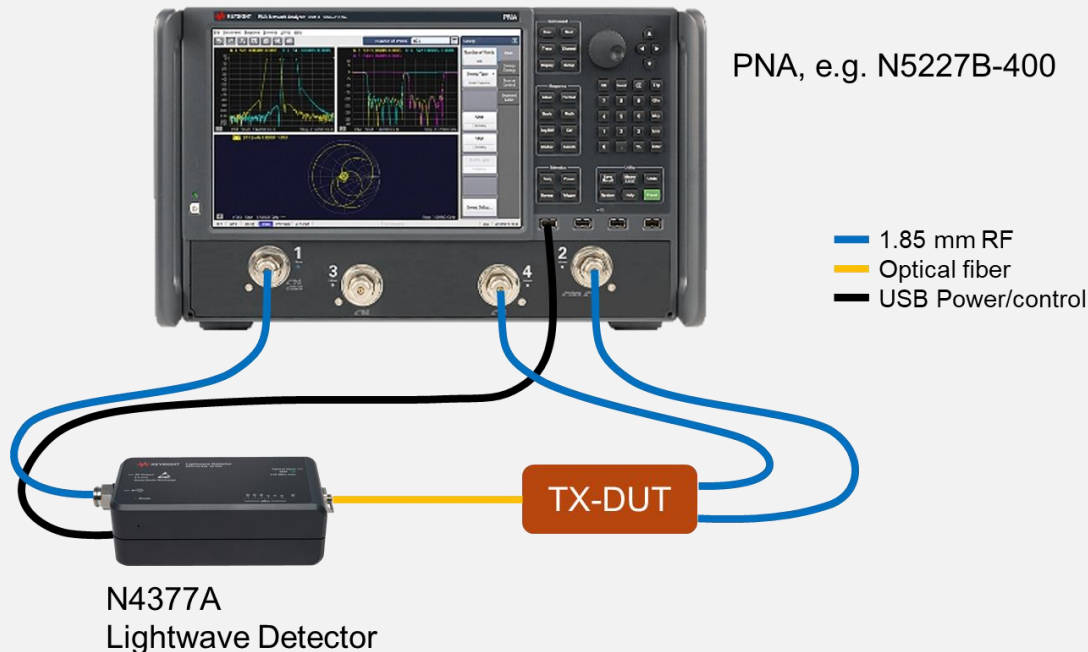


Figure 2: Dual-drive optical transmitter test configuration (example)

## Measurement Capabilities

Responsivity (amplitude and phase)	Reflectivity (amplitude and phase)
<ul style="list-style-type: none"> <li>Absolute frequency response, the conversion efficiency of a transmitter</li> <li>Relative frequency response, the filter shape of the electro-optical conversion</li> <li>3-dB bandwidth of the electro-optical transfer function</li> <li>Group Delay vs. frequency of the transfer function</li> <li>Optical Insertion Loss (IL) of modulators</li> </ul>	<ul style="list-style-type: none"> <li>Electrical reflectivity at the RF port</li> <li>Impedance match</li> </ul>
	Balanced measurements
	<ul style="list-style-type: none"> <li>Differential frequency response</li> </ul>

## Technical Specifications for Electrical to Optical Measurements

Product Option	N4377A-M40
Operating frequency range	DC to 43.5 GHz
Calibrated frequency range	10 MHz to 43.5 GHz
Calibration wavelengths	850 nm $\pm$ 10 nm optional <sup>1</sup> : 1310 nm $\pm$ 10 nm; 1550 nm $\pm$ 10 nm
Operating wavelength range	800 nm to 1600 nm
Relative frequency response uncertainty (typical, at 850 nm)	$\leq \pm 1.1$ dBc (10 MHz to 26.5 GHz), $\leq \pm 1.4$ dBc (> 26.5 GHz to 40 GHz)
Average optical power measurement range (typical)	-30 dBm to +5 dBm
Average optical power measurement uncertainty	$\leq \pm 0.5$ dB at 850 nm, typical $\leq \pm 0.5$ dB in operating wavelength range
Average optical power measurement update rate	2 updates per second
Max. safe average input power	+8 dBm
Optical return loss (typical)	>13 dB
Optical input connector type	FC/PC
RF output connector type	2.4 mm, male

<sup>1</sup> Requires option N4377A-MW2. Correction data for 1310 nm, 1550 nm generated using single mode input signals.

