Lightwave Catalog 2011

Enabling Optical and Digital Innovation
Volume 2: Transceiver Test

Agilent Technologies

Agilent Technologies Lightwave Catalog 2011
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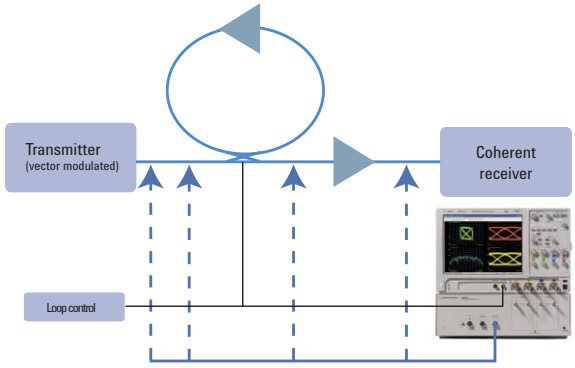
Volume II: Transceiver Test

Reference

Link qualification

New tools allow optical links to be characterized by measuring the link impairments on the vector modulated signal. Research engineers and scientists, who are interested in characterization of the performance of an optical link, now get the tools at hand to characterize vector modulated signals along the link down to the receiver.



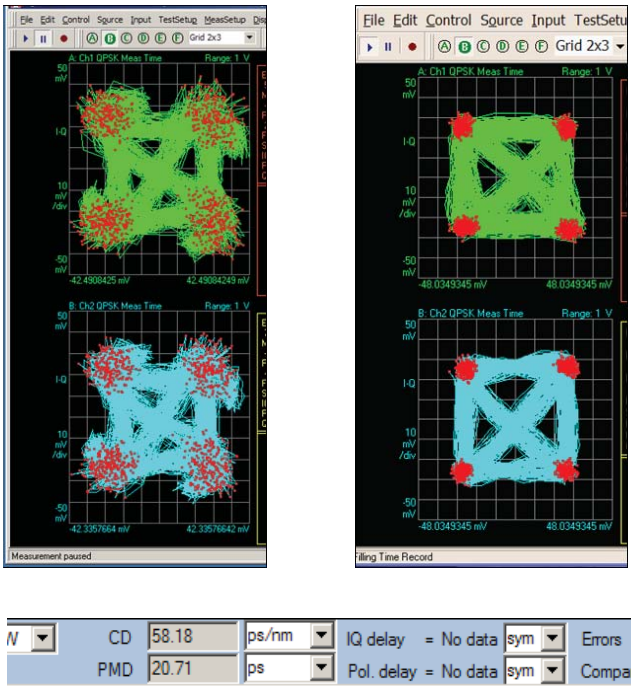
Tools for link test

- CD compensation
- In-channel CD measurement
- PMD compensation
- In-channel 1-st order PMD measurement
- Trigger mode (gating) for loop experiments
- Selection of 4 different CD compensation algorithms
- Selection of 4 different PMD algorithms
- Error vector magnitude measurements as figure of merit for signal quality
- Physical layer BER
- Support of user defined algorithms

By using these tools it is very easy to create diagrams showing the signal quality influenced by various link impairment such as CD, PMD, Loss or PDL. Even the effect of non-linear link impairments can be qualified with EVM.

CD, PMD measurement

Impairments along an optical link will distort the received signal and are visible in a distorted constellation. Algorithms to compensate this very effectively in real time are under active research. The highly sophisticated CD and PMD algorithms of the N4391A are able not only to compensate for this distortion, but can also measure in-channel CD and first-order in-channel PMD.

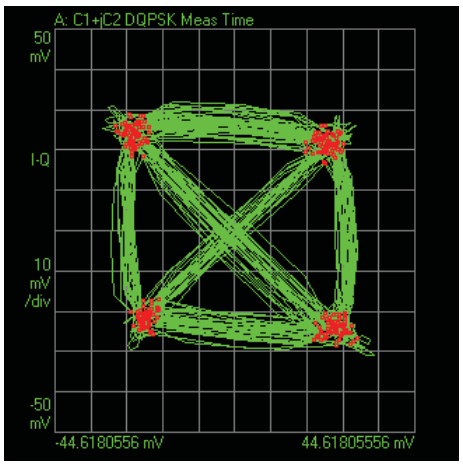


Left screen shot shows the signal before CD compensation, right screen show's the constellation after applying one of the available CD compensation algorithms

Optical I-Q diagram

The I-Q diagram (also called a polar or vector diagram) displays demodulated data, traced as the in-phase signal (I) on the x-axis versus the quadrature-phase signal (Q) on the y-axis.

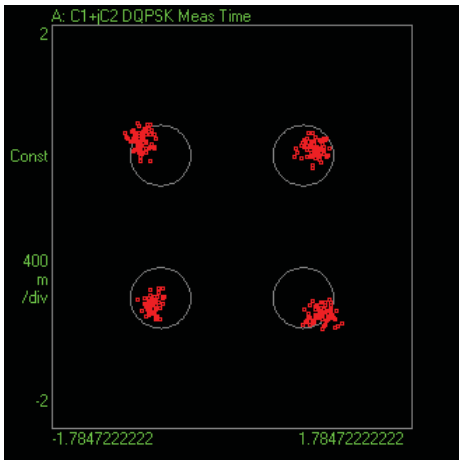
This tool gives deeper insight into the transition behavior of the signal, showing overshoot and an indication of whether the signal is bandwidth limited when a transition is not close to a straight line.



Optical constellation diagram

In a constellation diagram, information is shown only at specified time intervals. The constellation diagram shows the I-Q positions that correspond to the symbol clock times. These points are commonly referred to as detection decision-points, and are called symbols. Constellation diagrams help identify such things as amplitude imbalance, quadrature error, or phase noise.

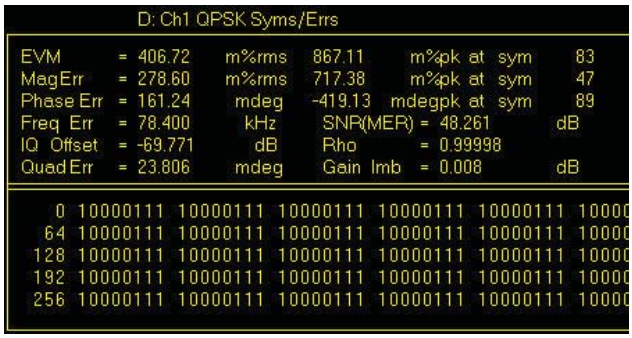
The constellation diagram gives fast insight into the quality of the transmitted signal as it is possible to see distortions or offsets in the constellation points. In addition, the offset and the distortion are quantified by value for easy comparison to other measurements.



Symbol table/error summary

This result is one of the most powerful of the digital demodulation tools. Here, demodulated bits can be seen along with error statistics for all of the demodulated symbols. Modulation accuracy can be quickly assessed by reviewing the rms EVM value. Other valuable parameters are also reported as seen in the image below.

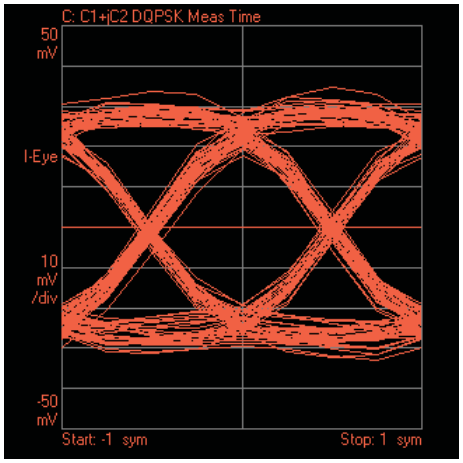
- Frequency error
- I-Q offset
- Quadrature error
- Gain imbalance



Eye diagram of I or Q signal

An eye diagram is simply the display of the I (real) or Q (imaginary) signal versus time, as triggered by the symbol clock. The display can be configured so that the eye diagram of the real (I) and imaginary (Q) part of the signal are visible at the same time.
Eye diagrams are well-known analysis tools in the optical ON/OFF keying modulation analysis. Here, this analysis capability is extended include the imaginary part.

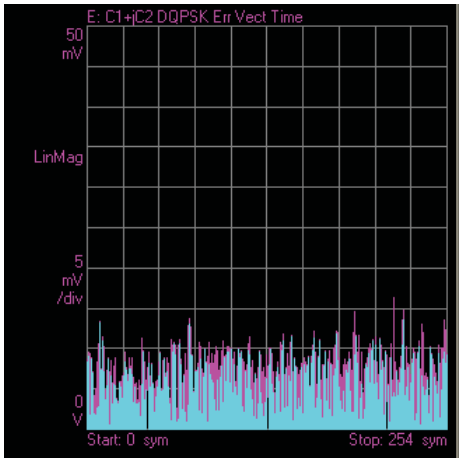
This tool allows comparison of I and Q eye opengs, illustrating possible imbalances very quickly



Error vector magnitude

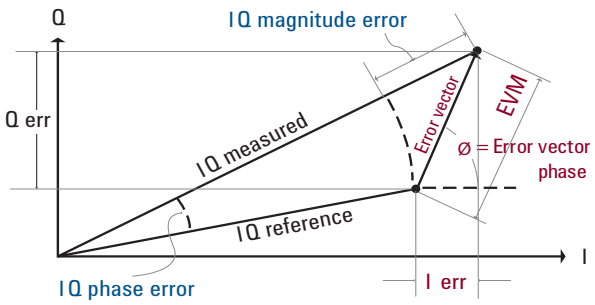
The error vector time trace shows computed error vector between corresponding symbol points in the I-Q measured and I-Q reference signals. The data can be displayed as error vector magnitude, error vector phase, only the I component or only the Q component.

This tool gives a quick visual indicion of how the signal matches the ideal signal.



$$EVM\,[n] = \sqrt{I\ err\,[n]^2 + Q\ err\,[n]^2}$$

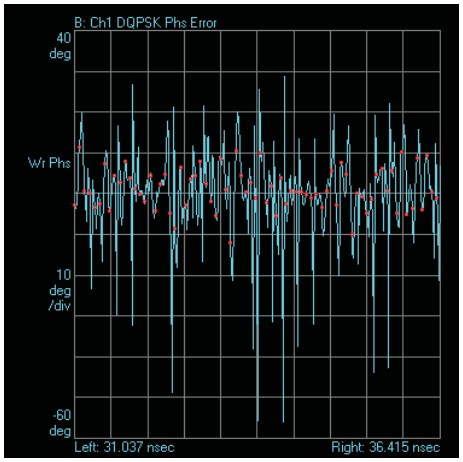
Where [n] = measurement at the symbol time
I err = I reference – I measurement
Q err = Q reference – Q measurement



Phase Error Analysis

The concept of error vector analysis is a very powerful tool, offering more than just EVM, it provides the magnitude and the phase error (Fig 15.) for each symbol or sample. The phase error is displayed for each sample point and each constellation point in the same diagram, showing what happens during the transition.

This information gives an indication about the shape of phase error. It can be a repetitive or a random-like shape, which can give a valuable indication about the source of the phase error, like in jitter analysis.



Bit/Symbol/Error analysis

Beside the wide variety of physical parameters that can be analyzed, the optical modulation analyzer also offers the bit and symbol error analysis. Being able to detect the transmitted symbols and bits, enables comparison of the measured data against the real transmitted data. With PRBS of any polynomial up to 2^31 and the option for user defined patterns, the optical modulation analyzer is able to actually count the symbol errors and measure the bit error ratio during a burst.

Having these analysis tools, it is now very easy to identify the error causing element, - transmitter, link or receiver - if a classic electrical point to point BER test fails.

In addition this feature offers the option to perform a stress test on a receiver, by exactly knowing the quality of the receiver input signal and being able to compare to the overall BER of the system.

Application Overview

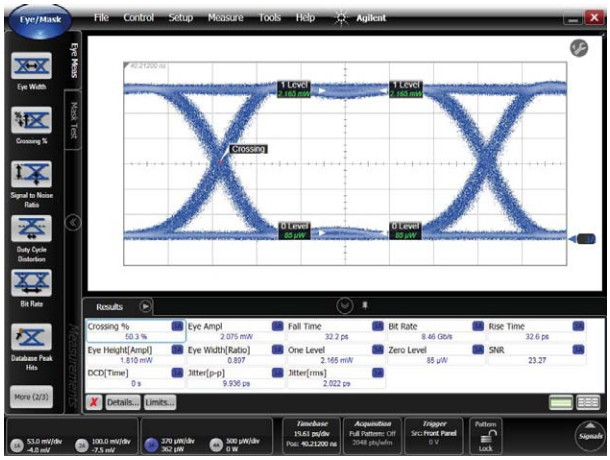
For any high-speed communications signal, the channel and basic signal characteristics must be assessed for compliance with standards and interoperability with other devices in the system path. Digital Communications Analyzers (DCA's) based on wide bandwidth sampling oscilloscopes are recognized as the industry standards for accurate analysis of optical waveforms in R&D, device validation and volume transceiver manufacturing. In addition to basic eye-diagram and pulse waveform characterization, DCA's perform advanced jitter analysis and channel impedance characterization

Transmitter compliance testing and eye diagram analysis

Viewing the eye diagram is the most common method to characterize the quality of a high-speed digital transmitter signal. Industry standards such as SONET, SDH, Fibre Channel and Ethernet rely on eye diagram analysis to confirm transmitter specifications. The eye is examined for mask margin, amplitude, extinction ratio and overall quality. Tests are commonly performed using a well defined reference receiver to provide consistent results both in manufacturing test, incoming inspection, and system level applications. Standards based reference receivers and test procedures are built into the DCA's to provide compliance test capability.

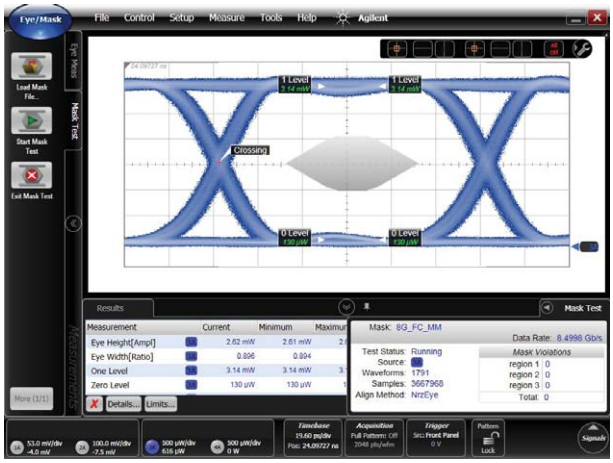
In these standard tests automatic histogram analysis determines signal levels to derive key waveform parameters including but not limited to:

- Extinction ratio: How efficiently laser power is converted to information power
- Optical modulation amplitude (OMA): A measure of modulation power
- Eye height and width: An indication of how open the eye is
- One and Zero levels: The logic levels of the eye
- Signal to noise ratio; Signal strength compare to noise
- Duty cycle distortion and crossing percentage: A measure of eye symmetry
- Basic peak to peak and RMS jitter: A measure of the timing stability of the signal



Parameters are automatically derived from the eye diagram

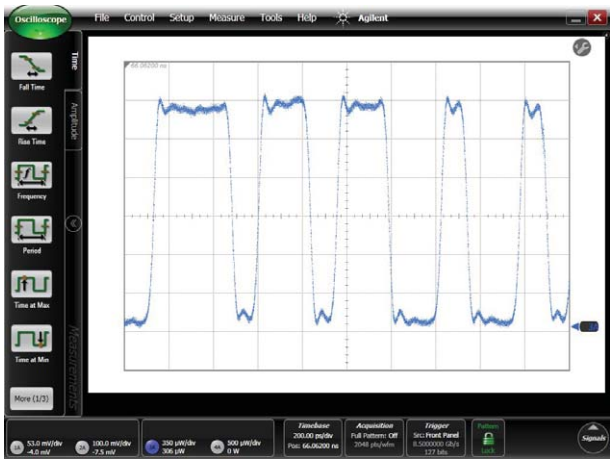
For eye mask testing industry defined masks are compared to the transmitter eye diagram. Pass/Fail is quickly determined. Mask margins can be automatically determined. Eye mask test to industry defined hit-ratios (a relatively new concept defined as the allowed number of hits compared to the total number of waveform samples) is also automatically performed. Eye mask tests are almost always performed using a reference receiver. A reference receiver defines the entire measurement system to have a specific low pass frequency response, the most common being a fourth-order Bessel low-pass response with the -3dB frequency at 75% of the data rate. For example, a 10 Gb/s reference receiver would have a 7.5 GHz bandwidth. A reference receiver allows the waveform to be viewed closer to what a receiver in an actual communications system would see.



Eye mask tests are performed with a reference receiver based test system

Waveform Measurements

Not all waveform measurements of optical signals are performed with a reference receiver. The filtering can be switched out to provide a wider bandwidth measurement system. The unfiltered properties of the waveform are accurately observed. The transmitter output may be viewed as an unfiltered eye, or as a pulse train depending on how the DCA is triggered. A DCA can be placed in 'pattern lock' mode to view the individual bits of a digital communications signal allowing a simple analysis of the waveform quality including parameters such as rise and fall times, pulsewidth and overshoot. In 'pattern lock' mode a complete single-valued waveform record, up to 2^23 bits long, can be recorded for off-line analysis. Advanced signal processing is available with the 86100D (see pages 23)



Individual bits can be observed in a 'pattern lock' display

Typically an external timing reference is used to synchronize the oscilloscope to the test signal. In cases where a trigger signal is not available or when required for a standards compliance measurement, clock recovery modules are available to derive a timing reference directly from the waveform to be measured. Clock recovery not only provides a convenient method to synchronize the oscilloscope, it can also control the amount of jitter displayed. Clock recovery effectively creates a high-pass effect in the jitter being observed on the oscilloscope. The clock recovery system loop bandwidth defines the filtering range (see Agilent Product Note 86100-5).

