infiniium DCA-J

Agilent 86100C Wide-Bandwidth Oscilloscope

Technical Specifications

Four instruments in one

A digital communications analyzer,
a full featured wide-bandwidth oscilloscope,
a time-domain reflectometer, and a jitter analyzer

- Automated jitter decomposition
- Internally generated pattern trigger
- Modular platform for testing waveforms up to 40 Gb/s and beyond
- Compatible with Agilent 86100A/B-series, 83480A-series, and 54750-series modules
- 200 fs intrinsic jitter
- Open operating system – Windows® XP Pro

Agilent Technologies

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Overview of infiniium DCA-J

Features

PatternLock Triggering

The Enhanced Trigger Option (Option 001) on the 86100C provides a fundamental capability never available before in an equivalent time sampling oscilloscope. This new triggering mechanism enables the DCA-J to generate a trigger at the repetition of the input data pattern – a pattern trigger. Historically, this capability required the pattern source to provide this type of trigger output to the scope. PatternLock automatically detects the pattern length, data rate and clock rate making the complex triggering mechanism transparent to the user.

PatternLock enables the 86100C to behave more like a real-time oscilloscope in terms of user experience. Investigation of specific bits within the data pattern is greatly simplified. Users that are familiar with real-time oscilloscopes, but perhaps less so with equivalent time sampling scopes will be able to ramp up quickly.

PatternLock adds another new dimension to pattern triggering by enabling the mainframe software to take samples at specific locations in the data pattern with outstanding timebase accuracy. This capability is a building block for many of the new capabilities available in the 86100C described later.

Four Instruments in One

The 86100C Infiniium DCA-J can be viewed as four high-powered instruments in one:

- A general-purpose wide-bandwidth sampling oscilloscope; the new PatternLock triggering significantly enhances the usability as a general purpose scope
- A digital communications analyzer; the new Eyeline Mode feature adds a powerful new tool to eye diagram analysis
- A time domain reflectometer
- A jitter analyzer

Just select the instrument mode and start making measurements.

Configurable to meet your needs

The 86100C supports a wide range of plug-ins for testing both optical and electrical signals. Select plug-ins to get the specific bandwidth, filtering, and sensitivity you need.

Jitter Analysis

The “J” in DCA-J represents jitter analysis. The 86100C is a Digital Communications Analyzer with Jitter analysis capability. The 86100C adds a fourth mode of operation – Jitter Mode.

As data rates increase in both electrical and optical applications, jitter is an ever increasing measurement challenge. Decomposition of jitter into its constituent components is becoming more critical. It provides critical insight for jitter budgeting and performance optimization in device and system designs. Many emerging standards require jitter decomposition for compliance. Traditionally, techniques for separation of jitter have been complex and often difficult to configure, and availability of instruments for separation of jitter becomes very limited as data rates increase.

The DCA-J provides simple, one button setup and execution of advanced waveform analysis. Jitter Mode decomposes jitter into its constituent components and presents jitter data in various insightful displays. Jitter Mode operates at all data rates the 86100C supports, removing the traditional data rate limitations from complex jitter analysis. The 86100C brings several key attributes to jitter analysis:

- Very low intrinsic jitter (both random and deterministic) translates to a very low jitter noise floor which provides unmatched jitter measurement sensitivity.
- Wide bandwidth measurement channels deliver very low intrinsic data dependent jitter and allow analysis of jitter on all data rates up to 40 Gb/s and beyond.
- PatternLock triggering technology provides sampling efficiency that makes jitter measurements very fast.

Jitter analysis functionality is segmented into two software package options. Option 100 is the standard jitter analysis software, and Option 101 is the advanced waveform analysis software. Option 100 includes:

- Decomposition of jitter into Total Jitter (TJ), Random Jitter (RJ), Deterministic Jitter (DJ), Periodic Jitter (PJ), Data Dependent Jitter (DDJ), Duty Cycle Distortion (DCD), and Jitter induced by Intersymbol Interference (ISI).
- Various graphical and tabular displays of jitter data
- Export of jitter data to convenient delimited text format
- Save / recall of jitter database

Windows is a U.S. registered trademark of Microsoft Corporation.

Option 101 requires Option 100 and adds additional capability:

- Periodic jitter frequency
- Isolation and analysis of Sub-Rate Jitter (SRJ), that is, periodic jitter that is at an integer sub-rate of the bitrate.
- Bathtub curve display
- Jitter Mode operation with the patented 86107A Precision Timebase Module
- Adjustable total jitter probability

As bit rates increase, channel effects cause significant eye closure. Many new devices and systems are employing equalization and pre/de-emphasis to compensate for channel effects. Option 101 Advanced Waveform Analysis will provide key tools to enable design and test of devices and systems that must deal with difficult channel effects:

- Capture of long single valued waveforms. PatternLock triggering and the waveform append capability of Option 101 enable very accurate pulse train data sets up to 256 megasamples long.
- Equalization. The DCA-J can take a long single valued waveform and route it through an equalizer algorithm (default or user defined) and display the resultant equalized waveform. The user can simultaneously view the input (distorted) and output (equalized) waveforms.
- Pattern lock triggering with 86107A

Digital communications analysis

Accurate eye-diagram analysis is essential for characterizing the quality of transmitters used from 100 Mb/s to 40 Gb/s. The 86100C was designed specifically for the complex task of analyzing digital communications waveforms. Compliance mask and parametric testing no longer require a complicated sequence of setups and configurations. If you can press a button, you can perform a complete compliance test. The important measurements you need are right at your fingertips, including:

- industry standard mask testing with built-in margin analysis
- extinction ratio measurements with accuracy and repeatability
- eye measurements: crossing %, eye height and width, '1' and '0' levels, jitter, rise or fall times and more

The key to accurate measurements of lightwave communications waveforms is the optical receiver. The 86100C has a broad range of precision receivers integrated within the instrument.

- Built-in photodiodes, with flat frequency responses, yield the highest waveform fidelity. This provides high accuracy for extinction ratio measurements.
- Standards-based transmitter compliance measurements require filtered responses. The 86100C has a broad range of filter combinations. Filters can be automatically and repeatably switched in or out of the measurement channel remotely over GPIB or with a front panel button. The frequency response of the entire measurement path is calibrated, and will maintain its performance over long-term usage.
- The integrated optical receiver provides a calibrated optical channel. With the accurate optical receiver built into the module, optical signals are accurately measured and displayed in optical power units.

Switches or couplers are not required for an average power measurement. Signal routing is simplified and signal strength is maintained.

Eye diagram mask testing

The 86100C provides efficient, high-throughput waveform compliance testing with a suite of standards based eye-diagram masks. The test process has been streamlined into a minimum number of keystrokes for testing at industry standard data rates.

Standard masks

	Rate (Mb/s)
1X Gigabit Ethernet	1250
2X Gigabit Ethernet	2500
10 Gigabit Ethernet	9953.28
10 Gigabit Ethernet	10312.5
Fibre Channel	1062.5
2X Fibre Channel	2125
4X Fibre Channel	4250
10X Fibre Channel	10518.75
STM0/OC1	51.84
STM1/OC3	155.52
STM4/OC12	622.08
STM16/OC48	2488.3
Infiniband	2500
XAUI	3125
STM64/OC192	9953.28
STM64/OC192 FEC	10664.2
STM64/OC192 FEC	10709
STM64/OC192 Super FEC	12500
STM256/OC768	39813
STS1 EYE	51.84
STS3 EYE	155.52

Other eye-diagram masks are easily created through scaling those listed at left. In addition, mask editing allows for new masks either by editing existing masks, or creating new masks from scratch. A new mask can also be created or modified on an external PC using a text editor such as Notepad, then can be transferred to the instrument's hard drive using LAN or the A: drive.

Perform these mask conformance tests with convenient user-definable measurement conditions, such as mask margins for guardband testing, number of waveforms tested, and stop/limit actions.

Eyeline Mode

Eyeline Mode is a new feature only available in the 86100C that provides insight into the effects of specific bit transitions within a data pattern. The unique view assists diagnosis of device or system failures do to specific transitions or sets of transitions within a pattern. When combined with mask limit tests, Eyeline Mode can quickly isolate the specific bit that caused a mask violation.

Traditional triggering methods on an equivalent time sampling scope are quite effective at generating eye diagrams. However, these eye diagrams are made up of samples whose timing relationship to the data pattern is effectively random, so a given eye will be made up of samples from many different bits in the pattern taken with no specific timing order. The result is that amplitude versus time trajectories of specific bits in the pattern are not visible. Also, averaging of the eye diagram is not valid, as the randomly related samples will effectively average to zero.

