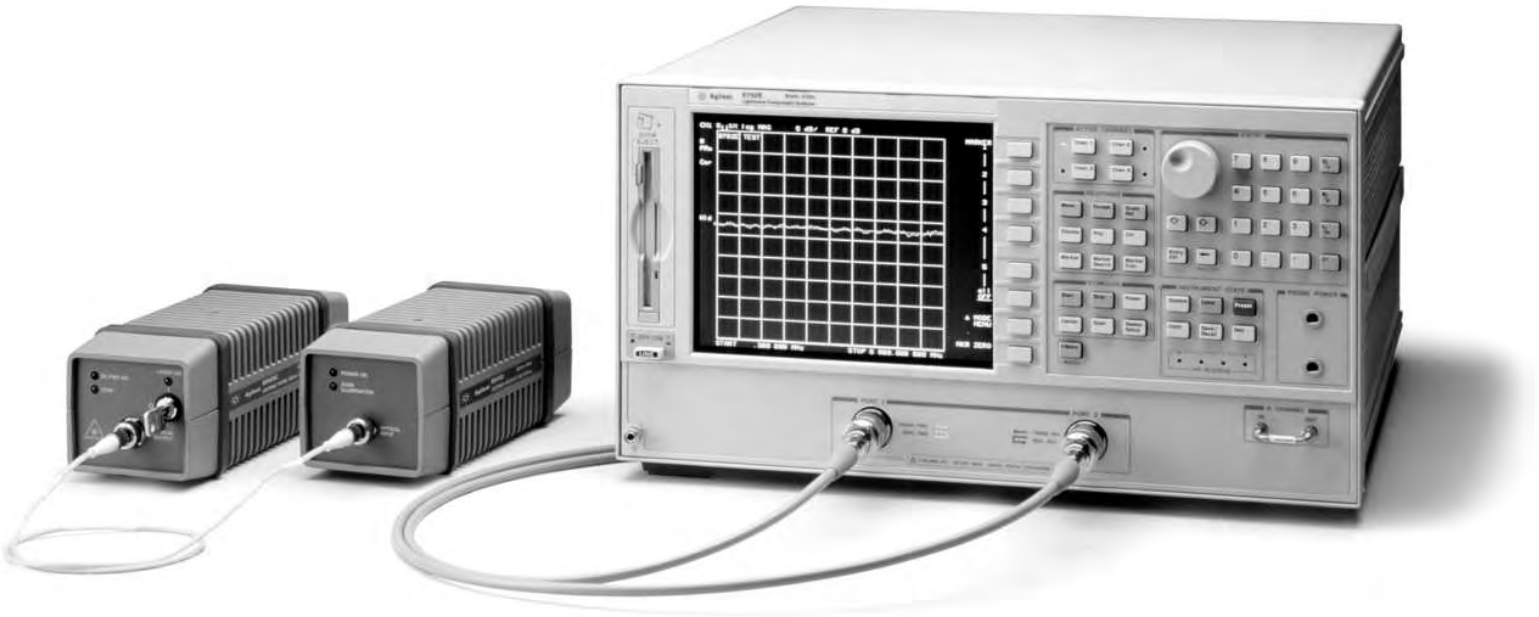
Agilent 8702E
Lightwave Component Analyzer
850 nm, 1300 nm, 1550 nm
300 kHz to 3 or 6 GHz