Jitter Analysis

Every high-speed communications design faces the issue of jitter. When data are jittered from their expected positions in time, receiver circuits can make mistakes in trying to interpret logic levels and bit error ratio (BER) is degraded. As data rates increase, jitter problems tend to be magnified. For example, the bit period of a 10 Gb/s signal is only 100 picoseconds, signal impairments such as attenuation, dispersion and noise can cause the few picoseconds of timing instability that can mean the difference between achieving or failing to reach BER objectives. The problem is further aggravated by the difficulty presented in making accurate measurements of jitter. A variety of measurement approaches exist but there has been frustration within the industry around the complexity of setting up a measurement, getting repeatable results and the inconsistency of different techniques. The "equivalent time" sampling oscilloscope, with configurations having over 80 GHz of bandwidth and extremely low levels of intrinsic jitter, is the most accurate tool available for jitter measurements at high data rates.

In many communications systems and standards, specifying jitter involves determining how much jitter can be on transmitted signals. Jitter is analyzed from the approach that for a system to operate with very low BER's (one error per trillion bits being common), it must be characterized accurately at corresponding levels of precision. This is facilitated through separating the underlying mechanisms of jitter into classes that represent root causes. Specifically, jitter is broken apart into its random and deterministic components. The deterministic elements are further broken down into a variety of subclasses. With the constituent elements of jitter identified and quantified, the impact of jitter on BER is more clearly understood which then leads to straightforward system budget allocations and subsequent device/component specifications. Breaking jitter into its constituent elements allows a precision measurement of the total jitter on a signal, even to extremely low probabilities.

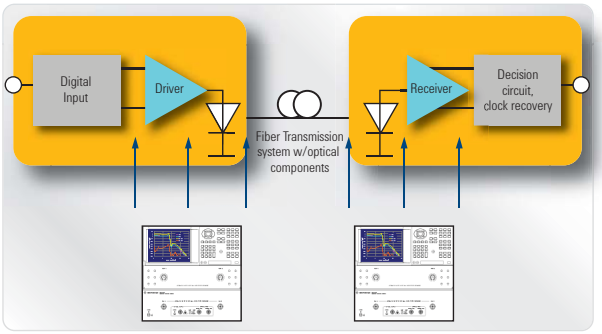
Advanced analysis identifies sources of jitter

Time Domain Reflectometry and Transmission

Most optical devices have high-speed electrical inputs and output paths. High signal integrity is achieved with well designed signal paths. DCA's can also be configured as time domain reflectometers (TDR) to easily determine the transmission and reflection properties of electrical channels. This information can be presented as a function of time or frequency as S-parameters. Most new circuit designs are differential to improve crosstalk and interference performance. Circuits need to be characterized in single-ended, differential signal and common signal configurations.

The TDR module sends a fast edge along the transmission line, then analyzes the reflected signal and displays voltage or impedance versus distance. This information can also be converted into the frequency domain to display return loss, VSWR or reflection coefficient versus frequency. Any selected portion of the trace can also be assessed for the excess inductance or capacitance, allowing the designer to estimate the amount of required compensation in that region.

In digital photonic transmission systems, the performance is ultimately determined by Bit Error Ratio Test (BERT). As this parameter describes the performance of the whole system, it is necessary to design and qualify subcomponents like modulators and PIN detectors, which are analog by nature, with different parameters that reflect their individual performance.



These components significantly influence the overall performance dependant of modulation frequency system with the following parameters:

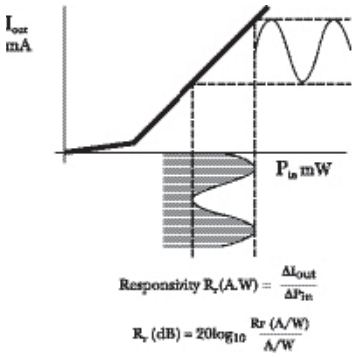
- 3 dB bandwidth of the electro- optical transmission
- Relative frequency response, quantifying how the signal is transformed between optical and electrical connection
- Absolute frequency response, relating the conversion efficiency of signals from the input to the output
- Electrical reflection at the RF port
- Group delay of the opto-electronic component to qualify the distortion caused by frequency dependent delay

In many cases it is necessary to qualify the lab prototype of a receiver or transmitter for manufacturing. In this case the device under test needs to be characterized under various environmental and operating conditions. With the .NET based remote control this task can be automized to verify the optimal working conditions of the device. In the following manufacturing process each device can be characterized using this automated control of the LCA via LAN.

O/E Characterization

The measurement of an electro-optical receiver device consists of the ratio of output electrical modulation current to input optical modulation power. Responsivity for OE devices described how a change in optical power produces a change in electrical current. Graphically this is shown in the figure below.

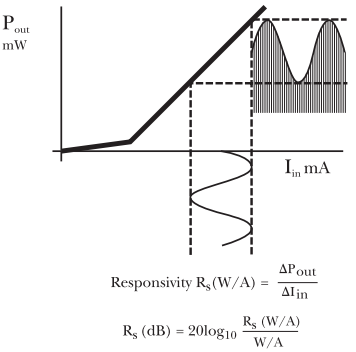
The LCA measures the input optical modulation power and output modulation current and displays the ratio of the two in Amps/Watt.



E/O Characterization

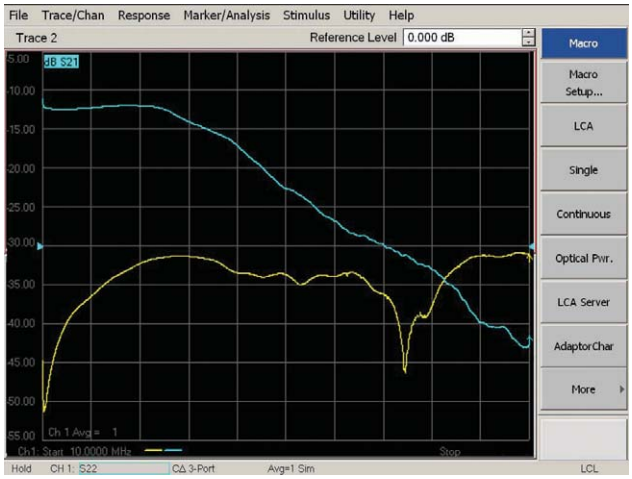
The measurement process for EO devices is similar to OE devices. The measurement of an EO transmitter is a combination of input modulating current and output optical modulation power. Slope responsivity is used to describe how a change in input current produces a change in optical power. Graphically this is shown in the figure below.

An LCA measures input modulating current and output modulation power and displays the ratio of the two in Watts/Amp, either linearly or in decibels.



Agilent N4373C 40/50/67 GHz Single-mode Lightwave Component Analyzer

www.agilent.com/find/lca



The N4373C 67 GHz lightwave component analyzer (LCA) is a high performance electro-optical S-parameter test system. It enables design, quality assurance and manufacturing of most advanced electro-optical components for 40/100 GbE.

Modern optical transmission systems require fast, accurate and repeatable characterization of the core electro-optical components (lasers, modulators and detectors), to guarantee best performance with respect to modulation bandwidth, jitter, gain, and distortion.

As turn-key solution with traceable specifications for relative and absolute responsivity it supports the fastest time to market with best available accuracy for all electro-optical tests.

The N4373C achieves fast measurements by including the E8361C performance network analyzer. A unique new calibration concept significantly reduces setup time resulting in increased productivity in R&D or manufacturing.

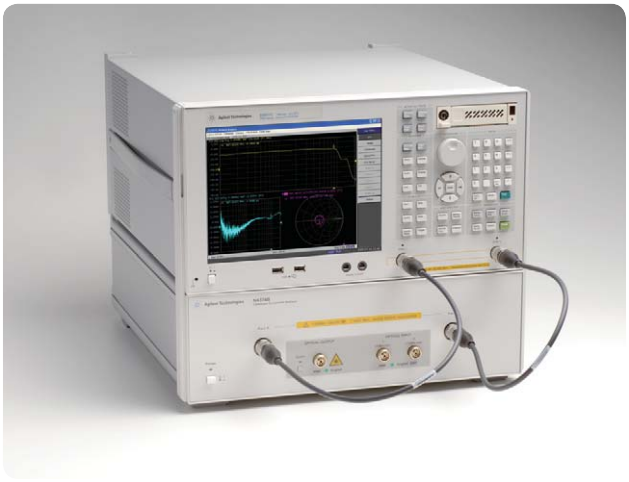
Key Benefits

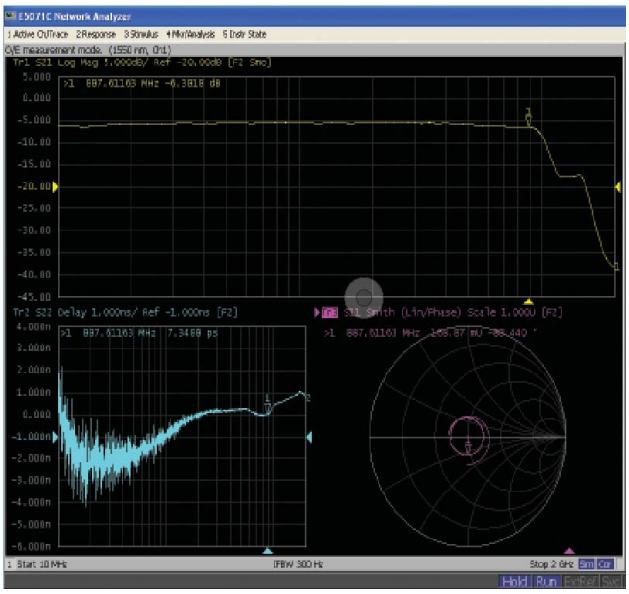
- High absolute and relative accuracy measurements speed up development and production processes. With the excellent accuracy and reproducibility, measurement results can be compared among test locations worldwide.
- High confidence and fast time-to-market with a NIST-traceable turn-key solution.
- Support of 100G electro-optical components
- Significantly increased productivity using the fast and easy measurement setup with a unique new calibration process leads to lower cost of ownership.
- Powerful remote control with state of the art COM programming interface based on Microsoft .NET® makes remote control fast and easy.
- 1310 nm (on special request) and 1550 nm transmitter wavelength for highest test flexibility.
- Integrated optical average power meter for fast transmitter power verification.
- External optical source input option
- Identical LCA software and remote control across the entire N437xB family simplifies integration.

System performance extract (typical data @1550 nm)		0.7 GHz to 20 GHz	20 GHz to 50 GHz	50 GHz to 65 GHz
Relative frequency response uncertainty	E/O O/E	± 0.5 dBe ± 0.5 dBe	± 0.5 dBe ± 0.5 dBe	± 1.3 dBe ± 1.3 dBe
Absolute frequency response uncertainty	E/O O/E	± 0.9 dBe ± 0.9 dBe	± 0.9 dBe ± 0.9dBe	± 1.3 dBe ± 1.3 dBe
Frequency response repeatability	E/O, O/E	± 0.02/± 0.02 dBe	± 0.1/± 0.1 dBe	± 0.2/± 0.5 dBe
Noise floor	E/O O/E	-64 dB (W/A) -60 dB (A/W)	-64 dB (W/A) -60 dB (A/W)	-59 dB (W/A) -55 dB (A/W)
Phase uncertainty (typ.)	E/O O/E	± 2.0° ± 2.0°-	± 2.7° ± 2.7°	± 8.0° ± 8.0°
Group delay uncertainty		Derived from phase uncertainty, see section "Group delay uncertainty". Example: ± 2.0° > ± 8 ps (1 GHz aperture)		

Agilent N4374B 4.5 GHz Single-mode Lightwave Component Analyzer

www.agilent.com/find/lca





The new N4374B lightwave component analyzer (LCA) is the successor of the 8702 LCA with target application in CATV and Radio over Fiber (RoF). It is based on ENA-C series network analyzers.

CATV is supported by offering a 75 Ω referenced measurement. To do this a minimum loss pad is included to adapt from 50 Ω to 75 Ω. With the adapter removal tool included in the ENA all test results show the correct 75 Ω referenced results.

With up to 4.5 GHz modulation frequency range electro-optical S-parameter tests for 3G and LTE RoF applications are well supported.

Traceable specifications for relative and absolute responsivity make the tests results independent of the instrument personality that makes the test results comparable between supplier and vendor or between various locations.

It's the excellent accuracy and repeatability that improves yield from tests performed with the N4374B, by narrowing margins needed to pass the tested devices resulting in improved manufacturing yield.

The turn-key solution offers fastest time to market. With the more than 3 times faster tests compared to the 8702 series this LCA helps to significant reduce manufacturing cost.

Key Benefits

- High absolute and relative accuracy measurements improve the yield of development and production processes.
- Support of 75 Ω of devices.
- Significantly increased productivity using fast and easy measurement setup with a unique new calibration process leads to lower cost of test.
- Identical LCA software and remote control across the N437xB/C family simplifies integration.
- Transmitter wavelength 1550 nm and/or 1310 nm
- Built-in optical power meter
- Settable transmitter output power
- External optical input option*
- Integrated Bias-T option in ENA

System performance extract (typical data @1550 nm)		100 Khz to 0.7 GHz	0.7 GHz to 4.5 GHz
Relative frequency response uncertainty	E/O O/E	±0.7 dBe ±0.7 dBe	±0.5 dBe ±0.5 dBe
Absolute frequency response uncertainty	E/O O/E	±1.7 dBe ±1.7 dBe	±1.5 dBe ±1.5 dBe
Frequency response repeatability	E/O, O/E	±0.02 dBe	±0.02 dBe
Noise floor	E/O O/E	-60 dB (W/A) -50 dB (A/W)	-80 dB (W/A) -70 dB (A/W)
Phase uncertainty (typ.)	E/O O/E	- -	±2.0° ±2.0°
Group delay uncertainty		Derived from phase uncertainty, see section "Group delay uncertainty". Example: ±2.0° ≈ ±8 ps (1 GHz aperture)	

Agilent N4375B 20/26.5 GHz Single-mode Lightwave Component Analyzer

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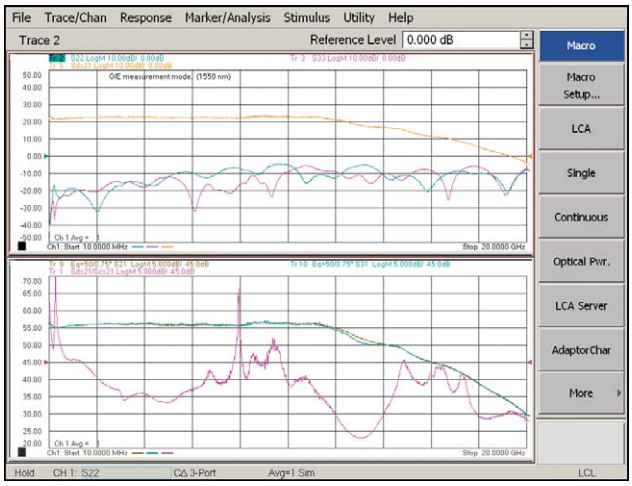


Agilent's N4375B lightwave component analyzer (LCA) is the successor of the industry standard 8703A/B LCA. Its target application is the test of electro-optical components for 10GbE, Fibre Channel FCx8, FCx10 and FCx16.

With a completely new design of the optical test set and a new RF-switched architecture, together with the latest PNA family of network analyzers, the N4375B guarantees excellent electro-optical measurement performance. In addition a unique new calibration concept significantly reduces time from powering up the LCA until the first calibrated measurement can be made. This increases productivity in R&D and on the manufacturing floor.

The fully integrated "turnkey" solution reduces time to market, compared to the time-consuming development of a selfmade setup.

By optimizing the electrical and optical design of the N4375B for lowest noise and ripple, the accuracy has been improved by more than a factor of 3 and is now independent of the electrical return loss of the device under test. It is the excellent accuracy that improves the yield from tests performed with the N4375B, by narrowing margins needed to pass the tested devices. NIST traceability ensures worldwide comparability of test results.

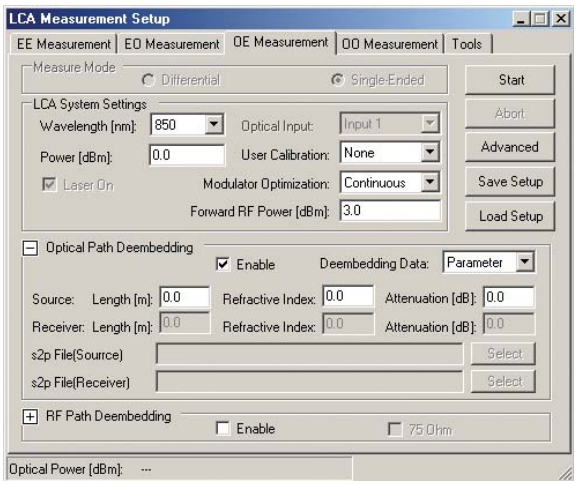
Key Benefits

- High absolute and relative accuracy measurements improve the yield of development and production processes.
- High confidence and fast time-to-market with a NIST traceable turnkey solution.
- Significantly increased productivity using the fast and easy measurement setup with a unique new calibration process leads to lower cost of test.
- More than 3 times faster than predecessor 8703A/B series speeds up every test procedure
- New switched architecture of optical test set for long term reliability and stability of test results.
- Identical LCA software and remote control across the N437xB/C family simplifies integration.
- Transmitter wavelength 1550 nm and/or 1310 nm
- Built-in optical power meter
- Settable transmitter output power
- External optical source input option*

System performance extract (typical data @1550 nm)		0.05 GHz to 0.2 GHz	0.2 GHz to 0.7 GHz	0.7 GHz to 20 GHz
Relative frequency response uncertainty	E/O O/E	± 0.7 dBe ± 0.7 dBe	± 0.5 dBe ± 0.5 dBe	± 0.5 dBe ± 0.5 dBe
Absolute frequency response uncertainty	E/O O/E	± 1.7 dBe ± 1.7 dBe	± 1.5 dBe ± 1.5 dBe	± 1.5 dBe ± 1.5 dBe
Frequency response repeatability	E/O, O/E	± 0.02 dBe	± 0.02 dBe ± 0.05 dBe	
Noise floor	E/O	-60 dB (W/A) O/E	-86 dB (W/A) -49 dB (A/W)	-86 dB (W/A) -72 dB (A/W) -74 dB (A/W)
Phase uncertainty (typ.)	E/O O/E	- -	± 2.0° ± 2.0°	± 2.0° ± 2.0°
Group delay uncertainty		Derived from phase uncertainty, see section "Group delay uncertainty". Example: ± 2.0° > ± 8 ps (1 GHz aperture)		

Agilent N4376B 20/26.5 GHz Multimode Lightwave Component Analyzer

www.agilent.com/find/lca



Agilent's N4376B multimode lightwave component analyzer (LCA) operates at 850 nm to characterize short wavelength 10GbE, Fibre Channel FCx8, FCx10 and FCx16 electro-optical components, with up to 20 or 26.5 GHz modulation range.