Eyeline Mode uses PatternLock triggering to build up an eye diagram from samples taken sequentially through the data pattern. This maintains a specific timing relationship between samples and allows Eyeline Mode to draw the eye based on specific bit trajectories. Effects of specific bit transitions can be investigated, and averaging can be used with the eye diagram.

Measurement speed

Measurement speed has been increased with both fast hardware and a user-friendly instrument. In the lab, don't waste time trying to figure out how to make a measurement. With the simple-to-use 86100C, you don't have to relearn how to make a measurement each time you use it.

In manufacturing, it is a battle to continually reduce the cost per test. Solution: Fast PC-based processors, resulting in high measurement throughput and reduced test time.

Measure

Standard measurements/features

The following measurements are available from the tool bar, as well as the pull down menus. Measurements available are dependent on the DCA-J operating mode.

Jitter Mode

Jitter Mode requires Option 001 Enhanced Trigger hardware.

There are two jitter analysis software packages for the DCA-J. Option 100 is the standard jitter analysis software, and Option 101 is the advanced waveform analysis software. Option 101 requires Option 100.

Measurements (Option 100 Jitter Analysis)
Total Jitter (TJ), Random Jitter (RJ), Deterministic Jitter (DJ), Periodic Jitter (PJ), Data Dependent Jitter (DDJ), Duty Cycle Distortion (DCD), Intersymbol Interference (ISI)

Data Displays (Option 100 Jitter Analysis)
TJ histogram, RJ/PJ histogram, DDJ histogram, Composite histogram, DDJ versus Bit position

Measurements (Option 101 Advanced Waveform Analysis)
Sub-Rate Jitter (SRJ)

Data Displays (Option 101 Advanced Waveform Analysis)
Bathtub curve, SRJ analysis, Equalized waveform

Oscilloscope mode

Time
Rise Time, Fall Time, Jitter RMS, Jitter p-p, Period, Frequency, + Pulse Width, - Pulse Width, Duty Cycle, Delta Time, [T_{max}, T_{min}, T_{edge}—remote commands only]

Amplitude
Overshoot, Average Power, V amptd, V p-p, V rms, V top, V base, V max, V min, V avg

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 (Q-Factor), 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 (Q-Factor), Duty Cycle, Bit Rate, Contrast Ratio

Mask Test

Open Mask, Start Mask Test, Exit Mask Test, Filter, Mask Test Margins, Mask Test Scaling, Create NRZ Mask

TDR/TDT Mode (requires TDR module)

Quick TDR, TDR/TDT Setup, Normalize, Response, Rise Time, Fall Time, Δ Time

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 or disk, Save screen image to disk

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 or disk, Save screen image to disk, Save summary to disk

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

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 (dB)

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)
Signal type (data or clock)
Measure based on edges (all, rising only, falling only)
Graph layout (single, split, quad)

Quick Measure Configuration

4 User Selectable Measurements for Each Mode

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 knobs)

Math measurements

4 User definable functions Operator — magnify, invert, subtract, versus, min, max

Source — channel, function, memory, constant, response (TDR)

Calibrate

All calibrations

Module (amplitude)
Horizontal (time base)
Extinction ratio
Probe
Optical channel

Front panel calibration output level

User selectable –2V to 2V

Utilities

Set time and date

Remote interface

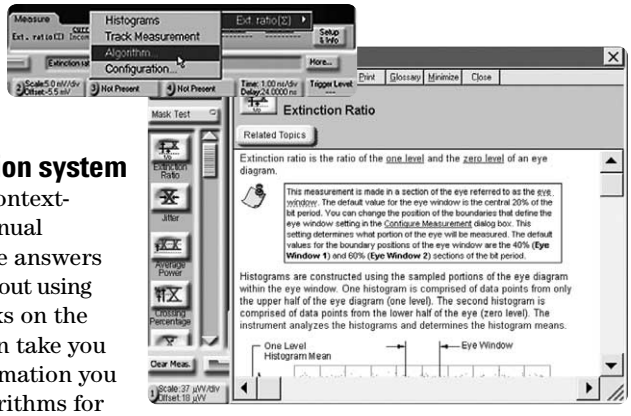
Set GPIB interface

Touch screen configuration/calibration

Calibration
Disable/enable touch screen

Upgrade software

Upgrade mainframe
Upgrade module



Built-in information system

The 86100C has a context-sensitive on-line manual providing immediate answers to your questions about using the instrument. Links on the measurement screen take you directly to the information you need including algorithms for all of the measurements. The on-line manual includes technical specifications of the mainframe and plug-in modules. It also provides useful information such as the mainframe serial number, module serial numbers, firmware revision and date, and hard disk free space. There is no need for a large paper manual consuming your shelf space.

File sharing and storage

Use the internal 40 GB hard drive to store instrument setups, waveforms, or screen images. A 64MB USB memory stick is included with the mainframe. Combined with the USB port on the front panel this provides for quick and easy file transfer. Images can be stored in formats easily imported into various programs for documentation and further analysis. LAN interface is also available for network file management and printing. An external USB CD-RW drive is included with the mainframe. This enables easy installation of software applications as well as storage of large amounts of data.

Powerful display modes

Use gray scale and color graded trace displays to gain insight into device behavior. Waveform densities are mapped to color or easy-to-interpret gray shades. These are infinite persistence modes where shading differentiates the number of times data in any individual screen pixel has been acquired.

Internal triggering through clock recovery

Typically an external timing reference is used to synchronize the oscilloscope to the test signal. In cases where a trigger signal is not available, clock recovery modules are available to derive a timing reference directly from the waveform to be measured. The Agilent 8349XA series of clock recovery modules are available for electrical, multimode optical, and single-mode optical input signals. All 8349XA modules have excellent jitter performance to ensure accurate measurements. Each clock recovery module is designed to synchronize to a variety of common transmission rates.

Clock recovery loop bandwidth

The Agilent clock recovery modules have two loop bandwidth settings. Loop bandwidth is very important in determining the accuracy of your waveform when measuring jitter, as well as testing for compliance.

- Narrow loop bandwidth provides a clean system clock for accurate jitter measurements
- Wide loop bandwidth in some applications is specified in the standards for compliance testing. It allows the recovered clock to track the data and is useful for extracting a signal that may have propagated through a complex network and have large amounts of jitter. While this obviously negates any ability to quantify the jitter, it does allow other parameters of an eye to be measured.

Note: When using recovered clocks for triggering, the amount of jitter observed will depend on the loop bandwidth. As the loop bandwidth increases, more jitter is “tracked out” by the clock recovery resulting in less observed jitter. This is desired by many standards, but it is important in a measurement environment to understand the effect that the clock recovery has on the quantity of jitter being measured.

Waveform autoscaling

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

Time domain reflectometery/time domain transmission (TDR/TDT)

High-speed design starts with the physical structure. The transmission and reflection properties of electrical channels and components must be characterized to ensure sufficient signal integrity. Reflections and signal distortions must be kept at a minimum. Use TDR and TDT to optimize microstrip lines, PC board traces, SMA edge launchers and coaxial cables.

Calibration techniques, unique to the 86100C, provide highest precision by removing cabling and fixturing effects from the measurement results. Translation of TDR data to complete single-ended, differential, and mixed mode S-parameters are available through the N1930A Physical Layer Test System software. Higher two-event resolution and ultra high-speed impedance measurements are facilitated through TDR pulse enhancers from Picosecond Pulse Labs[1].

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 N490XA Serial BERT

Error performance analysis represents an essential part of digital transmission test. The Agilent 86100C and N490XA Serial BERT have similar user interfaces and together create a powerful test solution.

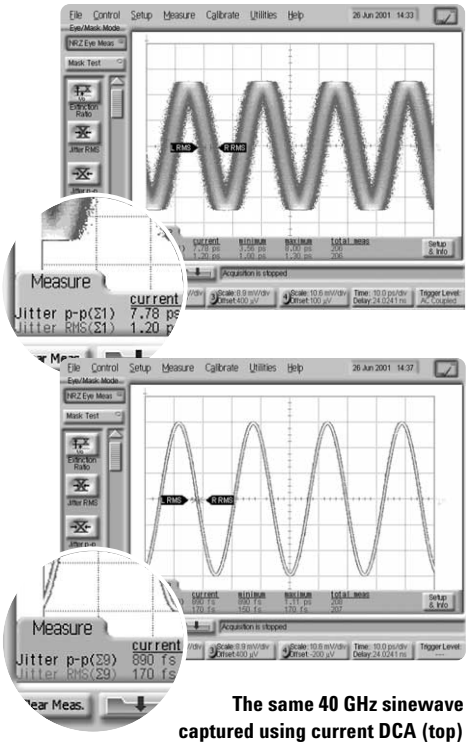
Transitioning from the Agilent 83480A and 86100A/B to the 86100C

While the 86100C has powerful new functionality that its predecessors don't have, it has been designed to maintain compatibility with the Agilent 86100A, 86100B and Agilent 83480A digital communications analyzers and Agilent 54750A wide-bandwidth oscilloscope. All modules used in the Agilent 86100A/B, 83480A and 54750A can also be used in the 86100C. The remote programming command set for the 86100C has been designed so that code written for the 86100A or 86100B 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.

