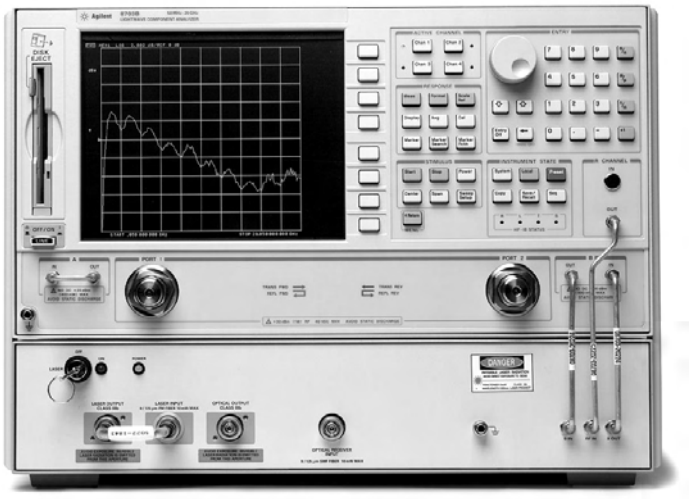
Agilent 8703B Lightwave Component Analyzer

Technical Specifications



50 MHz to 20.05 GHz modulation bandwidth

Agilent Technologies

The 8703B lightwave component analyzer is a unique, general-purpose instrument for testing electro-optical communication system components. It is designed specifically for the high-volume demands of 10 Gb/s component manufacturing test.

This technical specification describes the measurement accuracy and operating conditions of the Agilent 8703B lightwave component analyzer.

Additional ordering information can be found in the 8703B configuration guide.

Testing 10 Gb/s optical components

The 8703B is a manufacturing test solution for such diverse optical and electro-optical components, assemblies and devices as lasers and LEDs, photodiodes, fiber cables, connectors and transmitter/receiver pairs. Measurements can also be made on electrical microwave components such as amplifiers, cables, connectors, attenuators, and waveguides.

Source and receiver slope responsivity performance, including such parameters as modulation bandwidth, can be tested on optical sources and receivers. For sources and receivers, electrical reflection performance can also be tested. For optical devices, the 8703B offers optical transfer function tests, including insertion loss and group delay. Optical reflection performance can be tested on all types of components and devices using the external Agilent 11890A directional coupler. Microwave devices can also be tested for electrical transfer function test and electrical reflection response tests.

Calibrated Measurements

One of the key benefits of the 8703B is its ability to perform calibrated measurements on optical components. Through the temperature-compensated optical components in the lightwave deck and error-correction algorithms, the 8703B removes the inherent systematic errors from the measured data of the device. The ability to make calibrated, repeatable measurements assures accuracy, reliability and confidence in the components being tested. The 8703B is a general-purpose instrument that can measure a wide range of parameters. It is a flexible platform of measurement assurance for optical, electro-optical and electrical components.

3 dB bandwidth measurements can be easily automated on the 8703B.

Programmability

Reflecting the inherent need for test automation in the production environment, the 8703B incorporates robust GPIB programmability into the system firmware. Test limits such as a 3 dB bandwidth key are included. There are five markers, as well as limit lines for ripple and bandwidth, all of which are programmable through the GPIB port. There are 1601 trace data points for increased accuracy in the measurements.

The 8703B firmware is backward compatible with the Agilent 8703A lightwave component analyzer, allowing ease of integration into production lines that are already set up for that instrument.