The N4376B also supports the test of transmitter and receivers for ultra fast optical computer or server backplanes and optical chip-to-chip connections in high speed computers and server applications.

With a completely new design of the optical test set and a new RF-switched architecture, together with the latest PNA family of network analyzers, the N4376B guarantees excellent electro-optical measurement performance. In addition a unique new calibration concept significantly reduces time from powering up the LCA until the first calibrated measurement can be made. This increases productivity in R&D and on the manufacturing floor.

Multimode measurements are typical much more critical regarding repeatability and stability than single mode measurements. A well defined and stable launch condition increases measurement repeatability. The N4376B has typical multimode launch conditions as defined by the IEEE 802.3ae standard, resulting in application realistic and repeatable test results.

Key Benefits

- Traceable multimode S21 test at 850 nm wavelength.
- IEEE 802.3ae launch power distribution leads to test results comparable to the final application.
- Fast and easy measurement setup and calibration for all standard tests.
- High confidence and fast time-to-market with a traceable turn-key solution.
- Significantly increased productivity using the fast and easy measurement setup with an unique new calibration process leads to lower cost of test.
- Test right at target launch condition eliminates test uncertainty.
- Identical LCA software and remote control across the N437xB/C family simplifies integration.
- LC or SC straight connectors.
- Built-in optical power meter for fast transmitter power verification.
- Powerful remote control with state of the art programming interface based on Microsoft NET or COM.
- Identical LCA software and remote control across the N437xB/C family simplifies integration.

System performance extract (typical data @ 850 nm)		0.05 GHz to 0.2 GHz	0.2 GHz to 10 GHz	10 GHz to 20 GHz
Relative frequency response uncertainty	E/O	±1.3 dBe	±1.3 dBe	±1.6 dBe
	O/E	±1.3 dBe	±1.3 dBe	±1.6 dBe
Absolute frequency response uncertainty	E/O	±2.0dBe	±2.0 dBe	±2.0 dBe
	O/E	±1.7 dBe	±2.0 dBe	±2.0 dBe
Frequency response repeatability	E/O, O/E	±0.2 dBe	±0.1 dBe	±0.1 dBe
Noise floor	E/O	-50 dB (W/A)	-70 dB (W/A)	-70 dB (W/A)
	O/E	-40 dB (A/W)	-60 dB (A/W)	-60 dB (A/W)

Agilent N4391A Optical Modulation Analyzer

NEW

www.agilent.com/find/oma

- **40/100G coherent transmission test**
- **Advanced research for 400 G/1 Tb**
- **Coherent transmitter characterization**
- **Coherent transmission link test**
- **Highest true analog bandwidth**

Unlike the high-speed optical networks of the past, where modulating an optical wave's amplitude on and off at high-rates was sufficient, today's optical links are following the wireless industry's lead to high order modulation formats. Complex modulation formats extend beyond on-off keying by encoding communication symbols with both amplitude and phase information. The N4391A optical modulation analyzer is optimized for analysis of this kind of now optical modulation formats. It supports transmission rates of 40/100G and beyond. The N4391A is the ideal instrument for advanced research on higher than112 Gbit/s transmission speeds.

Characterization of the signal quality of a vector modulated signal right at the transmitter output or along the link is the core application of this kind of instrument. Most important analysis and measurement tools are:

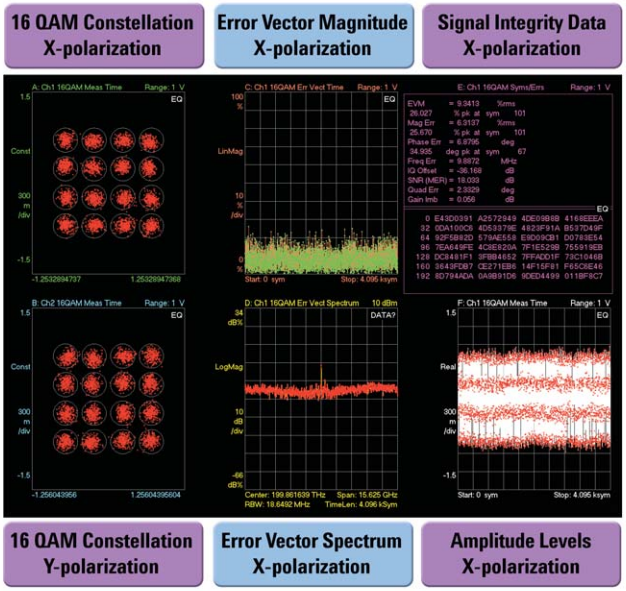
- Optical constellation diagram
- Error vector magnitude (EVM)
- Phase error
- BER on physical layer
- CD, 1st order PMD compensation and measurement
- Quadrature Error
- IQ imbalance
- I or Q Eye diagram
- High resolution spectrum
- Spectrogram of many analysis tools
- Laser line width
- Polarization of analyzed symbols
- Support of more than 30 modulation formats
- Adaptive equalization
- Variable phase tracking bandwidth

Key performance data in combination with two with 90000-X series scopes

- Up to 32 GHz true analog system bandwidth
- Up to 60 Gbaud symbol rate
- Up to 240 Gbit/s analysis for DP-DQPSK
- Up to 64 GHz spectral analysis span
- 700 fs rms jitter between scopes

Features and Benefits

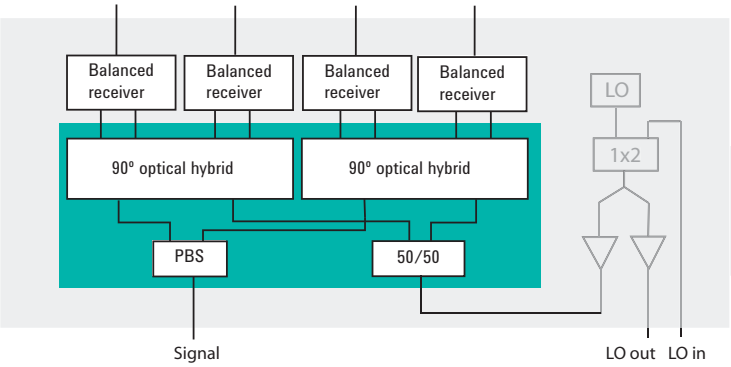
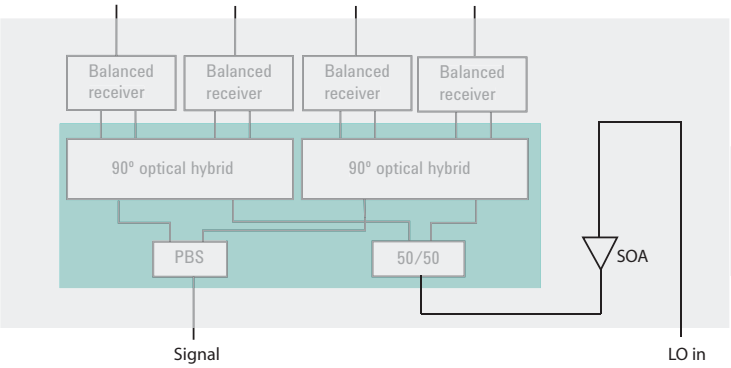
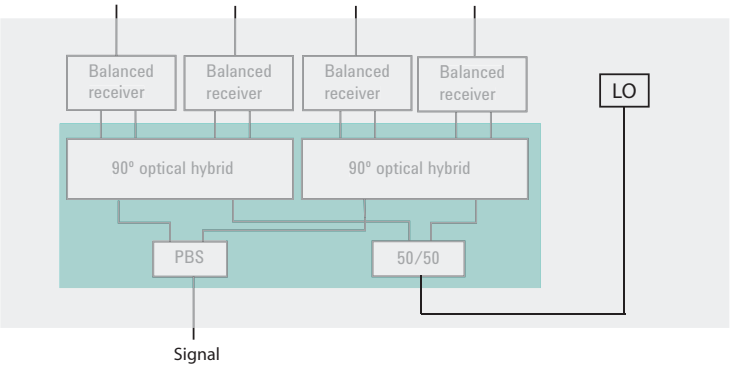
- Wide-bandwidth time-domain polarization-diverse coherent optical receiver, for state-of-the art advanced modulation format analysis.
- Very easy user performable performance verification within minutes for highest reliability of your test results.
- Real-time sampling for optimal phase tracking.
- Highest flexibility, with numerous modulation formats, analysis tools and instrument configurations.
- In-depth analysis of optical transmitters and links with new analysis tools, such as constellation diagram with masks and error vector analysis.
- Full support of DQPSK/DPSK with polarization multiplexed signals.
- No clock input or hardware clock recovery necessary.
- Long pattern analysis available
- Flexible hardware and software concept for future adoption to new requirements and investment protection.
- CD and first order PMD measurement and compensation for link tests with vector modulated signals.



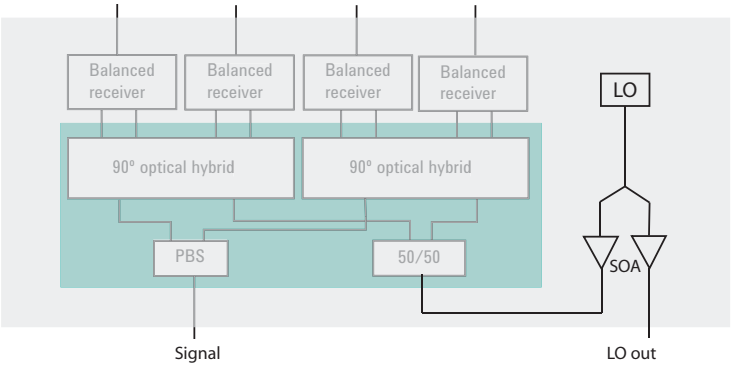
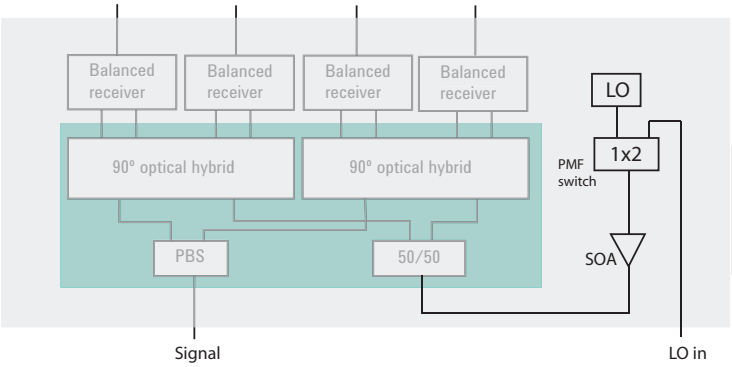
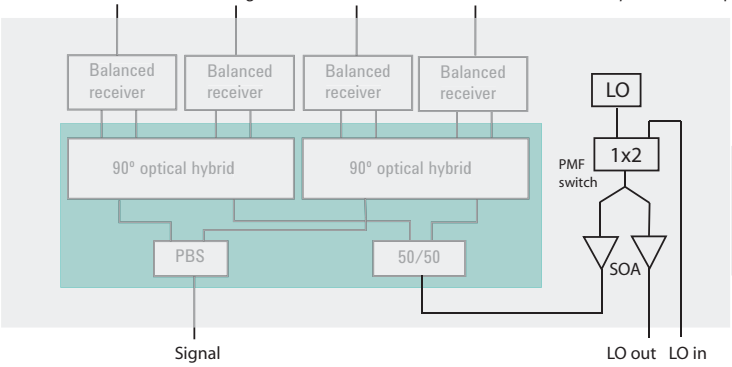
www.agilent.com/find/oma

The table below provides a description and a block diagram of the available hardware configurations.

In addition a selection of tree types of local oscillators are offered.

Product number	Hardware configuration description
N4391A-110	**Optical modulation analyzer with 4 channel receiver and analysis software.** This option is the core hardware with analysis software and has always to be ordered. 
N4391A-200	**External Local Oscillator Input** Local oscillator must be provided by the user and is amplified by an internal semiconductor amplifier (SOA) 
N4391A-210	**Internal Local Oscillator.** For the internal local oscillator a selection of 3 types of laser is provided. C or L band iTLA with slow tuning speed or fast 50nm/s tuning C & L band laser. Select the laser type with option block 5xx. 

www.agilent.com/find/oma

Product number	Option description
N4391A-211	**Internal Local Oscillator with Local Oscillator Out.** For the internal local oscillator a selection of 3 types of laser is provided. C or L band iTLA with slow tuning speed orfast 50nm/s tuning C & L band laser. Select the laser type with option bloc 5xx. In addition a semiconductor amplified high power output of the internal laser signal is available at the instrument output. 
N4391A-212	**Internal Local Oscillator and External Local Oscillator Input.** For the internal local oscillator a selection of 3 types of laser is provided. C or L band iTLA with slow tuning or 50nm/s tuning C & L band laser. Select the laser type with option block 5xx. In addition an external local oscillator signal can be feed into the receiver for homodyne test setups. 
N4391A-220	**Internal Local Oscillator and External Local Oscillator Input and Local Oscillator.** For the internal local oscillator a selection of 3 types of laser is provided. C or L band iTLA with slow tuning or 50nm/s tuning C & L band laser. Select the laser type with option block 5xx. In addition a semiconductor amplified output of the local oscillator signal is provided at the instrument's output and an external local oscillator signal can be feed into the receiver for homodyne test setups 

Agilent Infiniium 90000 X-Series Wide Bandwidth Oscilloscope

NEW

www.agilent.com/find/90000X-Series

- **32 GHz true analog bandwidth**
- **80 GSa/s maximum sample rate**
- **2 Gpts of memory**
- **Industry's lowest noise floor**
- **Over 40 analysis, protocol, and compliance applications**

The Infiniium 90000 X-Series oscilloscope is the world's fastest real-time oscilloscope

The Infiniium 90000 X-Series is the world's fastest oscilloscope with 32 GHz of true analog bandwidth, the deepest memory depth at 2 Gpts, the fastest sampling rate at 80 GSa/s, the lowest noise floor, and the lowest jitter measurement floor. Whether you are designing high speed serial busses, directly digitizing very high frequency carrier frequencies, looking for transient measurements in high end physicists measurements, or analyzing very complex modulation schemes; the 90000 X-Series will provide the most accurate and truest representation of your actual signal.

The 90000 X-Series is the culmination of the last 10 years of oscilloscope design expertise, it features seven new chips designed in Agilent's custom Indium Phosphide technology.

True analog bandwidth

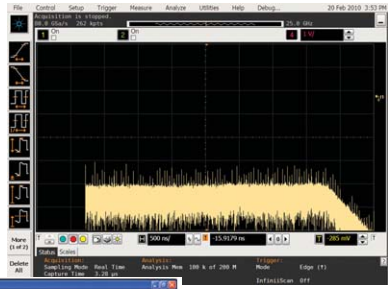
The quest for higher real-time scope bandwidth involves pushing against the physical limitations of state-of-the art integrated circuit technology. Agilent defines true analog bandwidth as performance achieved directly through the hardware of the real-time oscilloscope, and we've achieved breakthrough performance of 32 GHz with the Infiniium 90000 X-Series. Other vendors, limited to 16 GHz hardware, employ various techniques to boost the bandwidth specification of their scopes. However, these methods introduce noise and distortions that negatively impact measurements limiting the analysis capabilities of your modulation analysis research. Agilent firmly believes, that true analog bandwidth is the one and only technique to cope with the challenges of the high-speed digital and optical communication world.

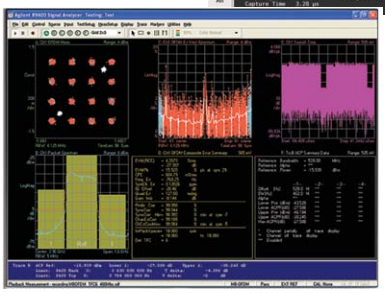
Specifications

- 32 GHz true analog bandwidth
- 16 GHz analog bandwidth (4 channels)
- 80 GSa/s sample rate
- 2 Gpts of memory
- < 2.2 mVrms noise at 50 mV/div and 32 GHz
- < 500 uV at 10 mV/div
- EVM rated at 1.2%
- 150 fs jitter measurement floor
- > 5 ENOB at 30 GHz
- > 1000 wfm/s update rate
- 22 GHz edge trigger
- ± 0.2 db magnitude flatness to 32 GHz
- 30 GHz probing system

Not just a tool for the digital world

Infiniium built-in FFT allows users to quickly and easily analyze the frequency components of their signals. Both FFT magnitude and phase can be displayed and can be combined with other built-in math functions or MATLAB® based measurements. Standard windowing of Hanning, Flattop and Rectangular are supported along with cursor based power measurements. When more powerful frequency domain measurements are required, including modulation analysis, consider the Agilent 89600 Vector Signal Analyzer software.





90000-X Series the digitizer of choice to start with optical modulation analysis.

The 90000 X-Series Scopes offer lowest noise, highest number of effective bits and flattest frequency response at the market. This is the ideal prerequisite for using this kind of scopes for receiver development and research on highly sophisticated algorithms. In case a fully turn-key instrument that offers fast and easy full characterization of physical layer optical vector modulated signals the 90000-X is an bias investment to upgrade to the N4391A optical modulation analyzer, which is based on this high performance oscilloscope of up to 32 GHz true analog bandwidth.

