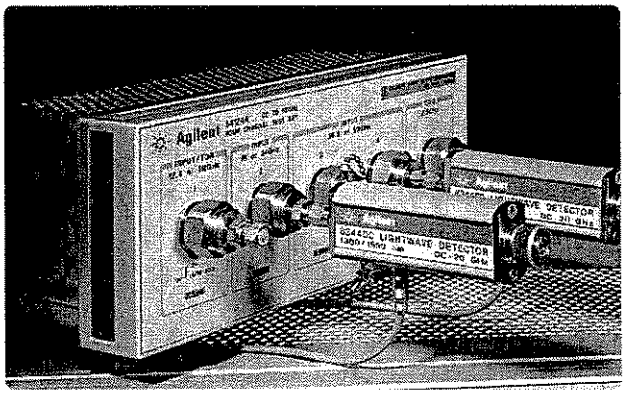
Agilent 83440B/C/D High-Speed Lightwave Converters

DC-6/20/30 GHz, 1000 to 1600 nm

Technical Specifications



Fast optical detector for characterizing lightwave signals

- Fast 15, 22, or 73 ps full-width half-max (FWHM) pulse response
- Broad 6, 20, or 30 GHz bandwidth (3 dB_{opt})
- Small, convenient package
- Low pulse aberrations
- Integral bias regulation
- Ideal for high-speed digitizing oscilloscopes

Make lightwave measurements with traditional electrical instruments; the Agilent 83440 family offers a high-speed optical interface for oscilloscopes, spectrum analyzers, and network analyzers.

With as low as 15 ps FWHM pulse response, the 83440 accurately converts modulated optical waveforms to electrical signals, enabling electrical instruments to measure time domain pulse parameters and frequency domain spectral content. Characterize and optimize laser and optical modulator output performance for fiber optic telecommunications.

Description

The 83440 lightwave converters are fast, accurate, DC-coupled optical-to-electrical (O/E) converters packaged as small optical probes. They mount directly to electrical instrument front panels to simplify integration and minimize distortion and loss from cables, connectors, and signal conditioning components. A simple internal structure ensures very low signal distortion for improved output signal fidelity. By eliminating all unnecessary components along the signal path, the 83440 family offers very accurate electrical representations of modulated optical waveforms. The 83440 family features hermetically sealed, unamplified, InGaAs photodiodes. The input optical port features the Agilent universal optical interface, compatible with most common optical connectors (see Connectors, page 6), while the output electrical port features a precision 3.5 mm (83440B/C) or 2.4 mm (83440D) microwave coaxial connector.

Time Domain Applications

Ideal for high-speed laser and modulator testing, the DC-coupled 83440 family faithfully reproduces incoming optical signals for accurate pulse parameter characterization. Broad bandwidth, nearly Gaussian response characteristics, and low pulse aberrations make these optical detectors an excellent choice for high-speed time domain measurements.

Frequency Domain Applications

The frequency domain allows users to measure, quantify, and model modulated characteristics such as spectral purity, harmonic content, and noise spectral density. The 83440 family allows electrical frequency domain instruments like network and spectrum analyzers to accept optical input signals for basic lightwave measurements.

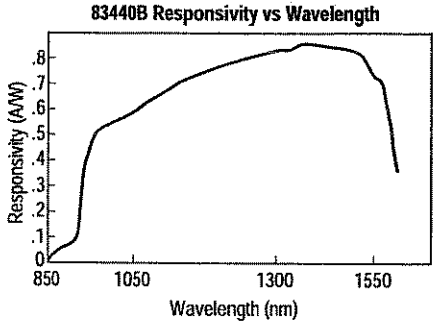
Agilent Technologies

Agilent 83440B
Specifications and Characteristics

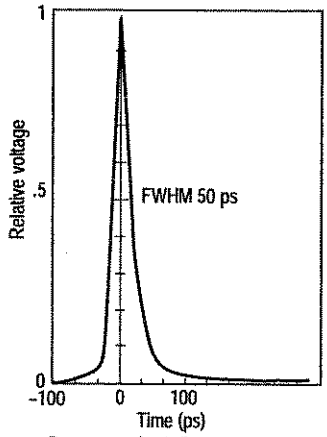
Specifications describe the instrument's warranted performance over the temperature range 0 to 55°C (except where noted). **Supplemental Characteristics** are intended to provide information useful in applying the instrument by giving typical but non-warranted performance parameters. These are denoted as "typical," "nominal," or "approximate."