Product Overview

Accurate modulation frequency response measurements of lightwave components

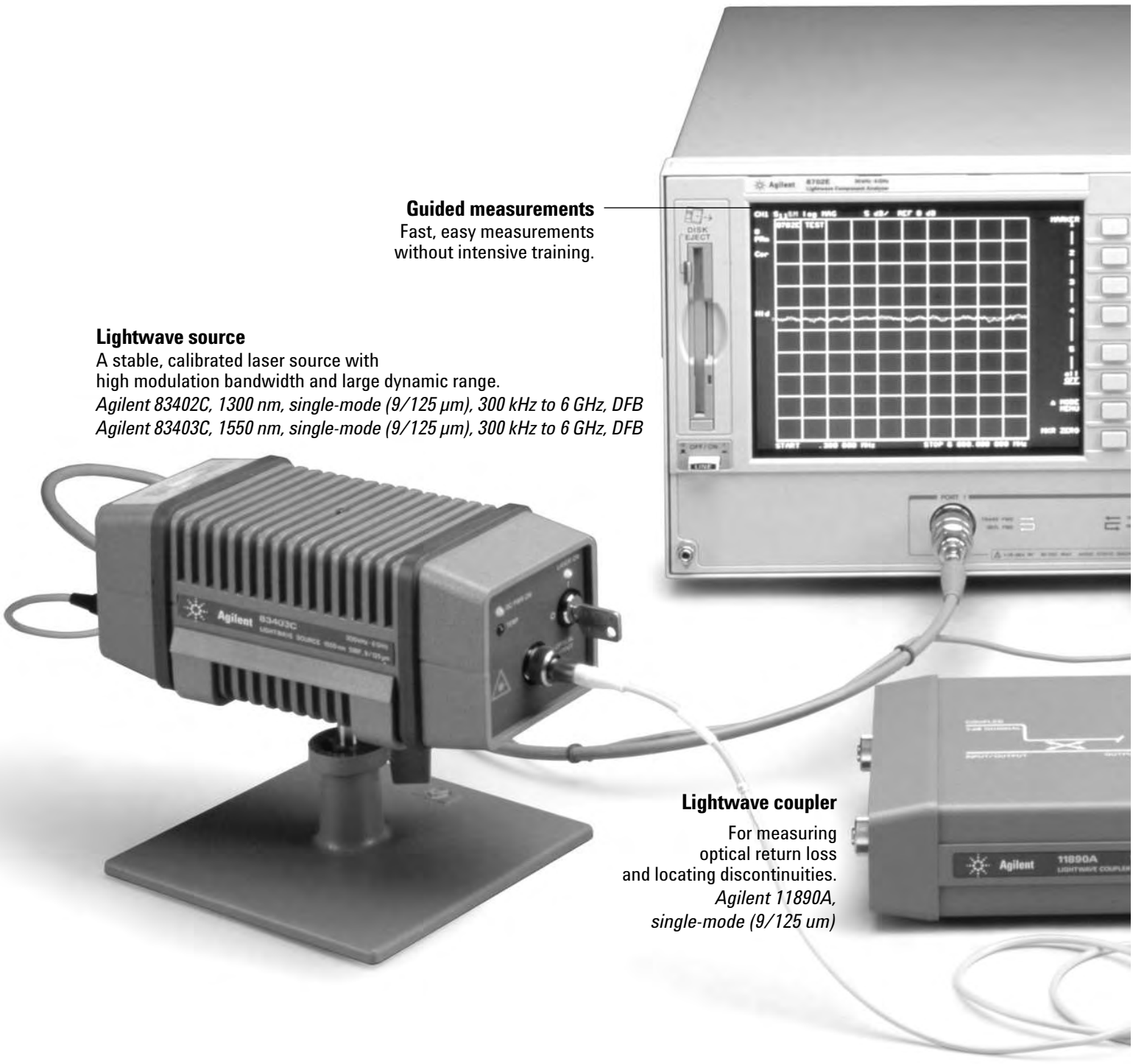


Agilent Technologies

Measurement versatility by design

Guided measurements
Fast, easy measurements
without intensive training.

Lightwave source
A stable, calibrated laser source with
high modulation bandwidth and large dynamic range.
Agilent 83402C, 1300 nm, single-mode (9/125 µm), 300 kHz to 6 GHz, DFB
Agilent 83403C, 1550 nm, single-mode (9/125 µm), 300 kHz to 6 GHz, DFB



Lightwave coupler
For measuring
optical return loss
and locating discontinuities.
Agilent 11890A,
single-mode (9/125 um)

Electrical, optical, and electro-optical calibrations
Accurate, repeatable measurements of all the components of a fiber optic system.

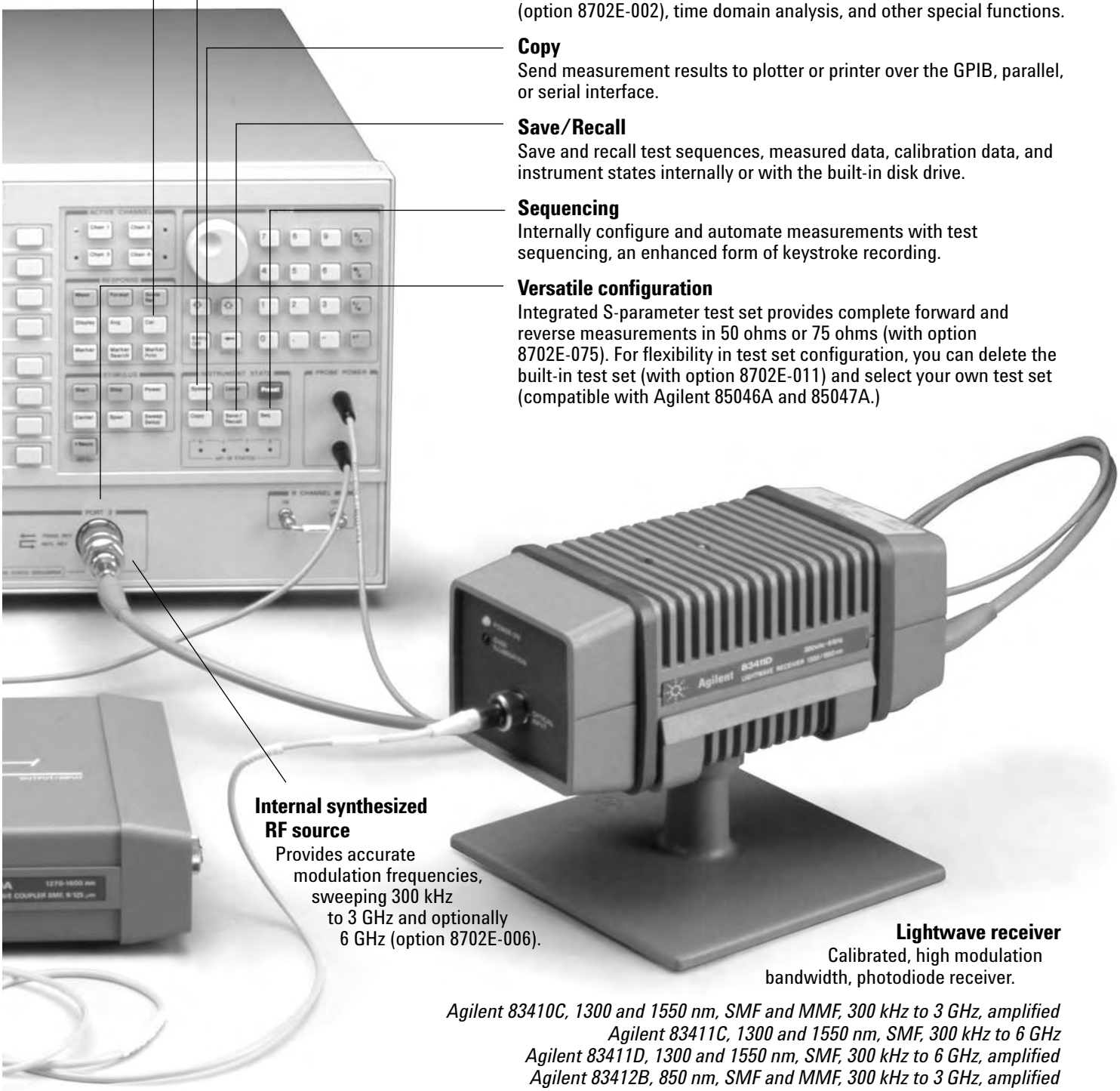
System
Provides access to limit testing, swept harmonic measurements (option 8702E-002), time domain analysis, and other special functions.

