Agilent 71400C
Lightwave Signal Analyzer

Product Overview

Calibrated measurements of high-speed modulation, RIN, and laser linewidth

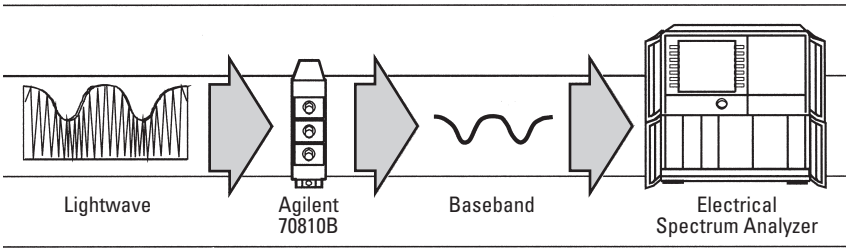
Agilent Technologies

High-Speed Lightwave Analysis

The Agilent 71400C lightwave signal analyzer combines Agilent's highest-performance RF spectrum analyzers with a sensitive, wide-bandwidth optical-receiver for analyzing lightwave communications systems and components.

Featuring bandwidths from 100 kHz to 22 GHz and wavelength operation from 1200 to 1600 nm, the Agilent 71400C easily and accurately makes measurements of relative intensity noise (RIN), linewidth, and modulation performance on single-mode optical fiber.

The Agilent 71400C can achieve a displayed average noise level low enough (–65 dBm optical) to observe and measure intensity noise and RIN produced by semiconductor lasers. Coupled with a built-in attenuator that enables lasers with up to 1 watt of power to be tested, the lightwave signal analyzer provides you with outstanding measurement range.



The Agilent 70810B module provides the solution

The key to Agilent's lightwave signal analyzer is the Agilent 70810B lightwave module. Consisting of an optical attenuator, broadband photodetector, microwave preamplifier, and optical power meter, the Agilent 70810B compensates for photodetector responsivity and preamplifier gain variations. Frequency-response corrections and mismatch losses are no longer a worry.

The Agilent 70810B module has a new optical path with reduced internal reflections and an improved total return loss of 35 dB or better.

The Agilent 70810B can also be used in stand-alone configurations to provide general-purpose wide-band optical to electrical conversion. Insert multiple modules into a single mainframe for parallel conversion.

Power meter adds flexibility

The Agilent 71400C includes a built-in power meter. An analog bar gives easy visual indication of power level and carrier-to-noise information. A digital power readout gives you precision power-level monitoring in either optical or electrical units. You may also choose either linear or logarithmic terms. This power meter is especially useful in tests for RIN, relative-modulation, and modulation depth. Now you can adjust your systems for optimum alignment, bias, power level, and modulation characteristics with one connection.

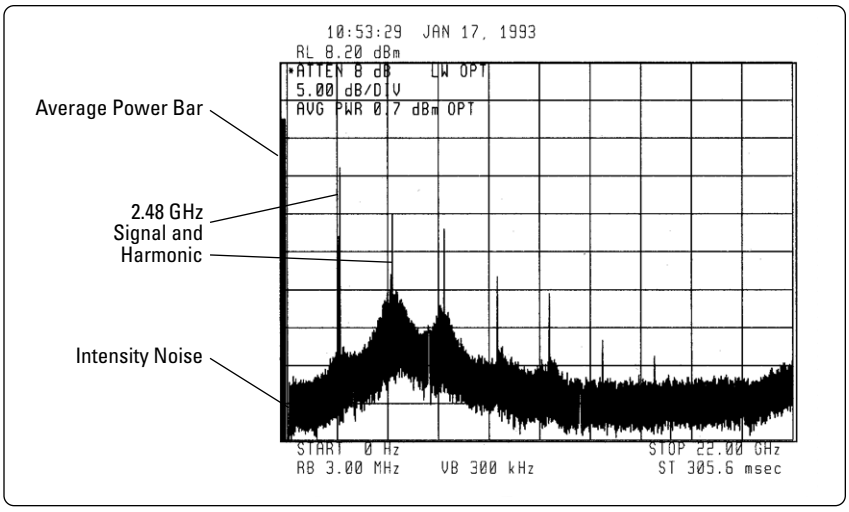
Flexible and easy to use

The Agilent 71400C is easy to operate. A custom key pad provides single key operation for the most often used functions. Logical menus offer quick access to rich function and marker capabilities. You have complete control over all functions. Use the default settings or over ride them. For example, you can display the amplitude information in log or linear format with either optical or equivalent electrical units.