1 Picosecond Pulse Labs (www.picosecond.com)

Lowest intrinsic jitter

The patented 86107A precision timebase reference module represents one of the most significant improvements in wide-bandwidth sampling oscilloscopes in over a decade. Jitter performance has been reduced by almost an order of magnitude to 200 fs RMS. Oscilloscope jitter is virtually eliminated! The reduced jitter of the 86107A precision timebase module allows you to measure the true jitter of your signal. When using the 86107A, the minimum timebase resolution for oscilloscope and eye/mask displays is 500 fs/division, rather than 2 ps/div with the standard timebase.



The same 40 GHz sinewave captured using current DCA (top) and now with 86107A precision timebase module (bottom).

The standard timebase of the 86100C has very low intrinsic jitter compared to other advanced waveform analysis solutions. However, for users who need the absolute best sensitivity for their jitter measurements, the 86107A provides the ultimate timebase performance. Using the 86107A with Jitter Mode requires the Option 101 Advanced Waveform Analysis software package. Jitter measurements with the 86107A are targeted at users who are trying to accurately measure very low levels of jitter and need to minimize the jitter contribution of the scope.

The 86107A requires an electrical reference clock that is synchronous with the signal under test. For specific requirements of the clock signal, see the 86107A specifications on page 11.

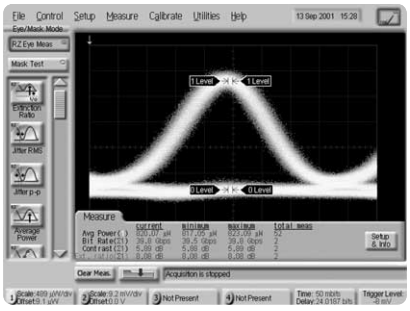
Accurate views of your 40 Gb/s waveforms

When developing 40 Gb/s devices, even a small amount of inherent scope jitter can become significant since 40 Gb/s waveforms only have a bit period of 25 ps. Scope jitter of 1ps RMS can result in 6 to 9 ps of peak-to-peak jitter, causing eye closure even if your signal is jitter-free. The Agilent 86107A reduces the intrinsic jitter of 86100 family mainframes to the levels necessary to make quality waveform measurements on 40 Gb/s signals.

Meeting your growing need for more bandwidth

Today's communication signals have significant frequency content well beyond an oscilloscope's 3-dB bandwidth. A high-bandwidth scope does not alone guarantee an accurate representation of your waveform. Careful design of the scope's frequency response (both amplitude and phase) minimizes distortion such as overshoot and ringing.

The Agilent 86116A, 86116B and 86109B are plug-in modules that include an integrated optical receiver designed to provide the optimum in bandwidth, sensitivity, and waveform fidelity. The 86116B extends the bandwidth of the 86100C infiniium DCA-J to 80 GHz electrical, 65 GHz optical in the 1550 nm wavelength band. The 86116A covers the 1300 nm and 1550 nm wavelength bands with 63 GHz of electrical bandwidth and 53 GHz of optical bandwidth. The 86109B is an economical solution with 50 GHz electrical and 40 GHz optical bandwidth. You can build the premier solution for 40 Gb/s waveform analysis around the 86100 mainframe that you already own.



Performing return-to-zero (RZ) waveform measurements

An extensive set of automatic RZ measurements are built-in for the complete characterization of return-to-zero (RZ) signals at the push of a button.

Specifications

Specifications describe warranted performance over the temperature range of +10 °C to +40 °C (unless otherwise noted). The specifications are applicable for the temperature after the instrument is turned on for one (1) hour, and while self-calibration is valid. Many performance parameters are enhanced through frequent, simple user calibrations. ***Characteristics*** *provide useful, non-warranted information about the functions and performance of the instrument. Characteristics are printed in italic typeface.*

Factory Calibration Cycle -For optimum performance, the instrument should have a complete verification of specifications once every twelve (12) months.

General specifications

This instrument meets Agilent Technologies' environmental specifications (section 750) for class B-1 products with exception as described for temperature and condensation. Contact your local field engineer for complete details. Product specifications and descriptions in this document subject to change without notice.

Temperature	
Operating	10 °C to +40 °C (50 °F to +104 °F)
Non-operating	–40 °C to +65 °C (–40 °F to +158 °F)
Humidity	
Operating	Up to 90% humidity (non-condensing) at +40 °C (+104 °F)
Non-operating	Up to 95% relative humidity at +65 °C (+149 °F)
Altitude	
Operating	Up to 4,600 meters (15,000 ft)
Non-operating	Up to 15,300 meters (50,000 ft)
Vibration	
Operating	Random vibration 5 to 500 Hz, 10 minutes per axis, 0.21 g (rms)
Non-operating	Random vibration 5 to 500 Hz, 10 minutes per axis, 0.3 g (rms); Resonant search, 5 to 500 Hz swept sine, 1 octave/min sweep rate, 0.5 g, 5 minute resonant dwell at 4 resonances/axis
Power requirements	
Voltage	90 to 132 or 198 to 264 Vac, 48 to 66 Hz
Power (including modules)	604 VA; 391 W
Weight	
Mainframe without modules	15.5 kg (34 lb)
Typical module	1.2 kg (2.6 lb)
Mainframe dimensions (excluding handle)	
Without front connectors and rear feet	215.1 mm H x 425.5 mm W x 566 mm D (8.47 in x 16.75 in x 22.2 in)
With front connectors and rear feet	215.1 mm H x 425.5 mm W x 629 mm D (8.47 in x 16.75 in x 24.8 in)

Mainframe specifications

HORIZONTAL SYSTEM (time base)		**PATTERN LOCK**
Scale factor (full scale is ten divisions)		
Minimum	2 ps/div (with 86107A: 500 fs/div)	
Maximum	1 s/div	250 ns/div
Delay[1]		
Minimum	24 ns	40.1 ns
Maximum	1000 screen diameters or 10 s, whichever is smaller	1000 screen diameters or 25.401 µs, whichever is smaller
Time interval accuracy[2]	1 ps + 1.0% of Δ time reading[3] 8 ps + 0.1% of Δ time reading	
Time interval accuracy – jitter mode operation[4]	*1 ps*	
Time interval accuracy – with 86107A precision timebase	< 200 fs	
Time interval resolution	≤ (screen diameter)/(record length) or 62.5 fs, whichever is larger	
Display units	Bits or time (TDR mode–meters)	

VERTICAL SYSTEM (channels)	
Number of channels	4 (simultaneous acquisition)
Vertical resolution	14 bit A/D converter (up to 15 bits with averaging)
Full resolution channel scales	Adjusts in a 1-2-5-10 sequence for coarse adjustment or fine adjustment resolution from the front panel knob
Adjustments	Scale, offset, activate filter, sampler bandwidth, attenuation factor, transducer conversion factors
Record length	16 to 4096 samples – increments of 1

[1] Time offset relative to the front panel trigger input on the instrument mainframe.
[2] Dual marker measurement performed at a temperature within ±5 °C of horizontal calibration temperature.
[3] Delay settings: Δ time is in the range (26 + N*4 ns) ±1.9 ns, where N = 0, 1, 2, ... 17.
[4] Characteristic performance. Test configuration: PRBS of length $2^7 - 1$ bits, Data and Clock 10 Gb/s.