Product Option	N4377A-S40	
Operating frequency range	DC to 43.5 GHz	
Calibrated frequency range	10 MHz to 43.5 GHz	
Calibration wavelengths	1310 nm $\pm$ 10 nm; 1550 nm $\pm$ 10 nm	
Operating wavelength range	1260 nm to 1650 nm	
	1310 nm	1550 nm
Relative frequency response uncertainty (typical)	$\leq \pm 1.1$ dBe (10 MHz to 10 GHz), $\leq \pm 1.5$ dBe (> 10 GHz)	$\leq \pm 1.1$ dBe
Phase uncertainty (typical)	$\leq \pm 3.6^\circ$ (10 MHz to 10 GHz), $\leq \pm 4.6^\circ$ (> 10 GHz to 26.5 GHz), $\leq \pm 5.2^\circ$ (> 26.5 GHz to 40 GHz)	$\leq \pm 3.6^\circ$ (10 MHz to 10 GHz), $\leq \pm 3.6^\circ$ (> 10 GHz to 26.5 GHz), $\leq \pm 4.5^\circ$ (> 26.5 GHz to 40 GHz)
Average optical power measurement range (typical)	-30 dBm to +5 dBm	
Average optical power measurement uncertainty	$\leq \pm 0.5$ dB at calibration wavelengths, typical $\leq \pm 0.5$ dB in operating wavelength range	
Average optical power measurement update rate	2 updates per second	
Max. safe average input power	+9 dBm	
Optical return loss (typical)	>25 dBo	
Optical input connector type	FC/APC	
RF output connector type	2.4 mm, male	

Product Option	N4377A-S70	
Operating frequency range	DC to 70 GHz	
Calibrated frequency range	10 MHz to 70 GHz	
Calibration wavelengths	1310 nm $\pm$ 10 nm; 1550 nm $\pm$ 10 nm	
Operating wavelength range	1260 nm to 1650 nm	
	1310 nm	1550 nm
Relative frequency response uncertainty (typical)	$\leq \pm 1.1$ dBe (10 MHz to 10 GHz), $\leq \pm 1.5$ dBe (> 10 GHz to 40 GHz), $\leq \pm 1.8$ dBe (> 40 GHz to 67 GHz)	$\leq \pm 1.1$ dBe (10 MHz to 10 GHz), $\leq \pm 1.1$ dBe (> 10 GHz to 40 GHz), $\leq \pm 1.6$ dBe (> 40 GHz to 67 GHz)
Phase uncertainty (typical)	$\leq \pm 3.6^\circ$ (10 MHz to 10 GHz), $\leq \pm 4.6^\circ$ (> 10 GHz to 26.5 GHz), $\leq \pm 5.2^\circ$ (> 26.5 GHz to 40 GHz), $\leq \pm 6.7^\circ$ (> 40 GHz to 60 GHz), $\leq \pm 9.5^\circ$ (> 60 GHz to 65 GHz)	$\leq \pm 3.6^\circ$ (10 MHz to 10 GHz), $\leq \pm 3.6^\circ$ (> 10 GHz to 26.5 GHz), $\leq \pm 4.5^\circ$ (> 26.5 GHz to 40 GHz), $\leq \pm 5.9^\circ$ (> 40 GHz to 60 GHz), $\leq \pm 9.5^\circ$ (> 60 GHz to 65 GHz)
Average optical power measurement range (typical)	-30 dBm to +5 dBm	
Average optical power measurement uncertainty	$\leq \pm 0.5$ dB at calibration wavelengths, typical $\leq \pm 0.5$ dB in operating wavelength range	
Average optical power measurement update rate	2 updates per second	
Max. safe average input power	+13 dBm	
Optical return loss (typical)	>30 dBo	
Optical input connector type	FC/APC	
RF output connector type	1.85 mm, male	

## General Specifications

General Specifications	N4377A-M40, N4377A-S40, N4377A-S70
Storage Temperature Range	-40°C to +70°C
Operating Temperature Range	+10°C to +40°C
Humidity	15% to 80% RH, non-condensing
Maximum operating altitude	2000 m (6600 ft)
Recommended Recalibration Period	1 year

## Ordering Information

Option	Description
N4377A-M40	Lightwave Detector 40 GHz, multimode, 850 nm calibration
N4377A-S40	Lightwave Detector 40 GHz, single mode, 1310/1550 nm calibration
N4377A-S70	Lightwave Detector 70 GHz, single mode, 1310/1550 nm calibration

Option	Calibration Option
N4377A-MW2	Add correction data for 1310/1550 nm to N4377A-M40, generated using single mode input signals

## Lightwave Component Analyzers Online Information

[www.keysight.com/find/lca](http://www.keysight.com/find/lca)

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