Typical Response Curves

83440B Responsivity vs Wavelength

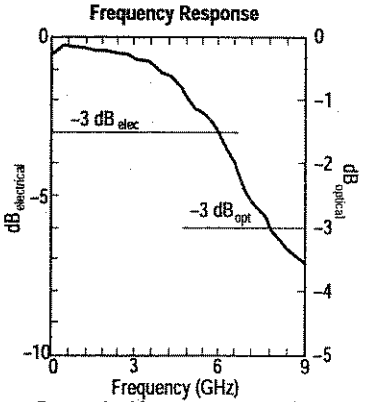


83440B Uncorrected Pulse System Response[13]



Response of a Agilent 83440B lightwave detector on an Agilent 54124 oscilloscope due to a 2 ps pulsed YAG laser.

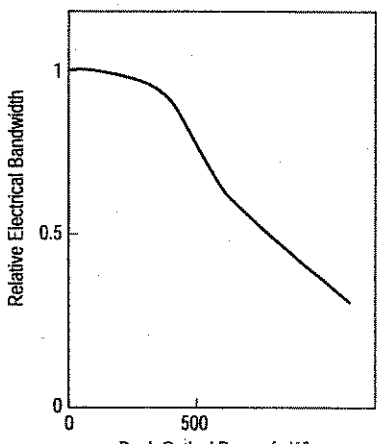
83440B Frequency Response



Deconvolved frequency response from 2 ps pulsed YAG laser measured by Agilent 83440B and Agilent 54124 oscilloscope.

Time Domain	Frequency Domain
Conversion Gain[1,4] (min, into 50 Ω load) 1300 nm: 35 V/W 1550 nm: 32.5 V/W Opt 050: 16.5 V/W 15 V/W	**DC Responsivity**[1,4] (min) 1300 nm 1550 nm 0.70 A/W 0.65 A/W –3.1 dB[2] –3.7 dB[2] 0.33 A/W 0.30 A/W –9.6 dB[2] –10.5 dB[2]
Pulse Width[3, 4,10] < 73 ps FWHM[6] (calculated:FWHM=0.44/BW_{opt}=0.312/BW_{el})	**Bandwidth**[3,4] dc to >6 GHz (-3dB optical)
Rise/Fall Time[7,10] (10-90%) <80ps (calculated)	
System Aberrations[4,13] (response to 2 ps FWHM pulse) 10% peak-to-peak max, 5% typical	
Noise[5,11] 2 µW RMS max, equivalent optical noise power	**Noise Equivalent Power**[5,11] < 18 pW/ $\sqrt{Hz}$ typical
Dark Current[11] 50 nA max, <15 nA typical	
Maximum Safe Input Optical Power 10 mW (Peak) +10 dBm (Peak)	
Maximum Operating Input Optical Power (Compression Point) 2 mW (Peak) +3 dBm (Peak) See saturation chart for pulsed power characteristics	
Input Optical Reflection[8] (HMS-10 optical connector) 0.05% (1250-1600 nm)	**Input Optical Return Loss**[8] (HMS-10 optical connector) >33 dB (1250-1600 nm)
Wavelength Spectral Response[4] 1000 nm - 1600 nm	