Copy
Send measurement results to plotter or printer over the GPIB, parallel, or serial interface.

Save/Recall
Save and recall test sequences, measured data, calibration data, and instrument states internally or with the built-in disk drive.

Sequencing
Internally configure and automate measurements with test sequencing, an enhanced form of keystroke recording.

Versatile configuration
Integrated S-parameter test set provides complete forward and reverse measurements in 50 ohms or 75 ohms (with option 8702E-075). For flexibility in test set configuration, you can delete the built-in test set (with option 8702E-011) and select your own test set (compatible with Agilent 85046A and 85047A.)



Internal synthesized RF source
Provides accurate modulation frequencies, sweeping 300 kHz to 3 GHz and optionally 6 GHz (option 8702E-006).

Lightwave receiver
Calibrated, high modulation bandwidth, photodiode receiver.

Agilent 83410C, 1300 and 1550 nm, SMF and MMF, 300 kHz to 3 GHz, amplified
Agilent 83411C, 1300 and 1550 nm, SMF, 300 kHz to 6 GHz
Agilent 83411D, 1300 and 1550 nm, SMF, 300 kHz to 6 GHz, amplified
Agilent 83412B, 850 nm, SMF and MMF, 300 kHz to 3 GHz, amplified

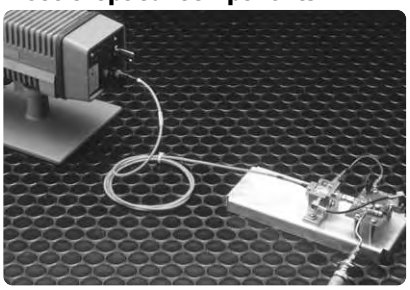
Measurements across the system

Modern lightwave transmission systems require accurate and repeatable characterization of their electro-optical, optical, and electrical components to guarantee high-speed performance. The Agilent 8702E lightwave component analyzer improves the design and specification of these lightwave components. It operates by analyzing a swept frequency signal modulating a 1300 or 1550 nm optical carrier.

With the capabilities of the Agilent 8702E you can:

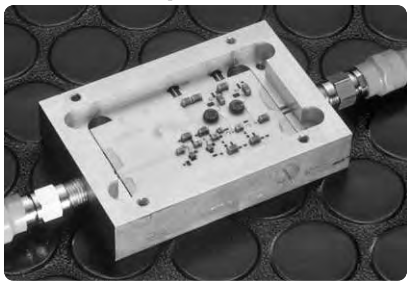
- Characterize component bandwidths with modulation frequencies to 3 GHz (6 GHz optionally).
- Isolate laser and photodiode response with calibrated transmitter and receiver measurements.
- Accurately measure electrical return loss of photodiodes, lasers, connectors, and other lightwave components.
- Measure the swept frequency response of modulation second and third harmonics.
- Locate reflections and view step response with distance/time domain measurements.

Electro-optical components



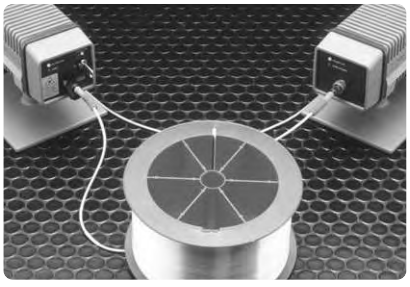
Often the limiting elements in a fiber optic transmission system are the electro-optical components (e.g. lasers, APDs, PIN photodiodes, and, modulators) which convert the electrical information to optical or vice versa. With the 8702E, calibrated measurements of modulation bandwidth, responsivity, and modulation range of an individual transducer are possible.

Electrical components



Linear electrical components such as amplifiers, filters, and transmission lines are used in fiber optic systems. They also require characterization to ensure optimal performance. Typically the bandwidth, insertion loss/gain, insertion phase, impedance, match and group delay are required measurements.