Versatile Measurement Capability

Modulation and signal distortion measurements

With the lightwave signal analyzer you can see the laser's intensity noise, relaxation oscillation peak, baseband intensity modulation, and signal harmonics out to 22 GHz. Monitor analog transmissions and find difficult digital system problems using frequency domain signal analysis. While measuring the signal, monitor the laser's average power. Or, utilize the analyzer's calibrated receiver as a standard to test and evaluate your photodetectors with the electrical input port.



RIN and laser intensity-noise characterization

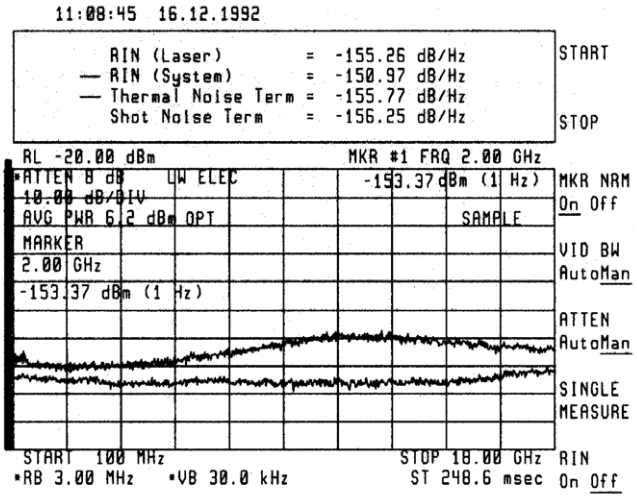
The Agilent 71400C features two relative intensity noise (RIN) measurements. A RIN marker reads out the total system RIN, which includes the receiver's shot noise, the thermal noise, and the laser's intensity noise at a marker location. This noise measurement samples, averages, and corrects for analyzer bandwidth and filter shapes. The RIN marker is the fastest measure of RIN and can make measurements to –150 dBc/Hz on a 1 mW laser.

Often overlooked, when comparing RIN values, is the dynamic nature of laser noise. RIN can change dramatically with different reflection conditions or when the laser is modulated. It is not enough to know the static RIN value with best-case reflection conditions or to rely on data-sheet RIN specifications to predict the effects of laser noise within an operating system.

The Agilent 71400C, with its real-time wide-frequency display, is ideal for helping you observe the interaction of RIN and modulation, determine any problems, and verify their solutions.

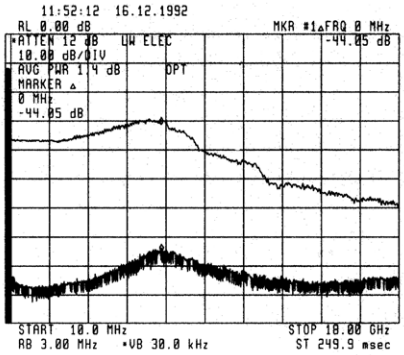
Advanced RIN program

To measure lasers with RIN values down to –165 dBc/Hz, an advanced measurement program is provided. This program removes the photodiode's shot noise and the analyzer's thermal noise contributions. The program can provide laser RIN measurement values as much as 16 dB below the thermal and shot noise contributions.



Modulation frequency response

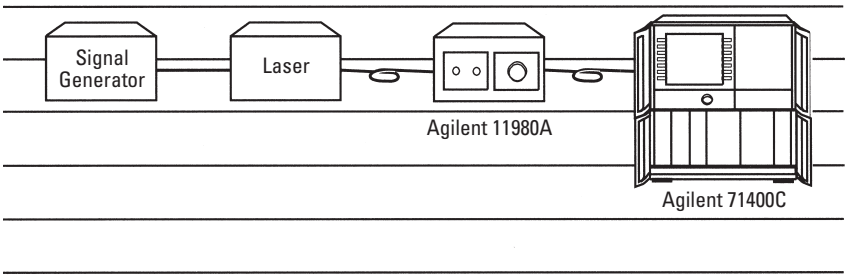
The shape and amplitude of a laser's intensity-noise spectrum provide useful information. The laser's relaxation resonance appears as a peaking in the intensity noise floor of the laser. The maximum modulation rate of the laser is directly related to the location of this resonance peak which is related to the bias-current level. More current will widen the resonance and shift its position higher in frequency.