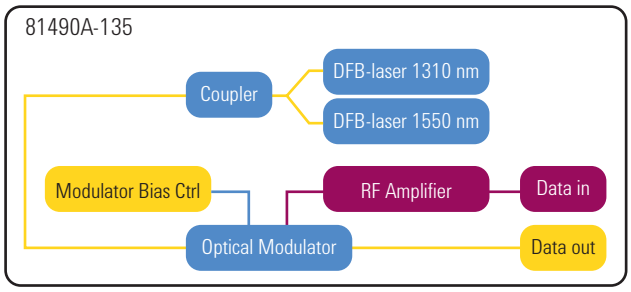
Agilent 81490A Reference Transmitter

www.agilent.com/find/ref

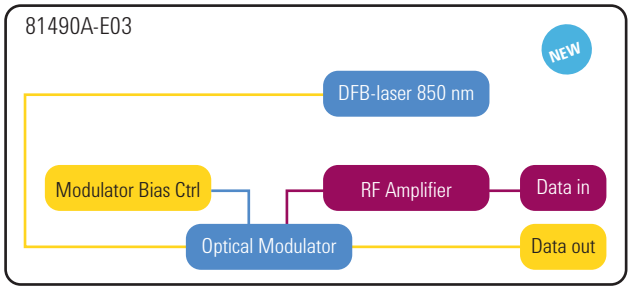
Agilent's 81490A Reference Transmitter is designed to offer excellent eye quality as a reference for testing 10GbE -LR/-ER, 10G Fibre Channel and short reach transceivers, such as 10GBase-SR, 40GBase-SR4, 100GBase-SR10 and according to 10 GFC Fibre Channel specifications. The modules are fully integrated into the industry standard Lightwave Measurement System (LMS) 816xB platform.

NEW

The Reference Transmitter is available for Multimode 850 nm and Singlemode 1310 nm/1550 nm applications. Offering both 1310 nm and 1550 nm in one module gives the fastest reconfiguration between these two transmission bands without reconnecting. The integration in the LMS mainframe offers an integration of the reference transmitter into the N4917A stressed eye software package. Of course a separate usage of the transmitter is also supported with SCPI language.



81490A-135 1310 nm/1550 nm reference transmitter



81490A-E03 850 nm reference transmitter

The separation of the signal source and the modulator is the only way to offer a zero-chirp modulation. This is essential for a clean and repeatable eye diagram when modulating with an appropriate clean external source to fulfill the requirements of the IEEE standard. Another advantage of this design compared to directly modulated transmitters is the wide extinction ratio range that can only be achieved with this design.

Benefits

- Repeatable and reproducible measurements permit lower production test margins and improved specifications of the characterized devices.
- Reliable measurements ensure comparability of the test results.
- Support for full compliance to IEEE 802.3 stressed eye test in combination with the N4917A Optical Receiver Stress Test solution.
- Wide extinction range offers highest test range coverage to ensure best quality of the tested devices under all target operating conditions.
- Rapid test reconfiguration with dual-wavelength to switch between 1310 nm and 1550 nm by remote control or manually without exchanging a module.
- Scalability with integration into industry-standard Agilent LMS platform extends your optical workbench capabilities.

Application

- Reference transmitter for stressed eye compliance test according to IEEE 802.3 and 10G Fiber Channel.
- Creation of arbitrary optical modulation signals in combination with waveform generators.
- General transmission system test with special pulse patterns in combination with a pattern generator.

Specifications

Maximum extinction ratio

> 10dB

Vertical eye closure penalty

VECP < 0.7 dB (Opt. E03) , VECP < 0.5 dB (Opt. 135)

Jitter (peak - peak)

< 18ps (Opt. E03), < 12 ps (Opt. 135)

Relative intensity noise (RIN)

RIN < -136 dB/Hz

Transmitter wavelength:

850 ± 10 nm (Opt. E03), 1310 ± 10 nm, 1550 nm ± 10 nm (Opt. 135)

Average optical output power

P > 0.0 dBm (Opt. E03), P > 5.0 dBm (Opt. 135)

Agilent 90000 Series Oscilloscopes with the 81495A Optical Reference Receiver

www.agilent.com/find/90000A
www.agilent.com/find/ref

- Capture optical signals of interest using advanced triggering capabilities for maximum flexibility
- Take advantage of a record length of up to 1 billion samples to acquire a contiguous optical waveform for extended analysis
- Perform various functions on your optical waveforms in real time with the built-in math functions or tightly integrated MATLAB® environment

Make Optical Measurements with the Flexibility of a Real-time Scope

The Agilent Infiniium 90000 Series real-time digital storage oscilloscopes (DSO) and digital signal analyzers (DSA) provide superior signal integrity and deep application analysis to give you better insight into your designs. Now you can use these high-performance scopes with the 81495A optical reference receiver to make advanced optical measurements. The 81495A is an optical electrical (O/E) converter optimized for transceiver loop-back test. Combine the 81495A with a 90000 Series scope and you can quickly and smoothly move through optical waveform measurement and advanced analysis using the Infiniium's intuitive interface and large touch screen.

Use the Ideal Optical Front-end Solution

The 81495A optical reference receiver is a module for the industry-standard Agilent lightwave measurement systems (LMS) mainframes. The module's linear transfer characteristics and advanced capabilities make it an excellent optical front end for real-time oscilloscopes:

- Reference receiver response with modulation bandwidth of 9 GHz
- Multimode fiber input, accepting both single-mode and multimode signals
- Optical wavelengths from 750 nm to 1650 nm
- Measurements with 20% to 80% rise-times down to about 35 ps

Perform a Range of Analyses

An Infiniium 90000 Series oscilloscope combined with the 81495A optical reference receiver offers an excellent real-time solution that enables advanced analysis of optical waveforms. Measurements and math functions include:

- Waveform
- Eye diagram
- Jitter analysis
- Statistics
- Histogram analysis of "1" and "0" levels for extinction ratio (ER) and optical modulation amplitude (OMA) measurements
- Mask testing
- Waveform math

In addition, this combination of instruments supports any scientific optical measurement setup that requires O/E conversion up to 9 GHz.

81495A Reference Receiver

Simplify Optical Measurements

The intuitive user-interface and versatility of the 90000 Series oscilloscopes let you connect to the 81495A and set up your scope for optical measurements in just a few simple steps. The seamless integration of the module-scope system into the industry-standard Agilent LMS platform extends your optical test capabilities. The user-friendly front panel of 90000 Series scopes gives you instant access to automated measurements and functions, including marker and fine/vernier control.

Get the Most Accurate Measurements

The 90000 Series oscilloscopes feature the industry's lowest noise floor, which ensures you see the true performance of the device under test. Combining the scope with the low noise floor and low jitter of the 81495A optical reference receiver produces a powerful system that supports reliable O/E conversion for advanced optical waveform analysis.

Speed up Optical Measurements

The 90000 Series scopes' real-time signal acquisition allows fast single-shot capture of optical data streams. The integrated average optical power meter of the 81495A optical reference receiver provides quick signal-level verification and diagnosis.

Enjoy Advanced Capture and Analysis Capabilities

With the 90000 Series' industry-exclusive ultra-deep 1 Gpts of memory and combined software/hardware triggering, you can quickly capture complex and infrequent signals for the most effective debugging and analysis. Agilent's advanced InfiniiScan software enables you to trigger on specific data patterns and provides virtually unlimited triggering combinations. In addition, the available record length of up to 1 billion samples allows capture and analysis of long data streams – up to 25 ms of data at 40 GSa/s with post-processing.

Increase Productivity

The 90000 Series scopes use the familiar Infiniium graphical user interface, including convenient drag-and-drop measurement icons. Infiniium's analog-like front panel has a full set of controls color-coded to waveforms and measurements, making tasks simple. The scope also includes a full suite of measurements and waveform math functions.

Performance Overview

- 2.5 to 13 GHz bandwidth
- 20 GSa/s or 40 GSa/s sampling rate
- 10 Mpts to 1 Gpts record length
- 22 MSa/s max data transfer rate
- Advanced triggering, industry's only 3-level sequence triggering

- **Filter mode**
- **Excellent wavelength accuracy and low polarization dependence**
- **-90 dBm sensitivity and 90 dB dynamic range**
- **Flexible monochromator output model**
- **Applications with automatic pass/fail checking**

Agilent 86146B

The Agilent 8614xB family of grating-based optical spectrum analyzers display the amplitude of light versus wavelength over a 600 to 1700 nm wavelength range. The OSA uses a patented double-pass monochromator design to simultaneously achieve high sensitivity and dynamic range with a fast sweep time. This is key for characterizing DWDM components and multiple channel systems, especially in a manufacturing environment where speed, accuracy and throughput are critical. The OSAs also have a two year calibration cycle keeping production on-line longer.

Built-in Applications

Agilent Technologies has developed a unique concept for built-in applications. The complete suite of applications enables the user to develop tests that can be customized to their particular measurement. The current package of applications contains the following:

- Passive component test application
- WDM application
- Amplifier test application
- Source test application

Additional Features

The Agilent 8614xB family of optical spectrum analyzers feature up to six traces and four independent markers. The built-in trace math function of the OSA allows for multiple traces to be used for normalization measurements. The markers allow for easy measurement of wavelength separation (GHz or nm), power density and optical signal-to-noise ratio.

Filter Mode

In Filter Mode, available with the 86146B, the light from the grating monochromator is directed to a single-mode fiber optical output from the instrument. The monochromator can be swept or set to a fixed wavelength. At the front panel, the user has the option of routing the light back to a photodetector in the OSA, especially for alignment, or to another instrument for analysis. As with standard operation, the resolution bandwidth of this tunable wavelength filter can be set by the user.

Channel Drop

One of the features of Filter Mode is to allow a single channel to be isolated from a tightly spaced DWDM signal. The WDM firmware application can sequentially or selectively drop WDM channels that require additional analysis. It is possible to select a certain wavelength or a certain channel to be dropped out. It can then be quantitatively analyzed in the time domain. It is now possible to switch between parametric measurements in the physical domain to functional measurements in the time domain.

Time Resolved Chirp

Agilent's filter mode channel-drop feature enables lower cost of test and higher flexibility of use than other solutions. However, the benefits don't end there. A second feature of Agilent's filter mode is the ability to measure time-resolved chirp (TRC). Chirp is the small frequency shift that occurs during optical signal modulation. It is caused by the slight changes in refractive index of the optical modulator. TRC is the instantaneous optical frequency deviation versus time. Measuring TRC enables lower cost lasers to be used in DWDM components.

The TRC measurement is made using the 86146B OSA and the 86100D digital communication analyzer. The 86100D requires an optical module like the 86105B, 86105C or 86116A. The software, provided with the 86146B performs the TRC measurement and Dispersion Penalty Calculation (DPC). The DPC routine can be used to qualify transmitters for the distance over which they can be used and is an alternative to measuring dispersion penalty using a bit error ratio setup.

Core Specification*	**86142B**	**86146B**
Wavelength		
Range	600-1700 nm	
Accuracy		
1480-1570 nm	± 0.01 nm	
1570-1620 nm	± 0.025 nm	
Resolution Bandwidth		
FWHM	0.06, 0.1, 0.2, 0.4, 1.2, 5, 10 nm	0.06, 0.07, 0.1, 0.14 0.2, 0.33, 0.4, 1.2, 5, 10 nm
Polarization dependence		
1530 nm, 1565 nm	± 0.05 dB	± 0.05 dB
1250 nm-1650 nm	± 0.25 dB	± 0.25 dB
Dynamic Range (0.1 nm RBW)		
1250-1610nm		
± 0.5, 1, 5 nm	-70 dB	
At ± 0.8 nm	-60 dB	-60 dB
At ± 0.4 nm	-55 dB	-55 dB

*For detailed spec conditions please refer to technical specification pub. no. 5980-0177E.

- **Characterize WDM spectra during R&D, manufacturing and commissioning**
- **Wavelength accuracy < ± 0.3 pm with 0.5s update rate**
- **Simultaneously measure wavelengths and powers of up to 1000 channels**
- **Automatic optical signal-to-noise ratio measurements**
- **Automated measurement routines and data logging**

As the demand for access to more information increases, the need for greater capacity on transmission systems drives component manufacturers and network equipment manufacturers to push their capabilities to new limits. The successful design and deployment of DWDM systems requires that stringent performance criteria are met in order to guarantee quality of service. With Agilent multi-wavelength meters, you will be able to address these demands with confidence.

The Performance You Need – When You Need It

The Agilent family of multi-wavelength meters is just that – a family. Each model uses compatible SCPI remote commands. You pay for only the performance you need, when you need it. If your requirements become more demanding in the future, you can substitute another Agilent multi-wavelength meter, avoiding unnecessary cost and time developing new code for your test system. With the 86122A, you can upgrade to a unit with the best performance available. Agilent multi-wavelength meters allow you to optimize test costs while protecting your investments.

Simultaneously Measure up to 1000 Wavelengths and Powers

The Agilent 86120B, 86120C and 86122A multi-wavelength meters, like other, Michelson interferometer-based wavelength meters, allow you to measure the average wavelength of the input signal. In addition, the Agilent multi-wavelength meters – with advanced digital processing – accurately and easily differentiate and measure up to 1000 (200 and 100 for the 86120C and 86120B, respectively) discrete wavelengths.

Agilent multi-wavelength meters simultaneously measure the individual powers of discrete wavelengths, offering the following measurement capabilities:

- 1 to 1000 wavelengths and powers
- Average wavelength and total power
- Up to ± 0.2 ppm wavelength accuracy
- Up to 5 GHz wavelength resolution
- Calibrated for evaluation in air or vacuum
- Wavelength units in nm, THz, or wave number (cm^{-1})
- Amplitude units in dBm, mW, or µW
- OSNR and averaged OSNR for WDM SONET/SDH systems
- Rugged design to withstand strong shocks and vibrations

WDM Transmission Systems

Combining measurement performance with reliability, the Agilent multi-wavelength meters allow easy and accurate verification of optical carrier performance in transmission systems by measuring wavelength, power and optical signal-to-noise ratios during design and manufacturing test. The 86122A multi-wavelength meter is optimized for measuring ultra-dense channel spacing with an absolute wavelength accuracy of up to ± 0.2 ppm (± 0.3 pm referenced to 1550 nm). With a resolution of < 5 GHz, it is an ideal solution for the design and manufacturing of next-generation optical networks.

With a rugged and portable package, the 86120B and 86120C multi-wavelength meters are ideal for optical network commissioning and monitoring applications. With the 86120C resolution of < 10 GHz (< 20 GHz for the 86120B) and absolute wavelength accuracy of ± 2 ppm or ± 3 pm at 1550 nm (± 3 ppm, ± 5 pm at 1550 nm for the 86120B), you can confidently verify system performance of DWDM systems with channels spaced at < 50 GHz.

Sources

The superior wavelength and amplitude measurement capabilities of the Agilent 86120B, 86120C and 86122A multi-wavelength meters enable maximum performance of your components. You can measure DFB, FP, iTLA or multiple DFB laser wavelengths and amplitudes during burn-in, environmental evaluation, mode mapping, final test and incoming inspection. Calculate center wavelengths of broader linewidth sources, such as LED's or Bragg-Gratings filtered ASE responses, using the user-selectable broadband algorithm.

Features and Advanced Measurement Applications:

- Relative Wavelength and Amplitude Measurements
- Built-in Data Logging
- Drift: current and Min / Max values
- Optical Signal-To-Noise Ratio
- Fabry-Perot Laser Characterization (available on 86120C and 86122A)
- Coherence Length (available on 86120B only)

Instrument Drivers

Instrument drivers compatible with LabView, Visual Basic, C++, and LabWindows are available for the Agilent 86120B, 86120C, and 86122A multi-wavelength meters. These drivers enable remote program development by offering building blocks that allow you to customize your measurements.

Specifications

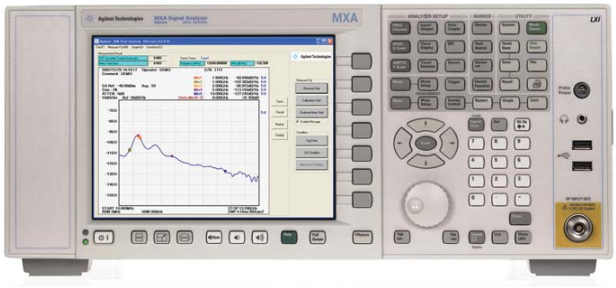
The technical specifications apply to all functions over the temperature range 0 to 55°C and relative humidity <95%, unless otherwise noted. All specifications apply after the instrument's temperature has been stabilized for 15 minutes in Normal Update mode, unless otherwise noted. Specifications describe the instrument's warranted performance. Supplementary performance characteristics provide information about non-warranted instrument performance in the form of nominal values, and are printed in italic typeface.

