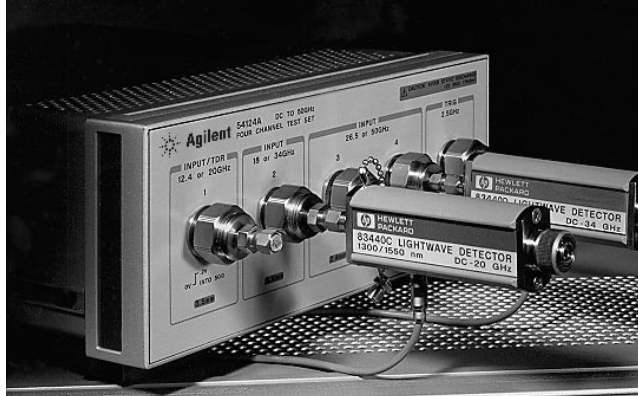


Agilent 83440B/C/D High-Speed Lightwave Converters

DC-6/20/32 GHz, 1000 to 1600 nm
Product Overview



- 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.

Fast optical detector for characterizing lightwave signals

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. Use them with a high-speed digitizing oscilloscope like the 83480 family to accurately measure rise and fall time, overshoot, undershoot, ringing, pulse amplitude (peak power), pulse width, amplitude noise, jitter, and extinction ratio on incoming optical waveforms. Combine the 50-ohm termination version of the 83440B, option 050, with the 87441 family of fourth-order Bessel-Thomson filters for SDH/SONET transmitter eye diagram 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.



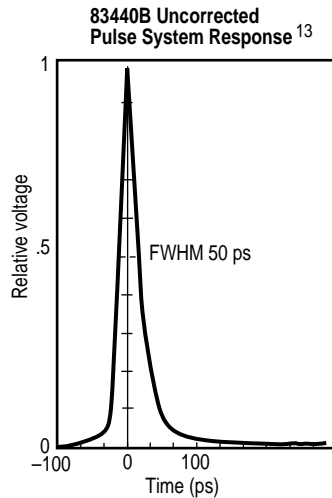
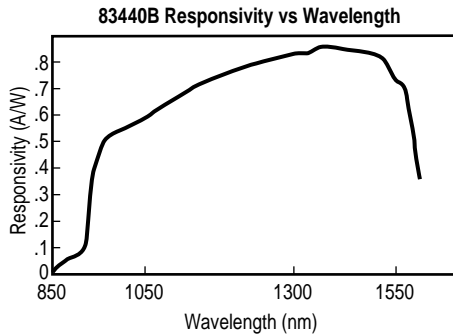
Agilent Technologies

Innovating the HP Way

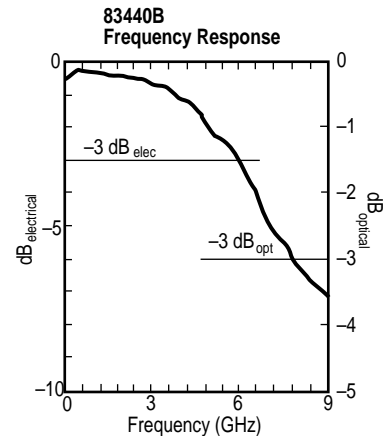
Agilent 83440B Specifications and Characteristics

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



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



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

Time 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

Deflection Factor¹ (min, Agilent 54120 family oscilloscope)

1300 nm: 29 μW/div 1550 nm: 31 μW/div
Opt 050: 61 μW/div 65 μW/div

Pulse Width^{3, 4, 10}

< 73 ps FWHM⁶ (calculated: $FWHM=0.44/BW_{opt} \approx 0.312/BW_{el}$)

Rise/Fall Time^{7, 10} (10-90%)

< 80 ps (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

Frequency Domain

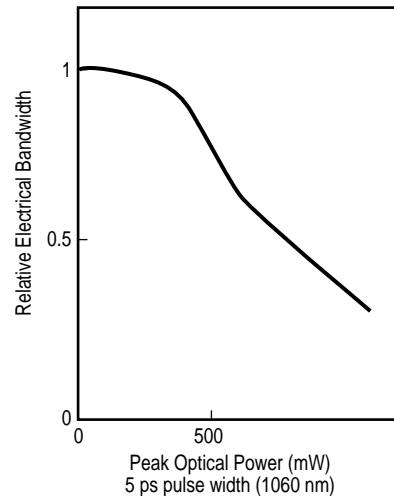
DC Responsivity^{1, 4} (min)

| | |
|----------------------|-----------------------|
| 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 |

