

# Infiniium DCA-X

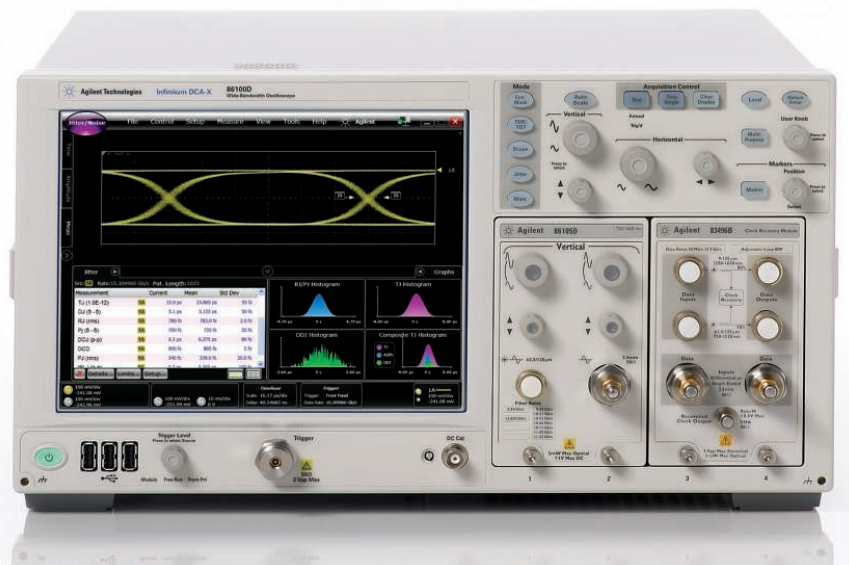
## 86100D

### Wide-Bandwidth Oscilloscope Mainframe and Modules

#### Data Sheet

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### See the TRUE performance of your designs.

The 86100D DCA-X performs precision measurements on high-speed digital designs from 50Mb/s to over 80Gb/s. Applications include:

- Optical
  - Transceiver Design and Manufacturing
- Electrical
  - ASIC/FPGA/IC Design and characterization
- TDR/TDT/S-Parameter
  - Serial Bus Designs, Cables, and PCB characterization



# Overview of the Infiniium DCA-X

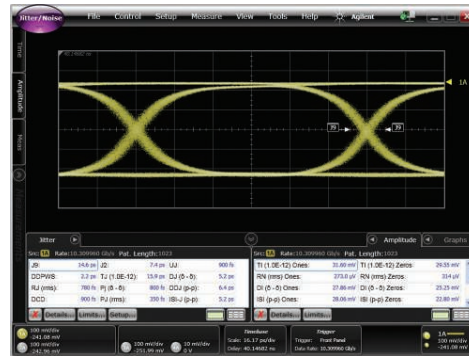
the 86100D DCA-X can be viewed as four powerful instruments in one:

## Scope mode



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

## Jitter mode



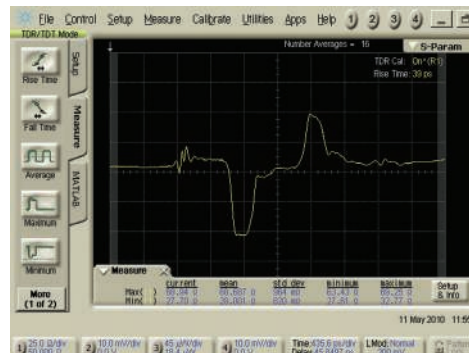
Precision jitter, amplitude, and frequency analysis capability

## 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 50Mb/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.

# Specifications

## General and mainframe

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

## Comparing specifications

When comparing performance attributes between instruments, ensure you compare the same type of parameter. For example, compare warranted specifications from both instruments, or compare characteristics or typical performance. Warranted specifications include measurement uncertainties and are conservative compared to other types of unwarranted attributes.