Optical components

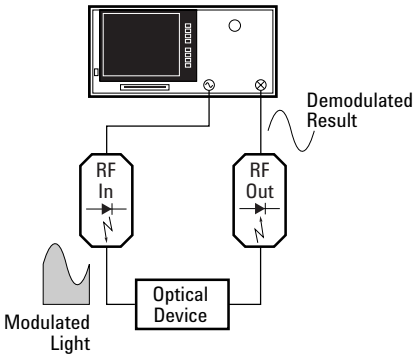


Optical components such as fiber, connectors, splitters, couplers, and lenses make up much of a fiber optic network. The 8702E measures the modulation bandwidth, insertion loss, length and optical return loss of these components. Reflections can be located and the step response of a component viewed with the time domain feature.

System Operation

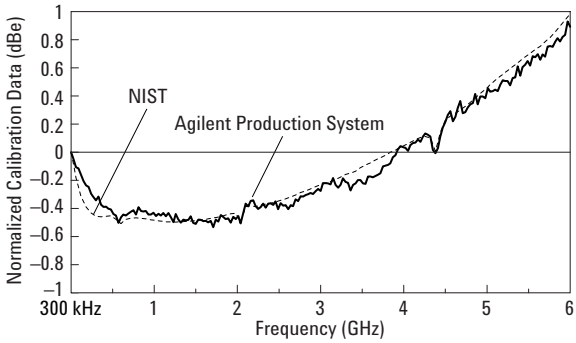
The 8702E consists of an RF source that provides a known swept, synthesized modulation signal, and a receiver that measures the magnitude and phase of the returned RF signal.

To measure a lightwave device, the RF source of the 8702E provides a modulation signal to an external lightwave source, which provides a modulated light signal to the optical device. An external lightwave receiver module demodulates the lightwave signal after it passes through the optical device under test. The demodulated RF signal is passed to the receiver of the 8702E where the magnitude and phase response of the signal is measured. With this system, the transfer function of the test device is determined as a function of modulation frequency.



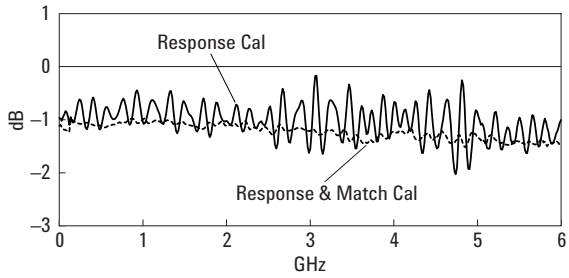
Lightwave sources and receivers for improved measurement accuracy

The Agilent 83400 family of lightwave sources and receivers offer wide bandwidth, stability, and dynamic range. Each receives an individual, NIST traceable calibration which significantly improves measurement accuracy of your electro-optical devices. The density of calibration data points has been increased at low modulation frequencies.



New lightwave response/match calibration

A response calibration allows the 8702E to remove the response of the test system, including the electrical cables, optical fiber, the lightwave source and receiver, and the analyzer itself for the highest measurement accuracy. The new response/match calibration improves measurement accuracy for O/E and E/O devices with non-ideal electrical match.

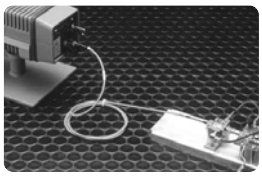


New RF features provide more performance and value

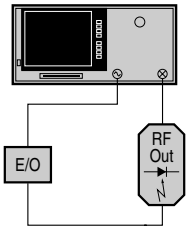
The 8702E combines the convenience of calibrated lightwave measurements with all the RF measurement capability of the Agilent 8753ES RF network analyzer. Following are a few of the new capabilities and improvements.

- **Integrated RF test set** provides complete forward and reverse S-parameter measurements with a single connection.
- **Built-in disk drive** with LIF/DOS formats allows convenient storage of instrument states, data, and test sequences.
- **Serial and parallel interfaces** for support of a wide selection of printers and plotters.
- **Faster operation** 67% faster CPU clock rate provides faster error correction, time domain calculations, and data transfers.
- **Real time clock** for convenient time-stamping of data printouts and files.
- **Improved electrical performance from 3 to 6 GHz** Wider output power range (–85 to +10 dBm standard) and dynamic range (110 dB to 3 GHz and 105 dB to 6 GHz.)
- **More non-volatile memory** Internal storage of calibration data, as well as a maximum of 32 instruments states.
- **Test sequencing** 8702E stores keystrokes for automation without external computer control.
- **Harmonic measurement capability** Characterize your amplified opto-electric component's swept 2nd and 3rd harmonic response absolutely, or in dBc (dB below carrier.)

Electro-optical component measurements



Characterize modulation transfer functions

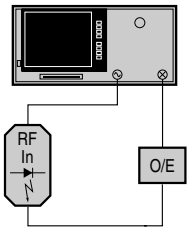


In any lightwave system, it is difficult to measure the modulation response of a laser independently from a photodiode, and vice versa. Unlike any other system, the 8702E can independently measure the modulation transfer function of electro-optical transducers. Modulation bandwidth, flatness, and phase linearity can also be determined. Lasers, LED's, modulators, and photodiodes can be measured, and an absolute value assigned to the responsivity.