Bandwidth^{3, 4}

dc to >6 GHz (-3dB optical)

Typical 83440B Saturation Characteristics



Dark Current¹¹

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 Reflection⁸

(HMS-10 optical connector)
0.05% (1250-1600 nm)

Input Optical Return Loss⁸

(HMS-10 optical connector)
>33 dB (1250-1600 nm)

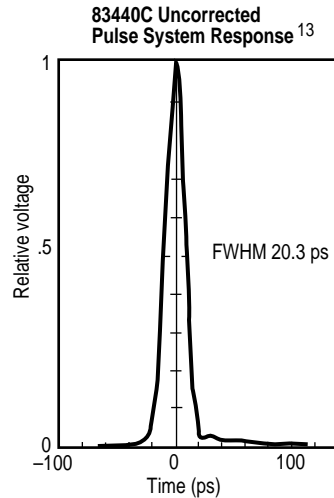
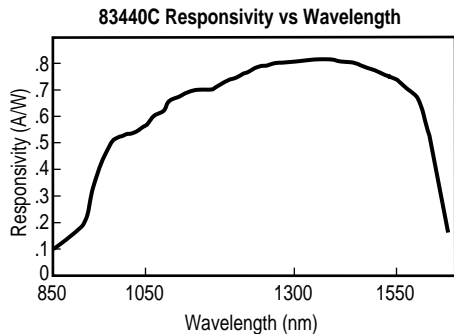
Wavelength Spectral Response⁴

1000 nm - 1600 nm

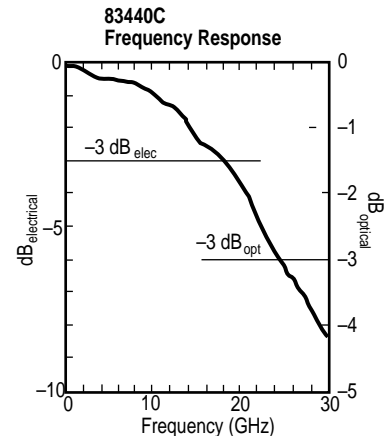
Agilent 83440C Specifications and Characteristics

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

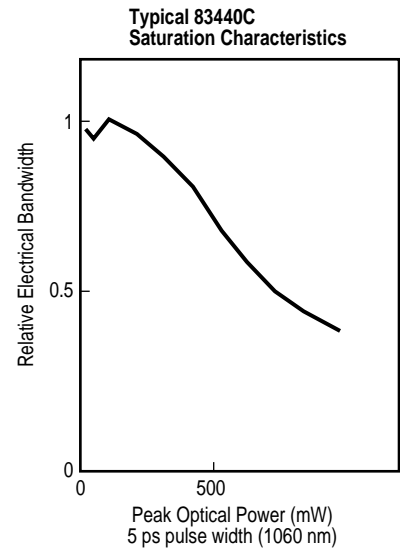


Response of a Agilent 83440C lightwave detector on an Agilent 54124 oscilloscope due to a 2 ps pulsed YAG laser.



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

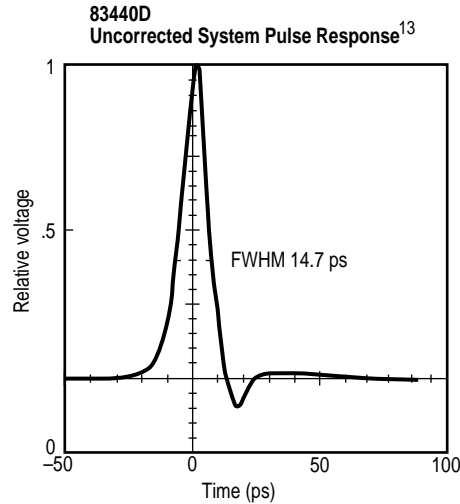
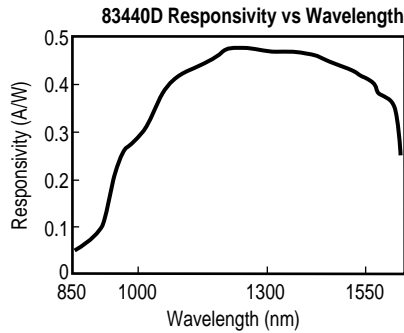
| Time Domain | Frequency Domain |
|---|---|
| Conversion Gain^{1,4} (min, into 50 Ω load) 1300 nm: 35 V/W 1550 nm: 32.5 V/W | DC Responsivity^{1,4} (min) 1300 nm 1550 nm 0.70 A/W 0.65 A/W -3.1 dB ² -3.7 dB ² |
| Deflection Factor¹ (min, Agilent 54120 family oscilloscope) 1300 nm: 29 μW/div 1550 nm: 31 μW/div | |
| 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 Current¹¹ 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 Reflection⁸ (HMS-10 optical connector) 0.05% (1250-1600 nm) | Input Optical Return Loss⁸ (HMS-10 optical connector) >33 dB (1250-1600 nm) |
| Wavelength Spectral Response⁴ 1000 nm - 1600 nm | |