		86120B	86120C	86122A
Maximum Number of Laser Lines Input		100	200	1000
Wavelength	Range	700 – 1650 nm (182 to 428 THz)	1270 – 1650 nm (182 to 236 THz)	1270 – 1650 nm (182 to 236 THz)
	Absolute Accuracy	± 3 ppm (±0.005 nm at 1550 nm, ± 0.004 nm at 1310 nm) for laser lines separated by ≥ 30 GHz	±2 ppm (±0.003 nm at 1550 nm and 1310 nm) for laser lines separated by ≥ 15 GHz	± 0.5 ppm (± 0.75 pm at 1550 nm and ± 0.65 pm at 1310 nm); ±0.2 ppm[1] (± 0.3 pm at 1550 nm and 1310 nm) for laser lines separated by ≥ 10 GHz
	Minimum Resolvable Separation (equal power lines input)	20 GHz (0.16 nm at 1550 nm, 0.11 nm at 1300 nm)[2]	10 GHz (0.08 nm at 1550 nm, 0.06 nm at 1300 nm)[3]	5 GHz (0.04 nm at 1550 nm; 0.03 nm at 1310 nm)[4]
	Display Resolution	0.001 nm, normal update mode; 0.01 nm, fast update mode	0.001 nm	0.0001 nm
	Units	nm (vacuum or standard air), cm^{-1}, THz	nm (vacuum or standard air), cm^{-1}, THz	nm (vacuum or standard air), cm^{-1}, THz
Power	Absolute Accuracy	± 0.5 dB (at ±30 nm from 780, 1310, and 1550 nm)	± 0.5 dB (at ±30 nm from 1310 and 1550 nm)	± 0.5 dB (at ±30 nm from 1310 and1550 nm)
	Flatness, 30 nm from any wavelength	± 0.2 dB, 1200 – 1600 nm ± 0.5 dB, 700 – 1650 nm	± 0.2 dB, 1270 – 1600 nm ± 0.5 dB, 1270 – 1650 nm	± 0.2 dB, 1270 – 1600 nm ± 0.5 dB, 1270 – 1650 nm
	Linearity	± 0.3 dB, 1200 – 1600 nm,	± 0.3 dB, 1270 – 1600 nm,	± 0.3 dB, 1270 – 1600 nm,
	Polarization Dependence	± 0.5 dB, 1200 – 1600 nm ± 1.0 dB, 700 – 1650 nm	± 0.5 dB, 1270 – 1600 nm ± 1.0 dB, 1600 – 1650 nm	± 0.5 dB, 1270 – 1600 nm ± 1.0 dB, 1600 – 1650 nm
	Units	dBm, mW, µW	dBm, mW, µW	dBm, mW, µW
Sensitivity[5]	Single Line Input	–40 dBm, 1200 – 1600 nm	–40 dBm, 1270 – 1600 nm –30 dBm, 1600 – 1650 nm	–40 dBm, 1270 – 1600 nm –30 dBm, 1600 – 1650 nm
	Multiple Lines Input	30 dB below total input power, but not less than single line input sensitivity, 700 – 1650 nm	30 dB below total input power, but not less than single line input sensitivity, 1270 – 1650 nm	30 dB below total input power, but not less than single line input sensitivity, 1270 – 1650 nm
Measurement Cycle Time		1.0 s	1.0 s	0.5 s
Input Power	Maximum Displayed Level (sum of all lines input)	+10 dBm	+10 dBm	+10 dBm
	Maximum Safe Input Level (sum of all lines input)	+18 dBm	+18 dBm	+18 dBm
Built-in Automatic Measurement Applications				
	Signal-to-Noise Ratio (0.1 nm noise bandwidth), lines above –25 dBm	> 35 dB, channel spacing ≥ 200 GHz > 27 dB, channel spacing ≥ 100 GHz	> 35 dB, channel spacing ≥ 100 GHz > 27 dB, channel spacing ≥ 50 GHz	> 35 dB, channel spacing ≥ 100 GHz > 27 dB, channel spacing ≥ 50 GHz
	Signal-to-Noise Ratio of Modulated Lasers (with averaging) (0.1 nm noise bandwidth), lines above –25 dBm, 100 averages	> 35 dB, channel spacing ≥ 200 GHz > 27 dB, channel spacing ≥ 100 GHz	> 35 dB, channel spacing ≥ 100 GHz > 27 dB, channel spacing ≥ 50 GHz	> 35 dB, channel spacing ≥ 100 GHz > 27 dB, channel spacing ≥ 50 GHz
	Drift	Max, Min, Max-Min wavelengths and powers over time		
Laser Classification		FDA Laser Class I according to 21 CFR 1040.10; IEC Laser Class 1 according to IEC 60825		
Dimensions HxWxD		140 mm x 340 mm x 465 mm (5.5 in x 13.4 in x 18.3 in)		133 mm x 425 mm x 520 mm (5.2 in x 16.7 in x 20.5 in)
Weight		9 kg (19 lb)		14.5 kg (32 lb)

[1] Specify 86122A-002 option.
[2] For lines separated by less than 30 GHz, wavelength accuracy is reduced.
[3] For lines separated by less than 15 GHz, wavelength accuracy is reduced.
[4] For lines separated by less than 10 GHz, wavelength accuracy is reduced.
[5] Contact Agilent Technologies for availability of special instruments with higher sensitivity.

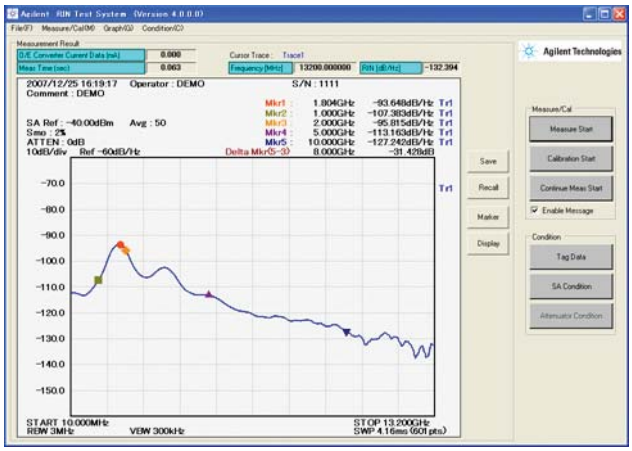
Agilent N4371A RIN Measurement System

www.agilent.com/find/rin



N4371A RIN Measurement System

- **Accurate, high-speed and easy measurements of RIN frequency characteristics**
- **Reduced uncertainty by using Agilent original calibration technique (patent pending)**
- **High-speed measurement (5 seconds or less for 20 GHz span, 2000 point, 10 average)**
- **Analysis on multiple traces by various markers**



RIN Measurement User Interface

Agilent provides accurate, high-speed and easy-to-use spectral RIN measurement system by combination of a sensitive, low-noise optical receiver, a industry-standard x-series spectrum analyzer and a digital multi-meter. RIN (Relative Intensity Noise) is a parameter representing temporal fluctuations of intensity of a laser signal and is used as an evaluation index of the noise characteristic of the laser devices. RIN is an indispensable item for indicating the signal quality of both digital and analog optical transmission systems.

Agilent N4371A RIN measurement system provides accurate RIN measurements with a specially developed calibration technique (patent pending) for the photoelectric frequency response of the entire system. Agilent RIN measurement system also reduces uncertainties by removing the interference by thermal noise and shot noise precisely.

The measurement speed of N4371A RIN measurement system is very fast by special control of the spectrum analyzer. The measurement time is less than 5 seconds with the condition of a 20 GHz frequency span, 2,000 frequency points and 10 times average. The high-speed measurement enables a real-time observation of RIN frequency characteristics with varying parameters of the DUT.

The user interface of N4371A RIN measurement system shown in the image left is easily accessible from the spectrum analyzer display. The user interface provides functions of displaying up to 5 traces, placing up to 5 markers and searching minimum or maximum RIN values in specific frequency range.

Performance Characteristics

Corresponding wavelength	1265 nm – 1625 nm
Frequency range	100 kHz to 3 GHz, 10 MHz to 6.7 GHz / 13.2 GHz / 20 GHz
Maximum input optical power	≤ +10 dBm @1310 nm and 1550 nm
Minimum RIN measurement value	≤ -160 dB/Hz @0 dBm received optical power; 1310 nm and 1550 nm

System Configuration

N9020A MXA signal analyzer
Agilent optical receiver
34410A digital multimeter

Frequency Range	**100kHz to 3GHz**	**10MHz to 6.7GHz**	**10MHz to 13.2GHz**	**10MHz to 20GHz**
MXA series option	N9020A-503	N9020A-508	N9020A-513	N9020A-526

Agilent 86100D Wide-Bandwidth Oscilloscope Mainframe and Modules

NEW

www.agilent.com/find/dcax

The 86100 series Digital Communications Analyzer is the industry standard for characterizing high-speed transmitter waveforms.
Integrated, calibrated optical reference receivers coupled with built-in automated compliance software are the key to accurate measurements.

The 86100D DCA-X has been engineered for unmatched accuracy, insight, and ease-of-use. In addition to providing industry leading signal integrity measurements, the DCA-X provides:

Accurate characterization of optical waveforms

The 86100D is the ideal tool for viewing optical transceiver signals. A variety of plug-in modules are available with built-in optical receivers allowing the highest accuracy in waveform analysis. Industry standard reference receivers provide the correct frequency response to validate compliance to SONET/SDH, Ethernet, Fibre Channel and other specifications. Select from several plug-in modules to get the configuration that best matches your transceiver applications. Built-in test applications provide the following measurements:

- Automatic testing to industry standard eye masks
- Accurate measurement of eye diagram parameters including extinction ratio, eye-height and width, crossing percentage etc.
- Fast throughput and simultaneous multiple channel testing for extremely low cost-of-test.

Powerful new INSIGHT

- Integrated de-embedding / embedding capability (using 86100D-SIM InfiniiSim-DCA license)
- Advanced signal processing such as filtering, FFT, differentiate and integrate functions
- New measurement capability, including Data Dependent Pulse Width Shrinkage (DDPWS), uncorrelated jitter (UJ), J2, J9 and more...

Improved USABILITY

- Dual user interfaces
- FlexDCA - a new customizable vector-based user interface for scope, eye, and jitter measurements
- DCA-J "classic" user interface for 100% backwards compatibility
- Customizable user-interface
- Display up to 64 measurements simultaneously
- ONE button setups

Improved PRODUCTIVITY

- Built-in Waveform Simulator with random/periodic jitter and noise generator
- Live or Offline Signal Analysis (using N1010A FlexDCA Remote Access Software)

NEXT GENERATION Platform

- Supports up to 16 channels (with future mini-modules) for testing high density ASIC/FPGA testing and parallel designs
- Vertical gain and offset controls that can be assigned to all channels and functions
- User-defined multi-purpose button
- User-defined analog control knob
- 3X faster CPU than DCA-J
- 100% backwards compatibility with all DCA modules

Improves margins and helps to differentiate products for a wide range of applications such as:

- Transceiver Design and Manufacturing
- ASIC / FPGA / IC Design and Characterization
- Signal Integrity measurements on Serial Bus Designs,
- Cables, Printed Circuit Boards (PCB)

Precision measurements on high-speed signals at the touch of one button!

- Scope Mode yields the most accurate waveform measurements
- Eye/Mask Mode provides fast and accurate compliance testing of transceivers
- TDR/TDT Mode for precision impedance measurements with S-Parameter capability
- Jitter and Amplitude Mode for comprehensive analysis of signal characteristics

Powerful analysis features provide greater insight

- Integrated de-embedding, embedding, and equalization capability
- Jitter Spectrum and Phase Locked Loop (PLL) Analysis
- Jitter analysis on long patterns such as PRBS31
- Custom measurements and analysis using The MathWorks MATLAB software

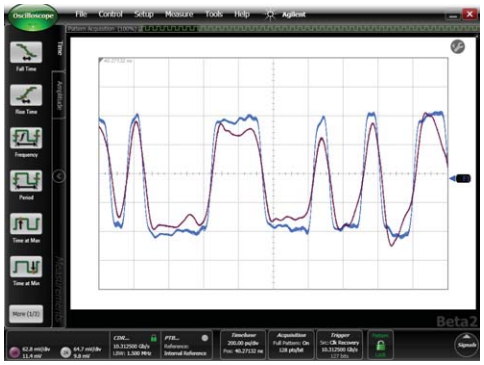
Lowest Cost of Test

- Modular platform supports up to 16 parallel channels
- Optimized algorithms designed for manufacturing test
- Modular – buy only what you need today knowing you can upgrade later
- Protect your investment - the 86100D is 100% compatible with all DCA modules

Agilent 86100D DCA-X (four powerful instruments in one)

www.agilent.com/find/dcax

Scope Mode

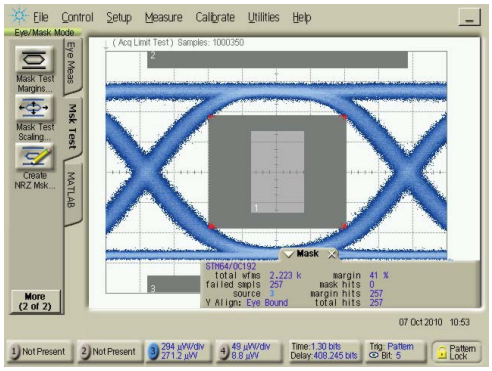


High-fidelity waveform characterization (Purple: raw trace, Blue: de-embedded waveform)

Jitter Mode

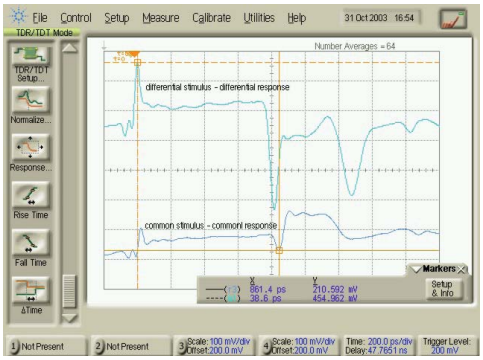
Precision jitter, amplitude, and frequency analysis capability

Eye/Mask Mode



Fast transmitter characterization using eye diagram analysis and automated mask margin measurements

TDR/TDT Mode



Accurate time domain reflectometry/transmission and S-Parameter measurements

These modes are further complemented by the following features that provide additional insight and analysis capability:

- De-embedding, embedding, equalizer capability
- Phase Noise/Jitter Spectrum Analysis
- Phase Locked Loop (PLL) Analysis
- And more...

Precision Measurements, More Margin, and More Insight

The 86100D DCA-X oscilloscope combines high analog bandwidth, low jitter, and low noise performance to accurately characterize optical and electrical designs from 50 Mb/s to over 80 Gb/s. The mainframe provides the foundation for powerful insight and measurement capability, such as de-embedding of cables and fixtures, that improve margins and allow engineers to see the true performance of their designs.

Modular

The modular system means that the instrument can grow to meet your needs, when you need it. There's no need to purchase capability that you don't need now. The DCA-X supports a wide range of modules for testing optical and electrical designs. Select modules to get the specific bandwidth, filtering, and sensitivity you need. The DCA-X supports all modules in the DCA family and is 100% backwards compatible with the 86100C mainframe.

Software

The DCA-X provides powerful analysis capability that is enabled through licensed software options. Examples include 86100D-200 for fast and accurate jitter analysis, and 86100D-SIM for de-embedding and/or embedding of fixtures and cables.

Agilent 86100D DCA-X Measurements

www.agilent.com/find/dcax

The 86100D DCA-X features two user interfaces for optimum ease-of-use. It includes the classic DCA interface for complete backwards compatibility with earlier DCA mainframes. It also includes the new FlexDCA interface that provides new measurements and powerful analysis capability in a fully customizable application.
The following measurements are available from the tool bar, as well as the pull down menus. The available measurements depend on the DCA-X operating mode.

Oscilloscope mode

Time

Rise Time, Fall Time, Jitter RMS, Jitter p-p, Period, Frequency, + Pulse Width, – Pulse Width, Duty Cycle, Delta Time, [Tmax, Tmin, Tedge—remote commands only]

Amplitude

Overshoot, Average Power, V amptd, V p-p, V rms, V top, V base, V max, V min, V avg, OMA (Optical Modulation Amplitude)

Eye/mask mode

- **NRZ eye measurements**

Extinction Ratio, Jitter RMS, Jitter p-p, Average Power, Crossing Percentage, Rise Time, Fall Time, One Level, Zero Level, Eye Height, Eye Width, Signal to Noise, Duty Cycle Distortion, Bit Rate, Eye Amplitude

- **RZ eye measurements**

Extinction Ratio, Jitter RMS, Jitter p-p, Average Power, Rise Time, Fall Time, One Level, Zero Level, Eye Height, Eye Amplitude, Opening Factor, Eye Width, Pulse Width, Signal to Noise, Duty Cycle, Bit Rate, Contrast Ratio

Mask Test

Open Mask, Start Mask Test, Exit Mask Test, Filter, Mask Test Margins, Mask Margin to a Hit Ratio, Mask Test Scaling, Create NRZ Mask

Advanced measurement options

The 86100D's software options allow advanced analysis.
Options 200, 201, and 300 require mainframe Option 001.
Option 202 does not require Option 86100-001.
Option 401 does not require Options 001 and 200 unless a DDPWS measurement is required.

Option 200 enhanced jitter analysis software

- **Measurements**

Total Jitter (TJ), Random Jitter (RJ), Deterministic Jitter (DJ), Periodic Jitter (PJ), Data Dependent Jitter (DDJ), Duty Cycle Distortion (DCD), Intersymbol Interference (ISI), Sub-Rate Jitter (SRJ), Asynchronous periodic jitter frequencies, Subrate jitter components.

- **FlexDCA adds the following measurements:**

Data Dependent Pulse Width Shrinkage (DDPWS), Uncorrelated Jitter (UJ), J2, J9

- **Data displays**

TJ histogram, RJ/PJ histogram, DDJ histogram, Composite histogram, DDJ versus Bit position, Bathtub curve (log or Q scale)

Option 201 advanced waveform analysis

- **Measurements**

Deep memory pattern waveform, user-defined measurements through MATLAB interface,

- **Data displays**

Equalized waveform

Option 202 enhanced impedence and S-parameters

Option 300 amplitude analysis/RIN/Q-factor (requires Option 200)

- **Measurements**

Total Interference (TI), Deterministic Interference (Dual-Dirac model, DI), Random Noise (RN), Periodic Interference (PI), and Inter-symbol Interference (ISI), RIN (dBm or dB/Hz), Q-factor

- **Data Displays**

TI histogram, RN/PI histogram, ISI histogram

Option 400 PLL and jitter spectrum measurement software

- **Jitter spectrum/phase noise measurements**

Integrated Jitter: Total Jitter (TJ), Random Jitter (RJ), Deterministic Jitter (DJ); DJ Amplitude/Frequency, Jitter Spectrum Graph, Jitter versus Time Graph, Frequency versus Time Graph, Jitter Histogram, Post Processed Jitter Measurements, Phase Noise Graph dBc/Hz versus frequency

- **Phase Locked Loop (PLL) measurements**

PLL Bandwidth, PLL Peaking, Data Rate, Jitter Transfer Function (JTF) Graph, Observed Jitter Transfer (OJTF) Graph, JTF Model.