Responsivity measurements

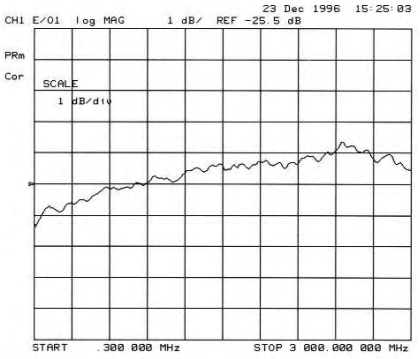
Signal energy enters a lightwave system through a laser and exits through the photodiode. To determine signal noise and system loss budgets, it is important to know how much signal energy a laser or photodiode transmits. The 8702E measures this when it measures modulation transfer function of E/O and O/E devices. This quantity is called responsivity, and is measured in a 50 ohm electrical environment. Responsivity is the ratio of optical modulation power to electrical current for an E/O transducer (laser, LED), and the inverse for an O/E transducer (photodiode).

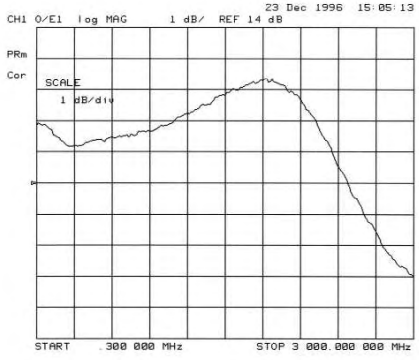
Dynamic range

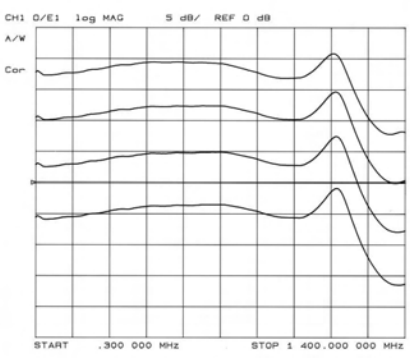


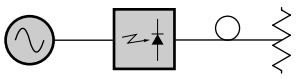
By adding a variable attenuator, the 8702E can be used to measure the dynamic range of an O/E transducer (photodiode). The 8702E can measure the linearity and noise of a receiver over as much as a 100 dB range.

In this example, an Agilent 8347A RF amplifier was used to boost the electrical signal from the lightwave receiver, extending the dynamic range of the system.

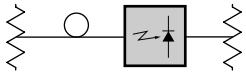




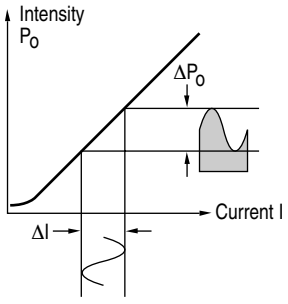




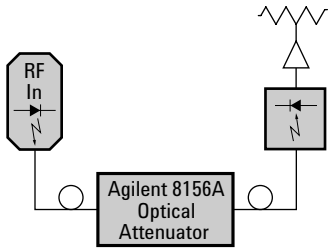
E/O modulation bandwidth



O/E demodulation bandwidth

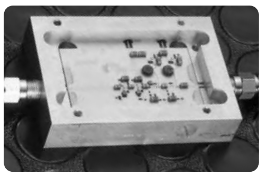


Responsivity ($\Delta P_0 / \Delta I$)

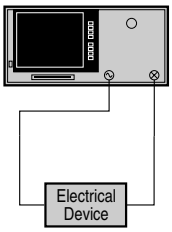


O/E transducer responsivity at several different levels of optical attenuation

Electrical component measurements



Electrical measurements



The 8702E will measure the transfer function and impedance of electrical devices with unparalleled accuracy.

Typical transfer function measurements include the loss, gain, linearity, flatness, phase, group delay, and length of the test device.

Impedance measurements show match, return loss, reflection coefficient, SWR, and complex impedance.

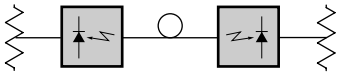
High accuracy

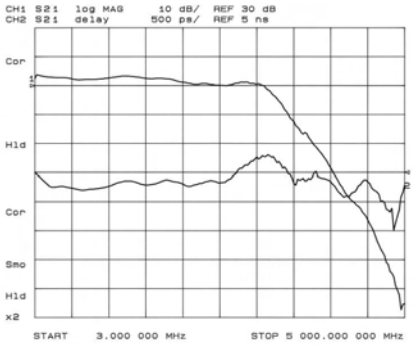
The accuracy of these measurements comes from the high performance hardware and from built-in electrical measurement calibrations.

The synthesized RF source and high dynamic range receiver allow the 8702E to easily measure a wide variety of demanding devices. The measurement calibration further improves the accuracy by calculating systematic errors and removing them from the measurement data.

System measurements

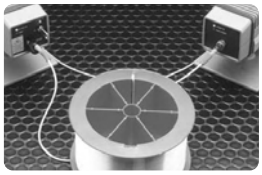
As well as measuring electrical devices, the 8702E can measure the bandwidth, insertion loss, delay and linearity of a complete fiber optic transmission system. A system level measurement can then be related back to measurements of the individual components to allow location and improvement of the weakest elements.