Add Linewidth and Chirp Measurements

Accessories extend versatility

Add the Agilent 11980A fiber optic Mach-Zehnder interferometer and the Agilent 70880A automatic linewidth personality to a lightwave signal analyzer to fully automate linewidth measurements. Add a modulation source, that can be gated on and off, and you can fully characterize your laser for chirp and frequency modulation (FM).

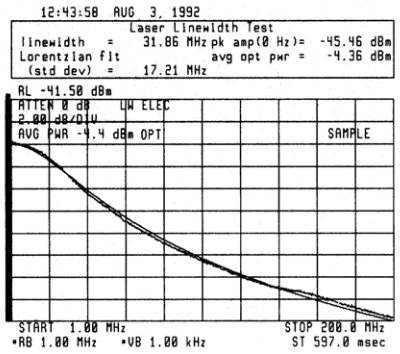


Linewidth

Linewidth is the measure of phase noise present on the laser's output. The Agilent 11980A uses the self-homodyne technique to translate the spectral line from the terahertz region to 0 Hz.

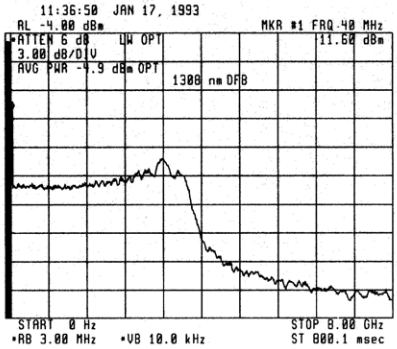
The Agilent 70880A personality is an advanced measurement program that automatically measures the linewidth of distributed feedback (DFB) lasers, and determines the fit and possible deviation of the laser from the ideal lorentzian lineshape. This linewidth personality makes linewidth measurements automatically from the instrument or remotely across the GPIP bus. Automatic instrument setup is also provided allowing true hands-off operation.

With this program, every data point is used to determine the linewidth. Specific values, such as the peak or –3 dB points need not be present to determine accurate linewidths. By analyzing and averaging all data points, noise on any single value will not adversely affect the total linewidth evaluation or accuracy.



Chirp

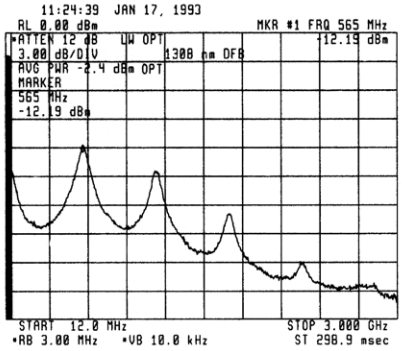
Modulating a laser's injection current causes the laser to chirp, or change frequency (FM). This incidental FM, or chirp, can be an unwanted by-product, causing chromatic dispersion on the transmission line or, it can be a desired feature for lightwave systems, allowing frequency shift keying (FSK) or other FM techniques to be employed.



Sinewave, squarewave, and PRBS modulation each cause different chirp levels. But, large amounts of amplitude modulation from any source will cause large FM deviations.

Low levels of modulation allow the individual FM sidebands to become visible. The width of these sidebands is determined by the phase noise or linewidth of the laser.

By using these FM sidebands (changing the modulating amplitude to null a sideband) and knowing the modulation frequency, you can determine the alpha factor (ratio of FM to IM) and other FM characteristics of the laser.



Extended calibration

The Agilent 71400C comes standard with extended calibration that provides additional flatness corrections for the analyzer. The 70810B-020 option adds this extended calibration to the Agilent 70810B module bought separately for use in an existing Agilent 71210 or 71100 system.