Typical 83440B Saturation Characteristics



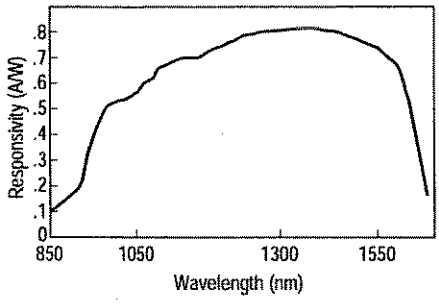
See Notes, page 7

Agilent 83440C
Specifications and Characteristics

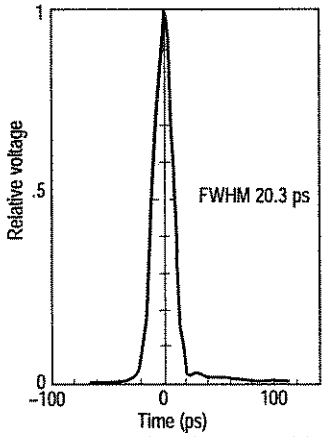
Specifications describe the instrument's warranted performance over the temperature range 0 to 55°C (except where noted). **Supplemental Characteristics** are intended to provide information useful in applying the instrument by giving typical but non-warranted performance parameters. These are denoted as "typical," "nominal," or "approximate."

Typical Response Curves

83440C Responsivity vs Wavelength

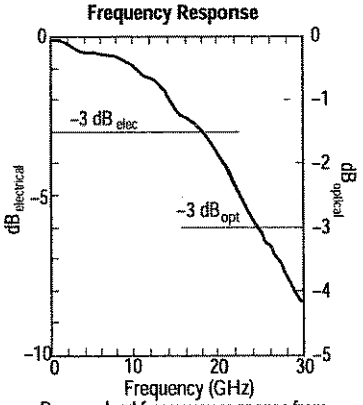


83440C Uncorrected Pulse System Response [13]



Response of a Agilent 83440C lightwave detector on an Agilent 54124 oscilloscope due to a 2 ps pulsed YAG laser.

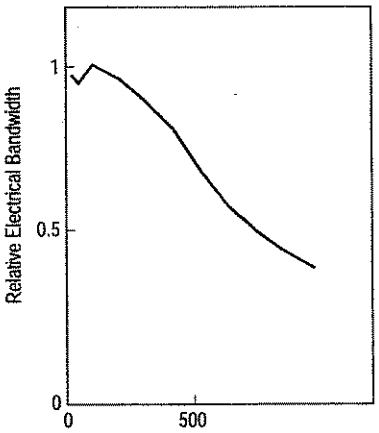
83440C Frequency Response



Deconvolved frequency response from 2 ps pulsed YAG laser measured by Agilent 83440C and Agilent 54124 oscilloscope.

Time Domain	Frequency Domain
Conversion Gain[1,4] (min, into 50 Ω load) 1300 nm: 35 V/W 1550 nm: 32.5 V/W	**DC Responsivity**[1,4] (min) 1300 nm 1550 nm 0.70 A/W 0.65 A/W –3.1 dB[2] –3.7 dB[2]
Pulse Width[3,4,10] < 22 ps FWHM[6] (calculated:FWHM=0.44/BW_{opt}=0.312/BW_{el})	**Bandwidth**[3,4] dc to >20 GHz (-3dB optical)
Rise/Fall Time[7,10] (10-90%) <24ps (calculated)	
System Aberrations[4,13] (response to 2 ps FWHM pulse) 10% peak-to-peak max, 5% typical	
Noise[5,11] 3.7 µW RMS max, equivalent optical noise power	**Noise Equivalent Power**[5,11] < 18 pW/ √Hz typical
Dark Current[11] 20 nA max, 3 nA typical	
Maximum Safe Input Optical Power 10 mW (Peak) +10 dBm (Peak)	
Maximum Operating Input Optical Power (Compression Point) 2 mW (Peak) +3 dBm (Peak) See saturation chart for pulsed power characteristics	
Input Optical Reflection[8] (HMS-10 optical connector) 0.05% (1250-1600 nm)	**Input Optical Return Loss**[8] (HMS-10 optical connector) >33 dB (1250-1600 nm)
Wavelength Spectral Response[4] 1000 nm - 1600 nm	