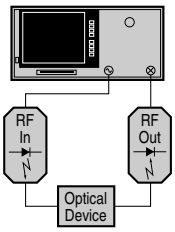


Gain and group delay of a linear amplifier

Optical component measurements



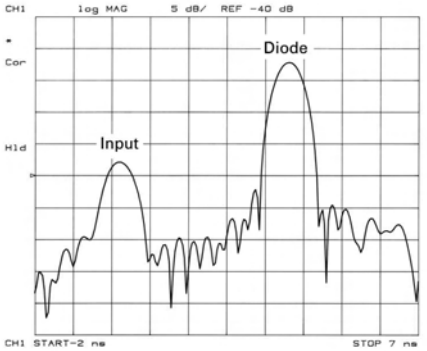
Optical measurements



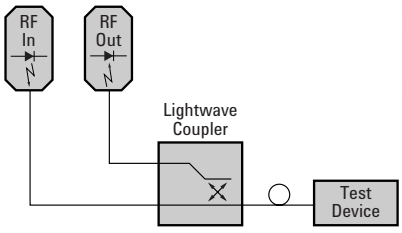
An 8702E equipped with a lightwave source and receiver has the ability to characterize optical components as a function of modulation frequency. Typical measurements include bandwidth, loss, and optical return loss.

Optical reflections

In high-speed systems, reflections from components reduce transmitted power, cause errors in detection, and can interfere with the operation of a laser. The 8702E can be configured to measure optical reflections using an Agilent 11890 series lightwave coupler. The 8702E's high dynamic range allows detection of very small reflections.



Optical return loss of a PIN photo diode

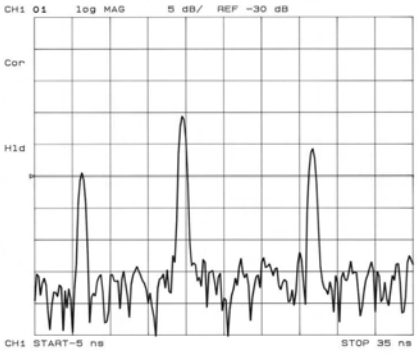


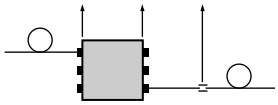
Optical reflection block diagram

Distance-time domain

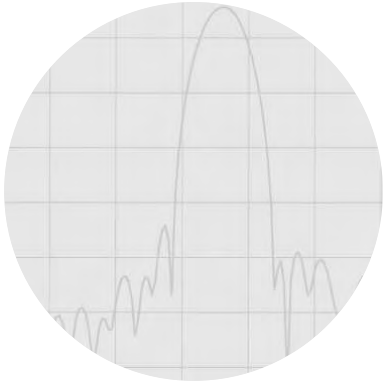
The 8702E can calculate the step or impulse response of a device from its frequency response using the inverse Fourier transform.

Applying the time domain transform to an optical return loss measurement allows high resolution location of reflections with effectively no dead zone. The 8702E can resolve multiple responses as close as 6 cm apart (3 cm for the 6 GHz system). The 8702E can also locate a single response to better than one millimeter.





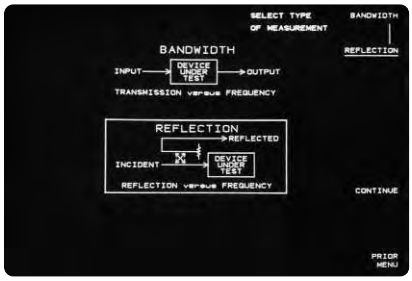
Time domain reflection response through a distribution panel, showing a failed splice

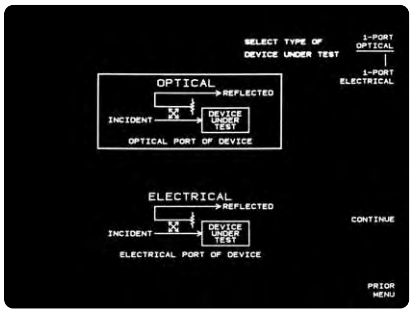


All supported by an extensive feature set

Guided measurements

The 8702E will easily guide the user through basic modulation bandwidth and match measurements with figures and instructions on the CRT. Test setup is simplified and made easier to perform.





GPIB hardcopy, disc access

The 8702E can be computer controlled over GPIB. Its serial and parallel ports support printers and plotters for measurement hardcopy. Data, calibrations, and instrument states can be saved to and read from internal memory, or the built-in LIF/DOS disk drive.

Automate repetitive tasks without a computer

In test sequencing mode, you make the measurement once and the 8702E stores the keystrokes. Complex measurements can be stored in a sequence and later recalled rapidly and consistently with the touch of a button.

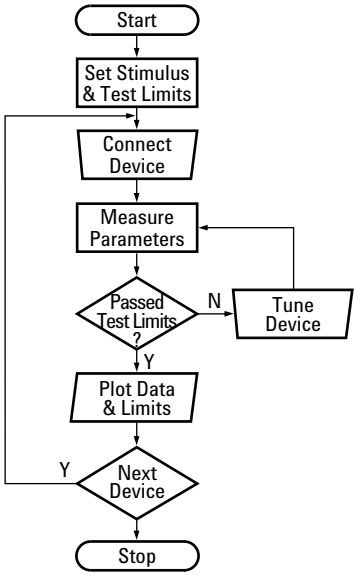
Let the 8702E determine if measurement results are within user-defined limits. You can choose any combination of single-point, horizontal or sloping line limits from the front panel. Pass/fail is indicated on the display, audibly, over GPIB or from a BNC rear panel TTL output.