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

## General specifications

Temperature	Operating Non-operating	10 °C to +40 °C (50 °F to +104 °F) –40 °C to +65 °C (–40 °F to +158 °F)
Altitude	Operating	Up to 4,600 meters (15,000 feet)
Power (max)	100/120Vac 50/60/400 Hz 220/240Vac 50/60 Hz, 700 Watts Maximum	With typical modules: 150 VA to 230 VA at 25°C
Weight	Mainframe without modules Typical module	20.5 kg (43 lb) 1.2 kg (2.6 lb)
Mainframe dimensions (excluding handle)	Without front connectors and rear feet	221 mm H x 426 mm W x 530 mm D (7 inch x 16.76 inch x 20.9 inch)
	With front connectors and rear feet	234 mm H x 426 mm W x 601 mm D (9.23 inch x 16.76 inch x 23.67 inch)
	With front cover and rear feet	234 mm H x 426 mm W x 612 mm D (9.23 inch x 16.76 inch x 24.1 inch)

## Mainframe specifications

<b>Horizontal system (time base)</b>		<b>Pattern lock</b>
<b>Scale factor</b> (full scale is ten divisions)		
Minimum	2 ps/div (with 86107A: 500fs/div)	250 ns/div
Maximum	1 s/div	
<b>Delays</b> <sup>1</sup>		
Minimum	24 ns	40.1 ns default, 24 ns min
Maximum	1000 screen diameters or 10 s whichever is smaller	1000 screen diameters or 25.401 μs whichever is smaller
Time interval accuracy <sup>2</sup>	1 ps + 1.0% of Δ time reading <sup>3</sup> or 8 ps, whichever is smaller	
Jitter mode operation <sup>4</sup>	Time interval accuracy - jitter mode operation 1 ps	
Time interval resolution	≤ (screen diameter)/(record length) or 62.5 fs, whichever is larger	
Display units	Bits or time (TDR mode–meters)	
<b>Vertical system (channels)</b>		
Number of channels	16 (simultaneous acquisition)	
Vertical resolution	14 bit A/D converter (16 or more bits with averaging) or when using the N1045 plug-in module	
Full resolution channel	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	Legacy UI: 16 to 16K samples FlexDCA without pattern lock: 16 to 64K samples FlexDCA with pattern lock: 16 up to 32M samples <sup>5</sup>	

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. The maximum delay setting is 100 ns and delta time does not span across  $(28 + N \times 4) \text{ ns} \pm 100 \text{ ps}$  delay setting, where  $N=0,1,2,\dots,18$ . If delta time measurement span exceeds above criteria, time interval accuracy is 8 ps + 0.1% of Δ time reading.

4. Characteristic performance. Test configuration: PRBS of length 127 bits, Data and Clock 10 Gb/s.

5. Maximum number of samples depends on pattern, number of active channels and available memory.

# Specifications

## Mainframe continued

	Option STR (standard trigger)	Option ETR (enhanced trigger)
<b>Trigger modes</b>		
Internal trigger <sup>1</sup>	Free run	Free run
External direct trigger <sup>2</sup>		
Limited bandwidth <sup>3</sup>	DC to 100 MHz	DC to 100 MHz
Full bandwidth	DC to 3.2 GHz	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)
Module Bay Trigger <sup>7</sup>	N/A	Yes, supported.
<b>Jitter</b>		
Characteristic	< 1.0 ps RMS + 5*10E-5 of delay setting <sup>4</sup>	1.2 ps RMS for time delays less than 100 ns <sup>6</sup>
Maximum	1.5 ps RMS + 5*10E-5 of delay setting <sup>4</sup>	1.7 ps RMS for time delays less than 100 ns <sup>6</sup>
<b>Trigger sensitivity</b>		
	200 mV <sub>pp</sub> (sinusoidal input or 200 ps minimum pulse width)	200 mV <sub>pp</sub> sinusoidal input: 50 MHz to 8 GHz 400 mV <sub>pp</sub> sinusoidal input: 8 GHz to 13 GHz 600 mV <sub>pp</sub> sinusoidal input: 13 GHz to 15 GHz
<b>Trigger configuration</b>		
Trigger level adjustment	-1 V to +1 V	AC coupled
Edge select	Positive or negative	N/A
Hysteresis <sup>5</sup>	Normal or High sensitivity	N/A
<b>Trigger gating</b>		
Gating input levels (TTL compatible)	Disable: 0 to 0.6 V, Enable: 3.5 to 5 V Pulse width > 500 ns, period > 1 μs	
<b>Gating delay</b>		
	Disable: 27 μs + trigger period + Maximum time displayed Enable: 100 ns	
<b>Trigger impedance</b>		
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 unless a precision timebase is used in Eye/Mask mode. 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 ≥ 2 V/ns

7. The Module Bay Trigger routes trigger signals from the module's rear panel to the mainframe. 86100D-ETR is recommended when using a DCA module equipped with a rear-panel trigger circuit. Examples include 54754A, 83496x, and 86108A/B modules. If operating these modules in an 86100D with Option STR, an external cable (such as P/N 5062-6690) must be connected from the module's front panel trigger/clock output to the 86100D's trigger input.

