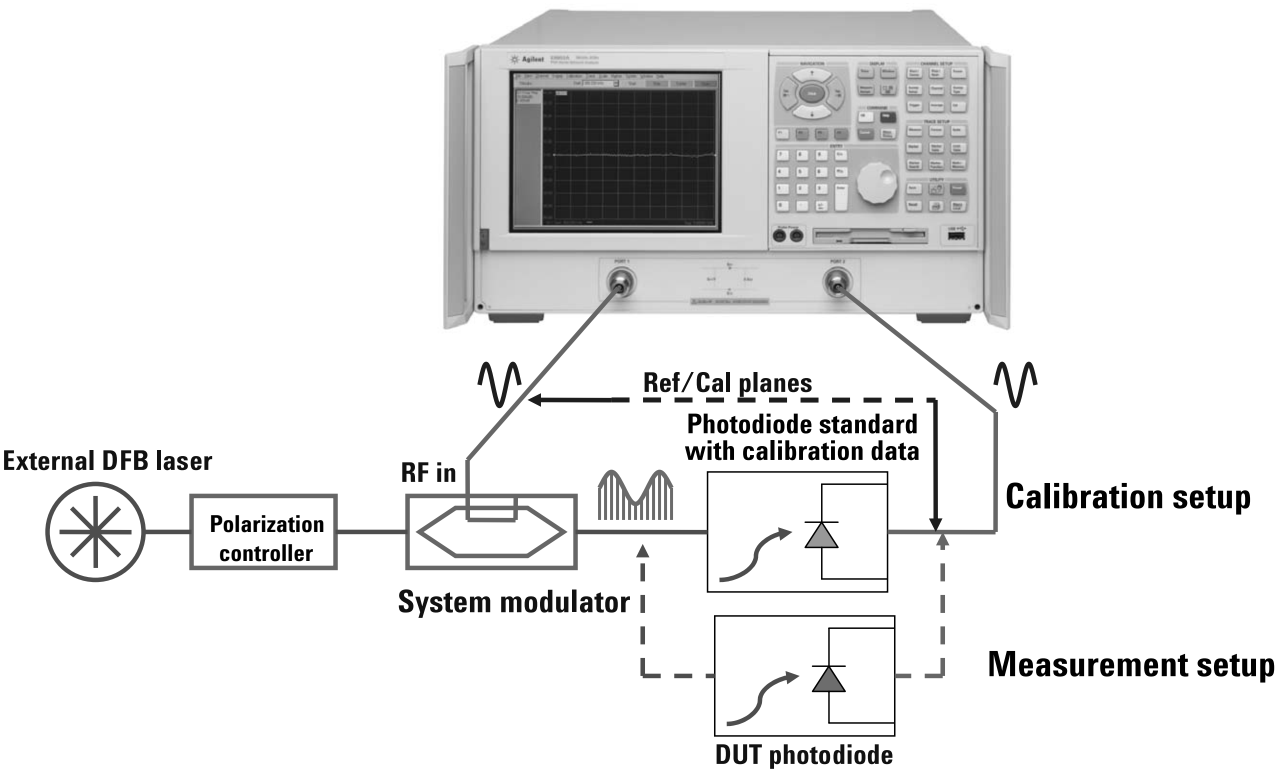
Agilent
PNA Network Analyzers

Application Note 1408-14

Using the PNA Series to Analyze Lightwave Components



Agilent Technologies

Introduction

The desire for more bandwidth has resulted in an increase in research of data transmission in optical networks. Examples of components used in an optical network include photodiodes (optical to electrical, O-E, transducers) and optical modulators (electrical to optical, E-O, transducers). Typically, these components are used to form the basis of an optical transmission path where light energy is used to transmit data.

A Lightwave Component Analyzer (LCA) is often used to characterize various optical components used in the transmission media. A conceptual LCA is shown below in Figure 1.