Mainframe specifications *(continued)*

	Standard (direct trigger)	Option 001 (enhanced trigger)
Trigger Modes		
Internal trigger[1]	Freerun	
External direct trigger[2]		
Limited bandwidth[3]	DC to 100 MHz	
Full bandwidth	DC to 3.2 GHz	
External Divided Trigger	N/A	3 GHz to 13 GHz *(3 GHz to 15 GHz)*
PatternLock	N/A	50 MHz to 13 GHz *(50 MHz to 15 GHz)*
Jitter		
Characteristic	*< 1.0 ps RMS + 5*10E-5 of delay setting*[4]	*1.2 ps RMS for time delays less than 100 ns*[6]
Maximum	1.5 ps RMS + 5*10E-5 of delay setting[4]	1.7 ps RMS for time delays less than 100 ns[6]
Trigger sensitivity	200 m Vpp (sinusoidal input or 200 ps minimum pulse width)	200 m Vpp sinusoidal input: 50 MHz to 8 GHz 400 m Vpp sinusoidal input: 8 GHz to 13 GHz *600 m Vpp sinusoidal input: 13 GHz to 15 GHz*
Trigger configuration		
Trigger level adjustment	–1 V to + 1 V	AC coupled
Edge select	Positive or negative	N/A
Hysteresis[5]	Normal or high sensitivity	N/A
Trigger gating		
Gating input levels (TTL compatible)	*Disable: 0 to 0.6 V* *Enable: 3.5 to 5 V* *Pulse width > 500 ns, period > 1 µs*	
Gating delay	*Disable: 27 ns + trigger period +* *Max time displayed* *Enable: 100 ns*	
Trigger impedance		
Nominal impedance	*50 Ω*	
Reflection	*10% for 100 ps rise time*	
Connector type	3.5 mm (male)	
Maximum trigger signal	2 V peak-to-peak	

[1] The freerun trigger mode internally generates an asynchronous trigger that allows viewing the sampled signal amplitude without an external trigger signal but provides no timing information. Freerun is useful in troubleshooting external trigger problems.

[2] The sampled input signal timing is recreated by using an externally supplied trigger signal that is synchronous with the sampled signal input.

[3] The DC to 100 MHz mode is used to minimize the effect of high frequency signals or noise on a low frequency trigger signal.

[4] Measured at 2.5 GHz with the triggering level adjusted for optimum trigger.

[5] High Sensitivity Hysteresis Mode improves the high frequency trigger sensitivity but is not recommended when using noisy, low frequency signals that may result in false triggers without normal hysteresis enabled.

[6] Slew rate ≥ 2V/ns

Precision time base 86107A[1]

	86107A Option 010	86107A Option 020	86107A Option 040
Trigger bandwidth	2.4 to 4.0 GHz 9.0 to 12.6 GHz	9.0 to 12.6 GHz 18.0 to 25.0 GHz	9.0 to 12.6 GHz 18.0 to 25.0 GHz 39.0 to 43.0 GHz
Typical jitter (RMS)	2.4 to 4.0 GHz trigger: < 280 fs 9 to 12.6 GHz trigger: < 200 fs	< 200 fs	9 to 12.6 GHz, 18 to 25 GHz trigger bands: < 250 fs 38 to 45 GHz trigger: < 200 fs
Time base linearity error	< 200 fs		
Input signal type	Synchronous clock, no constraint on waveform shape.		
Input signal level	0.5 to 1.0 Vpp 0.2 to 1.5 Vpp (Typical functional performance)		
DC offset range	±200 mV[2]		
Required trigger signal-to-noise ratio	≥ 200 : 1		
Trigger gating **Gating input levels (TTL compatible)**	Disable: 0 to 0.6 V Enable: 3.5 to 5 V Pulse width > 500 ns, period > 1 µs		
Trigger impedance (nominal)	50 Ω		
Connector type	3.5 mm (male)		3.5 mm (male) 2.4 mm (male)

[1] Requires 86100 software revision 3.0 or above.

[2] For the 86107A with Option 020, the Agilent 11742A (DC Block) is recommended if the DC offset magnitude is greater than 200 mV.

Computer system and storage

CPU	1 GHz microprocessor
Mass storage	40 GByte internal hard drive External USB CD-RW drive 64 MB USB pen memory
Operating System	Microsoft Windows® XP Pro
DISPLAY[1]	
Display area	170.9 mm x 128.2 mm (8.4 inch diagonal color active matrix LCD module incorporating amorphous silicon TFTs)
Active display area	171mm x 128 mm (21,888 square mm) 6.73 in x 5.04 in (33.92 square inches)
Waveform viewing area	103 mm x 159 mm (4.06 in x 6.25 in)
Entire display resolution	640 pixels horizontally x 480 pixels vertically
Graticule display resolution	451 pixels horizontally x 256 pixels vertically
Waveform colors	Select from 100 hues, 0 to 100% saturation and 0 to 100% luminosity
Persistence modes	Gray scale, color grade, variable, infinite
Waveform overlap	When two waveforms overlap, a third color distinguishes the overlap area
Connect-the-dots	On/Off selectable
Persistence	Minimum, variable (100 ms to 40 s), infinite
Graticule	On/Off
Grid intensity	0 to 100%
Backlight saver	2 to 8 hrs, enable option
Dialog boxes	Opaque or transparent
FRONT PANEL INPUTS AND OUTPUTS	
Cal output	BNC (female) and test clip, banana plug
Trigger input	APC 3.5 mm, 50 Ω, 2 Vpp base max
USB[2]	
REAR PANEL INPUTS AND OUTPUTS	
Gated trigger input	TTL compatible
Video output	VGA, full color, 15 pin D-sub (female) 10
GPIB	Fully programmable, complies with IEEE 488.2
RS-232	Serial printer, 9 pin D-sub (male)
Centronics	Parallel printer port, 25 pin D-sub (female)
LAN	
USB[2] **(2)**	

1 Supports external display. Supports multiple display configurations via Windows® XP Pro display utility.

2 USB Keyboard and mouse included with mainframe. Keyboard has intergrated, 2-port USB hub.

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Module overview

Optical/electrical modules

750-860 nm

The 86101A, 86102A and 86102U modules support waveform compliance testing of short wavelength signals with up to 15 GHz of optical bandwidth. Each module also has an electrical channel with 20 GHz of bandwidth.

1000–1600 nm

< 20 GHz Optical and Electrical Channels:

The 86103A, 86103B, and 86105B modules are optimized for testing long wavelength signals with up to 18 GHz of optical bandwidth. Each module also has an electrical channel with 20 GHz of bandwidth.

The 86105B provides the best pulse fidelity, good sensitivity, and the most data rate flexibility of any DCA plug-in module. It is the recommended module for 10 Gb/s compliance applications. The 86103A and 86103B are recommended when sensitivity is the dominant requirement, as their amplified O/E converters provide the best sensitivity.

20 to 40 GHz Optical and Electrical Channels:

The 86106B has 28 GHz of optical bandwidth with multiple 10Gb/s compliance filters, and has an electrical channel with 40 GHz of bandwidth.

40 GHz and Greater Optical and Electrical Channels:

The 86109B and 86116A are optimized for testing 40 Gb/s signals. The 86109B has an optical channel with 40 GHz of bandwidth and an electrical channel with 50 GHz of bandwidth. The 86116A has more than 50 GHz of optical bandwidth and 60 GHz of electrical bandwidth. The 86116B is the widest bandwidth optical module with more than 65 GHz optical (1550nm band only) and 80 GHz electrical bandwidth.

Dual optical channel modules

86111A and 86111U are short wavelength optical modules that have up to 15 GHz of bandwidth optimized for testing signals from 155 Mb/s to 10 Gb/s.

86113A is a long wavelength module with 2.85 GHz of optical bandwidth optimized for testing of signals up to 2.5 Gb/s.

86115B is a long wavelength module that has 28 GHz of optical bandwidth. This module is designed for testing 10 Gb/s signals.

Dual electrical modules

86112A has two low-noise electrical channels with 20 GHz of bandwidth.

86117A has two electrical channels with up to 50 GHz of bandwidth ideal for testing signals up 10 Gb/s.

86118A has two electrical channels, each housed in a compact remote sampling head, attached to the module with separate light weight cables. With over 70 GHz of bandwidth, this module is intended for high bit rate applications where signal fidelity is crucial.

Clock recovery modules

This range of clock recovery modules is designed to provide a trigger signal for the infiniium DCA-J when no clock is present. The different modules are targeted at different applications based on data rate and transmission media (electrical, optical, or both).

The 83491A is an electrical module. It works for rates up to 2.5 Gb/s.

The 83492A works for optical signals and has multimode inputs, one working over the 750 to 860 nm range, the other 1000 to 1600 nm.

The 83493A and 83494A work with single-mode input, 1000 to 1600 nm. The 83493A works for various rates up to 2.5 Gb/s. The 83494A works for various rates up to 10 Gb/s.

The 83495A works for optical and electrical signals and has either multimode (750 to 860 nm) or single mode (1000 to 1600 nm) inputs. It operates over a continuous range of rates from 9.95 Gb/s to 11.3 Gb/s.

Time domain reflectometry (TDR)

The infiniium DCA-J may also be used as a powerful, high accuracy TDR, using the 54754A differential TDR module.

86100 family plug-In module matrix

The 86100 has a large family of plug-in modules designed for a broad range of data rates for optical and electrical waveforms. The 86100 can hold up to 2 modules for a total of 4 measurement channels.