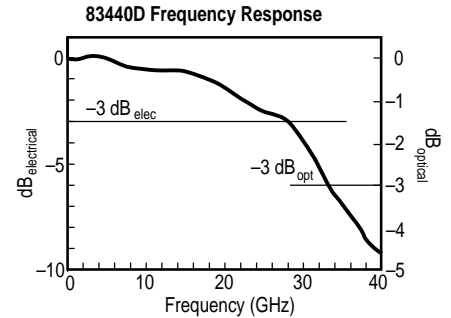
Agilent 83440D Specifications and Characteristics

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

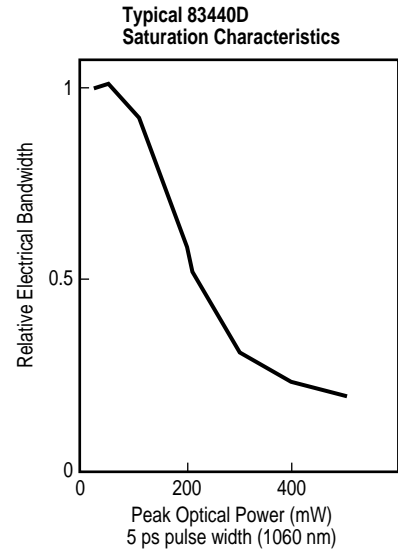


Response of a Agilent 83440D lightwave detector on an Agilent 54124 oscilloscope due to a 2 ps pulsed YAG laser.



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

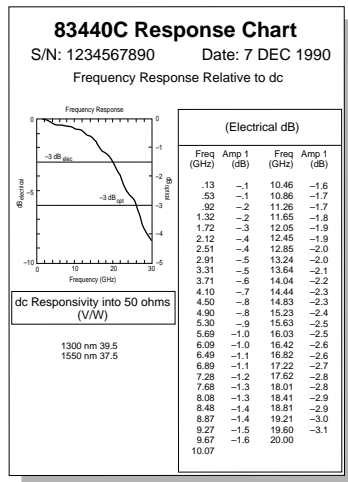
| Time Domain | Frequency Domain |
|---|--|
| Conversion Gain^{1,4} (min into 50 Ω load) 1300 nm: 20 V/W 1550 nm: 15 V/W | DC Responsivity^{1,4} (min) 1300 nm 1550 nm 0.3 A/W 0.3 A/W -8 dB ² -10.5 dB ² |
| Deflection Factor¹ (min, Agilent 54120 family oscilloscope) 1300 nm: 50 μW/div 1550 nm: 67 μW/div | Bandwidth^{4,12,14} dc to 30 GHz nominal (-3dB optical) |
| Pulse Width^{4,10,14} (calculated: FWHM=0.44/BW _{opt} ≈0.312/BW _{el}) < 13 ps FWHM ⁶ | |
| Rise/Fall Time^{7,10} (10-90%) < 15 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 Current¹¹ 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 Reflection⁸ (HMS-10 optical connector) 0.10 % (1250-1600 nm) | Input Optical Return Loss⁸ (HMS-10 optical connector) >30 dB (1250-1600 nm) |
| Wavelength Spectral Response⁴ 1000 nm - 1600 nm | |



Using the Agilent 83440B/C/D Lightwave Converter

General

| | |
|---|--|
| RF Connector | Agilent 83440B/C (3.5 mm [m]) or 83440D (2.4 mm [m]), 50 Ω |
| ESD Susceptibility at RF Pin ⁹ | 200 V |
| DC Bias Voltage | +10 to +15V dc (Available from Agilent 54121/4 test set bias port or Agilent 87421 Power Supply with 83440-60009 bias cable) For use with ac-coupled instruments a bias tee such as Agilent 11612A is required to supply dc bias return path. |
| 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 |
| Output Impedance | Unterminated/50 Ω terminated for Agilent 83440B Opt 050 Agilent 83440B Opt 050, -15 dB return loss, nominal |
| Calibration | Recommended calibration interval is two years. |