Types of measurements performed with the Agilent 8703B

Lightwave source characterization
(electrical-in and optical-out)

Source slope responsivity tests
- Modulation bandwidth
- Modulated output power flatness
- Modulation signal group delay and differential phase
- Reflected signal sensitivity
- Distance-time response

Optical reflection tests
- Port return loss

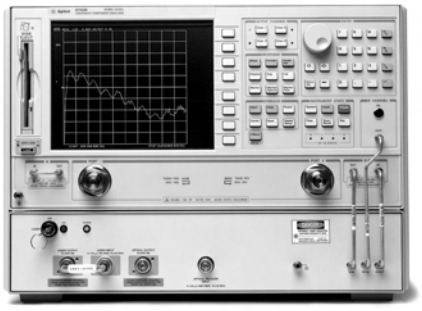
Electrical reflection tests
- Port impedance or return loss

Lightwave receiver characterization
(optical-in and electrical-out)

Receiver slope responsivity tests
- Modulation bandwidth
- Modulated output power flatness
- Modulation signal group delay and differential phase

Optical reflection tests
- Port return loss

Electrical reflection tests
- Port impedance or return loss



Optical device characterization
(optical-in and optical-out)

Optical transfer function tests
- Insertion loss or gain
- Modulated output power flatness
- Modulation signal group delay and differential phase
- Modal dispersion

Optical reflection response tests
- Port return loss

Microwave device characterization
(electrical-in and electrical-out)

Electrical transfer function tests
- Insertion loss or gain
- Output power flatness
- Group delay and deviation from linear phase

Electrical reflection response tests
- Port impedance or return loss

8703B Specifications and Characteristics

Specifications apply to instruments in the following situation:

- Temperature is in the range of +20°C to +30°C
- Analyzer has had a warm-up time of two hours in a stable ambient temperature
- Measurement calibration has been performed

Description	Specification	Characteristic
Lightwave Source		
Wavelength		
Option 155	1555 nm,± 5 nm	
Option 131	1308 nm,±9.5 nm	
Average Optical Output Power from Laser		*+5 Bm*
Laser Beam Divergence		*12%*
Spectral Width		*<20 MHz*
Modulation Bandwidth	0.05 to 20.05 GHz	
Modulation Frequency Resolution	1 Hz	
Maximum Optical Power Input to Modulator	10 dBm (10 mW)	
Insertion Loss of Modulator		*9 dB*
Average Optical Output Power from Modulator		*-4 dBm (400 µW)*
Modulated Signal Output Power from Modulator (p-p)		*-7 Bm (200 µW)*
Modulation Index[a]		*40% to 100%*
Optical Output Return Loss (for all front panel optical ports)		*>30dB*
Lightwave Receiver		
Wavelength	1000-1600 nm	
Input Modulation Bandwidth	0.05 to 20.05 GHz	
Maximum Average Input Power Operating Level	+3 Bm	
Input Port Return Loss		*>30 B*
Microwave Source		
Frequency Bandwidth	0.05 to 20.05 GHz	
Frequency Resolution	1 Hz	
Output Power Range	-65 to +5 dBm	
Microwave Receiver		
Frequency Bandwidth	0.05 to 20.05 GHz	
Maximum Input Power Operating Level	+10 dBm	

a. Modulation index is calculated as: maximum signal power/average power.

Measurement Conditions

The specifications in the following sections apply for measurements made using the following conditions:

- 30 Hz IF Bandwidth
- Stepped Sweep Mode
- Autobias ON
- 0.5% Smoothing

Optical-to-Optical Device Measurement Specifications

The following data applies after a response and isolation calibration has been performed.

O/O Noise Floor

Optical-to-Optical Measurement Performance Data

Description	Frequency Range	Noise Floor (dBo)
Maximum Noise Floor Amplitude[1]	0.05 to 8 GHz	-30
	8.0 to 20.05 GHz	-25

[1] Noise floor is measured with 30 Hz IF bandwidth and with an averaging factor of 6.

Optical-to-Electrical Device Measurement Specifications

Relative frequency response can be used to calculate the error in measuring the 3 dB bandwidth of an O/E device.

Relative Frequency Response Performance Data

Table 1

Optical-to-Electrical Measurement Performance Data Description	Frequency Range	Specification[1]
System Relative Frequency Response Accuracy	0.05 to 11 GHz 11 to 20.05	±0.65 dB ±0.90 dB

[1] Applies to a device with ρ = ≤0.25 and measurement settings of IF bandwidth = 30 Hz and smoothing = 0.5%.