Specifications

For general and electrical specifications on the systems not given here, refer to data sheets of the Agilent 71210C (for the Agilent 71400C). ***Specifications*** describe the instrument's warranted performance over the 0°C-55°C temperature range, except where noted. All specifications apply after the instrument's temperature has stabilized (typically 30 min. from turn-on), and after all self-calibration routines have been run. ***Characteristics*** provide information about non-warranted instrument performance in the form of ***nominal values***. All amplitude specifications are in optical dB unless noted by an asterisk (*).

Agilent 71400C Specifications

Wavelength Range (Characteristic)	1200 nm to 1600 nm	
Frequency Range	100 kHz to 22 GHz	
Average Power Accuracy	**Factory calibrated:** ±0.65 dB ±0.5 nW ±Connnector variation[1]	
At 1300 and 1550 nm, or 830 nm for opt. 850	**User Calibrated:** ±0.05 dB ±0.5 nW ±power meter accuracy[2] (By external power meter)	
Modulated Power		
Amplitude Accuracy	**20°C-30°C**	±1.0 dB
at 100 MHz	**0°C-55°C**	±1.8 dB
Frequency Response[3]		
Relative to 100 MHz		
100 kHz-2.9 GHz:	**20°C-30°C**	±1.0 dB
	0°C-55°C	±1.3 dB
2.9 GHz-22 GHz:	**20°C-30°C**	±1.0 dB
	0°C-55°C	±3.0 dB
RF Input Frequency Response[3]		
100 kHz-2.9 GHz	±2.3 dB*	
2.9 GHz-22 GHz	±2.8 dB*	
Displayed Average Optical Noise Level	*Frequency*	*Displayed Noise Level*
10 Hz Res BW, 3 Hz Vid BW, Ref Level ≤–40 dBm	100 kHz-1 MHz	–51 dBm
	1 MHz-10 MHz	–57 dBm
	10 MHz-100 MHz	–62 dBm
	100 MHz-16 GHz	–66 dBm
	16 GHz-22 GHz	–60 dBm
Harmonic Distortion		
with modulated input power		
<–20 dB	≤–50 dBc*	
<–30 dB	≤–70 dBc*	
Input Return Loss		
with HMS10		
Total	≥35 dB	
Internal	≥40 dB	
Maximum Safe Input Power	+15 dBm	
Input Connectors[6]		
Single mode fiber	Diamond HMS10, FC/PC, ST, DIN, SC, D4	

Specifications

Agilent 70810B lightwave section This module is for use in the Agilent 71400C lightwave signal analyzer or with the Agilent 71210C, 71201C, or 71100C spectrum analyzers. It can also be used in stand-alone applications as a lightwave converter housed in an Agilent 70001A mainframe. ***Specifications*** describe the instrument's warranted performance over the 0°C-55°C temperature range, except where noted. ***Characteristics*** provide information about non-warranted instrument performance in the form of ***nominal values***. All amplitude specifications are in optical dB unless noted by an asterisk(*).

Agilent 70810B

Wavelength Range (Characteristic): 1200 nm to 1600 nm

Frequency Range: 100 kHz to 22 GHz

Average Power Accuracy At 1300 and 1550 nm:
Factory Calibrated
± 0.65 dB ± 0.5 nW
+ Connector variation[1]
User Calibrated (By extrnl pwr mtr)
± 0.05 dB ±0.5 nW
+ Pwr mtr accuracy[2]

Responsivity (Characteristic): The responsivity is given for each instrument and is accurate to ± 20%.
Nominal Value at 100 MHz: 1200 V/W

Noise Equivalent Power (dBm/$\sqrt{\text{Hz}}$)

Frequency	*Noise Equivalent Power*
100 kHz-10 MHz	–55
10 MHz-100 MHz	–66
100 MHz-16 GHz	–70
16 GHz-22 GHz	–64

Frequency Response Relative to 100 MHz

Frequency	**Corrected**[4]
100 kHz-2.9 GHz	±2.0 dB*
2.9 GHz-22 GHz	±5.0 dB*

(Uncorrected response is <25 dB*, 100 kHz -22 GHz)[5]

Maximum Safe Input Power with 30 dB atten.

Average Power	**Modulated Power**
+15 dBm	+15 dBm

Harmonic Distortion Output ≤–10 dBm*: 43 dB* below fundamental

Input Return Loss with HMS10

Total	>35 dB
Internal	>40 dB

Agilent 70810B cont.