Option 401 advanced EYE analysis

- **Jitter measurements**

Total Jitter (TJ), Random Jitter (RJ), Deterministic Jitter (DJ), J2 Jitter (J2), J9 Jitter (J9), Data Dependent Pulse Width Shrinkage (DDPWS)*
** Requires 86100D-200*

- **Amplitude measurements**

Total Interference (TI), Random Noise (RN), Deterministic Interference (DI), Eye Opening

- **Mask test**

Pass/Fail Status, BER limit

Option SIM InfiniiSim-DCA

2-port de-embedding and embedding; 4-port de-embedding and embedding; add simulated random jitter and noise

TDR/TDT mode (requires TDR module)

- **Quick TDR, TDR/TDT Setup,**

Normalize, Response, Rise Time, Fall Time, Δ Time, Minimum Impedance, Maximum Impedance, Average Impedance, (Single-ended and Mixed-mode S-parameters with Option 202)

Additional capabilities

- **Standard functions**

Standard functions are available through pull down menus and soft keys, and some functions are also accessible through the front panel knobs.

- **Markers**
  - Two vertical and two horizontal (user selectable)
- **TDR markers**
  - Horizontal — seconds or meter
  - Vertical — Volts, Ohms or Percent Reflection
  - Propagation — Dielectric Constant or Velocity

Limit tests

- Acquisition limits
- Limit Test "Run Until" Conditions — Off, # of Waveforms, # of Samples
- Report Action on Completion — Save waveform to memory, save screen image

Measurement limit test

- Specify Number of Failures to Stop Limit Test
- When to Fail Selected Measurement — Inside Limits,

Outside Limits, Always Fail, Never Fail

- Report Action on Failure — Save waveform to memory, save screen image, save summary
- Mask limit test
- Specify Number of Failed Mask Test Samples
- Report Action on Failure — Save waveform to memory, save screen image, save summary

- **Configure measurements**
- **Thresholds**
  - 10%, 50%, 90% or 20%, 50%, 80% or Custom
- **Eye Boundaries**
  - Define boundaries for eye measurments
  - Define boundaries for alignment
- **Format Units for**
  - Duty Cycle Distortion — Time or Percentage
  - Extinction/Contrast Ratio — Ratio, Decibel or Percentage
  - Eye Height — Amplitude or Decibel (dB)
  - Eye Width — Time or Ratio
  - Average Power — Watts or Decibels (dBm)
- **Top Base Definition**
  - Automatic or Custom
- **Δ Time Definition**
  - First Edge Number, Edge Direction, Threshold
  - Second Edge Number, Edge Direction, Threshold
- **Jitter Mode**
  - Units (time or unit interval, watts, volts, or unit amplitude)
  - Signal type (data or clock)
  - Measure based on edges (all, rising only, falling only)
  - Graph layout (single, split, quad)

Quick measure configuration

When using the classic DCA interface, "Quick Measure" measurements are initiated by pressing the <Multi-Purpose> button on the front panel.

- Four user-selectable measurements for Each Mode, Eye-mask,TDR, etc.
- Default Settings (Eye/Mask Mode) Extinction Ratio, Jitter RMS, Average Power, Crossing Percentage
- Default Settings (Oscilloscope Mode) Rise Time, Fall Time, Period, V amptd

Histograms

- **Configure**
  - Histogram scale (1 to 8 divisions)
  - Histogram axis (vertical or horizontal)
  - Histogram window (adjustable window via marker knob)

Math measurements - Classic DCA User Interface

- Four user-definable functions Operator magnify, invert, subtract, versus, min, max
- Source — channel, function, memory, constant, response (TDR)

Signal Processing Measurements - FlexDCA

- Math - Add, Subtract, Multiply, Average, Invert, Maximum, Minimum, Median
- Signal Processing - Difference (Differentiate), Summation (Integrate), Interpolation (Linear, Sin(x)/x), Filters: 4th Order Bessel, Butterworth, Gaussian
- Transforms - FFT, Versus
- Equalizer (Option 201) - Linear Feed-forward Equalizer (LFE, up to 64 taps)
- Simulation (Option SIM) - De-embedding, Embedding, Random Jitter, Random Noise

Calibrate - Classic DCA User Interface

- **All calibrations**
  - Module (amplitude)
  - Horizontal (time base)
  - Extinction ratio
  - Probe
  - Optical channel
- **Front panel calibration output level**
  - User selectable –2 V to 2 V
- **Utilities**
  - Set time and date
  - Remote interface
  - Set GPIB interface
- **Touch screen configuration/calibration**
  - Calibration
  - Disable/enable touch screen
- **Upgrade software**
  - Upgrade mainframe
  - Upgrade module

Additional capabilities

- **Waveform autoscaling**

Autoscaling provides quick horizontal and vertical scaling of both pulse and eye-diagram (RZ and NRZ) waveforms.

- **Gated triggering**

Trigger gating port allows easy external control of data acquisition for circulating loop or burst-data experiments. Use TTL compatible signals to control when the instrument does and does not acquire data.

- **Easier calibrations**

Calibrating your instrument has been simplified by placing all the performance level indicators and calibration procedures in a single high-level location. This provides greater confidence in the measurements made and saves time in maintaining equipment.

- **Stimulus response testing using the Agilent N490X BERTs**

Error performance analysis represents an essential part of digital transmission test. The Agilent 86100D and N490X BERT have similar user interfaces and together create a powerful test solution. If stimulus only is needed, the 81133A and 81134A pattern generators work seamlessly with the 86100D.

- **Transitioning from the Agilent 83480A and 86100A/B/C to the 86100D**

While the 86100D has powerful new functionality that its predecessors don't have, it has been designed to maintain compatibility with the Agilent 86100A, 86100B, 86100C and Agilent 83480A digital communications analyzers and Agilent 54750A wide-bandwidth oscilloscope. All modules used in the Agilent 86100A/B/C, 83480A and 54750A can also be used in the 86100D. Since the 86100D includes the classic DCA interface, the remote programming command set for the 86100D designed for the 86100A/B/C will work directly. Some code modifications are required when transitioning from the 83480A and 54750A, but the command set is designed to minimize the level of effort required.

- **IVI-COM capability**

Interchangeable Virtual Instruments (IVI) is a group of new instrument device software specifications created by the IVI Foundation to simplify interchangeability, increase application performance, and reduce the cost of test program development and maintenance through design code reuse. The 86100D IVI-COM drivers are available for download from the Agilent website.

- **VXII.2 and VXII.3 instrument contro**

The 86100D DCA-X provides LAN based instrument control.

Agilent 86100D Modules Selection Table

www.agilent.com/find/dcax

86100 family plug-in module matrix

The 86100 has a family of plug-in modules designed for a broad range of precision optical, electrical, and TDR/TDT measurements. The 86100 can accommodate up to 4 modules for a total of 16 measurement channels.

										Filtered data rates																					
Module	Option	No. of optical channels	No. of electrical channels	Probe power[1]	Wavelength range (nm)	Unfiltered opt. bw (GHz)	Electrical bandwidth (GHz)	Fiber input (µm)	Mask test sensitivity (dBm)	155 Mb/s	622 Mb/s	1063 Mb/s	1244/1250 Mb/s	2125 Mb/s	2488/2500 Mb/s	2.666 Gb/s	3.125 Gb/s	4.25 Gb/s	5.00 Gb/s	6.25 Gb/s	8.50 Gb/s	9.953 Gb/s	10.3125 Gb/s	10.51875 Gb/s	10.664 Gb/s	10.709 Gb/s	11.096 Gb/s	11.317 Gb/s	14.025 Gb/s	25.80 Gb/s	27.70 Gb/s	39.813 Gb/s	43.018 GB/s
86105C	100[2]	1	1		750-1650	8.5	20	62.5	-20	•	•	•	•	•	•	•	•	•	•	•												
	200	1	1		750-1650	8.5	20	62.5	-16												•	•	•	•	•	•	•	•				
	300[2]	1	1		750-1650	8.5	20	62.5	-16	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				
86105D[3]		1	1		750-1650	20	35	62.5	-12												•	•	•	•	•	•	•	•	•			
86115D[3]	002	2	0		750-1650	20		62.5	-12												•	•	•	•	•	•	•	•	•			
	004[4]	4	0		750-1650	20		62.5	-11												•	•	•	•	•	•	•	•	•			
86116C[3]	025	1	1		1300-1620	45	80	9	-10																					•	•	
86116C[3]	040	1	1		1300-1620	65	80	9	-5																							•	•
83496B clock recovery module. 50 Mb/s to 14.2 Gb/s. Option 100 electrical inputs. Option 101 optical and electrical inputs, single-mode and multimode compatible																																
54754A		0	2	•	N/A		18																									
86108[3]		0	2	•	N/A		32																									
86112A		0	2		N/A		20																									
86117A		0	2		N/A		50																									
86118A		0	2		N/A		70																									

1. *Module has receptacle to supply power for external probe.*
2. *Pick any 4 rates (155 Mb/s to 6.25 Gb/s).*
3. *This module is not compatible with the 86100A and 86100B Digital Communication Analyzer (DCA) mainframes.*
4. *4 optical input ports are switched internally to 2 optical-to-electrical (O/E) converters*

Typical System Configurations

86100D Infiniium DCA-X Mainframe

86100D Hardware Options

Trigger Options (select one only):
STR - Standard – for basic eye measurements only
ETR – Enhanced - for pattern waveforms, jitter analysis, extend trigger bandwidth to 13 GHz

Remote Connection Options (select one only):
GPI - GPIB card interface installed
GPN - No GPIB card

86100D Software Options (select any):

061/062 – Add Matlab Analysis Package
200 – Enhanced Jitter Analysis
201 – Advanced Waveform Analysis
202 – Enhanced Impedance and S-Parameters
300 – Advanced Amplitude Analysis / RIN /Q-scale
SIM – InfiniiSim-DCA de-embedding / embedding
86100DU-400 PLL and Jitter Spectrum Analysis
86100DU-401 Advanced Eye Analysis (Jitter on PRBS31)

DCA plug-in modules (for typical[1] applications)

Electrical / PLL
1 to 12 Gb/s
86112A
Dual channels
BW>20 GHz each
83496B
Electrical clock recovery
(#100, 200, 300)

Electrical / PLL
1 to 14.2 Gb/s
(high-performance)
86108A
Dual remote heads
BW>32 GHz each
with integrated
precision timebase
& clock recovery

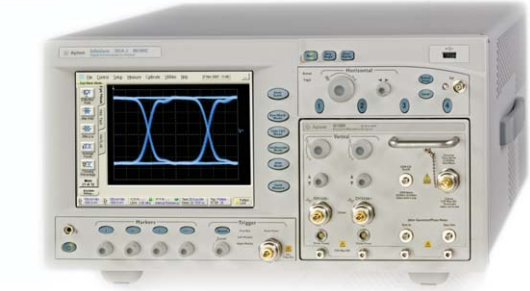
Electrical
20, 40 Gb/s
(high-performance)
86118A
Dual remote heads
BW>70 GHz each
86107A
precision timebase
(#40)

Optical
1 to 12 Gb/s
86105C
9 GHz optical channel
20 GHz electrical channel
86107A
precision timebase
(#40)

Optical
20, 40 Gb/s
86116C
65 GHz optical channel
80 GHz electrical channel
86107A
precision timebase
(#40)

TDR/TDT
54754A
Differential TDR/TDT
Duel 18 GHz Channels
Note -also performs as an 18 GHz duel channel electrical receiver

1. **Contact your local Agilent sales representative to help configure a system for your specific application.**



The Ultimate in Accuracy and Ease-of-use for Analyzing High-speed Electrical Digital Communications Signals

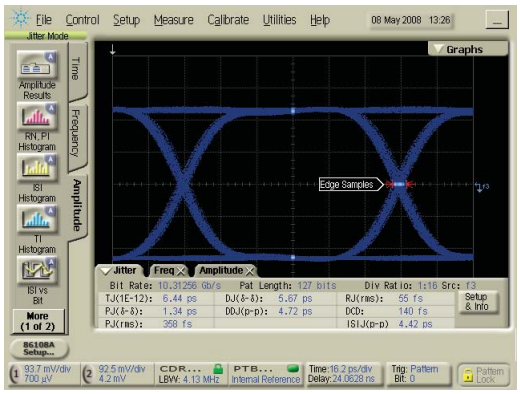
Highest Accuracy Scope Featuring:

- Ultra-low Jitter < 60 fs (typical)
- Wide bandwidth / Low noise hardware settings:
  - > 35 GHz / < 420uV (typical)
  - > 16 GHz / < 240uV (typical)
- Clock-data delay mitigation ("0 ns" delay)

- **Easy Setup and Operation:**
  - Simple one connection 'triggerless' operation
  - Auto setup for serial bus differential signaling including PCI-EXPRESS®, SATA, HDMI, DisplayPort, SFP+, 8G FC, 10 GbE
- **PLL Characterization / Jitter Transfer:**
  - Flexible operation: data or clock input/output, 50 Mb/s-14.2 Gb/s or 25 MHz-6.75 GHz
  - Compliant: PCI SIG approved, SONET/SDH
- **Integrated Hardware Clock Recovery:**
  - Continuous rates 50 Mb/s to 14.2 Gb/s
  - Adjustable loop bandwdith (LBW) / Type-2 transition frequency (Peaking)
    - "Golden PLL" loop bandwidth adjustment 15 KHz to 10 MHz (rate dependent)
    - Peaking 0dB to > 2dB (bandwidth dependent)
  - Exceeds industry standards for SSC tracking

The Agilent 86108A precision waveform analyzer is a plug-in module used with the 86100C Infiniium DCA-J digital communications analyzer. An optimum combination ultra-low jitter, low noise, and wide bandwidth makes the 86108A the ideal choice in helping engineers develop and test designs for PCI-EXPRESS®, SATA, SAS, HDMI, DisplayPort, SFP+, Fibre Channel, and Gb Ethernet.

The 86108A overcomes conventional test equipment limitations and provides designers with the confidence that the waveform displayed by the oscilloscope is a faithful representation of the true device performance for todays technologies as well a future generations.

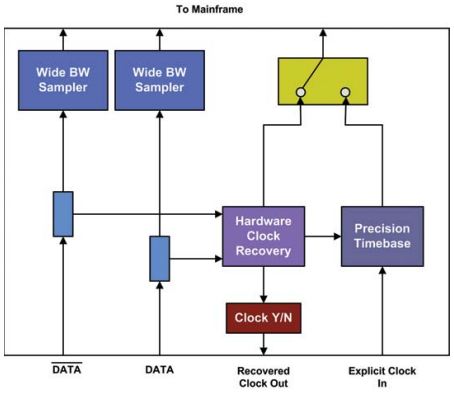


10.3125Gb/s, PRBS7, Clock Recovery Loop Bandwidth 4.13MHz

Standard Timebase	Precision Timebase	Ultra-Low Jitter Timebase
TJ(1E-12): 19.2ps	TJ(1E-12): 8.72 ps	TJ(1E-12): 6.44 ps
RJ(rms): 740 fs	RJ(rms): 193 fs	RJ(rms): 55 fs

New Architecture Yields Precision Measurements and Easy-to-use Operation

The 86108A combines two high-bandwidth channels, an instrumentation-grade clock recovery which features variable loop bandwidth and peaking, and a precision timebase into a single unit.



This combination results in the world's most accurate scope measurements available today. With setup similar to a real-time scope, it also provides significant ease-of-use advantages over traditional sampling scopes. The architecture virtually eliminates the trigger-sample delay inherent in most sampling instruments, and permits accurate and compliant measurement of large amounts of periodic jitter (e.g. SSC) without the use of specially matched cables which degrade performance.

PLL Bandwidth, Jitter Transfer and Jitter Spectrum

The on-board phase detector of the 86108A allows for a precision measurement of phase-locked loop (PLL) bandwidth, sometimes referred to as jitter transfer. An external software application running on a PC controls the jitter source to provide a modulated stimulus to the device under test (DUT).

The system is approved by the PCI SIG for PLL bandwidth compliance testing. The fast and flexible measurement can also test SONET/SDH and other PLL designs.

Agilent J-BERT N4903B High-Performance Serial BERT

NEW

www.agilent.com/find/JBERT

- **Operates from 150 Mb/s to 7 Gb/s, 12.5 or 14.2 Gb/s**
- **Built-in calibrated and compliant jitter sources for RJ, PJ1, PJ2, SJ, BUJ**
- **Interference channel with sinusoidal interference and switchable ISI traces**
- **Automated jitter tolerance sweep**
- **Second output channel with independent PRBS and pattern memory**
- **Built-in tunable CDR**
- **Half-rate clock with variable duty cycle, sub-rate clock outputs**

J-BERT N4903B high-performance serial BERT

Complete Receiver Jitter Tolerance

J-BERT provides built-in and calibrated jitter sources for the most accurate jitter tolerance testing of receivers used in many popular multigigabit serial bus interfaces.
It is used by R&D and test engineers in the semiconductor, computer, and communication industry to characterize new designs and verify standard compliance.
J-BERT supports testing of embedded and forwarded clock architectures for data rates up to 14.2 Gb/s.

Long-term Investment

J-BERT is configurable for today's test and budget needs but allows retrofit of all options when test needs change.