Typical 83440C Saturation Characteristics



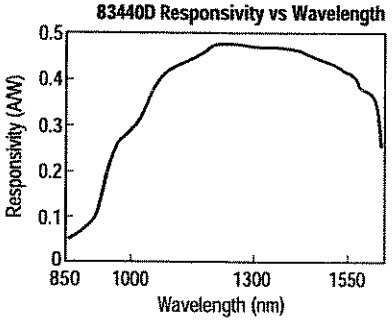
See Notes, page 7

Agilent 83440D
Specifications and Characteristics

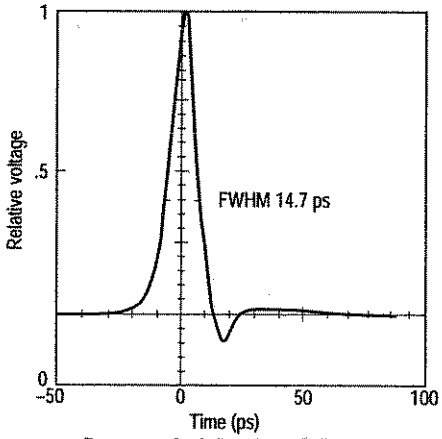
Specifications describe the instrument's warranted performance over the temperature range 0 to 55°C (except where noted). **Supplemental Characteristics** are intended to provide information useful in applying the instrument by giving typical but non-warranted performance parameters. These are denoted as "typical," "nominal," or "approximate."

Typical Response Curves

83440D Responsivity vs Wavelength

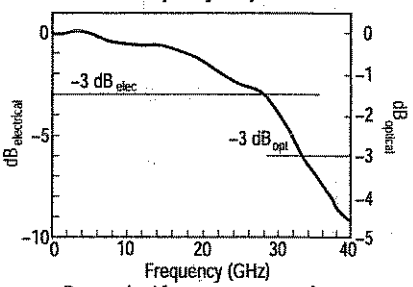


83440D
Uncorrected System Pulse Response[13]



Response of a Agilent 83440D lightwave detector on an Agilent 54124 oscilloscope due to a 2 ps pulsed YAG laser.

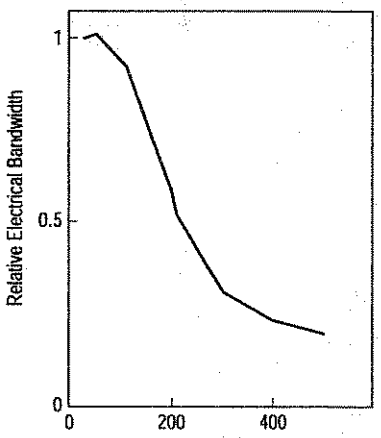
83440D Frequency Response



Deconvolved frequency response from 2 ps pulsed YAG laser measured by Agilent 83440D and Agilent 54124 oscilloscope.

Time Domain	Frequency Domain
Conversion Gain[1,4] (min into 50 Ω load) 1300 nm: 20 V/W 1550 nm: 15 V/W	**DC Responsivity**[1,4] (min) 1300 nm 1550 nm 0.3 A/W 0.3 A/W –8 dB[2] –10.5 dB[2]
Pulse Width[4,10,14] (calculated:FWHM=0.44/BW_{opt}≈0.312/BW_{el}) < 13 ps FWHM[6]	**Bandwidth**[4,12,14] dc to 30 GHz nominal (-3dB optical)
Rise/Fall Time[7,10] (10-90%) <16 ps (calculated)	
System Aberrations[4,13] (response to 2 ps FWHM pulse) 20% peak-to-peak max, <12% typical	
Noise[5,11] 8.1 µW RMS max, equivalent optical noise power	**Noise Equivalent Power**[5,11] < 18 pW/ √Hz typical
Dark Current[11] 20 nA max, 4 nA typical	
Maximum Safe Input Optical Power 10 mW (Peak) +10 dBm (Peak)	
Maximum Operating Input Optical Power (Compression Point) 2 mW (Peak) +3 dBm (Peak) See saturation chart for pulsed power characteristics	
Input Optical Reflection[8] (HMS-10 optical connector) 0.10 % (1250-1600 nm)	**Input Optical Return Loss**[8] (HMS-10 optical connector) >30 dB (1250-1600 nm)
Wavelength Spectral Response[4] 1000 nm - 1600 nm	