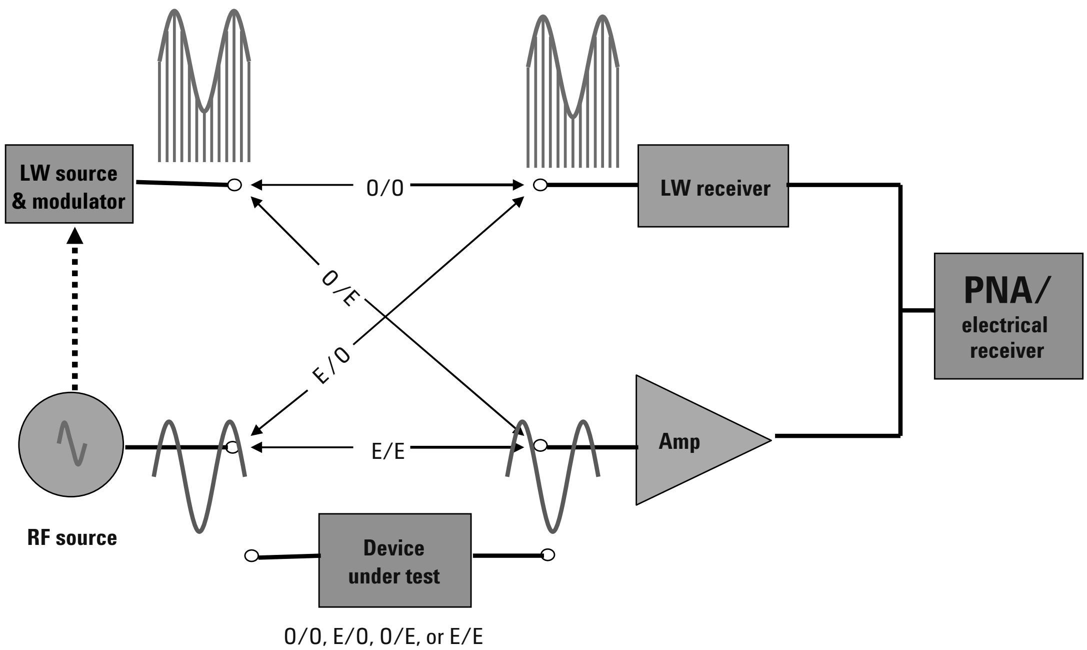


Figure 1. Conceptual LCA

The concept of lightwave component analysis is straightforward. Measurements are made of the small-signal linear transmission and reflection characteristics of a variety of lightwave components. These components include electro-optical components like lasers, photodiodes, optical modulators and optical fibers. A precise electrical (signal generator) or optical (laser) source is used to stimulate the component-under-test and a very accurate optical or electrical receiver measures the transmitted (or reflected) signal. Since characterization over a range of modulation frequencies is required, the frequency of modulation is normally swept over the bandwidth of interest.

The Agilent PNA Series of network analyzers can be used to test optical components. A key benefit of using the PNA Series is the ability to apply 2-port error correction along with de-embedding. De-embedding is applied through the fixturing application, which is included in the PNA Series (other methods may not utilize 2-port error correction which can lead to possible increased measurement error). This, along with industry-leading hardware performance, provides an accurate measurement representation of the optical component performance.

The content covered in this documentation applies to both the PNA and the PNA-L Series:

N5230A, PNA-L Series

Frequency range	Standard test set	Configurable test set
300 kHz to 6 GHz	Option 020	Option 025
300 kHz to 13.5 GHz	Option 120	Option 125
300 kHz to 20 GHz (4-port)	Option 240	Option 245
10 MHz to 20 GHz	Option 220	Option 225
10 MHz to 40 GHz	Option 420	Option 425
10 MHz to 50 GHz	Option 520	Option 525

PNA Series

10 MHz to 20 GHz	E8362B
10 MHz to 40 GHz	E8363B
10 MHz to 50 GHz	E8364B
10 MHz to 67 GHz	E8361A
10 MHz to 110 GHz	N5250A

Fixturing Application

The fixturing application allows the user to de-embed 2-port networks, such as a calibrated photodiode[1] or modulator from the displayed measurement results shown on the PNA. All four S-parameters of the calibrated photodiode or modulator can be de-embedded, whereas previous solutions only rely on the forward transmission response, which can lead to increased measurement error. The photodiode or modulator data needs to be stored in comma-separated format (CSV), which can then be imported into the analyzer by using the fixturing application. Once imported, the data can easily be de-embedded from the calibrated measurement results.