Key Applications

- Receiver jitter tolerance
- PCI Express
- USB3, SATA, SAS
- Forwarded clock interfaces: QPI, Hypertransport
- DisplayPort
- Fibre Channel
- XFP, SFP, SFP+
- 10 GbE, XAUI
- 100 GbE (10 x 10 Gb/s)
- Backplanes: CEI, 10 GBASE-KR, 100 GBASE-KR4

Specifications

Pattern generator

- Operation range: 620 Mb/s[1] to 7 Gb/s (Option C07 or G07), to 12.5 Gb/s (Opt C13 or G13), to 14.2 Gb/s (Opt G13 + D14 or C13 + D14)
- Data outputs: 1 or 2 (Option 002), differential or single-ended
- Output amplitude: 0.1 to 1.8 Vpp
- Jitter: < 9 ps pp
- Transition time: < 25 ps (10 to 90% and ECL levels)
- Cross point adjust: 20 to 80%
- Pattern: PRBS 2^n-1, n = 7, 10, 11, 15, 23, 31
- Memory: 32 Mbit and pattern sequencing (up to 120 blocks)
- Delay control input : 220 ps @ 1 GHz for external jitter injection

[1] 150 Mb/s when using external clock source

Jitter tolerance test

- Built-in, calibrated jitter sources (Option J10): RJ up to 15.7 ps rms @ 1 GHz, PJ1+2 up to 620 ps @ 300 MHz, SJ multiple UIs up to 5 MHz, BUJ up to 220 ps, according CEI
- SSC (Option J11): triangular and arbitrary modulation, up to 5000 ppm @ 0.1 to 100 kHz
- Interference channel (Option J20): ISI by switchable board traces, sinusoidal interference (vertical eye closure) common and differential mode up to 400 mV @ 3.2 GHz

Error detector

- External clock: 150 Mb/s to 7 Gb/s
- (Option C07) or 12.5 Gb/s (Option C13)
- Data input: 1, differential or single-ended
- Delay adjust: ± 0.75 ns
- Clock recovery: always incl., variable loop bandwidth 0.5 to 12 MHz
- Sensitivity: < 50 mV

Measurement suite

- BER, accumulated, interval; symbol/frame error ratio (Option A02); bit recovery mode (Option A01); pattern capture
- BERT scan, "bathtub" curve including RJ, DJ, TJ
- Output level, Q-factor, eye diagram with BER contour and eye masks
- Fast eye mask, spectral jitter, error location capture, fast TJ

Ordering Information

- N4903B high-performance serial BERT. Includes six 50 Ohm resistors, ten adapters 3.5 to 2.4 mm, USB cable, Agilent I/O library
- N4903B-C07/C13 BERT with max. data rate 7 Gb/s/12.5 Gb/s
- N4903B-G07/G13 pattern generator w/ max. data rate 7/12.5 Gb/s
- N4903B-D14 data rate extension for pattern generator to 14.2 Gb/s
- N4903B-002 PRBS and pattern on aux data output (2nd output ch)
- N4903B-003 half-rate clock with variable duty cycle
- N4903B-J10 jitter sources (PJ1, PJ2, SJ, RJ, sRJ, BUJ)
- N4903B-J11 SSC, residual SSC
- N4903B-J12 jitter tolerance compliance suite
- N4903B-J20 interference channel
- N4903B-A01 bit recovery mode
- N4903B-A02 SER/FER analysis
- N4903B-UAB upgrade from N4903A

All options are upgradeable

Agilent N4876A 28 Gb/s Multiplexer 2:1

NEW

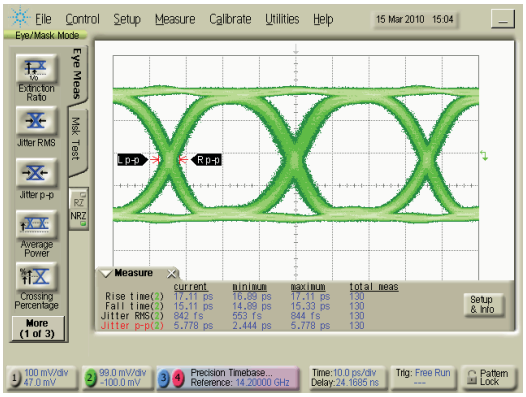
www.agilent.com/find/n4876

- **Extends the pattern generator data rate to up to 28.4 Gb/s**
- **Excellent output performance**
- **Transparent for timing jitter**
- **The small size allows locating the device under test closely to the output.**
- **Operation via J-BERT N4903B user interface or as stand-alone**

N4876A 28.4 Gb/s Multiplexer 2 : 1

Accurate Characterization up to 28 Gb/s

The N4876A 28 Gb/s multiplexer allows to extend the pattern generator data rate of the J-BERT N4903B and ParBERT 81250A up to 28.4 Gb/s. Design and test engineers in the semiconductor, communications, storage and computer industry can now accurately characterize the next generation of serial interfaces. N4876A offers excellent output performance to optimize design margins, it is transparent to jitter, so when using it with the J-BERT N4903B, calibrated RJ and PJ can be generated. The small size allows locating the device under test closely to the output.



28.4 Gb/s PRBS output signal of multiplexer N4876A

Target Applications

- IEEE 802.3 ba 100 GBASE-LR4, -ER4 interfaces operating at data rates
- of 25.78125 Gb/s
- OIF CEI backplanes operating between 19.9 and 28 Gb/s
- T11 16x or 32x Fibre Channel
- Clean generator for transmitter test
- Stressed generator for receiver tolerance testing
- Clock/2 jitter injection

Specifications

- Output data rate: 1.25 to 27.0 Gb/s (28.4 Gb/s when using J-BERT N4903B Option D14)
- Output amplitude: 0.05 to 1.800 V in a –2 to +3 V window
- Intrinsic jitter : 1 ps rms typ. for clock pattern
- Transition time: 10 ps typ. (20 – 80%)
- Crossing point: 20 to 80%
- Clock/2 jitter: 45 to 55% shorter/longer even bits than odd bits
- Output: differential or single-ended, 50 Ohm

Agilent ParBERT 81250 Parallel Bit Error Ratio Tester

www.agilent.com/find/parbert

- **Different modules covering a range of data rates from 333 kb/s to 13.5 Gb/s**
- **Up to 66 synchronous pattern generator and analyzer channels**
- **Powerful pattern sequencer providing looping and branching on events enabling control of complex tests and devices**
- **PRBS/PRWS and memory based patterns up to 64 Mb**
- **Delay control input for jitter generation**
- **Error detector modules featuring individual CDR**
- **Measurement suite**

The ParBERT 81250 parallel bit error ratio tester provides extremely fast parallel BER testing for high-speed digital communication ports, components, chips or modules. ParBERT is a modular, flexible and scalable platform with comprehensive software and measurement suite suited for many applications in the semiconductor, computer, storage, communications and consumer industry.

Applications

- R&D characterization and compliance testing of single and multi-lane receiver and transmitter ports
- Manufacturing test of multiple devices in parallel MUX, DeMUX testing
- A/D, D/A converter testing
- Multi-lane computer buses: PCI Express, HDMI, MIPI, Fibre Channel,
- CPU-frontside buses such as Hypertransport, QPI, memory buses such as AMB, SMI
- Communication interfaces: PON ONU/OLT, IEEE 802.3 xx (10 GbE, 40 GbE, 100 GbE) , XAUI, SONET/SDH, SFI-4, SFI-5, CEI backplanes

Powerful Pattern Sequencing

Run complex tests with a variety of test patterns in one shot without stopping the instrument for pattern download is enabled through the powerful ParBERT 81250 pattern sequencer with its up to five nested loop levels and branching on external and internal events or upon programming command.

Configurable with Multiple Bit Rates and Channels

Modules for four speed-classes are available for the ParBERT 81250 System that cover data generation and analysis from 333 kb/s up to 13.5 Gb/s. Users can configure the number of analyzer and generator channels independently. Each channel can be programmed with individual level, pattern and timing parameters. Once purchased in a certain configuration ParBERT 81250 can easily be extended to fit future needs protecting investment over a long timeframe.

Real-Time Analysis of Multiple Lanes

The ParBERT analyzers can automatically synchronize the incoming data stream. ParBERT offers a comprehensive measurement suite:

- BER measurement (one-/zero errors, accumulated errors...)
- Fast eye mask measurement (mask test with pass/fail)
- DUT output timing measurement (RJ, DJ, TJ, phase margin)
- Spectral decomposition of jitter (spectral jitter analysis)
- DUT output level measurement (high/low level, amplitude, Q-factor)
- Eye opening (3-dimensional eye analysis voltage-time-BER)

Receiver Jitter Tolerance

The ParBERT generator modules with 13.5/7/3.35 Gb/s data rates offer jitter injection capabilities via the external delay control input. This allows in depth receiver jitter tolerance analysis.

Agilent N5980A 3.125 Gb/s Manufacturing Serial BERT

www.agilent.com/find/n5980

- **Standard measurements at rates between 125 Mb/s and 3.125 Gb/s**
- **Generation of pseudo random bit sequence (PRBS) polynomials and a K28.5 pattern at low voltage differential signal (LVDS) or emitter coupled logic (ECL) levels**
- **Flexible connections to the device under test via 3.5 mm differential electrical coax connectors and/or standard optical**
- **SFP module plug-ins**
- **Optical and electrical error injection once or at selectable bit error ratio (BER)**
- **Analysis of gated BER with display of the absolute number of errors and selectability of gate time**
- **Dramatically simplified transceiver measurements that provide just the essential tests via the one page graphical user interface (running on an external Windows XP PC via a USB 2.0 interface)**
- **Full programmability of all graphical user interface features from another software program**

The Agilent N5980A 3.125 Gb/s serial BERT is ideal for manual or automated manufacturing test of electrical and optical devices running at speeds between 125 Mb/s and 3.125 Gb/s. It addresses all common standard speeds via selectable bit rates.

Easy-to-Use and Cost Efficient

The software user interface has one standard or one advanced screen to ensure intuitive use for operators. It makes the instrument easy to use and easy to learn.

Twice the Measurement Throughput

By using both the electrical and optical (SFP) interfaces concurrently, you can double your measurement throughput (electrical in/optical out and vice versa).

Automation Made Easy

The remote programmability of the user interface, using SCPI – syntax, makes it simple to integrate the N5980A into other programs.

PRBS, K28.5 Pattern or Clock Generation and Integrated Clock Data Recovery

The N5980A can generate standard PRBS polynomials, K28.5 ('Comma') characters and different sub-rate clocks (/2 to /20). It can also inject errors with an adjustable error ratio. The receiver has a clock-data recovery (CDR) built-in and differential inputs (SMA) for signals from 50 mVpp to 2 Vpp amplitude.

Standard (SFP) Optical Module Plug-In

The instrument has a standard SFP – female connector. This enables all different kind of user-selectable optical modules e.g for multi-mode/ single-mode fiber at 850, 1310 and 1550 nm for the test set-up.

Specifications

Data Rates

- Fast Ethernet: 125 Mb/s
- OC-3: 155.52 Mb/s, OC-12: 622.08 Mb/s, OC-48: 2.48832 Gb/s
- OC-48 with FEC: 2.66606 Gb/s
- 1 x FC: 1.0625 Gb/s, 2 x FC: 2.125 Gb/s
- 1 x Gigabit Ethernet: 1.25 Gb/s
- XAUI: 3.125 Gb/s
- Accuracy: ±50 ppm

Pattern Generator

Pattern

- PRBS: 2^7–1, 2^{15}–1, 2^{23}–1, 2^{31}–1
- Data pattern: K28.5
- Clock pattern: data rate divide by n, n = 2, 4, 8, 10, 16, 20
- The pattern can be individually adjusted for pattern generator electrical out and optical out

Error injection

- Fixed electrical and optical error inject:
- Fixed error ratios of 1 error in 10^n bits, n = 3, 4, 5, 6, 7, 8, 9
- Single error injection
- Separate error ratios can be adjusted for pattern generator electrical out and optical out

Pattern generator electrical out

- A differential electrical output is provided on the front-panel

Output Amplitude

ECL:

- 850 mVpp typ., single-ended/1700 mVpp typ., differential

LVDS:

- 400 mVpp typ., single-ended/800 mVpp typ., differential

Jitter:

- 0.05 UI typ. @ OC-12, 0.08 UI typ. @ GbE, 0.15 UI typ. @ OC-48

Pattern generator optical out

- A standard SFP housing is provided
- Minimum number of insertion/deinsertion cycles: 200

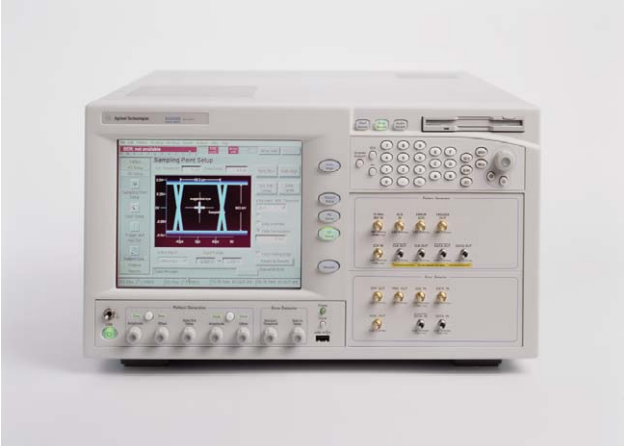
Error detector

- A differential electrical input is provided on the front-panel
- Data rate is the same as pattern generator
- Pattern: PRBS: 2^7–1, 2^{15}–1, 2^{23}–1, 2^{31}–1
- Data input: differential AC coupled
- Max. input amplitude: 1 Vpp, single-ended, 2 Vpp, differential
- Clock data recovery: internal CDR
- Impedance: 100 Ohms nominal, Sensitivity: < 50 mV
- Synchronization: automatically on level, polarity, phase, bit and pattern

Agilent N4906B-003 (3.6 Gb/s) & N4906B-012 (12.5 Gb/s) Serial BERT

www.agilent.com/find/n4906

- **Excellent price/performance ratio**
- **Variable bit rates up to 3.6 or 12.5 Gb/s**
- **< 25 ps transition time**
- **< 50 mV pp input sensitivity**
- **Fast eye mask measurement for pass/fail testing (Opt. 101)**
- **True differential data generation and analysis capability Enhanced measurement suite (Option 101)**
- **Integrated clock data recovery (Option 102)**
- **Small form factor saves bench or rack space**
- **LAN, USB, GPIB for remote control**
- **Compatibility with existing remote commands, e.g. Agilent 71612, 86130A Series and N4900 Series**
- **Applications: manufacturing test, Telecom transceivers such as SONET/SDH Fibre Channel, 10 GbE, XFP/XFI, PON-OLT's and high-speed serial computer buses**



The serial BERT N4906B is a general-purpose bit error ratio tester, designed for testing high-speed digital communication components and systems.
It is ideal for cost-effective manufacturing and telecom device testing. It offers a 3.6 or 12.5 Gb/s pattern generator and error detector with excellent price/performance ratio.

Transition times < 25 ps allow precise measurements.

The analyzer can be configured with CDR to test clockless interfaces and with true differential inputs to test LVDS and other differential interfaces.
The compact size of the N4906B saves rack space; LAN, USB and GPIB interfaces allow smooth integration into automated test environments. For bench users the N4906B serial BERT offers an intuitive user interface with state-of-the-art Windows-XP based touch-screen.

Deeper insight into the device's performance can be obtained with the enhanced measurement suite. It offers many valuable signal analysis tools, such as BERT Scan (so-called bathtub curves) with total jitter and its separation into RJ and DJ, eye contours, spectral jitter decomposition and more.

Specifications

Pattern Generator

- Operation range:
  - 9.5 to 12.5 Gb/s (Option 012)
  - 150 Mb/s to 12.5 Gb/s (Option 102)
  - 150 Mb/s to 3.6 Gb/s (Option 003)
- Data output: 1, differential or single-ended
- Output amplitude: 0.10 to 1.8 V in 5 mV steps
- Jitter: 9 ps pp typical
- Transition time: < 25 ps (10 to 90% and ECL levels)
- Cross point adjust: 20 – 80%

Pattern

- PRBS 2^n–1, n = 7, 10, 11, 15, 23, 31
- User-definable memory: 32 Mbit

Error Detector

- Operation range:
  - 9.5 to 12.5 Gb/s
  - 150 Mb/s to 12.5 Gb/s (Option 102)
- Data input: 1, single-ended or differential (Option 101 or 003)
- Delay adjust: 1.5 ns
- Clock data recovery (Option 102):
- 1.058 to 1.6 Gb/s, loop bandwidth 1 MHz typ.
- 2.115 to 3.2 Gb/s: loop bandwidth 2 MHz typ.
- 4.23 to 6.4 Gb/s: loop bandwidth 4 MHz typ.
- 9.9 to 10.9 Gb/s: loop bandwidth 8 MHz typ.
- Sensitivity: < 50 mV

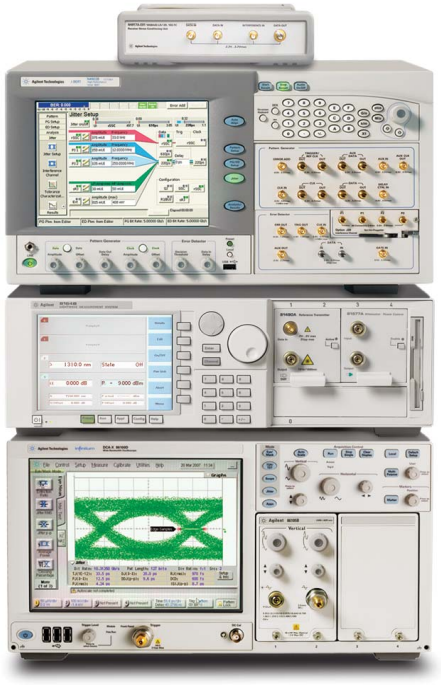
Measurements

- BER
- Fast eye mask measurement with pass/fail (Option 101)
- BERT scan with RJ/DJ separation (Option 101)
- Fast total jitter (Option 101)
- Spectral jitter decomposition (Option 101)
- Eye contour (Option 101)
- Output level (Option 101)
- Error location capture (Option 101)

Agilent N4917A Optical Receiver Stress Test Solution

www.agilent.com/find/optical_stress

- **Calibrated injection of OMA (optical modulation amplitude), ER (extinction ratio), and VECP (vertical eye closure penalty) for accurate results**
- **Supports multiple standards: 10 Gb Ethernet -LR, -ER, -SR, 10 GFC**
- **Automated BER versus OMA measurement saves engineering time**
- **Reproducible results with Agilent proven and complete accessory kits**
- **Affordable with one reference transmitter for 1310 nm and 1550 nm, single mode**
- NEW **Reference transmitter for 850 nm, multimode**



Complete optical receiver stress test solution for robust designs

The Agilent N4917A provides repeatable and calibrated characterization and conformance test results. Design and test engineers can now accurately test optical transceivers and ROSAs up to 14.2 Gb/s.

Complete, Calibrated and Repeatable Stress Test of Optical Receivers

- Optical transceivers and ROSAs (receive optical sub assemblies) up to 14.2 Gb/s
- 10 Gb Ethernet, Fibre Channel
- Compliance test and characterization
- R&D and test of optical storage and communication devices

Calibrated Injection of ER, OMA and VECP

The N4917A automation and calibration software controls all instruments and allows the user to enter compliant ER, OMA and VECP.