Typical 83440D
Saturation Characteristics



5 ps pulse width (1060 nm)

See Notes, page 7

Using the Agilent 83440B/C/D Lightwave Converter

O/E Conversion Process

The 83440 detects the modulated baseband signal from the lightwave carrier, converting it to an electrical signal for processing. The resultant electrical signal can be analyzed in the time domain or frequency domain using electrical oscilloscopes, signal analyzers, and network analyzers. The 83440B/C/D are DC coupled receivers. For proper operation, a DC path to ground is necessary at the RF output. When using the 83440 with an AC-coupled instrument (except opt 050), a bias tee such as the 11612A is required to supply dc bias return path. Alternatively, an attenuator on the output may be used to provide a dc bias return path.

Supplying +15V to the 83440

Depending on the instruments that the Agilent 83440 will be used with, there are several possible configurations to supply the needed +15V bias voltage to the 83440:

86100B: Use the 83440-60004 cable to connect to the +15V supply at the rear of the 86100B

Agilent Network Analyzers with Probe Power: Use the 83440-60006 cable to connect to the Probe Power Port of the network analyzer.

87421A Power Supply: Use the 83440-60009 cable in series with the 83440-60004 to connect to the power supply

11899A Probe Power Supply: Use the 83440-60006 cable to connect to the stand-alone probe power supply.

General Purpose Variable Power Supply: Use the 83440-60005 cable in series with the 83440-60004 cable.

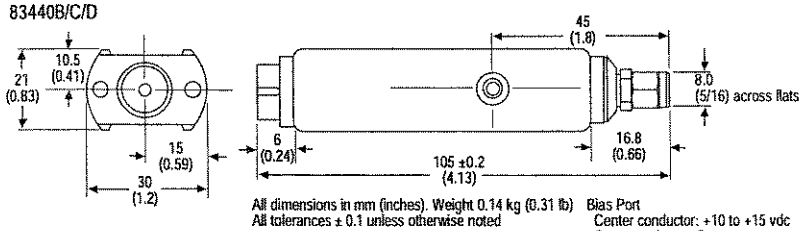
Physical Characteristics

General

RF Connector	Agilent 83440B/C (3.5 mm [m]) or 83440D (2.4 mm [m]), 50Ω
ESD Susceptibility at RF Pin[9]	200 V
DC Bias Voltage	+10 to +15V dc required
Power Consumption	< 18 mVA
Weight	0.14 kg (0.31 lb)
Operating Temperature	0-55 deg C
Compatible Fiber	9/125 single mode fiber
Photodiode Package	Hermetically sealed PIN-diode
Output Impedance	Unterminated (50Ω terminated for Agilent 83440B Opt 050)
Calibration	Recommended calibration interval is two years.

Mechanical

83440B/C/D



All dimensions in mm (inches). Weight 0.14 kg (0.31 lb)
All tolerances ± 0.1 unless otherwise noted

Bias Port
Center conductor: +10 to +15 vdc
Outer conductor: Common

Connectors

Optical Input:
Specify optical input connector option when ordering Agilent 83440B/C/D.