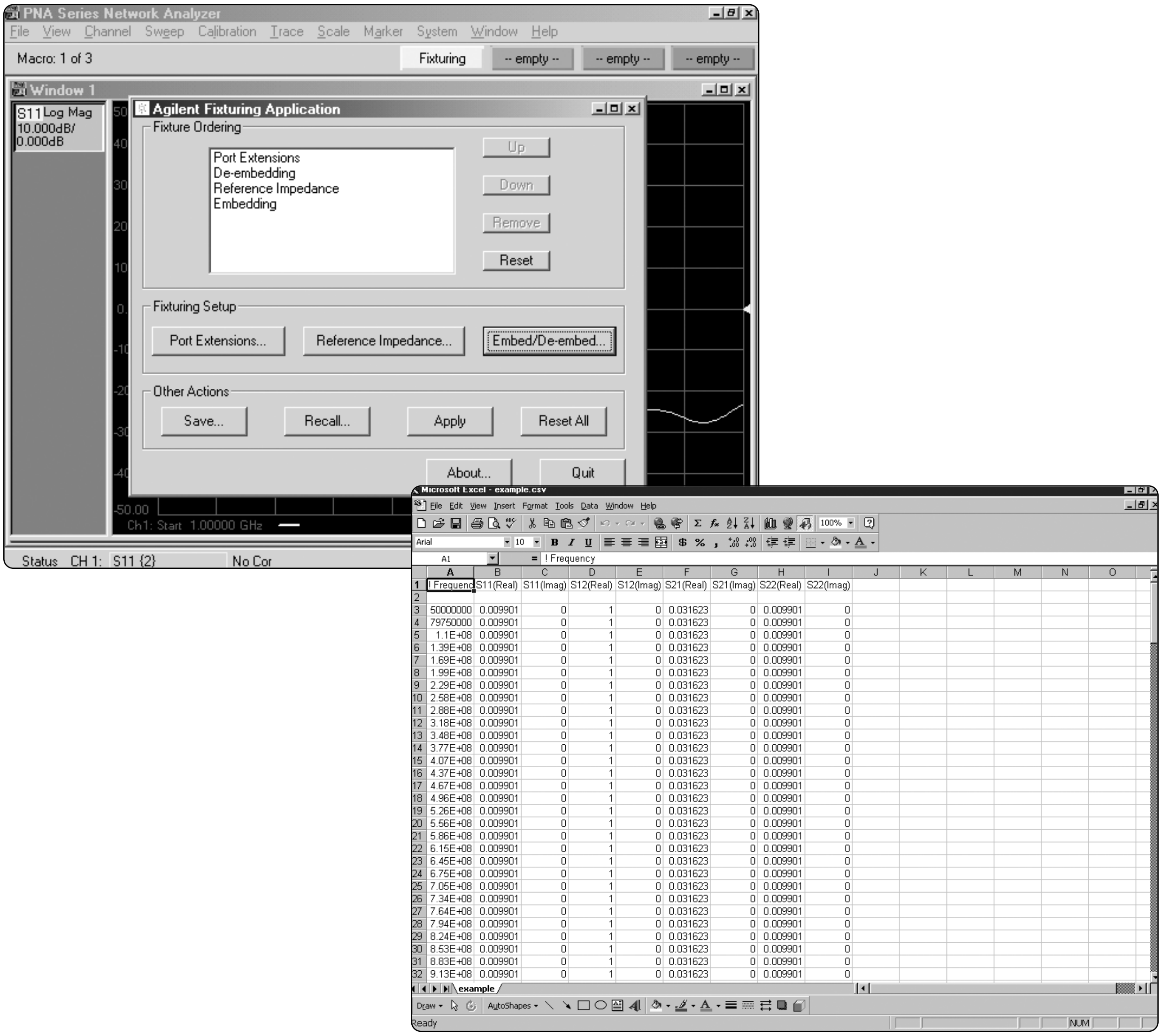


Figure 2. PNA fixturing application

1. Photodiodes with calibration data are available through Agilent. Please contact you local sales representative for more information.

Optical Modulator (E-O) Measurements

For electrical-optical (E-O) measurements:

1. Perform a 2-port calibration at the end of the coaxial cables where the optical modulator and photodiode will be connected.
2. To measure the E-O (modulator), connect the cables from the analyzer to the modulator (port 1) and to the photodiode (port 2). See Figure 3 for details.
3. To obtain the measurements of the modulator, simply de-embed the calibrated photodiode characteristics from the measured results using the fixturing application in the PNA. (Photodiodes purchased from Agilent contain the characteristic data for used in de-embedding.)