	Module	Option	No. of optical channels	No. of electrical channels	Wavelength range (nm)	Unfiltered optical bandwidth (GHz)	Electrical bandwidth (GHz)	Fiber input (µm)	Mask test sensitivity (dBm)	Filtered data rates														
										155 Mb/s	622 Mb/s	1063 Mb/s	1250 Mb/s	2125 Mb/s	2488/2500 Mb/s	2.666 Gb/s	2.72 Gb/s	3.125 Gb/s	3.1875 Gb/s	3.32 Gb/s	9.953 Gb/s	10.3125 Gb/s	10.51875 Gb/s	10.664 Gb/s	10.709 Gb/s
Optical/ electrical	86101A	201	1	1	750-860	2.85	20	62.5	–17	■	■														
		202	1	1	750-860	2.85	20	62.5	–17			■	■												
	86102A	201	1	1	750-860	10	20	62.5	–13.5					■					■						
		202	1	1	750-860	10	20	62.5	–13.5						■			■							
		203	1	1	750-860	10	20	62.5	–13.5								■			■					
	86102U	201	1	1	750-860	15	20	62.5	–7.5				■		■										
		202	1	1	750-860	15	20	62.5	–7.5						■			■							
		203	1	1	750-860	15	20	62.5	–7.5									■				■			
	86103A	201	1	1	1000-1600	2.85	20	62.5	–20	■	■														
		202	1	1	1000-1600	2.85	20	62.5	–20			■	■												
	86103B	201	1	1	1000-1600	10	20	62.5	–15		■				■										
		202	1	1	1000-1600	10	20	62.5	–15			■	■												
		203	1	1	1000-1600	10	20	62.5	–15					■	■										
	86105B	101	1	1	1000-1600	15	20	9	–12												■	■	■	■	■
		102	1	1	1000-1600	15	20	9	–12	■	■				■	■					■	■	■	■	■
		103	1	1	1000-1600	15	20	9	–12			■	■	■	■						■	■	■	■	■
	86106B		1	1	1000-1600	28	40	9	–7												■	■	■		
		410	1	1	1000-1600	28	40	9	–7												■	■	■	■	■
	86109B		1	1	1000-1600	40	50	9	N/A																
	86116A		1	1	1000-1600	53	63	9	N/A																
	86116B		1	1	1480-1620	65	80	9	N/A																
Dual optical	86111A	201	2	0	750-860	2.85	N/A	62.5	–17	■	■														
		202	2	0	750-860	2.85	N/A	62.5	–17			■	■												
	86111U	201	2	0	750-860	15	N/A	62.5	–7.5				■		■										
		202	2	0	750-860	15	N/A	62.5	–7.5						■			■							
	86113A	201	2	0	1000-1600	2.85	N/A	62.5	–20	■	■														
		202	2	0	1000-1600	2.85	N/A	62.5	–20			■	■												
		301	2	0	1000-1600	2.5	N/A	62.5	–20	■	■				■										
	86115B	101	2	0	1000-1600	28	N/A	9	–7												■				
		410	2	0	1000-1600	28	N/A	9	–7												■	■	■	■	■
Dual electrical	54754A		0	2		N/A	18																		
	86112A		0	2		N/A	20																		
	86117A		0	2		N/A	50																		
	86118A		0	2		N/A	70																		

Module specifications: single-mode & multimode optical/electrical

Multimode and single-mode	**86101A**	**86102A**	**86102U**
OPTICAL CHANNEL SPECIFICATIONS			
Optical channel unfiltered bandwidth	2.85 GHz (3 GHz typical)	10 GHz	15 GHz
Wavelength range	750 to 860 nm		
Calibrated wavelengths	850 nm		
Optical sensitivity[1]	*–17 dBm*	*–13.5 dBm*	*–7.5 dBm*
Transition time (10% to 90% calculated from TR = 0.48/BW optical)			
Unfiltered	*160 ps*	*48 ps*	*32 ps*
RMS noise			
Characteristic	*1.5 µW*	*3.4 µW*	*14 µW*
Maximum	2.5 µW	5.5 µW	20 µW
Scale factor (per division)			
Minimum	5 µW		20 µW
Maximum	100 µW		500 µW
CW accuracy (single marker, referenced to average power monitor, <50 µW/division)	±6 µW ±0.4% of full scale ±3% of (reading-channel offset)		±25 µW ±2% of (reading-channel offset), 15 GHz
CW offset range (referenced two divisions from screen bottom)	+0.2 mW to –0.6 mW		+1 mW to –3 mW
Average power monitor (specified operating range)	–30 dBm to –2.2 dBm	–30 dBm to –2.2 dBm	–27 dBm to +3 dBm
Factory calibrated accuracy	±5% ±100 nW ±connector uncertainty, 20 °C to 30 °C		
User calibrated accuracy	±2% ±100 nW ±power meter uncertainty, < 5 °C change		
Maximum input power			
Maximum non-destruct average	0.4 mW (–4 dBm)	0.8 mW (–1 dBm)	2 mW (+3 dBm)
Maximum non-destruct peak	10 mW (+10 dBm)		
Fiber input	62.5/125 µm, user selectable connector		
Input return loss (HMS-10 connector fully filled fiber)	20 dB		

ELECTRICAL CHANNEL SPECIFICATIONS	
Electrical channel bandwidth	12.4 and 20 GHz
Transition time (10% to 90%, calculated from TR = 0.35/BW)	28.2 ps (12.4 GHz) 17.5 ps (20 GHz)
RMS noise	*0.25 mV (12.4 GHz)*
Characteristic	*0.5 mV (20 GHz)*
Maximum	0.5 mv (12.4 GHz) 1 mV (20 GHZ)
Scale factor	
Minimum	1 mV/division
Maximum	100 mV/division
DC accuracy (single marker)	±0.4% of full scale ± 2 mV ±1.5% of (reading-channel offset), 12.4 GHz ±0.4% of full scale ± 2 mV ±3% of (reading-channel offset), 20 GHz
DC offset range (referenced to center of screen)	±500 mV
Input dynamic range (relative to channel offset)	±400 mV
Maximum input signal	±2 V (+16 dBm)
Nominal impedance	50 Ω
Reflections (for 30 ps rise time)	5%
Electrical input	3.5 mm (male)

[1] Smallest average optical power required for mask test. Values represent typical sensitivity of NRZ eye diagrams. Assumes mask test with complicance filter switched in.

Module specifications: single-mode & multimode optical/electrical *(continued)*

Multimode and single-mode Optical/electrical modules	**86103A**	**86103B**	**86105B**
OPTICAL CHANNEL SPECIFICATIONS			
Optical channel unfiltered bandwidth	2.85 GHz	10 GHz	15 GHz
Wavelength range	1000 to 1600 nm		
Calibrated wavelengths	1310 nm/1550 nm		
Optical sensitivity[1]	*–20 dBm Opt 201* *–18 dBm Opt 202*	*–15 dBm*	*–12 dBm*
Transition time (10% to 90% calculated from TR = 0.48/BW optical)	*160 ps*	*48 ps*	*32 ps*
RMS noise			
Characteristic	0.75 µW Opt 201 1.0 µW Opt 202	2 µW	5 µW, (10 GHz) 12 µW, (15 GHz)
Maximum	1.5 µW Opt 201 2.5 µW Opt 202	3.7 µW	8 µW, (10 GHz) 15 µW (15 GHz)
Scale factor (per division)			
Minimum	5 µW		20 µW
Maximum	100 µW		500 µW
CW accuracy (single marker, referenced to average power monitor)	±6 µW ±0.4% of full scale ±3% of (reading-channel offset)		±25 µW ±2% of (reading-channel offset), 10 GHz ±25 µW ±4% of (reading-channel offset), 15 GHz
CW offset range (referenced two divisions from screen bottom)	+0.2 mW to –0.6 mW		+1 mW to –3 mW
Average power monitor (specified operating range)	–30 dBm to 0 dBm		–30 dBm to +3 dBm
Factory calibrated accuracy			
Single mode	±5% ±100 nW ±connector uncertainty (20 °C to 30 °C)		
Multi mode	±10% ±100 nW ±connector uncertainty (20 °C to 30 °C)		N/A
User calibrated accuracy	±2% ±100 nW ±power meter uncertainty, < 5 °C change		
Maximum input power			
Maximum non-destruct average	0.4 mW (–4 dBm)	0.8 mW (–1 dBm)	2 mW (+3 dBm)
Maximum non-destruct peak	10 mW (+10 dBm)		
Fiber input	62.5/125 µm, user selectable connector		9/125 µm user selectable connector
Input return loss (HMS-10 connector fully filled fiber)	20 dB		33 dB

ELECTRICAL CHANNEL SPECIFICATIONS	
Electrical channel bandwidth	12.4 and 20 GHz
Transition time (10% to 90%, calculated from TR = 0.35/BW)	28.2 ps (12.4 GHz) 17.5 ps (20 GHz)
RMS noise	
Characteristic	*0.25 mV (12.4 GHz)* *0.5 mV (20 GHz)*
Maximum	0.5 mv (12.4 GHz) 1 mV (20 GHz)
Scale factor	
Minimum	1 mV/division
Maximum	100 mV/division
DC accuracy (single marker)	±0.4% of full scale ±2 mV ±1.5% of (reading-channel offset), 12.4 GHz ±0.4% of full scale ±2 mV ±3% of (reading-channel offset), 20 GHz
DC offset range (referenced to center of screen)	±500 mV
Input dynamic range (relative to channel offset)	±400 mV
Maximum input signal	±2 V (+16 dBm)
Nominal impedance	50 Ω
Reflections (for 30 ps rise time)	5%
Electrical input	3.5 mm (male)

[1] Smallest average optical power required for mask test. Values represent typical sensitivity of NRZ eye diagrams. Assumes mask test with complicance filter switched in.