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

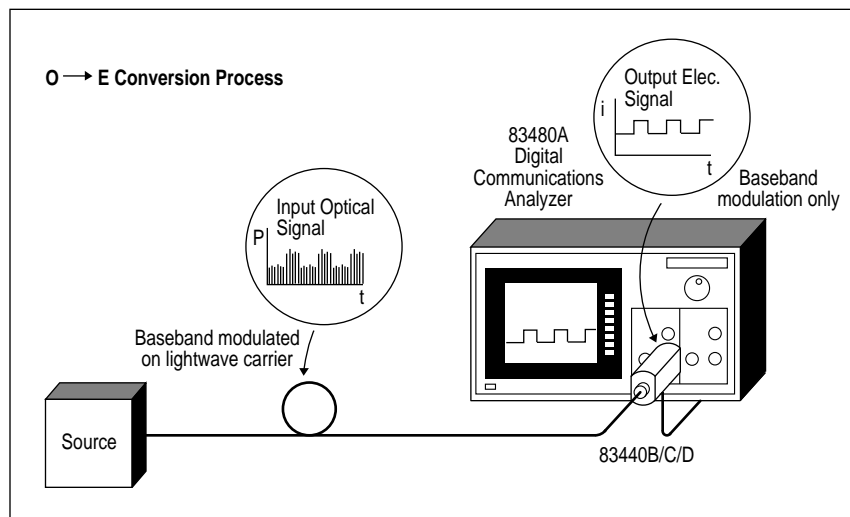
O/E Conversion Process

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, a 3 dB fixed attenuator on the output may be used to provide a dc bias return.

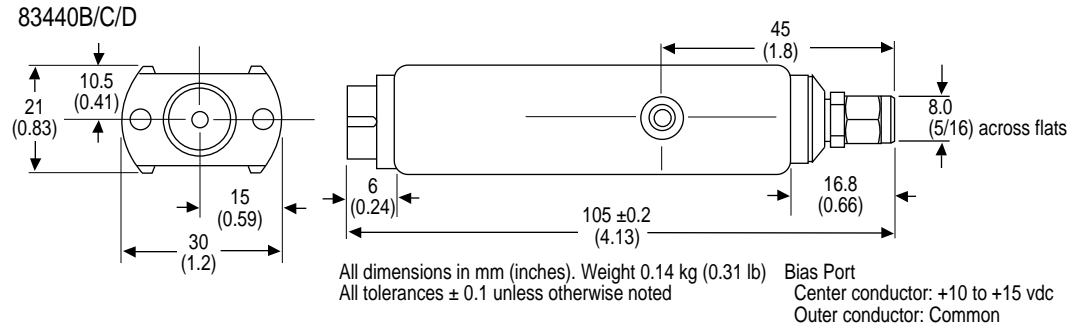
Eye-Pattern Measurements

Eye-pattern transmitter tests are called for in CCITT (International Telegraph and Telephone Consultative Committee) G.957 and in EIA/TIA OFSTP-4 (Electronics Industry Association/Telecommunications Industry Association Fiber Standard Test Procedure) for SDH and SONET. The 83440 family may be used with the 87441 SDH/SONET filters to perform these measurements. The 83440B option 050 is terminated in 50 ohms to prevent reflections between the receiver's output and the filter's input to maintain the fourth-order Bessel-Thomson response.

An input optical signal of at least -4 dBm is recommended to produce an adequate eye pattern on a 83480 digital communications analyzer. Standard 83440 lightwave converters, which are unterminated, require a 6-dB attenuator between the converter output and the filter to provide reasonable match with the 87441. While this helps to achieve good frequency response, overall sensitivity is significantly reduced. The 83440B/C/D may be used with the electrical measurement channels on the 83480A digital communications analyzer. Fully calibrated, integrated, optical channels are also available with the 83480A.



Mechanical



Connectors

Optical Input:

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

| | |
|---------------------|---------|
| Diamond HMS-10 | Opt 011 |
| FC/PC connector | Opt 012 |
| DIN 47256 connector | Opt 013 |
| ST connector | Opt 014 |
| Biconic connector | Opt 015 |

Electrical Output:

3.5 mm (83440B/C)
2.4 mm (83440D)

DC Bias Input: 2 quick connect bias cables: SMB (Agilent 54120 compatible) connector to 83440 and bare leads (clear: +, black: com) to 83440.