# Specifications

## computer system and storage

Computer system and storage	
CPU	Intel Core 2 Duo 3.06 GHz
Mass storage	80 GByte internal hard drive (default) or 80 GByte removable hard drive (Option 090)
Operating system	Microsoft Windows XP Pro
Display <sup>1</sup>	
Display area	210.4 mm x 157.8 mm (10.4 inch diagonal color active matrix LCD module incorporating amorphous silicon TFTs)
Entire display resolution	1024 pixels horizontally x 768 pixels vertically
Waveform colors	Select from over 16 colors; user may change color assignment of all traces (channels, waveform memory and signal processing functions)
Persistence modes	Gray scale, color grade, variable, infinite
Waveform overlap	When two waveforms overlap, a third color distinguishes the overlap area (classic DCA-J interface only)
Connect-the-dots	On/Off selectable
Persistence	Minimum, variable (100 ms to 40 s), infinite
Graticule	On/Off
Grid intensity	0 to 100%
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 <sup>4</sup> , 50 $\Omega$ , 2 V <sub>pp</sub> base max
USB <sup>2</sup>	Three low-power USB 2.0 ports; Voltage: 5.00V $\pm$ 0.25V ; Current: 100 mA each
Rear panel inputs and outputs	
Gated trigger input	TTL compatible
Video output	VGA, full color, 15 pin D-sub (female) 10
GPIB <sup>3</sup>	Fully programmable, complies with IEEE 488.2
RS-232	9 pin D-sub (male)
LAN	
USB <sup>2</sup>	Four USB 2.0 ports; Voltage: 5.00 $\pm$ 0.25V; Current: 500 mA each

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

2. USB Keyboard and mouse included with mainframe.

3. The GPIB card interface is optional. To include this interface, order 86100D-GPI.

4. Mainframe ships with 3.5 mm female-female connector saver (P/N 5061-5311).

# Specifications

## precision time base module

Measurement performance can be further enhanced by adding precision time base capability to the 86100 mainframe. The precision time base reduces the intrinsic jitter of the scope and is recommended when analyzing high-speed data signals.

Precision Time Base 86107A			
	86107A Option 010	86107A Option 020	86107A Option 040
Trigger bandwidth	2.0 to 15.0 GHz	2.4 to 25.0 GHz	2.4 to 48.0 GHz
Typical jitter (RMS) using 86100D mainframe <sup>4</sup>	2.4 GHz: < 150 fs 10 GHz: < 100 fs	2.4 GHz: < 150 fs 10, 20 GHz: < 100 fs	2.4 GHz: < 150 fs 10, 20, 40 GHz: < 100 fs
Typical jitter (RMS) using 86100D mainframe <sup>5</sup>	2.4 GHz: < 280 fs 10 GHz: < 200 fs	2.4 GHz: < 280 fs 10, 20 GHz: < 200 fs	2.4 GHz: < 280 fs 10, 20, 40 GHz: < 200 fs
Time base linearity error	< 200 fs		
Input signal type	Synchronous clock <sup>1</sup>		
Input signal level	0.5 to 1.0 V <sub>pp</sub> 0.2 to 1.5 V <sub>pp</sub> (typical functional performance)		
DC offset range	±200 mV <sup>2</sup>		
Required trigger signal-to-noise ratio	≥ 200: 1		
Trigger gating	Disable: 0 to 0.6 V		
Gating input levels (TTL compatible)	Enable: 3.5 to 5 V Pulse width > 500 ns, period > 1 μs		
Trigger impedance (nominal)	50 Ω		
Connector type <sup>3</sup>	3.5 mm (male)		3.5 mm (male) 2.4 mm (male)

1. Filtering provided for Option 010 bands 2.4 to 4.0 GHz and 9.0 to 12.6 GHz, for Option 020 9.0 to 12.6 GHz and 18 to 25.0 GHz, for Option 40 9.0 to 12.6 GHz, 18.0 to 25.0 GHz, and 39.0 to 48.0 GHz. Within the filtered bands, a synchronous clock signal should be provided (clock, sinusoid, BERT trigger, etc.). Outside these bands, filtering is required to minimize harmonics and subharmonics and provide a sinusoid to the 86107 input.