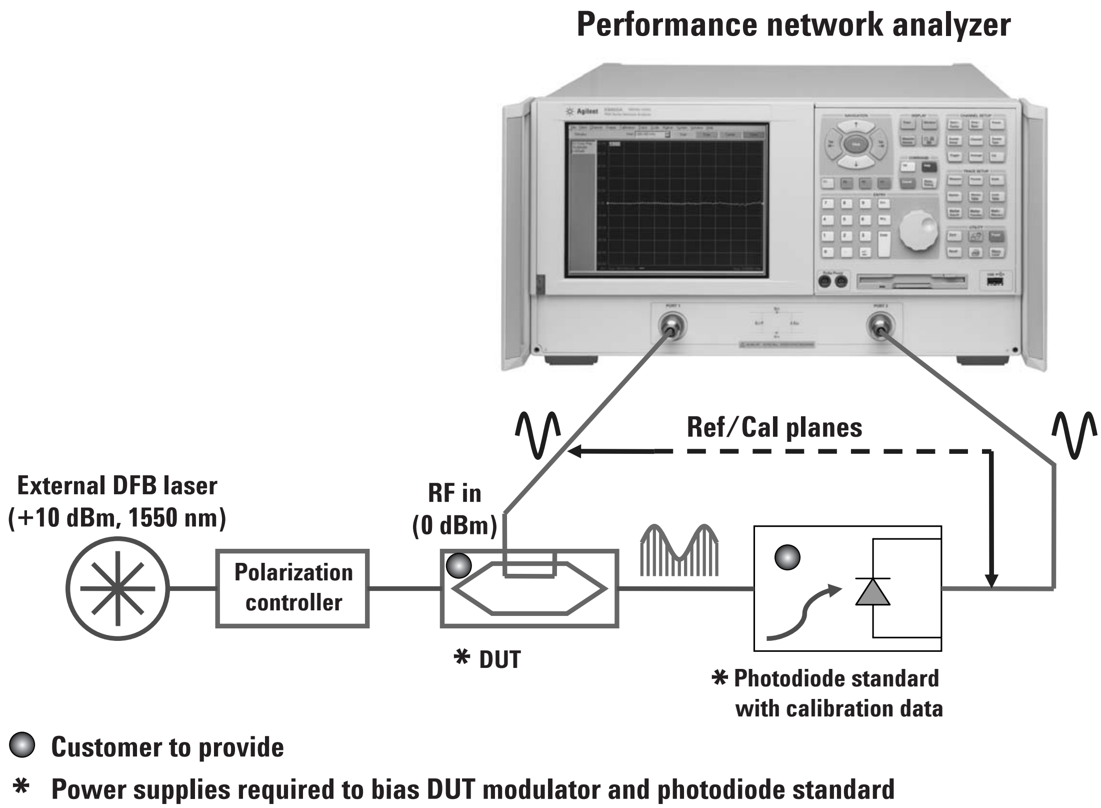


Figure 3. Modulator measurement

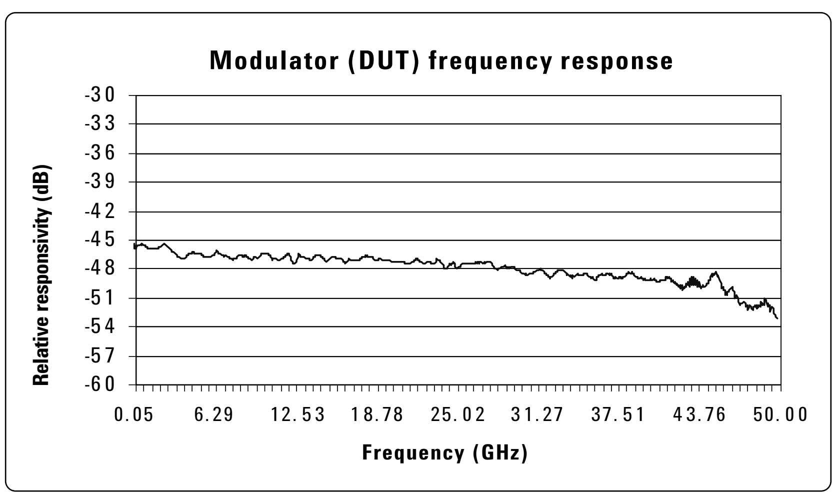


Figure 4. Measured optical modulator response using the PNA Series

Photodiode (O-E) Measurements

For optical-electrical (O-E) measurements:

1. Perform a 2-port calibration at the end of the coaxial cables.
2. With the modulator in place, a photodiode standard (with calibration data) is used to calibrate (Data/Mem) the system. See Figure 5 for details.
3. The photodiode standard is then replaced with the O-E DUT (photodiode). The resulted measurements will be relative to the photodiode standard. See Figure 5 for details.