81000 AI	Diamond HMS-10
81000FI	FC/PC connector
81000 SI	DIN 47256 connector
81000 VI	ST connector
81000 KI	SC connector

Electrical Output:
3.5 mm (83440B/C)
2.4 mm (83440D)

DC Bias Input: Quick connect (LEMO) bias port

ESD Sensitive Parts[9]
The 83440 features a captive RF connector cap to protect the RF center pin from electrostatic discharge (ESD). Use proper ESD precautions when working with RF and bias ports. *Keep RF port capped when not in use.*

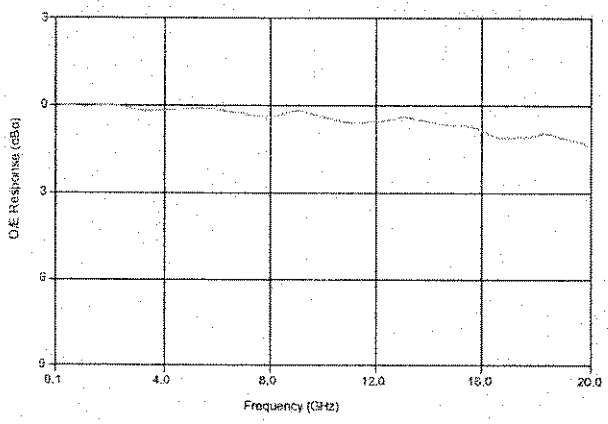
See Notes, page 7

Shipping Contents

- One 83440 Lightwave Detector with response data sheet (example shown below)
- User specified optical connector adapter
- Three dc bias cables (83440-60004, 83440-60005, 83440-60006)

Each 83440 is shipped with instrument-specific frequency response and conversion gain (dc responsivity) data.

83440C
S/N: XXXXAXXXXX
Frequency Response Relative to DC



DC Responsivity (V/W)

1310 nm	47.41
1550 nm	41.97

O/E Response (dBo)

Freq (GHz)	Ampl (dBo)	Freq (GHz)	Ampl (dBo)	Freq (GHz)	Ampl (dBo)	Freq (GHz)	Ampl (dBo)
0.0500	0.000	4.4000	-0.164	9.8000	-0.304	15.0000	-0.692
0.0600	0.008	4.6000	-0.151	10.0000	-0.342	15.2000	-0.704
0.0700	0.003	4.8000	-0.134	10.2000	-0.360	15.4000	-0.712
0.0800	-0.007	5.0000	-0.148	10.4000	-0.410	15.6000	-0.755
0.0900	-0.001	5.2000	-0.145	10.6000	-0.429	15.8000	-0.785
0.1000	-0.005	5.4000	-0.147	10.8000	-0.482	16.0000	-0.864
0.2000	-0.033	5.6000	-0.143	11.0000	-0.546	16.2000	-0.944
0.4000	-0.029	5.8000	-0.121	11.2000	-0.574	16.4000	-1.028
0.6000	-0.047	6.0000	-0.119	11.4000	-0.582	16.6000	-1.092
0.8000	-0.045	6.2000	-0.138	11.6000	-0.569	16.8000	-1.105
1.0000	-0.040	6.4000	-0.165	11.8000	-0.573	17.0000	-1.102
1.2000	-0.073	6.6000	-0.202	12.0000	-0.549	17.2000	-1.103
1.4000	-0.038	6.8000	-0.242	12.2000	-0.542	17.4000	-1.106
1.6000	-0.045	7.0000	-0.269	12.4000	-0.503	17.6000	-1.101
1.8000	-0.041	7.2000	-0.312	12.6000	-0.490	17.8000	-1.100
2.0000	-0.018	7.4000	-0.337	12.8000	-0.464	18.0000	-1.091
2.2000	-0.020	7.6000	-0.360	13.0000	-0.431	18.2000	-1.055
2.4000	-0.035	7.8000	-0.381	13.2000	-0.427	18.4000	-1.029
2.6000	-0.076	8.0000	-0.399	13.4000	-0.455	18.6000	-1.029
2.8000	-0.106	8.2000	-0.389	13.6000	-0.489	18.8000	-1.063
3.0000	-0.136	8.4000	-0.366	13.8000	-0.546	19.0000	-1.121
3.2000	-0.182	8.6000	-0.314	14.0000	-0.583	19.2000	-1.184
3.4000	-0.203	8.8000	-0.245	14.2000	-0.615	19.4000	-1.216
3.6000	-0.215	9.0000	-0.193	14.4000	-0.613	19.6000	-1.238
3.8000	-0.221	9.2000	-0.184	14.6000	-0.623	19.8000	-1.306
4.0000	-0.214	9.4000	-0.207	14.8000	-0.645	20.0000	-1.399

Ordering Information

Agilent 83440B DC-6 GHz Lightwave Converter
83440B-050, 50Ω termination for use with SDH/SONET filters
Agilent 83440C DC-20 GHz Lightwave Converter
Agilent 83440D DC-30 GHz Lightwave Converter
Note: All 83440 orders must specify an optical connector option.