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

3. Ships with female-female connector saver(s).

4. With 86107A module and an 861xx module (electrical channel).

5. With 86107A module and 54xxx, 8348x, and N1045A plug-in modules.

# Specifications

## precision time base (86108 configurations)

The 86108A/B can be triggered through clock recovery of the observed signal, through an external reference clock into the precision timebase section, or with the precision timebase operating on the clock signal recovered from the observed signal. The following specifications indicate the 86100 system timebase specifications achieved when using the 86108A/B plug-in module. (The 86100 mainframe and the 86108A/B module can also be triggered with a signal into the mainframe. In this configuration, the basic mainframe specifications are achieved.)

Precision Time Base 86108A/B	86108A	86108B-LBW	86108B-HBW
Typical jitter (clock recovery (CR) and precision timebase (PTB) configuration)	< 60 fs	< 60 fs	< 50 fs
Maximum jitter (clock recovery and precision timebase configuration) <sup>1</sup>	< 90 fs	< 90 fs	< 70 fs
Typical jitter (clock recovery without precision timebase active)	< 1.25 ps	< 1.25 ps	< 1.25 ps
Effective trigger-to-sample delay (CR and PTB configuration, typical)	< 200 ps	< 200 ps	< 200 ps
Typical jitter (trigger signal applied to precision timebase input)	< 60 fs	< 60 fs	< 60 fs
Maximum jitter (trigger signal supplied to precision timebase input) <sup>1</sup>	< 100 fs	< 100 fs	< 100 fs
Precision timebase trigger bandwidth	2 to 13.5 GHz (1 to 17 GHz)	1 to 18 GHz	1 to 18 GHz
Precision timebase external reference amplitude characteristic	1.0 to 1.6 Vpp	1.0 to 1.6 Vpp	1.0 to 1.6 Vpp
Precision timebase input signal type <sup>2</sup>	Sinusoid	Sinusoid	Sinusoid
Precision timebase maximum input level	±2 V (16 dBm)	±2 V (16 dBm)	±2 V (16 dBm)
Precision timebase maximum DC offset level	±200 mV	±200 mV	±200 mV
Precision timebase input impedance	50 Ω	50 Ω	50 Ω
Precision timebase connector type <sup>3</sup>	3.5 mm male	3.5 mm male	3.5 mm male
Timebase resolution (with precision timebase active)	0.5 ps/div	0.5 ps/div	0.5 ps/div
Timebase resolution (precision timebase disabled)	2 ps/div	2 ps/div	2 ps/div

1. Verified with maximum level input signal (~800 mVpp)

2. The precision timebase performs optimally with a sinusoidal input. Non-sinusoidal signals will operate with some degradation in timebase linearity.

3. 86108B-LBW are shipped with a 3.5mm (female) to 3.5mm (female) connector saver on the input channels (P/N 5061-5311). The 86108B-HBW is shipped with 2.4 mm female to 2.4 mm female connector savers on the input channels.