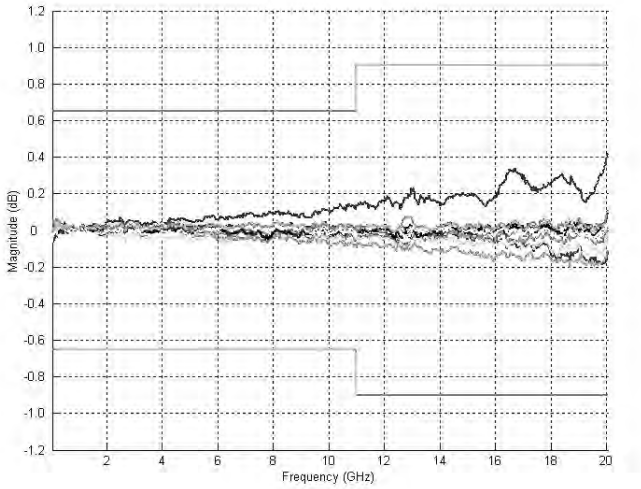


Figure 1. O/E Port 1 Characteristic Relative Frequency Response Error.

Limit lines are the system relative frequency response accuracy specifications from Table 1. Traces are actual measured data taken from 12 instruments.

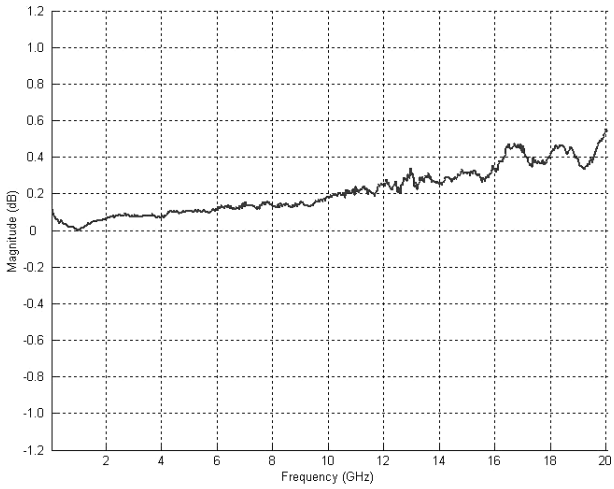


Figure 2. O/E Port 1 Characteristic Peak-to-Peak Repeatability.

The above graph shows the worst case deviation across a 20 GHz span between any 2 units in a sample set of 12, as shown in Figure 1.

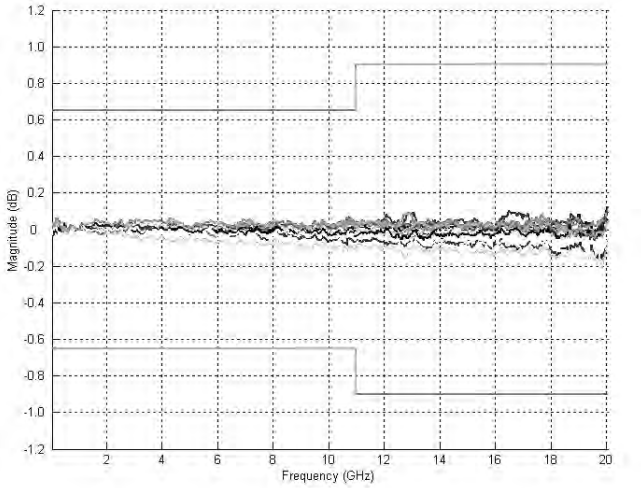


Figure 3. O/E Port 2 Characteristic Relative Frequency Response Error.

Limit lines are the system relative frequency response accuracy specifications from Table 1. Traces are actual measured data taken from 12 instruments.