Module specifications: single-mode optical/electrical

High bandwidth, single-mode Optical/electrical modules	**86106B**	**86109B**	**86116A**[1]	**86116B**[1]
OPTICAL CHANNEL SPECIFICATIONS				
Optical channel unfiltered bandwidth	*28 GHz*	*40 GHz*[2]	*53 GHz*	*65 GHz (best pulse fidelity)*
Wavelength range	1000 to 1600 nm			55 GHz (best sensitivity)
Calibrated wavelengths	1310/1550 nm			1480 to 1620 nm
Optical sensitivity[4]	*–7 dBm*			
Transition time (10% to 90%, calculated from TR = 0.48/BW optical)	*18 ps*	12 ps (FWHM)[3]	9.0 ps (FWHM)[3]	7.4 ps (FWHM)[3]
RMS noise				
Characteristic	*13 µW (Filtered)* *23 µW (Unfiltered)*	*25 µW (30 GHz)* *65 µW (40 GHz)*	*60 µW (50 GHz)* *190 µW (53 GHz)*	*50 µW (55 GHz)* *140 µW (65 GHz)*
Maximum	15 µW (Filtered) 30 µW (Unfiltered)	30 µW (30 GHz) 75 µW (40 GHz)	90 µW (50 GHz) 260 µW (53 GHz)	85 µW (55 GHz) 250 µW (65 GHz)
Scale factor				
Minimum	20 µW/division		200 µW/division	
Maximum	500 µW/division	1.0 mW/division	2.5 mW/division	5 mW/division
CW accuracy (single marker, referenced to average power monitor)	±50 µW ±4% of (reading-channel offset)		± 150 µW ± 4% of (reading-channel offset)	
CW offset range (referenced two divisions from screen bottom)	+1 mW to –3 mW	+6 mW to –2 mW	+5 mW to –15mW	+8 to –12 mW
Average power monitor (specified operating range)	–27 dBm to +3 dBm	–23 dBm to +9 dBm		
Factory calibrated accuracy **User calibrated accuracy**	±5% ±100 nW ±connector uncertainty, 20 °C to 30 °C ±2% ±100 nW ±power meter uncertainty, < 5 °C change			
Maximum input power				
Maximum non-destruct average	2 mW (+3 dBm)	10 mW (+10 dBm)		
Maximum non-destruct peak	10 mW (+10 dBm)	50 mW (+17 dBm)		
Fiber input	9/125 µm, user selectable connector			
Input return loss (HMS-10 connector fully filled fiber)	30 dB			20 dB

1 86116A and 86116B requires the 86100 software revision A.3.0 or above.

2 Specified with 8 point moving average in frequency response.

3 FWHM (Full Width Half Max) as measured from optical pulse with 700 fs FWHM, 5 MHz repetition rate and 10 mW peak power.

4 Smallest average optical power required for mask test. Values represent typical sensitivity of NRZ eye diagrams. Assumes mask test with compliance filter switched in.

ELECTRICAL CHANNEL SPECIFICATIONS				
Electrical channel bandwidth	18 and 40 GHz	26 and 50 GHz	43 and 63 GHz	80, 55 and 30 GHz
Transition time (10% to 90%, calculated from TR = 0.35/BW)	*19.5 ps (18 GHz)* *9 ps (40 GHz)*	*< 13.2 ps (26 GHz)* *7 ps (50 GHz)*	*8.1 ps (43 GHz)* *5.6 ps (63 GHz)*	*6.4 ps (55 GHz)* *4.4 ps (80 GHz)*
RMS noise				
Characteristic	*0.25 mV (18 GHz)* *0.5 mV (40 GHz)*	*0.25 mV (26 GHz)* *0.60 mV (50 GHz)*	*0.6 mV (43 GHz)* *1.7 mV (63 GHz)*	*0.6 mV (55 GHz)* *1.1 mV (80 GHz)*
Maximum	0.5m V (18 GHz) 1.0 mV (40 GHz)	0.50 mV (26 GHz) 1.0 mV (50 GHz)	0.9 mV (43 GHz) 2.5 mV (63 GHz)	1.1 mV (55 GHz) 2.2 mV (80 GHz)
Scale factor				
Minimum	1 mV/division		2 mV/division	
Maximum	100 mV/division		100 mV/division	
DC accuracy (single marker)	±0.4% of full scale ±2 mV ±1.5% of (reading-channel offset), 18 GHz ±0.4% of full scale ±2 mV ±3% of (reading-channel offset), 40 GHz	±0.4% of full scale ±2 mV ±1.5% of (reading-channel offset), 26 GHz ±0.4% of full scale ±2 mV ±2% of (reading-channel offset), 50 GHz	±0.8% of full scale ±2 mV ±1.5% of (reading-channel offset), 43 GHz ±2.5% of full scale ±2 mV ±2% of (reading-channel offset), 63 GHz	±0.4% of full scale ±3 mV ±2% of (reading-channel offset), ±2% of offset (all bandwidths)
DC offset range (referenced to center of screen)	±500 mV			
Input dynamic range (relative to channel offset)	±400 mV			
Maximum input signal	±2 V (+16 dBm)			
Nominal impedance	50 Ω			
Reflections (for 20 ps rise time)	5%			10% (DC to 70 GHz) 20% (70 to 100 GHz)
Electrical input	2.4 mm (male)		1.85 mm (male)	

Module specifications: dual optical

Dual mode optical modules[1]	**86111A**	**86111U**	**86113A**	**86115B**
OPTICAL CHANNEL SPECIFICATIONS				
Optical channel unfiltered bandwidth	*2.85 GHz*	*15 GHz*	*2.85 GHz*	*28 GHz*
Wavelength range	750 to 860 nm		1000 to 1600 nm	
Calibrated wavelengths	850 nm		1310/1550 nm	
Optical sensitivity[1]	*–17 dBm*	*–7.5 dBm*	*–20 dBm*	*–7 dBm*
Transition time (10% to 90%,calculated from TR = 0.48/BW optical)				
Unfiltered	*160 ps*	*32ps*	*160 ps*	*18 ps*
RMS noise				
Characteristic	*1.5 µW*	*14µW*	*1.0 µW*	*13 µW (Filtered)* *23 µW (Unfiltered)*
Maximum	2.5 µW	20 µW	2.5 µW	15 µW (Filtered) 30 µW (Unfiltered)
Scale factor				
Minimum Maximum	5 µW 100 µW	20 µW 500 µW	5 µW 100 µW	20 µW 500 µW
CW accuracy (single marker, referenced to average power monitor)	±6 µW ±0.4% of full scale ±3% of (reading-channel offset)	25 µW ±2% of (reading-channel offset), 15 GHz	±6 µW ±0.4% of full scale ±3% of (reading-channel offset)	±50 µW ±4% of (reading-channel offset)
CW offset range (referenced two divisions from screen bottom)	+0.2 mW to –0.6 mW	+1 mW to –3 mW	+0.2 mW to –0.6 mW	+1 mW to –3 mW
Average power monitor (specified operating range)	–30 dBm to –2.2 dBm	–27 dBm to +3 dBm	–30 dBm to 0 dBm	–27 dBm to +3 dBm
Factory calibrated accuracy Single mode	±5% ±100 nW ±connector uncertainty, (20 °C to 30 °C)			
Multi mode	±10% ±100 nW ±connector uncertainty, (20 °C to 30 °C)			N/A
User calibrated accuracy	±2% ±100 nW ±power meter uncertainty, <5 °C change			
Maximum input power				
Maximum non-destruct average	0.4 mW (–4 dBm)	2 mW (+3 dBm)	0.4 mW (–4 dBm)	2 mW (+3 dBm)
Maximum non-destruct peak	10 mW (+10 dBm)			
Fiber input	62.5/125 µm, user selectable connector			9/125 µm, user selectable connector
Input return loss (HMS-10 connector fully filled fiber)	20 dB			30 dB

[1] Requires the 86100 software revision 3.0 or above.