ESD Sensitive Parts⁹

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.*

Contents:

- One 83440 Lightwave Detector with response data sheet
- User specified optical connector adapter
- Two dc bias cables

Ordering Information

Agilent 83440B DC-6 GHz Lightwave Converter

Option 050, 50 Ω termination for use with SDH/SONET filters

Agilent 83440C DC-20 GHz Lightwave Converter

Agilent 83440D DC-32 GHz Lightwave Converter

Note: All 83440 orders must specify an optical connector option.

Recommended Accessories

| | |
|----------------------------|--|
| Agilent 87421A | DC Power Supply (For non 54120 applications) |
| Agilent 83440-60009 | Power supply bias cable for 87421A |
| Agilent 11612A | Bias network (for AC-coupled applications) |
| Agilent 5952-9654 | Fiber Optics Handbook |
| Agilent 8493C Opt 003, 006 | 3 and 6 dB fixed attenuators |
| Agilent 83440-60004 | Additional DC bias cable (83440-SMB) |
| Agilent 83440-60005 | Additional DC bias cable (SMB-bare wire) |
| Agilent 11901D | 2.4 mm (f) to 3.5 mm (m) Coax Adapter |
| Agilent 1250-1391 | SMB tee to expand 54120 oscilloscope test set bias output |
| Agilent 87441A/B/D | Fourth-order Bessel-Thomson SDH/SONET filter for STM-16/OC-48 eye-diagram measurements |
| Agilent 87490A | Mask Measurement Software for the 54120 |

Optical Connector Adapters

Use to transform the 83440 to the connector of interest for increased measurement versatility. One supplied with each 83440, depending upon option specified.

| | |
|-----------------|---|
| Agilent 81000AI | HMS-10 connector adapter (same as Opt 011) |
| Agilent 81000FI | FC/PC connector adapter (same as Opt 012) |
| Agilent 81000GI | D4 connector adapter |
| Agilent 81000JI | SMA connector adapter |
| Agilent 81000UI | SC connector adapter |
| Agilent 81000SI | DIN 47256 connector adapter (same as Opt 013) |
| Agilent 81000VI | ST connector adapter (same as Opt 014) |
| Agilent 81000WI | Biconic connector adapter (same as Opt 015) |

Other Agilent O/E Converters

| | |
|-------------------------|--|
| Agilent 11982A | DC-15 GHz <i>amplified</i> converter. 300 V/W conversion gain. Product Overview lit. no. 5966-1583E. |
| Agilent 83410B | 300 kHz-3 GHz <i>amplified</i> receiver (9-62.5/125 μ m fiber). Technical Specifications lit. no. 5965-6404E. |
| Agilent 83411A | 300 kHz-6 GHz receiver (9/125 μ m fiber). Technical Specifications lit. no. 5965-6404E. |
| Agilent 83411B | 300 kHz-6 GHz <i>amplified</i> receiver (9/125 μ m fiber). Technical Specifications lit. no. 5965-6404E. |
| Agilent 83412A | 300 kHz-3 GHz <i>amplified</i> receiver (850 nm) (50/125 μ m fiber). Technical Specifications lit. no. 5965-6404E. |
| Agilent 83446A/B | 2.4 Gb/s, 622 Mb/s lightwave clock and data receiver. Product Overview lit. no. 5962-1682E. |
| Agilent 83481A | 3 GHz, 155 Mb/s, 622 Mb/s optical/electrical module. Product Overview lit. no. 5964-2238E. |
| Agilent 83485A/B | 20 GHz, 30 GHz, 2.4 Gb/s, 10 Gb/s optical/electrical module. Product Overview lit. no. 5964-2238E. |

Notes

- ¹ Stated specs from 83440B/C /D into 50 Ω 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; $tr = \frac{.48}{BW_{opt}}$, ($\approx \frac{.34}{BW_{elec}}$) 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 \pm 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.

For more information about Agilent Technologies test and measurement products, applications, services, and for a current sales office listing, visit our web site,

www.agilent.com/comms/lightwave

You can also contact one of the following centers and ask for a test and measurement sales representative.

United States:

Agilent Technologies
Test and Measurement Call Center
P.O. Box 4026
Englewood, CO 80155-4026
(tel) 1 800 452 4844

Canada:

Agilent Technologies Canada Inc.
5150 Spectrum Way
Mississauga, Ontario
L4W 5G1
(tel) 1 877 894 4414

Europe:

Agilent Technologies
Test & Measurement
European Marketing Organisation
P.O. Box 999
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The Netherlands
(tel) (31 20) 547 2000

Japan:

Agilent Technologies Japan Ltd.
Measurement Assistance Center
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