# Modules specifications

## single-mode and multimode optical/electrical

Multiple and single-mode optical/electrical modules			
	86105C	86105D	86105D Option 281
<b>Optical channel specifications</b>			
Optical channel unfiltered bandwidth	8.5 GHz (9 GHz)	20 GHz (22 GHz)	34 GHz
Wavelength range	750 to 1650 nm	750 to 1650 nm	750 to 1650 nm
Calibrated wavelengths	850 nm/1310 nm/ 1550 nm	850 nm/1310 nm/ 1550 nm	850 nm/1310 nm/ 1550 nm
Optical sensitivity <sup>1</sup>	850 nm: ≤ 2.666 Gb/s, -20 dBm > 2.666 Gb/s to ≤ 4.25 Gb/s, -19 dBm > 4.25 Gb/s to 11.3 Gb/s, -16 dBm 1310 nm/1550 nm: ≤ 2.666 Gb/s, -21 dBm > 2.666 Gb/s to ≤ 4.25 Gb/s, -20 dBm > 4.25 Gb/s to 11.3 Gb/s, -17 dBm	850 nm: 8.5 to 11.3 Gb/s, -9 dBm 14.025 Gb/s, -6 dBm  1310 nm/1550 nm: 8.5 to 11.3 Gb/s, -12 dBm 14.025 Gb/s, -9 dBm	850 nm: 14.025 Gb/s, -6 dBm, 15 Gb/s, -9 dBm 25.78 Gb/s, -6 dBm, 27.95 to 28.05 Gb/s, -5 dBm  1310 nm/1550 nm: 14.025 Gb/s, -9 dBm, 15 Gb/s, -8 dBm 25.78 Gb/s, -7 dBm, 27.95 to 28.05 Gb/s, -6 dBm  1550 nm: 14.025 Gb/s, -9 dBm, 15 Gb/s, -8 dBm 25.78 Gb/s, -8 dBm, 27.95 to 28.05 Gb/s, -7 dBm
Transition time (10% to 90% calculated from TR = 0.48/BW optical)	56 ps	24 ps	15 ps
<i>RMS noise</i>			
Characteristic	850 nm: ≤ 2.666 Gb/s, 1.3 μW > 2.666 Gb/s to ≤ 4.25 Gb/s, 1.5 μW > 4.25 Gb/s to 11.3 Gb/s, 2.5 μW  1310 nm/1550 nm: ≤ 2.666 Gb/s, 0.8 μW > 2.666 Gb/s to ≤ 4.25 Gb/s, 1.0 μW > 4.25 Gb/s to 11.3 Gb/s, 1.4 μW	850 nm: 8.5 to 11.3 Gb/s, 10 μW 14.025 Gb/s, 16 μW  1310/1550 nm: 8.5 to 11.3 Gb/s, 5 μW 14.025 Gb/s, 8 μW	850 nm: 14.025 Gb/s, 16 μW, 15 Gb/s, 9 μW 25.78 Gb/s, 17 μW, 27.95 to 28.05 Gb/s, 18 μW unfiltered, 25 μW  1310 nm: 14.025 Gb/s, 8 μW, 25.78 Gb/s, 13 μW unfiltered, 18 μW  1550 nm: 14.025 Gb/s, 8 μW, 15 Gb/s, 8 μW 25.78 Gb/s, 15 μW, 27.95 to 28.05 Gb/s, 17 μW unfiltered, 21 μW
Maximum	850 nm: ≤ 2.666 Gb/s, 2.0 μW > 4.25 Gb/s to 11.3 Gb/s, 4.0 μW  1310 nm/1550 nm: ≤ 2.666 Gb/s, 1.3 μW > 2.666 Gb/s to ≤ 4.25 Gb/s, 1.5 μW > 4.25 Gb/s to 11.3 Gb/s, 2.5 μW	850 nm: 8.5 to 11.3 Gb/s, 12 μW 14.025 Gb/s, 24 μW  1310/1550 nm: 8.5 to 11.3 Gb/s, 7 μW 14.025 Gb/s, 12 μW	850 nm: 14.025 Gb/s, 24 μW, 15 Gb/s, 15 μW 25.78 Gb/s, 25 μW, 27.95 to 28.05 Gb/s, 25 μW unfiltered, 35 μW  1310 nm: 14.025 Gb/s, 12 μW, 15 Gb/s, 12 μW 25.78 Gb/s, 20 μW, 27.95 to 28.05 Gb/s, 20 μW unfiltered, 25 μW  1550 nm: 14.025 Gb/s, 12 μW, 15 Gb/s, 14 μW 25.78 Gb/s, 23 μW, 27.95 to 28.05 Gb/s, 23 μW unfiltered, 30 μW

1. Generally represents the power level where an ideal eye diagram will approach 0% mask margin due to noise of the oscilloscope. Provides a non-specified figure of merit to compare sensitivities of various optical channels.
2. Option 102 and 104 do not include filters for 14.025 Gb/s. Option 142 and 144 include filters for 14.025 Gb/s and no other rates.