Automated Conformance and Charactization Tests

Engineers save programming and test time with the automated BER versus OMA measurements.

Reproducible Test Results

The values of VECP, OMA and ER are calibrated with the 86100C/D Infiniium DCA controlled by the N4917A automation and calibration software. Reproducible test results, even across different test sites are now possible when using the Agilent verified accessory kits including all filters, adapters and cables required.

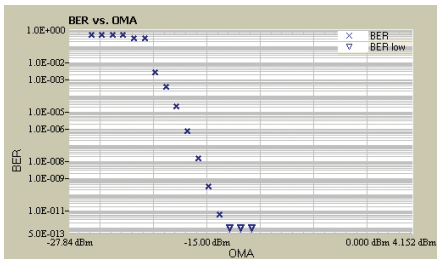
Affordable Solution for 850 nm, 1310 nm and 1550 nm

The Agilent 81490A reference transmitter supports 850nm multimode fibers and 1310/1550 nm single mode fibers, reducing the amount of test equipment needed when testing devices for multiple standards.

Calibration and Automation Software N4917A

This software controls all instruments required to run the optical receiver stress test.

It guides the user through the instrument set-up and calibration procedure with the 86100C/D Infiniium DCA.



The user interface allows the user to choose between standard compliant stress testing or custom stressed eye values for ER, OMA, sinusoidal interference and sinusoidal jitter. Automated BER versus OMA measurements can be made and displayed as a graphical result screen and documented in a test report.

The N4917A software runs on the J-BERT N4903A/B or on an external Windows XP PC.

Optical receiver stress test solution consists of:

- Calibration and automation software with accessory kits for 10 GbE and 10G Fibre Channel N4917A
- Lightwave measurement system frame 8164B with:
  - Reference transmitter:
    81490A-135 for 1310/1550 nm for single mode fiber
    or
    81490A-E03 for 850 nm, multimode fiber
  - Optical attenuator 81576A or 77-Series

- J-BERT N4903A/B -C13, -J10, -J12, -J20
- Digital communication analyzer 86100C/D with 86105B/C/D.

Agilent PXI Modular Transceiver Test Platform

www.agilent.com/find/pxit
www.agilent.com/find/pxi-chassis

- **Economic solution**
- **Small form factor**
- **High speed**
- **Modular**
- **Flexible**

M9018A PXIe chassis

N2099A Synthesizer

N2102B PPG

N2101B BERT

N2100B DCA

Agilent offers four cost effective PXI modules that are particularly useful to optical transceiver manufacturers. The modular PXI platform allows flexible instrument configurations in a single mainframe. Either a PXI embedded controller or a PXI interface card to connect to an external PC is required.
The N2099A PXI Synthesizer combined with the N2102B PXI pulse pattern generator is a complete source to stimulate the transceiver. For optical and electrical eye diagram analysis the N2100B PXI digital communications analyzer can be included in the system.
The N2101B PXI BERT includes the same pattern generation functionality as the N2102B PPG. In combination with the N2100B DCA and the N2099A PXI synthesizer, it can measure all required transceiver test parameters.

Specifications

N2099A PXI synthesizer

- Two frequency ranges available between 4.25 and 11.5 GHz
- Centered at 5.25 and 10.5 GHz
- Tuning range: ± 1.0 GHz
- Dual RF outputs
- Excellent phase noise performance
- External reference Osc. output Freq (TCXO): 10 MHz

N2102B PXI pulse pattern generator (PPG)

- Bit rate operation: 622 Mb/s to 10.3125 Gb/s
- PRBS generations 2^n - 1, (n = 7, 9, 11, 15, 23, 31)
- K28.5, K28.7, CR PAT and user defined patterns
- Single error and error rate injection
- Differential data output
- Rise/fall time (20% – 80%): 25 ps (max), 22 ps (characteristic)
- Output intrinsic jitter: 2.5 ps RMS (max), 1.5 ps RMS (characteristic)

N2101B PXI bit error ratio tester (BERT)

- Fixed internal clock rates from 622 Mb/s to 8.5 Gb/s
- Any rates from 155 Mb/s to 10.3125 Gb/s using external clock
- PRBS generations 2^n - 1, (n = 7, 9, 11, 15, 23, 31)
- K28.5, K28.7, CR PAT and user defined patterns
- Bathtub jitter measurement capability
- Output intrinsic jitter: 2.5 ps RMS (max), 1.5 ps RMS (characteristic)
- Rise/fall time (20% – 80%): 25 ps (max), 22 ps (characteristic)
- Output range: 250 mV – 1 V single ended
- Error detection input range: 50 mV – 2 V differential

N2100B PXI digital communications analyzer (DCA)

- Eye diagram, jitter and mask testing
- High throughput measurement engine
- 10GE and PON filters available
- 4 Bessel Thomson filters
- Sample rate: 160 MS/s
- Points-Max. number per-of acquisition: 1024/1024
- Pattern acquisition length: 2047 bits
- Clock recovery: < 2.7 Gb/s
- Clock input: 10 MHz to 11.318 GHz (characteristic), 0.5 to 1 V pp
- Electrical input
  - Bandwidth: 12 GHz (characteristic)
  - RMS noise: 2.5mV RMS (max) 1.3mV RMS (characteristic)
  - Connection type: AC coupled, single ended
  - AC input voltage range: 1 V pp (max)
  - Electrical return loss: –12 dB
- Optical input
  - Bandwidth: 7.5 GHz (max, characteristic)
  - For the optical input, must choose four filter rates out of a range from 155 Mb/s to 10.3125 Gb/s
  - Optical Responsivity: 750 – 1650 nm
  - Fiber input: 62/125 µm for multimode and single-mode fiber
  - Max. non-destructive input (1310 nm): –3 dBm avg, +7 dBm peak
  - Average power monitor range (850 nm): –30 dBm to –2 dBm

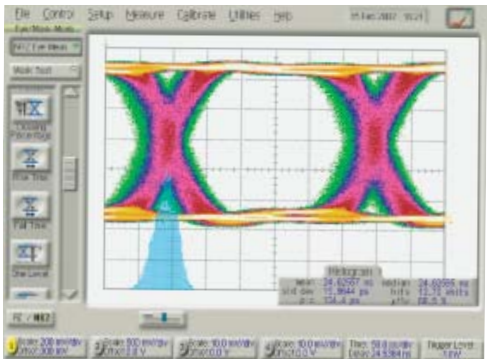
www.agilent.com/find/pulse

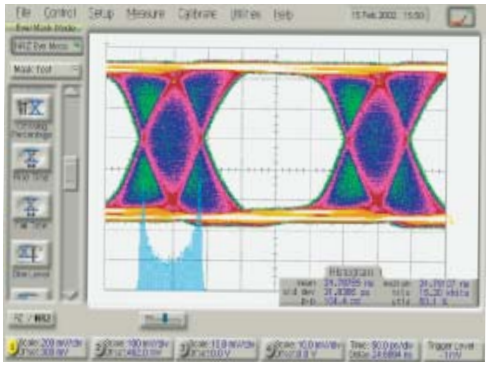
The Smart Way to Measure – Versatile and Precise Stimulus Solution

Agilent offers a comprehensive portfolio of signal generation instruments of digital and analog waveforms, data and versatile signals delivering the confidence you demand to ensure signal integrity in development and manufacturing.

Agilent 81133/4A 3.35 GHz Pulse Pattern Generator

www.agilent.com/find/81134





The Agilent 81133/4A 3.35 GHz pulse pattern generator provide the ultimate timing accuracy and signal performance. Their high quality signals and low intrinsic jitter enable you to perform quick and reliable measurements with accurate and repeatable results.

Performance Overview

- 1 or 2 channels
- 50 mV up to 2 Vpp amplitude
- 15 MHz to 3.35 GHz repetition rate
- Total jitter typically less than 2 ps
- Complex data pattern e.g. for PCI Express , S-ATA
- Pseudo Random Binary Sequence
- Delay modulation -250 ps to 250 ps (up to 500 ps total jitter)

The 81150A can be used as modulation and noise source for the 81133/4A. The instrument provides sinusoidal jitter and random jitter in one instrument to reduce cost of test.

Agilent 81150A Pulse Function Arbitrary Noise Generator

Agilent 81133/4A 3.35 GHz pulse pattern generator

The Agilent 81150A provides accurate and accelerated insight into your device through ideal and real-world signals. The product contains a pulse generator, function arbitrary generator and noise generator in one instrument to minimize cabling, space and test time.

Performance Overview

- 1 µHz – 120 MHz pulse generation with variable rise/fall time
- 1 µHz – 240 MHz sine waveform output
- 14-bit, 2 GSa/s arbitrary waveforms
- 512 ksamples deep arbitrary waveform memory per channel
- White Gaussian or arbitrary noise with a selectable crest factor. The noise is random through a signal repetition rate of 26 days.
- FM, AM, PM, PWM, FSK modulation capabilities up to 10 MHz
- 1 or 2 channels, coupled or uncoupled
- Differential outputs
- Two selectable output amplifiers
  - High bandwidth amplifier with a voltage window ± 5 V up to entire frequency
  - High voltage amplifier with a voltage window ± 10 V up to 50 MHz

Agilent 81180A Arbitrary Waveform Generator, 4.2 GS/s, 12 bit

NEW

www.agilent.com/find/81180A

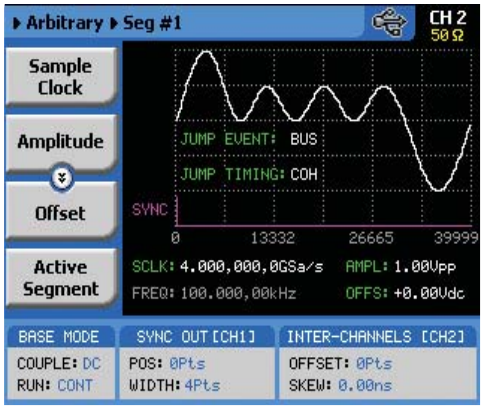
- **4.2 GS/s sample rate**
- **12 bit vertical resolution**
- **1 or 2 channels, 2 instruments can form a 4 channel instrument**
- **Differential outputs**
- **64 MS waveform memory**

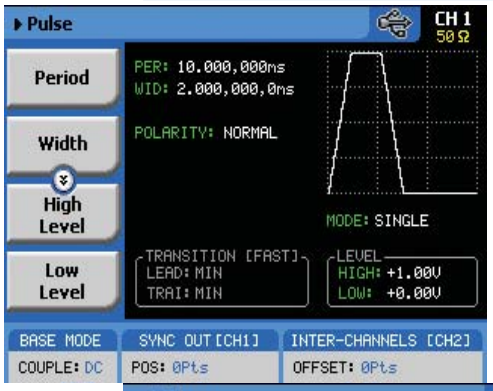
Applications

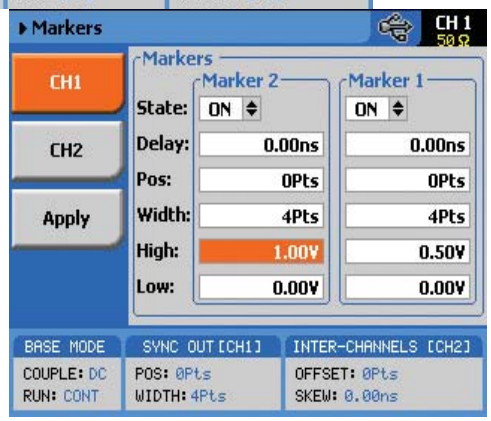
- Wireless standards with > 1 GHz modulation BW (WiHD,WiGig, Bluetooth 2.0)
- RF environment simulation up to 1.5 GHz (e.g. DVB-T/H, T-DMB)
- UWB up to 2 GHz modulation BW
- OFDM for optical access networks
- Software defined radio
- Satellite
- Radar
- Education

Specifications

- 10 MS/s – 4.2 GS/s, 12 bit arbitrary waveform and function generator
- 1 or 2 channel (coupled/uncoupled)
- 2 GHz IQ modulation bandwidth
- Two instrument can be synchronized to form 4 channel system
- Three software selectable amplifier
  - Optimized for I/Q applications in conjunction with Vector PSG with 1 GHz, differential output and DC coupled
  - Optimized for maximum bandwidth and flatness for direct RF applications with up to 1.5 GHz, single-ended and AC coupled
  - Optimized for applications in the time domain with low overshoot and jitter with differential output, DC coupled and 600 ps transition times
- Internal and external clock
- Up to 64 M sample memory
- Two markers per channel with adjustable width and levels
- Advanced sequencing capabilities (step, loop, nested and conditional jumps)
- Trigger input to control sequence advance
- 8-bit dynamic control connector
- Integration in Agilent Waveform Editor, MATLAB, LabView and Signal Studio







Ordering Information

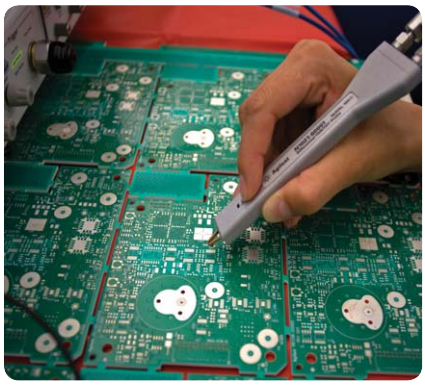
81180A 4.2 GS/s arbitrary waveform generator

- **81180A-116** 1 channel, 16 M points memory
- **81180A-216** 2 channel, 16 M points memory
- **81180A-264** 2 channel, 64 M points memory
- **81180A-SYN** synchronization cable to build up a 4 channel instrument out of two 81180A
- **81180A-F4G** reconstruction filter set for 4 Gsa/s – 1 channel

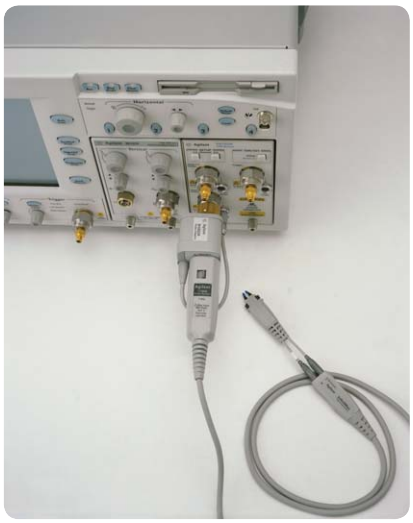
Probes, Adapters and other Interface Kits

Other application-specific probe and interfaces kits are available from Agilent Technologies or its channel partners. See www.agilent.com or contact your local sales office for details.

N1080A HDMI fixtures - literature number 5989-5118EN

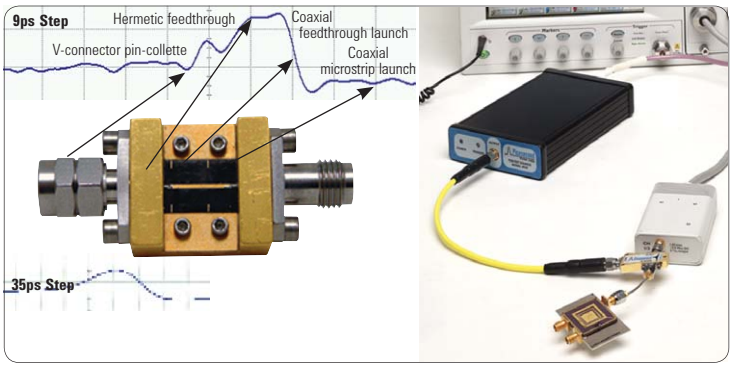


N1021A 18 GHz differential TDR probe. Literature number 5990-4013



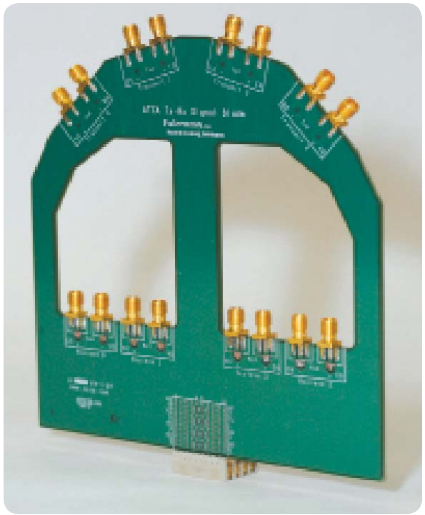
N1022A probe adapter for Agilent 1130 or 1150 probe series - literature number 5988-8541EN

N1024A TDR calibration kit - literature number 59889-4149EN

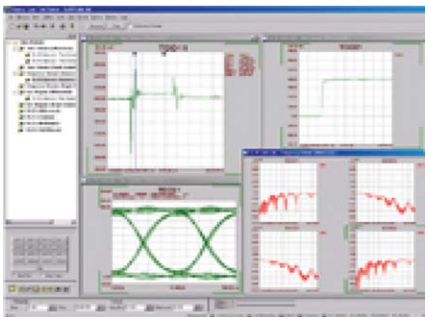


Picosecond Pulse Labs 4020 Source Enhancements Module with 86118A Remote Head for ultra fast TDR measurements.
www.picosecond.com

N1020A-K05 calibration substrate - literature number 5968-7376E



Advanced TCA Tx/Rx SignalBlade™ (F9 Systems - www.f9-systems.com)



The N1930B physical laser test system (PLTS) software provides confidence in your design through complete characterization and behavior model extraction of your device under test (DUT). It supports both TDR and VNA platforms from Agilent Technologies.

www.agilent.com
www.agilent.com/find/lightwave

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www.axiestandard.org AdvancedTCA® Extensions for Instrumentation and Test (AXIe) is an open standard that extends the AdvancedTCA® for general purpose and semiconductor test. Agilent is a founding member of the AXIe consortium.

www.lxistandard.org
LAN eXtensions for Instruments puts the power of Ethernet and the Web inside your test systems. Agilent is a founding member of the LXI consortium.

http://www.pxisa.org
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Agilent Electronic Measurement Group
KEMA Certified
ISO 9001:2008
Quality Management System

www.agilent.com/quality

Related Literature:

Lightwave Catalog Volume 1:
General Photonic Test 5989-6753EN

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Product specifications and descriptions in this document subject to change without notice.

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