Recommended Accessories

87421A	External 15V fixed power supply
11899A	External probe power supply
8493C-003, 006	3.5 mm fixed attenuators (3 dB and 6 dB respectively)
11901D	2,4 mm (f) to 3.5 mm (m) coax adapter
1250-1391	SMB-tee
11612A	3.5 mm bias network (45 MHz–26.5 GHz)
5952-9654	Fiber Optics Handbook

DC Bias Cables

83440-60004	SMB (f) to quick connect (LEMO)
83440-60005	SMB (m) to bare wire (ground = black, +15V = clear)
83440-60006	3-pin half-round (f) to quick connect (LEMO)
83440-60009	9-pin D-sub (m) to SMB (m)

Other Agilent O/E Converters

Agilent 11982A DC–15 GHz *amplified* converter. 300 V/W conversion gain.
Product Overview lit. no. 5966-1583E.

Agilent 83410C 300 kHz–3 GHz *amplified* receiver (62.5/125 µm fiber).
Technical Specifications lit. no. 5988-4308EN.

Agilent 83411A 300 kHz–6 GHz receiver (62.5/125 µm fiber).
Technical Specifications lit. no. 5988-4308EN.

Agilent 83411B 300 kHz–6 GHz *amplified* receiver (62.5/125 µm fiber).
Technical Specifications lit. no. 5988-4308EN.

Agilent 83412A 300 kHz–3 GHz *amplified* receiver *(850 nm)* (62.5/125 µm fiber).
Technical Specifications lit. no. 5988-4308EN.

Agilent 83434A 10 Gb/s lightwave clock and data receiver.
Product Overview lit. no. 5968-9251E.

Agilent 83446A/B 2.4 Gb/s lightwave clock and data receiver.
Product Overview lit. no. 5962-1682E.

Notes

[1] Stated specs from 83440B/C /D into 50Ω load.

[2] For an O/E device, responsivity (dB) = $20\log\left[\frac{\text{responsivity A/W}}{1\ \text{A/W}}\right]$

[3] Measured on 8703A lightwave component analyzer. Frequency response verified by deconvolving impulse response of 83440C on 54124 oscilloscope due to a 2 ps pulse YAG laser.

[4] See typical performance trace.

[5] Thermal noise limited; equivalent optical power limited by 50 Ω input impedance.

[6] Full-Width Half-Max.

[7] Calculated from bandwidth measurements; $t_r = \frac{.48}{BW_{opt}}$,($\approx \frac{.34}{BW_{elec}}$) Calculation assumes Gaussian pulse.

[8] Optical connector limited.

[9] ESD susceptibility limited to RF connector center pin. Overall package (other than bias port and RF connector) withstands >25,000 V ESD.

[10] Impulse response calculations verified using 2 ps pulsed YAG laser.

[11] At room temperature (23°C ± 3°C)

[12] All 83440D units are tested for 30 GHz minimum bandwidth. Measured frequency response data is supplied with each unit.

[13] Uncorrected *System* aberrations include oscilloscope response and source laser aberrations from 2 ps pulsed YAG laser system. Slower pulse width will generate lower aberration levels; high 83440D detector bandwidth can excite 50 GHz oscilloscope response.

[14] 83440D test system consists of 2-3 ps compressed Nd:YAG laser and 54124 50 GHz digitizing oscilloscope. 83440D frequency response is derived from Fourier transform after correcting for oscilloscope and input pulse frequency response. System verified with YAG heterodyne.

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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