	STIMULUS MHz	CH1 E/O1
	.300 000	-28.909 dB
	240.288 000	-29.843 dB
	480.276 000	-29.972 dB
	720.264 000	-30.151 dB
	960.252 000	-30.505 dB
1	200.240 000	-30.698 dB
1	440.228 000	-30.993 dB
1	680.216 000	-31.578 dB
1	920.204 000	-31.886 dB
2	160.192 000	-32.206 dB
2	400.180 000	-32.31 dB
2	640.168 000	-32.487 dB
2	880.156 000	-32.417 dB
3	120.144 000	-32.695 dB
3	360.132 000	-32.881 dB
3	600.120 000	-33.163 dB
3	840.108 000	-33.605 dB
4	080.096 000	-34.581 dB
4	320.084 000	-34.794 dB
4	560.072 000	-34.858 dB
4	800.060 000	-35.062 dB
5	040.048 000	-35.477 dB
5	280.036 000	-36.354 dB
5	520.024 000	-36.548 dB
5	760.012 000	-36.036 dB
6	000.000 000	-35.805 dB

Example of "list frequency" output

User-defined frequency testing

Speed up your testing by measuring your device at only selected frequencies. You can specify up to 30 arbitrary CW frequencies or frequency sweep segments at which to test your device.

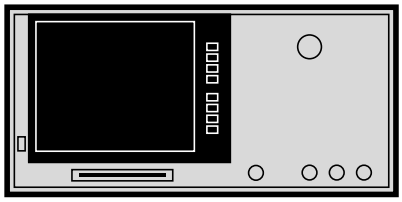


Test sequence flowchart

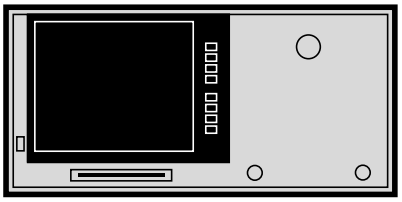
Change frequencies and remain calibrated

Perform a broadband calibration with up to 1601 points and then adjust your frequency span or number of measurement points for the particular device under test. The 8702E will use interpolation to recalculate the error terms for the new parameters. Use this feature to avoid recalibrating between testing different devices.

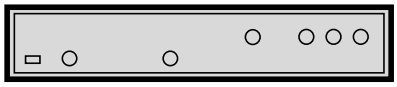
Agilent 8702 product family



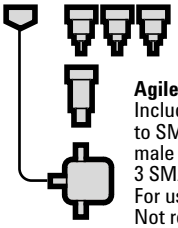
Agilent 8702E option 8702E-011 lightwave component analyzer
8702E-006 and Agilent 85047A test set extend
Agilent 8702E option 8702E-011 to 6 GHz.



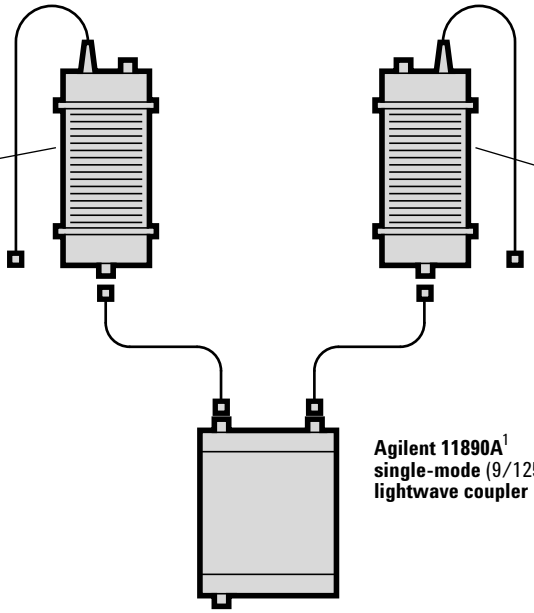
Agilent 8702E lightwave component analyzer
With integrated 50Ω test set
Option 8702E-006 extends operation to 6 GHz.



Agilent 85047A S-parameter test set
Adds 6 GHz capability to Agilent 8702E
options 8702E-006 and 8702E-011.
or
Agilent 85046A S-parameter test set
For use with Agilent 8702E
option 8702E-011.



Agilent 11889A RF interface kit
Includes power splitter, 3 type-N
to SMA adapters, a 20 dB pad,
male and female SMA barrels,
3 SMA elbows, and a custom cable.
For use with the Agilent 8702E option 8702E-011.
Not required for use with
Agilent 85046A or 85047A.