## Modules specifications

### single-mode and multimode optical/electrical

Multiple and single-mode optical/electrical modules	86115D Option 002, 102, 142 <sup>2</sup>	86115D Option 004, 104, 144 <sup>2</sup>	86115D Option 282
<b>Optical channel specifications</b>			
Optical channel unfiltered bandwidth	20 GHz (22 GHz)	20 GHz (22 GHz)	34 GHz
Wavelength range	750 to 1650 nm	750 to 1650 nm	750 to 1650 nm
Calibrated wavelengths	850 nm/1310 nm/ 1550 nm	850 nm/1310 nm/ 1550 nm	850 nm/1310 nm/ 1550 nm
Optical sensitivity <sup>1</sup>	850 nm: 8.5 to 11.3 Gb/s, -9 dBm 14.025 Gb/s, -6 dBm  1310 nm/1550 nm: 8.5 to 11.3 Gb/s, -12 dBm 14.025 Gb/s, -9 dBm	850 nm: 8.5 to 11.3 Gb/s, -8 dBm 14.025 Gb/s, -5 dBm  1310/1550 nm: 8.5 to 11.3 Gb/s, -11 dBm 14.025 Gb/s, -8 dBm	850 nm: 14.025 Gb/s, -6 dBm, 15 Gb/s, -9 dBm 25.78 Gb/s, -6 dBm, 27.85 to 28.05 Gb/s, -5 dBm  1310 nm/1550 nm: 14.025 Gb/s, -9 dBm, 15 Gb/s, -8 dBm 25.78 Gb/s, -7 dBm, 27.95 to 28.05 Gb/s, -6 dBm  1550 nm: 14.025 Gb/s, -9 dBm, 15 Gb/s, -8 dBm 25.78 Gb/s, -8 dBm, 27.95 to 28.05 Gb/s, -7 dBm
Transition time (10% to 90% calculated from TR = 0.48/BW optical)	24 ps	24 ps	15 ps
<i>RMS noise</i>			
Characteristic	850 nm: 8.5 to 11.3 Gb/s, 10 μW 14.025 Gb/s, 16 μW  1310/1550 nm: 8.5 to 11.3 Gb/s, 5 μW 14.025 Gb/s, 8 μW	850 nm: 8.5 to 11.3 Gb/s, 12 μW 14.025 Gb/s, 20 μW  1310/1550 nm: 8.5 to 11.3 Gb/s, 6 μW 14.025 Gb/s, 10 μW	850 nm: 14.025 Gb/s, 16 μW, 15 Gb/s, 9 μW 25.78 Gb/s, 17 μW, 27.95 to 28.05 Gb/s, 18 μW unfiltered, 25 μW  1310 nm: 14.025 Gb/s, 8 μW, 25.78 Gb/s, 13 μW unfiltered, 18 μW  1550 nm: 14.025 Gb/s, 8 μW, 15 Gb/s, 8 μW 25.78 Gb/s, 15 μW, 27.95 to 28.05 Gb/s, 17 μW unfiltered, 21 μW
Maximum	850 nm: 8.5 to 11.3 Gb/s, 12 μW 14.025 Gb/s, 24 μW  1310/1550 nm: 8.5 to 11.3 Gb/s, 7 μW 14.025 Gb/s, 12 μW	850 nm: 8.5 to 11.3 Gb/s, 14 μW 14.025 Gb/s, 30 μW  1310/1550 nm: 8.5 to 11.3 Gb/s, 8.5 μW 14.025 Gb/s, 14 μW	850 nm: 14.025 Gb/s, 24 μW, 15 Gb/s, 15 μW 25.78 Gb/s, 25 μW, 27.95 to 28.05 Gb/s, 25 μW unfiltered, 35 μW  1310 nm: 14.025 Gb/s, 12 μW, 15 Gb/s, 12 μW 25.78 Gb/s, 20 μW, 27.95 to 28.05 Gb/s, 20 μW unfiltered, 25 μW  1550 nm: 14.025 Gb/s, 12 μW, 15 Gb/s, 14 μW 25.78 Gb/s, 23 μW, 27.95 to 28.05 Gb/s, 23 μW unfiltered, 30 μW

1. Generally represents the power level where an ideal eye diagram will approach 0% mask margin due to noise of the oscilloscope. Provides a non-specified figure of merit to compare sensitivities of various optical channels.
2. Option 102 and 104 do not include filters for 14.025 Gb/s. Option 142 and 144 include filters for 14.025 Gb/s and no other rates.