Module specifications: dual electrical

Dual electrical channel modules	**86112A**	**54754A**
Electrical channel bandwidth	12.4 and 20 GHz	12.4 and 18 GHz
Transition time (10% to 90%, calculated from TR = 0.35/BW)	*28.2 ps (12.4 GHz);* *17.5 ps (20 GHz)*	*28.2 ps (12.4 GHz);* *19.4 ps (18 GHz)*
RMS noise		
Characteristic	*0.25 mV (12.4 GHz);* *0.5 mV (20 GHz)*	*0.25 mV (12.4 GHz);* *0.5 mV (18 GHz)*
Maximum	0.5 mv (12.4 GHz); 1 mV (20 GHz)	0.5 mv (12.4 GHz); 1 mV (18 GHz)
Scale factor		
Minimum	1 mV/division	
Maximum	100 mV/division	
DC accuracy (single marker)	±0.4% of full scale ±2 mV ±1.5% of (reading-channel offset), 12.4 GHz ±0.4% of full scale ±2 mV ±3% of (reading-channel offset), 20 GHz	±0.4% of full scale ±2mV ±0.6% of (reading-channel offset), 12.4 GHz ±0.4% of full scale or marker reading (whichever is greater) ±2 mV ±1.2% of (reading-channel offset), 18 GHz
CW offset range (referenced from center of screen)	±500 mV	
Input dynamic range (relative to channel offset)	±400 mV	
Maximum input signal	±2 V (+16 dBm)	
Nominal impedance	50 Ω	
Reflections (for 30 ps rise time)	5%	
Electrical input	3.5 mm (male)	

Dual electrical channel modules	**86117A**	**86118A**
Electrical channel bandwidth	30 and 50 GHz	50 and 70 GHz
Transition time (10% to 90%, calculated from TR = 0.35/BW)	*11.7 ps (30 GHz)* *7 ps (50 GHz)*	
RMS noise		
Characteristic	*0.4 mV (30 GHz)* *0.6 mV (50 GHz)*	*0.7 mV (50 GHz)* *1.3 mV (70 GHz)*
Maximum	0.7 mv (30 GHz); 1.0 mV (50 GHz	1.8 mV (50 GHz) 2.5 mV (70 GHz)
Scale factor		
Minimum	1 mV/division	
Maximum	100 mV/division	
DC accuracy (single marker)	±0.4% of full scale ±2 mV ±1.2% of (reading-channel offset) (30 GHz) ±0.4% of full scale ±2 mV ±2% of (reading-channel offset) (50 GHz)	±0.4% of full scale ±2 mV ±2% of (reading-channel offset) (50 GHz) ±0.4% of full scale ±2 mV ±4% of (reading-channel offset) (70 GHz)
CW offset range (referenced from center of screen)	±500 mV	
Input dynamic range (relative to channel offset)	±400 mV	
Maximum input signal	±2 V (+16 dBm)	
Nominal impedance	50 Ω	
Reflections (for 30 ps rise time)	5%	20%
Electrical input	2.4 mm (male)	1.85 mm (female)

TDR system

TDR system (Mainframe with 54754A module)	**Oscilloscope/TDR performance**	**Normalized characteristics**
Rise time	40 ps nominal	Adjustable from larger of 10 ps or 0.08 x time/div Maximum: 5 x time/div
TDR step flatness	≤ ±1% after 1 ns from edge ≤ ±5%, –3% 1 ns from edge	≤ 0.1%
Low level **High level**	0.00 V ±2 mV ±200 mV ±2 mV	

Clock recovery

Clock recovery single mode, Multimode and electrical modules	**83491A**	**83492A**	**83493A**	**83494A**
Channel type	Electrical	Multimode optical	Single mode optical	Single mode optical
Clock recovery phase locked loop bandwidth				
Internal path triggering	*50 to 70 kHz*			*90 kHz*
External output	*4 MHz ±10%*			
Data rates (Mb/s)	155, 622, 1063, 1250, 2125, 2488, 2500	155, 622, 1063, 1250, 2125, 2488, 2500	155, 622, 1250, 2488, 2500	155, 622, 2488, 9953
Tracking/Acquisition range	±0.1%			155, 622, 2488, ±0.1%; 9953 ±0.03%
Internal splitter ratio	50/50	50/50	10/90	10/90
Output jitter	< 0.0125 UI RMS			155, 622, 2488 0.02 UI RMS 9953 0.03 UI RMS
Input power for clock recovery	–10 dBm to +3 dBm	750 to 860 nm, –10 to +3 dBm 1000 to 1600 nm, –13 to +3 dBm	–20 dBm to +3 dBm	–12 dBm to +3 dBm (155, 622, 2488 Mb/s) –8 dBm to +3 dBm (9953 Mb/s)
Input/output connectors	APC 3.5 mm, 50 Ω	FC/PC, 62.5/125 µm multimode, user selectable connector	FC/PC, 9 /125 µm	
Auxiliary recovered clock and regenerated data outputs	Type N with SMA adapters			
Input return loss	DC to 1250 MHz, 20 dB 1250 to 2500 MHz, 15 dB	20 dB	28 dB	
Input insertion loss	DC to 1250 MHz, 7 dB 1250 to 2500 MHz, 15 dB	5 dB maximum	1.5 dB maximum	

Clock recovery single mode, Multimode and electrical modules	**83495A-100**	**83495A-101**
Channel type	Single mode optical and electrical	Multimode optical and electrical
Wavelenth range	1000 to 1600 nm	750 to 860 nm
Clock recovery phase locked loop bandwidth		
Internal path triggering[2]	*< 300 KHz* or < 4 MHz *(3.5 MHz[1])* user selectable	
External output[2]	*< 300 KHz* or < 4 MHz *(3.5 MHz[1])* user selectable	
Data rates (Gb/s)	9.953 to 11.32	
Tracking range	*±30 MHz*	
Acquisition range	Continuous within data rate range	
Internal splitter ratio	20/80	30/70[5]
Clock output jitter[3]	0.008 UI *(0.006 UI)* RMS	
Input level for clock recovery[4]	–12 dBm *(–14 dBm)* to +0 dBm optical *0.20 to 2.0 Vp-p electrical*	–9 dBm *(–11 dBm)* to +0 dBm optical[5] *0.20 to 2.0 Vp-p electrical*
Input/output connectors	FC/PC, 9/125 µm & Type N	FC/PC, 62.5/125 µm & Type N
Auxiliary recovered clock and regenerated data outputs	Type N with SMA adapters (no data output)	
Input return loss	28 dB maximum optical DC to 2.5 GHz, 20 dB electrical 2.5 GHz to 11.32 GHz, 15 dB electrical	
Input insertion loss	2.0 dB maximum optical	2.5 dB maximum optical

[1] Achieved with input power ≥ –8 dBm for Option 100; ≥ –5 dBm for Option 101.

[2] Loop BW transfer function is guaranteed to be less than a low pass response with the specified corner frequency rolling off –20 dB/dec.

[3] Measured with a PRBS 2^{23}-1 pattern. For total scope jitter, RSS clock output jitter with mainframe jitter.

[4] For optical input power, source extinction ratio ≥ 8.2 dB when measured per TIA/EIA OFSTP-4A. For extinction ratio equal to 8.2 dB, OMA is defined as ($P_1 - P_0$) and is equal to average input power (dBm) + 1.68 dB.

[5] Input is a fully filled multimode signal.