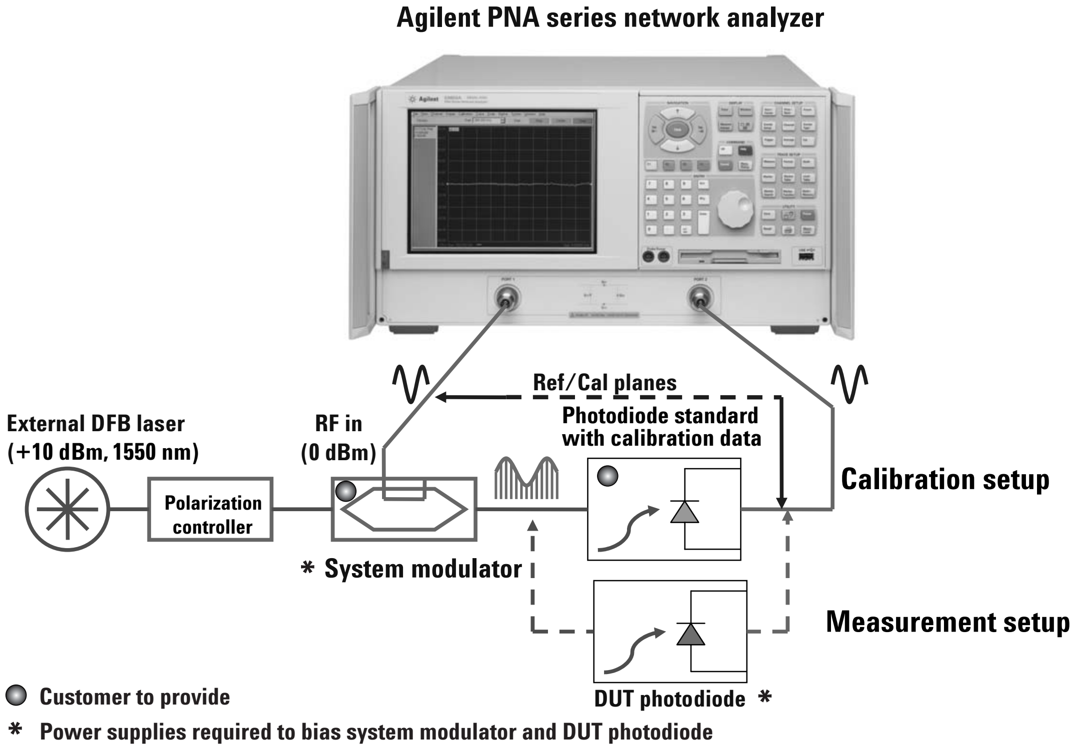


Figure 5. Photodiode measurement

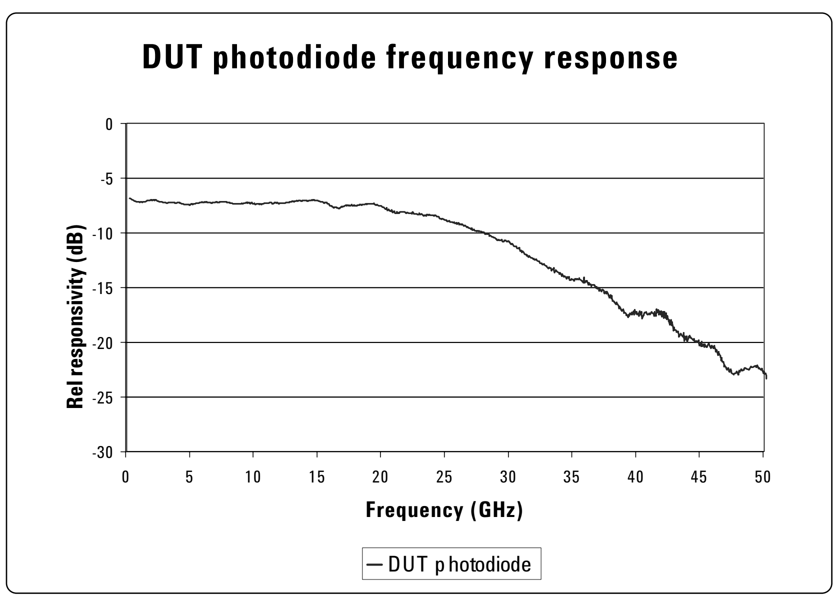
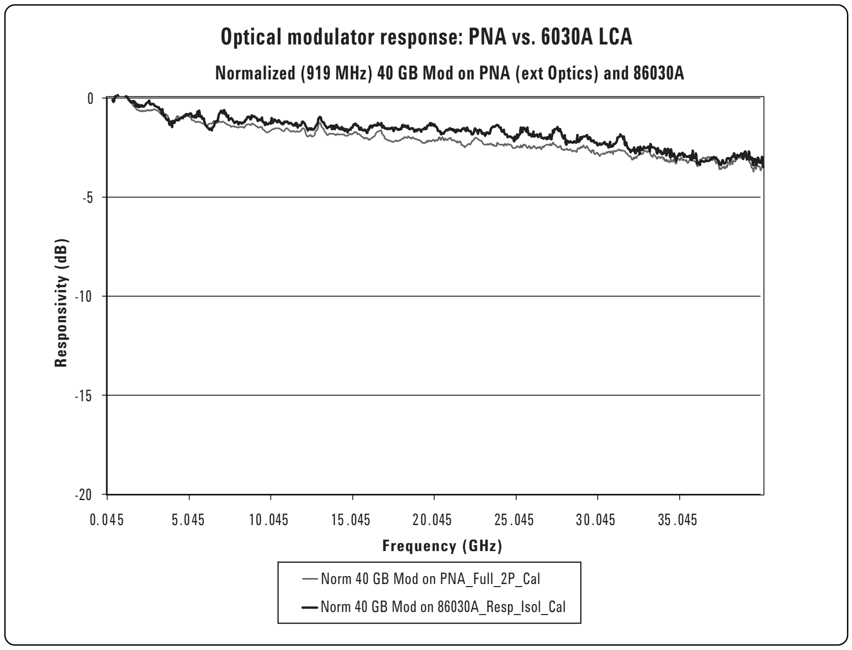


Figure 6. Measured photodiode response using the PNA Series

Results

The following figures compare the measurement results of a photodiode and modulator using the PNA Series of network analyzers versus the Agilent 86030A lightwave analyzer. Measured results from the two systems are closely correlated. Plus, measurements made with the PNA Series show less ripple due to the performance advantages of 2-port error correction and 2-port de-embedding as previously mentioned.



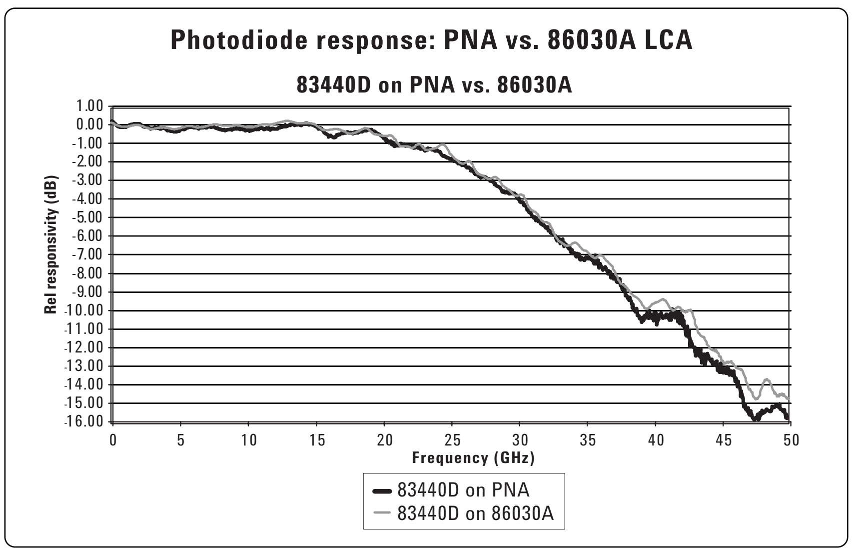


Figure 7. Measurement results as compared between the PNA Series and the 86030A LCA

Summary

The results shown indicate that optical measurements can be accurately performed using the Agilent PNA Series network analyzers. The superior performance of the PNA hardware over other analyzers, along with the fixturing application and 2-port error correction, provide a much more accurate measurement result over other previous measurement solutions.

Web Resources

Visit our Web sites for additional information and literature.

Microwave and RF network analyzers:
www.agilent.com/find/na

PNA microwave network analyzers:
www.agilent.com/find/pna

Electronic calibration (ECal):
www.agilent.com/find/ecal

Test and measurement accessories:
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