## Modules specifications

### single-mode and multimode optical/electrical

Multiple and single-mode optical/electrical modules	86105C	86105D	86105D Option 281	86115D Option 002, 102, 142 <sup>2</sup>	86115D Option 004, 104, 144 <sup>2</sup>
<b>Optical channel specifications (continued)</b>					
Scale factor (per division)					
Minimum	2 $\mu$ W	20 $\mu$ W	20 $\mu$ W	20 $\mu$ W	20 $\mu$ W
Maximum	100 $\mu$ W	500 $\mu$ W	500 $\mu$ W	500 $\mu$ W	500 $\mu$ W
CW <sup>1</sup> accuracy (single marker, referenced to average power monitor)	Single-mode: $\pm 25 \mu\text{W} \pm 3\%$  Multimode: $\pm 25 \mu\text{W} \pm 10\%$	Single-mode: $\pm 25 \mu\text{W} \pm (2\% (8/10 \text{ Gb/s}), 4\% (14 \text{ Gb/s}) 6\% \text{ unfiltered})$  Multimode: $\pm 25 \mu\text{W} \pm 10\%$	$\pm 25 \mu\text{W} \pm 4\%$ (14.025 Gb/s), $\pm 25 \mu\text{W} \pm 4\%$ (15.0 Gb/s), $\pm 25 \mu\text{W} \pm 6\%$ (25.78125 Gb/s), $\pm 25 \mu\text{W} \pm 6\%$ (27.7393 Gb/s to 28.05 Gb/s), $\pm 25 \mu\text{W} \pm 6\%$ (unfiltered)	Single-mode: $\pm 25 \mu\text{W} \pm (2\% (8/10 \text{ Gb/s}), 4\% (14 \text{ Gb/s}) 6\% \text{ unfiltered})$  Multimode: $\pm 25 \mu\text{W} \pm 10\%$	Single-mode: $\pm 25 \mu\text{W} \pm (2\% (8/10 \text{ Gb/s}), 4\% (14 \text{ Gb/s}) 6\% \text{ unfiltered})$  Multimode: $\pm 25 \mu\text{W} \pm 10\%$
CW offset range (referenced two divisions from screen bottom)	+0.2 $\mu$ W to -0.6 $\mu$ W	+1 $\mu$ W/-3 $\mu$ W	+1 mW to -3 mW	+1 $\mu$ W/-3 $\mu$ W	+1 $\mu$ W/-3 $\mu$ W
Average power monitor (specified operating range)	-30 dBm to 0 dBm	-30 dBm to +3 dBm	-30 dBm to +3 dBm	-30 dBm to +3 dBm	-30 dBm to +3 dBm
<b>Average power monitor accuracy</b>					
Single-mode	$\pm 5\% \pm 200 \text{ nW} \pm \text{connector uncertainty}$	$\pm 5\% \pm 200 \text{ nW} \pm \text{connector uncertainty}$	$\pm 5\% \pm 200 \text{ nW} \pm \text{connector uncertainty}$	$\pm 5\% \pm 100 \text{ nW} \pm \text{connector uncertainty (20 to 30 } ^\circ\text{C)}$	$\pm 5\% \pm 200 \text{ nW} \pm \text{connector uncertainty}$
Multimode (characteristic)	$\pm 10\% \pm 200 \text{ nW} \pm \text{connector uncertainty}$	$\pm 5\% \pm 200 \text{ nW} \pm \text{connector uncertainty}$	$\pm 10\% \pm 200 \text{ nW} \pm \text{connector uncertainty}$	$\pm 5\% \pm 200 \text{ nW} \pm \text{connector uncertainty}$	$\pm 5\% \pm 200 \text{ nW} \pm \text{connector uncertainty}$

1. CW refers to an unmodulated optical signal.

2. Option 102 and 104 do not include filters for 14.025 Gb/s. Option 142 and 144 include filters for 14.025 Gb/s and no other rates.