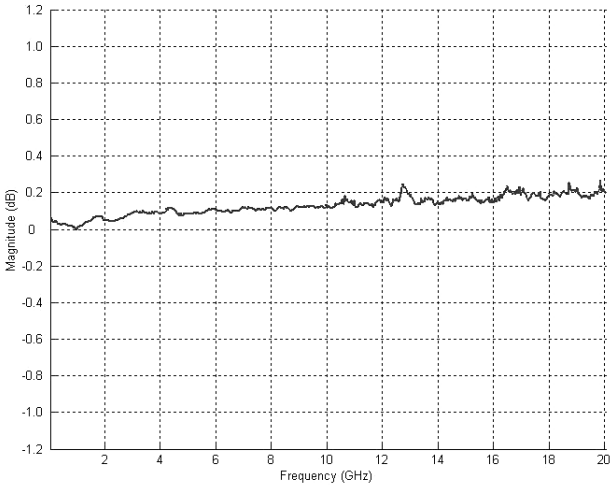


Figure 4. O/E Port 2 Characteristic Peak-to-Peak Repeatability.

The above graph shows the worst case deviation across a 20 GHz span between any 2 units in a sample set of 12, as shown in Figure 1-3.

O/E Frequency Response Error for Different Reflection Coefficients

A significant error term in this measurement is the electrical port match of the device under test (DUT). The following table lists the measurement uncertainty as a function of DUT electrical reflection coefficient. On PORT 1 measurements, you can perform response and match calibration to achieve values comparable to measurements of devices with $\rho = \leq 0.25$ as shown in Table 1.

Optical-to-Electrical Relative Frequency Response Versus ρ

Frequency Range	ρ < 0.5 Specification	ρ < 1.0 Specification
0.05 to 11 GHz	± 1.25	± 2.35
11 to 20.05 GHz	± 1.70	± 3.5

System Dynamic Range Characteristics and Responsivity Measurement Range

The following table shows the maximum and minimum values of the O/E device under test (DUT) frequency response.

Optical-to-Electrical Measurement Performance Data

Description	Frequency Range	Characteristic
System Dynamic Range	0.05 to 0.84 GHz	77 dB
	0.84 to 20.05 GHz	100 dB
Responsivity Measurement Range[1]	0.05 to 0.84 GHz	Maximum Value +43 dB A/W
		Minimum Value -34 dB A/W
	0.84 to 20.05 GHz	Maximum Value +43 dB A/W
		Minimum Value -57 dB A/W

[1] Pertains to a 10 Hz IF bandwidth.

Electrical-to-Optical Device Measurement Specifications

Relative frequency response can be used to calculate the error in measuring the 3 dB bandwidth of an E/O device.

Relative Frequency Response Performance Data

Table 2

Electrical-to-Optical Measurement Performance Data		
Description	**Frequency Range**	**Specification[1]**
System Relative Frequency Response Accuracy	0.05 to 0.5 GHz	±1.15 dB
	0.5 to 11 GHz	±0.85 dB
	11 to 20.05	±0.90 dB

[1] Applies to a device with ρ = ≤ 0.25 and measurement settings of IF bandwidth = 30 Hz and smoothing = 0.5%.

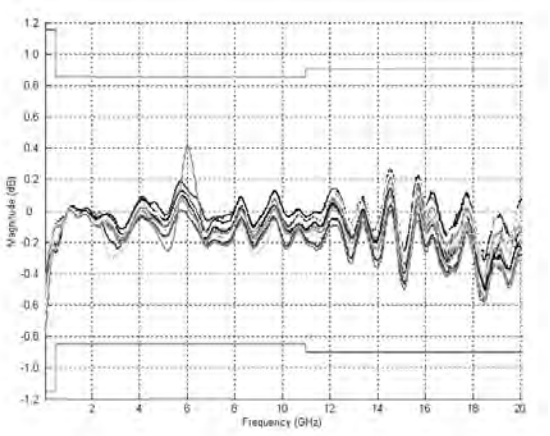


Figure 5. E/O Characteristic Relative Frequency Response Error
Limit lines are the system relative frequency response accuracy specifications from Table 2. Traces are actual measured data taken from 12 instruments.