Ordering Information

86100C infiniium DCA-J mainframe
86100C-001 Enhanced trigger
86100C-100 Jitter analysis software
86100C-101 Advanced waveform analysis software
86100C-AX4 Rack mount flange kit
86100C-AXE Rack mount flange kit with handles
86100C-UK6 Commercial cal certificate with test data

Optical/electrical modules

86101A 2.85 GHz optical channel; multimode, amplified (750 to 860 nm) 20 GHz electrical channel
86101A-201 155, 622 Mb/s
86101A-202 1.063, 1.25 Gb/s

86102A 10 GHz optical channel; multimode, amplified (750 to 860 nm) 20 GHz electrical channel
86102A-201 2.125, 3.187 Gb/s
86102A-202 2.488, 3.125 Gb/s
86102A-203 2.72, 3.32 Gb/s

86102U 15 GHz optical channel; multimode, unamplified (750 to 860 nm) 20 GHz electrical channel
86102U-201 1.25, 2.488 Gb/s
86102U-202 2.488, 3.125 Gb/s
86102U-203 3.125, 10.3125 Gb/s

86103A 2.85 GHz optical channel; multimode, amplified (1000 to 1600 nm) 20 GHz electrical channel
86103A-201 155, 622 Mb/s
86103A-202 1.063, 1.25 Gb/s

86103B 10 GHz optical channel; multimode, amplified (1000 to 1600 nm) 20 GHz electrical channel
86103B-201 622 Mb/s, 2.488 Gb/s
86103B-202 1.063, 1.25 Gb/s
86103B-203 2.125, 2.488 Gb/s

86105B 15 GHz optical channel; single-mode, unamplified (1000 to 1600 nm) 20 GHz electrical channel
86105B-101 9.953, 10.3125, 10.51875, 10.664, 10.709 Gb/s
86105B-102 155, 622 Mb/s
2.488, 2.5, 2.666, 9.953, 10.3125, 10.51875, 10.664, 10.709 Gb/s
86105B-103 1.063, 1.250, 2.125, 2.488, 2.5, 9.953, 10.3125, 10.51875, 10.664, 10.709 Gb/s

86106B 28 GHz optical channel; single-mode, unamplified (1000 to 1600 nm) 40 GHz electrical channel
86106B-410 9.953, 10.3125, 10.664, 10.709 Gb/s

86109B 40 GHz optical channel; single-mode, unamplified (1000 to 1600 nm) 50 GHz electrical channel

86116A 53 GHz optical channel; single-mode, unamplified (1000 to 1600 nm) 63 GHz electrical channel

86116B 65 GHz optical channel; single-mode, unamplified (1480 to 1620 nm) 80 GHz electrical channel

Dual optical channel modules

86111A Dual 2.85 GHz optical channels; multimode, amplified (750 to 860 nm)
86111A-201 155, 622 Mb/s
86111A-202 1.063, 1.25 Gb/s

86111U Dual 15 GHz optical channels; multimode, unamplified (750 to 860 nm)
86111U-201 1.25, 2.488 Gb/s
86111U-202 2.488, 3.125 Gb/s
86111U-203 3.125, 10.3125 Gb/s

86113A Dual 2.85 GHz optical channels; multimode, amplified (1000 to 1600 nm)
86113A-201 155, 622 Mb/s
86113A-202 1.063, 1.25 Gb/s
86113A-301 155 Mb/s, 622 Mb/s, 2.488 Gb/s

86115B Dual 28 GHz optical channels; single-mode, unamplified (1000 to 1600 nm)
86115B-101 9.953 Gb/s
86115B-410 9.953 Gb/s, 10.3125, 10.664, 10.709 Gb/s

Dual electrical channel modules

86112A Dual 20 GHz electrical channels

86117A Dual 50 GHz electrical channels

86118A Dual 70 GHz electrical remote sampling channels

TDR/TDT modules

Included with each of these TDR modules is a TDR demo board, programmers guide, 2 50 Ω terminations, APC-3.5 (m), and one short, APC-3.5 (m).

54754A Differential TDR module with dual 18 GHz TDR/electrical channels

Trigger module

86107A Precision timebase reference module
86107A-010 2.5 and 10 GHz clock input capability
86107A-020 10 and 20 GHz clock input capability
86107A-040 10, 20 and 40 GHz clock input capability

Clock recovery modules

The following modules provide a recovered clock from the data signal for triggering at standard telecommunications and enterprise data rates:

83491A Electrical signals. Data rates 155, 622, 1063, 1250, 2125, 2488, 2500 Mb/s

83492A Multimode optical. Data rates 155, 622, 1063, 1250, 2125, 2488, 2500 Mb/s

83493A Single-mode signals. Data rates 155, 622, 1250, 2488, 2500 Mb/s

83494A Single-mode signals. Data rates 155, 622, 2488 Mb/s and 9.953 Gb/s

83494A-103 Single-mode signals. Data rates 155, 622, 2488 Mb/s and 10.3125 Gb/s

83494A-106 Single-mode signals. Data rates 155, 622, 2488, 2666 Mb/s and 10.664 Gb/s

83494A-107 Single-mode signals. Date rates 155, 622, 2488, 2666 Mb/s and 10.709 Gb/s

83495A 10 Gb/s Clock recovery module

83495A-100 Single-mode signals (1000–1600 nm) and electrical

83495A-101 Multimode signals (750–860 nm) and electrical

83495A-200 Continuous data rates from 9.953 Gb/s to 11.32 Gb/s

Warranty options (for all products)

R1280A Customer return repair service

R1282A Customer return calibration service

Connector options (for All optical modules)

81000 AI Diamond HMS-10 connector

81000 FI FC/PC connector adapter

81000 SI DIN connector adapter

81000 VI ST connector adapter

81000 KI SC Connector Adapter

Accessories

11667B Power splitter, DC to 26.5 GHz, APC 3.5 mm

11667C Power splitter, DC to 50 GHz, 2.4mm

11742A 45 MHz to 26.5 GHz DC blocking capacitor

11742A-K01 50 GHz DC blocking capacitor

11898A 1.5 meter remote extender module

54008B 24 ns delay line

54121-68701 RF accessories kit

83430A 2.5 Gb/s lightwave transmitter

83440B/C/D Optical-to-electrical converters (6/20/32 GHz)

83446A 2.5 Gb/s lightwave receiver

8490D-020 2.4 mm 20dB attenuator

86101-60005 Filler panel

0960-2427 USB keyboard (included with 86100C)

1150-7799 USB mouse (included with 86100C)

N1020A 6 GHz TDR probe kit

N1025A 1 GHz active differential probe

Probes

1130 Series InfiniiMax probing systems

(Requires N1022A – see below)

1134A 7 GHz InfiniiMax probe amp – order one or both E266xA connectivity kits per amp

1132A 5 GHz InfiniiMax probe amp – order one or both E266xA connectivity kits per amp

1131A 3.5 GHz InfiniiMax probe amp – order one or both E266xA connectivity kits per amp

Connectivity kits model

E2669A InfiniiMax connectivity kit for differential measurements

E2668A InfiniiMax connectivity kit for single-ended measurements

Additional Components

E2675A InfiniiMax differential browser probe head and accessories. Includes 20 replaceable tips and ergonomic handle. Order E2658A for replacement accessories.

E2676A InfiniiMax single-ended browser probe head and accessories. Includes 2 ground collar assemblies, 10 replaceable tips, a ground lead socket and ergonomic browser handle. Order E2663A for replacement accessories.

E2677A InfiniiMax differential solder-in probe head and accessories. Includes 20 full bandwidth and 10 medium bandwidth damping resistors. Order E2670A for replacement accessories.

E2678A InfiniiMax single-ended/differential socketed probe head and accessories. Includes 48 full bandwidth damping resistors, 6 damped wire accessories, 4 square pin sockets and socket heatshrink. Order E2671A for replacement accessories.

E2679A InfiniiMax single-ended solder-in probe head and accessories. Includes 16 full bandwidth and 8 medium bandwidth damping resistors and 24 zero ohm ground resistors. Order E2672A for replacement accessories.

Adapters

N1022A Adapts 113x/115x active probes to 86100 Infiniium DCA

Other compatible probes

54006A 6 GHz passive probe

54701A 2.5 GHz active probe

Adapters for electrical channels

11900B 2.4mm (f-f) adapter

11901B 2.4mm (f) to 3.5mm (f) adapter

11901C 2.4mm (m) to 3.5mm (f) adapter

54124-24101 2.4mm termination

5061-5311 3.5mm (f-f) adapter

1250-1158 SMA (f-f) adapter

1810-0118 3.5mm termination

Firmware and software

Firmware and software upgrades are available through the Web or your local sales office. www.agilent.com/comms/dcaupgrade

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Phone or Fax

United States:
(tel) 800 829 4444
(fax) 800 829 4433

Canada:
(tel) 877 894 4414
(fax) 905 282 6495

China:
(tel) 800 810 0189
(fax) 800 820 2816

Japan:
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Korea:
(tel) (080) 769 0800
(fax) (080)769 0900

Latin America:
(tel) (305) 269 7500

Taiwan:
(tel) 0800 047 866
(fax) 0800 286 331

Other Asia Pacific Countries:
(tel) (65) 6375 8100
(fax) (65) 6755 0042
Email: tm_ap@agilent.com

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