Electrical Input Flatness[4] **Corrected** (Characteristic)

Frequency	**Amplitude Error**
100 kHz-6 GHz	±1.4 dB*
6 GHz-12 GHz	±1.6 dB*
12 GHz-16 GHz	±2.0 dB*
16 GHz-22 GHz	±2.2 dB*

Electrical Output Return Loss (Characteristic)

Frequency	**Return Loss**
100 kHz-6 GHz	12.0 dB*
6 GHz-12 GHz	10.5 dB*
12 GHz-16 GHz	8.5 dB*
16 GHz-22 GHz	7.5 dB*

Bypass Mode Insertion Loss

Frequency	**Insertion Loss**
100 kHz-6 GHz	2.5 dB*
6 GHz-12 GHz	3.7 dB*
12 GHz-16 GHz	4.9 dB*
16 GHz-22 GHz	5.2 dB*

Input Connectors[6]: **Single Mode Fiber Connectors** Diamond HMS10, FC/PC, ST, DIN, SC, D4

The Agilent 11980A is a Mach-Zehnder fiber-optic interferometer. It is for use with the Agilent 71400C lightwave signal analyzer to measure linewidth, FM, and chirp of single-frequency lasers.

Agilent 11980A

Optical Insertion Loss: 1300 nm: 8 dB[1]; 1550 nm: 8 dB[1]

Wavelength Range (Characteristic): 1250 nm to 1600 nm

Delay Time (Characteristic)

Standard	3.5 µsec
11980A-005	2.5 µsec

Optical Connectors[6]: **Single-mode fiber connectors** Diamond HMS 10, FC/PC, ST, DIN, SC, D4

[1] Connector reflections and losses vary with such factors as connector type and quality, connector cleanliness, temperature, damage, and wear.
[2] Applies to any wavelength when the average power readout is set to match an external calibrated optical power meter. Does not include VSWR losses.
[3] Specifications assume extended system calibration (Option 020) is applied. If not, use module specifications for frequency response.
[4] Specifications achieved by applying module responsivity and/or frequency correction factors stored in the Agilent 70810 memory.
[5] Characteristic.
[6] Specified with Diamond HMS 10 connector.
* Amplitude measurement in electrical dB.

Ordering Information

Agilent 71400C Lightwave Signal Analyzer 100 kHz to 22 GHz

The system includes the Agilent 71210C and Agilent 70810B module. Must order one of the optical connectors listed below.

71400C-001	Add the Agilent 11980A Fiber Optic Interferometer
71400C-121	Adds Distribution Amplifier
71400C-512	Additional memory for trace and program storage.

Agilent 70810B Lightwave Section 100 kHz to 22 GHz

Must order one of the optical connectors listed below.

70810B-020	System adjustment and calibration

Agilent 11980A Fiber Optic Interferometer

Must order one of the connectors listed below.

11980A-005	An extra 5 km of fiber for a total delay of 25 µsec.

Optical Connectors for the Agilent 71400C, 70810B and 11980A

81000AI	Diamond HMS-10 Connector
81000FI	FC/PC Connector
81000SI	DIN 47256 Connector
81000VI	ST Connector
81000GI	D4 Connector
81000UI	SC Connector

By internet, phone, or fax, get assistance with all your test & measurement needs.

Online assistance:
www.agilent.com/comms/lightwave

Agilent Email Updates
www.agilent.com/find/emailupdates
Get the latest information on the products and applications you select.

Phone or Fax
United States:
(tel) 1 800 452 4844

Canada:
(tel) 1 877 894 4414
(fax) (905) 282 6495

China:
(tel) 800-810-0189
(fax) 1-0800-650-0121

Europe:
(tel) (31 20) 547 2323
(fax) (31 20) 547 2390

Japan:
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Korea:
(tel) (82-2) 2004-5004
(fax)(82-2) 2004-5115

Latin America:
(tel) (305) 269 7500
(fax) (305) 269 7599

Taiwan:
(tel) 080-004-7866
(fax) (886-2) 2545-6723

Other Asia Pacific Countries:
(tel) (65) 375-8100
(fax) (65) 836-0252
Email: tm_asia@agilent.com

Printed in USA April 25, 2002
5980-1929E

Agilent Technologies