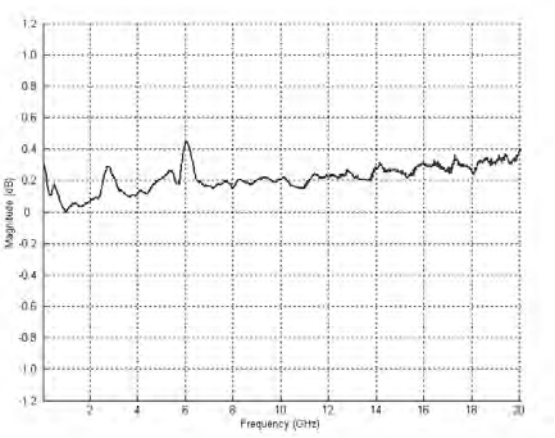


Figure 6. E/O Characteristic Peak-to-Peak Repeatability
The above graph shows the worst case deviation across a 20 GHz span between any 2 units in a sample set of 12, as shown in Figure 5.

E/O Frequency Response Error for Different Reflection Coefficients

A significant error term in this measurement is the electrical port match of the device under test (DUT). The following table lists the measurement uncertainty as a function of DUT electrical reflection coefficient. If you perform a response and match calibration, you can achieve values comparable to measurements of devices with $\rho = \leq 0.25$ as shown in Table 2.

Electrical-to-Optical Relative Frequency Response Versus ρ

Frequency Range	ρ < 0.5 Specification	ρ < 1.0 Specification
0.05 to 0.5 GHz	± 1.75	± 3.10
0.5 to 11 GHz	± 2.05	± 3.35
11 to 20.05 GHz	± 2.40	± 3.40

Electrical-to-Optical Measurement Dynamic Range Characteristics

Electrical-to-Optical Measurement Dynamic Range[1]

Description	Frequency Range	Characteristic
System Dynamic Range	0.05 to 20.05 GHz	80 dB

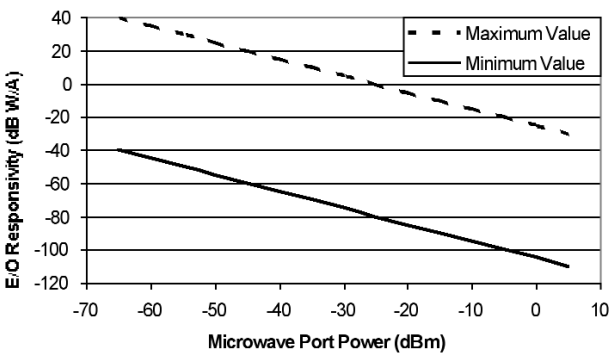
Electrical-to-Optical Measurement Responsivity Measurement Range

The following table shows the maximum and minimum values of the E/O device under test (DUT) frequency response, measured with microwave power applied from microwave port 1. The dynamic range stays constant irrespective of the microwave port power. That is, the maximum and the minimum dB W/A that can be measured increase with reduced microwave port power.

Electrical-to-Optical Measurement Responsivity Measurement Range[1]

Power at Port 1 (dBm)	Maximum Value (dB W/A) Characteristic	Minimum Value (dB W/A) Characteristic	Dynamic Range (dB) Characteristic
5	-30	-110	80
-65	40	-40	80

[1] Pertains to a 10 Hz IF bandwidth.



8703B General Information

Group delay measurements

Group delay is computed by measuring the phase change within a specified frequency aperture (determined by the frequency span and the number of points per sweep). The phase change, in degrees, is then divided by the frequency aperture, in Hz (times –360).

Aperture

Determined by the frequency span, the number of steps per sweep, and the amount of smoothing applied. (Minimum aperture limited by source frequency resolution of 1 Hz.)