Agilent 83402C lightwave source [1,2]
1300 nm, SMF (9/125 μm),
300 kHz to 6 GHz
or
Agilent 83403C lightwave source [1,2]
1550 nm, SMF (9/125 μm),
300 kHz to 6 GHz

Agilent 83410C lightwave receiver [1,2]
1300 and 1550 nm, 300 kHz to 3 GHz
or
Agilent 83411C lightwave receiver [1,2]
1300 and 1550 nm, 300 kHz to 6 GHz
or
Agilent 83411D lightwave receiver [1,2]
1300 and 1550 nm, 300 kHz to 6 GHz
or
Agilent 83412B lightwave receiver [1,2]
850 nm, 300 kHz to 3 GHz

Agilent 11890A[1]
single-mode (9/125 μm)
lightwave coupler

[1] These products have four optical connector types available. The connector option selects the type of interface adapter supplied:

81000 AI	Diamond HMS 10
Option 012	FC/PC
81000 SI	DIN 47256
81000 VI	ST

[2] A calibration disc that can be directly read by the Agilent 8702E is provided with these products. Calibration data can also be entered without a disc.

Options and accessories

Agilent 8702E Lightwave component analyzer

- **8702E-002** Add harmonic measurement capability
- **8702E-006** 6 GHz frequency extension
- **8702E-011** delete test set
- **8702E-075** 75 ohm impedance
- **8702E-110** deletes time domain capability
- **8702E-1D5** high stability frequency reference

Agilent 11890A lightwave coupler

A 3 port directional coupler with nominal coupling of 3 dB, and 34 dB nominal directivity.

Agilent 8156A optical attenuator

0 to 60 dB attenuator with high repeatability, linearity, and return loss.

Agilent 85046A and 85047A S-parameter test sets

The S-parameter test sets can be used with the option 8702E-011 and provide the capability to measure impedance and transmission characteristics (including S-parameters) of 2 port devices in either direction with a single connection. The test set is controlled from the 8702E and includes a step attenuator. The 85047A contains 6 GHz components and is used with the Agilent 8702E options 8702E-006 and 8702E-011. The test port connectors are precision 7 mm, and the Agilent 11857D 7 mm test port return cables are recommended.

Agilent 11889A RF interface kit

Contains the RF accessories needed to operate the 8702E option 8702E-011 when a test set is not used. Contains a power splitter, a 20 dB pad, SMA accessories, and adapters.

Agilent 85033D 3.5 mm calibration kit

Contains a set of precision 50 ohm 3.5 mm standards to calibrate the 8702E and 50 ohm test sets for the measurement of devices with precision 3.5 mm and SMA connectors. Precision 7 mm to 3.5 mm adapters are included.

Agilent 85032B 50 ohm type-N calibration kit

Contains precision 50 ohm type-N standards used to calibrate the 8702E and 50 ohm test sets for measurement of devices with 50 ohm type-N connectors. Precision 7 mm to Type-N adapters are included.

Agilent 85031B 7 mm calibration kit

Contains precision 7 mm standards to calibrate the 8702E and 50 ohm test sets for measurement of devices with precision 7 mm connectors.

Agilent 85036B 75 ohm type-N calibration kit

Contains a set of precision 75 ohm type-N standards to calibrate the 8702E and 75 ohm test sets for measurement of devices with 75 ohm type-N connectors. Precision 75 ohm type-N adapters are included.

Agilent 85039B-00F calibration kit

Contains a set of 75 ohm type-F standards to calibrate the 8702E and 75 ohm test sets for the measurement of devices with 75 ohm type-F connectors.

Agilent 85024A high impedance probe

A low capacitance probe (<0.7 pF) for making high frequency in-circuit measurements.

Agilent 8347A RF amplifier

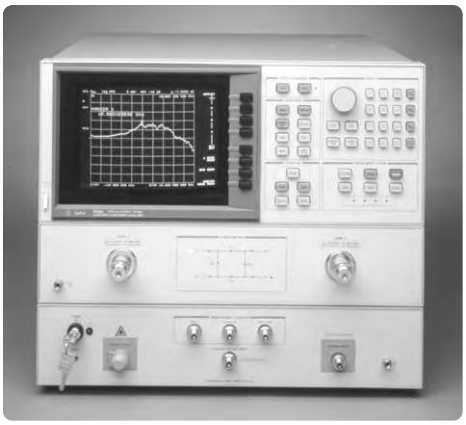
A 100 kHz to 3 GHz, +20 dBm leveled amplifier that can be used to extend the dynamic range of the 8702E.

Agilent 11899A probe power Supply

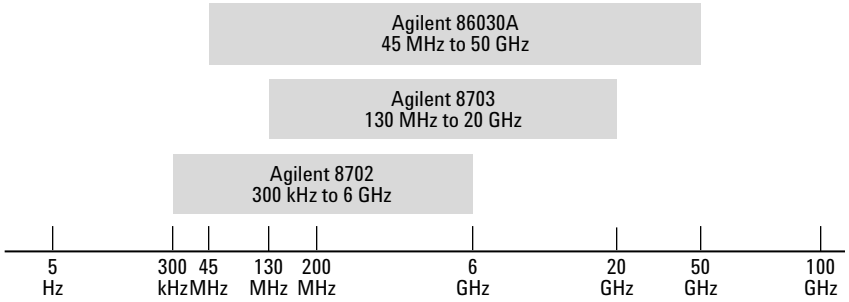
A DC power supply that can be used to power the lightwave source and receiver when they are used in stand-alone applications.

Agilent 8703 Lightwave Component Analyzer

For applications with modulation frequency range between 130 MHz and 20 GHz.



Agilent 8703 with built-in lightwave source and receiver



Agilent Family of Lightwave Component Analyzers

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

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

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 May 24, 2002
5988-1845EN

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

Agilent Technologies