Minimum aperture = (frequency span) / (number of points–1)

Maximum aperture = 20 % of the frequency span

Range

The maximum delay is limited to measuring no more than ±180 degrees of phase change within the minimum aperture. For example, with a minimum aperture of 1 Hz, the maximum delay that can be measured is 500 milliseconds.

Accuracy

Accuracy is a function of the uncertainty in determining the phase change. The following is a general formula for calculating typical accuracy, in seconds, for a specific group delay measurement.

$$\frac{\pm 0.003 \times \text{Phase Uncertainty (deg)}}{\text{Aperture (Hz)}}$$

Data accuracy enhancement

Lightwave measurement calibration types

Response: Simultaneously accounts for magnitude and phase errors due to a system's modulation frequency response. This applies for either transmission or reflection tests.

Response and match: Accounts for magnitude and phase responses as well as microwave source and receiver mismatch errors. The isolation part of this calibration can be included to compensate for directivity (reflection) and crosstalk (transmission).

Response and isolation: Compensates for modulation frequency responses plus directivity (reflection) or crosstalk (transmission).

System Bandwidths

IF bandwidth settings

- 6000 Hz
- 3700 Hz
- 3000 Hz
- 1000 Hz
- 300 Hz
- 100 Hz
- 30 Hz
- 10 Hz

8703B General Information

(continued)

Description	Specification	Characteristic
Rear Panel		
Electrical test port bias input		
Maximum voltage	±40 Vdc	
Maximum current	±500 mA	
VGA Video Output		15-pin mini D-Sub; female. Drives VGA compatible monitors.
GPIB		Type-57, 24-pin; Microribbon female
Parallel Port		25-pin D-Sub (DB-25); female; may be used as printer port or general purpose I.O. port
RS232		9-pin D-Sub (DB-9); male
Mini-DIN Keyboard/Barcode Reader		6-pin mini DIN (PS/2); female
Line Power		A third-wire ground is required.
Frequency for Microwave Test Set	47 Hz to 63 Hz	
Frequency for Lightwave Test Set	50 Hz to 60 Hz	
Voltage at 115 V setting	90 V to 132 V	115 V
Voltage at 230 V setting	198 V to 265 V	230 V
VA Maximum for Microwave Test Set	450 VA max	
VA Maximum for Lightwave Test Set	70W max	
Front Panel		
RF Connector		3.5-mm precision (male)
Operating Environment		
Temperature	+20°C to +30°C	Instrument powers up, phase locks, and displays no error messages within this temperature range.
Humidity	5% to 95% at +30°C (non-condensing)	
Altitude	0 to 4.5 km (15,000 ft)	
Storage Conditions		
Temperature	-40°C to +55°C	
Humidity	5% to 95% RH at +40°C (non-condensing)	
Altitude	0 to 15.24 km (50,000 ft)	
Cabinet Dimensions		
Height x Width x Depth		(323 x 430x 476 mm) (12.71 x 16.93 x 18.74 inches) Cabinet dimensions exclude front and rear protrusions.
Weight		
Shipping		151 lb
Net		76 lb
Internal Memory - Data Retention Time with 3 V, 1.2 Ah Battery[1]		
70°C		250 days (0.68 year)
40°C		1244 days (3.4 years)
25°C		10 years

[1] Analyzer power is switched off.

Performance Definitions

Specifications: Warranted performance. Specifications include guardbands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

Characteristics: Useful, non warranted, information about the functions and performance of the system.

Calibration Cycle

Agilent Technologies warrants instrument specifications over the recommended calibration interval. To maintain specifications, periodic recalibrations are necessary. We recommend that the analyzer be calibrated at an Agilent Technologies service facility every 12 months.

User Calibration Cycle

A user calibration, also known as a measurement calibration, should be performed at least once every 8 hours. If the ambient temperature drifts, then you should perform a calibration more frequently.

Agilent Technologies'
Test and Measurement Support, Services, and Assistance

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise

Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage

Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

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