## Modules specifications

### single-mode and multimode optical/electrical

Multiple and single-mode optical/electrical modules	86105C	86105D	86105D Option 281	86115D Option 002, 102, 142 <sup>1</sup>	86115D Option 004, 104, 144 <sup>1</sup>
<b>Optical channel specifications (continued)</b>					
<b>User calibrated accuracy</b>					
Single-mode	±3% ±200 nW ±power meter uncertainty, < 5 °C change	±2% ±100 nW ±power meter uncertainty	±3% ± 200 nW ± power meter uncertainty	±2% ±100 nW ±power meter uncertainty, < 5 °C change	±2% ±100 nW ±power meter uncertainty
Multimode (characteristic)	±10% ±200 nW ±power meter uncertainty, < 5 °C change	±10% ±200 nW ±power meter uncertainty	±10% ± 200 nW ± power meter uncertainty	±10% ±200 nW ±power meter uncertainty	±10% ±200 nW ±power meter uncertainty
<b>Maximum input power</b>					
Maximum non-destruct average	0.5 mW (-3 dBm)	5 mW (7 dBm)	5 mW (+7 dBm) 1310/1550 nm single mode: 6 mW (+8 dBm) 850 nm multimode: 3 mW (+5 dBm)	5 mW (7 dBm)	5 mW (7 dBm)
Maximum non-destruct peak	5 mW (+7 dBm)	10 mW (10 dBm)	10 mW (+10 dBm)	10 mW (10 dBm)	10 mW (10 dBm)
Fiber input	62.5/125 µm	62.5/125 µm user-selectable connector	62.5/125 µm	62.5/125 µm user-selectable connector	62.5/125 µm user-selectable connector
Polarization dependent loss at 1550 nm			0.2 dB (characteristic)		
Input return loss (HMS-10 connector fully filled fiber)	850 nm > 13 dB 1310 nm/1550 nm > 24 dB	27 dB single-mode 14 dB multimode	> 24 dB (1550 nm single mode) > 24 dB (1310 nm single mode) > 13 dB (850 nm multimode)	27 dB single-mode 14 dB multimode	27 dB single-mode 14 dB multimode

1. Option 102 and 104 do not include filters for 14.025 Gb/s. Option 142 and 144 include filters for 14.025 Gb/s and no other rates.

## Modules specifications

### single-mode and multimode optical/electrical

Multiple and single-mode optical/electrical modules	86105C	86105D	86105D Option 281	86115D Option 002, 102, 142 <sup>1</sup>	86115D Option 004, 104, 144 <sup>1</sup>
<b>Electrical channel specifications</b>					
Electrical channel bandwidth	12.4 and 20 GHz	25 and 35 GHz	25 and 35 GHz		
Transition time (10% to 90% calculated from TR = 0.35/BW)	28.2 ps (12.4 GHz) 17.5 ps (20 GHz)	14 ps (25 GHz) 10 ps (35 GHz)	12 ps (25 GHz) 7 ps (50 GHz)		
<b>RMS noise</b>					
Characteristic	0.25 mV (12.4 GHz) 0.5 mV (20 GHz)	0.25 mV (25 GHz) 0.5 mV (35 GHz)	0.25 mV (25 GHz) 0.6 mV (50 GHz)		
Maximum	0.5 mV (12.4 GHz) 1 mV (20 GHz)	0.5 mV (25 GHz) 1 mV (35 GHz)	0.5 mV (25 GHz) 1 mV (50 GHz)		
<b>Scale factor (per division)</b>					
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. Option 102 and 104 do not include filters for 14.025 Gb/s. Option 142 and 144 include filters for 14.025 Gb/s and no other rates.

## Modules specifications single-mode optical/electrical

High bandwidth single-mode optical/electrical modules		86116C Option 025	86116C Option 041
<b>Optical channel specifications</b>			
Optical channel unfiltered bandwidth		45 GHz	65 GHz
Wavelength range		1300 nm to 1620 nm <sup>3</sup>	
Calibrated wavelengths		1300 nm/1550 nm	
Optical sensitivity <sup>2</sup>	1310 nm	-9 dBm (17 Gb/s) -8 dBm (25.8 Gb/s) -7 dBm (27.7 Gb/s)	-3 dBm (39.8/43.0 Gb/s)
	1550 nm	-10 dBm (17 Gb/s) -9 dBm (25.8 Gb/s) -8 dBm (27.7 Gb/s)	-5 dBm (39.8/43.0 Gb/s)
Transition time (10% to 90% calculated from $T_r = 0.48/BW$ optical)		7.4 ps (FWHM) <sup>1</sup>	
<b>RMS noise</b>			
Characteristic	1310 nm	13 $\mu$ W (17 Gb/s) 17 $\mu$ W (25.8 Gb/s) 20 $\mu$ W (27.7 Gb/s) 60 $\mu$ W (40 GHz)	54 $\mu$ W (39.8/43.0 Gb/s) 75 $\mu$ W (55 GHz) 105 $\mu$ W (60 GHz) 187 $\mu$ W (65 GHz)
	1550 nm	10 $\mu$ W (17 Gb/s) 12 $\mu$ W (25.87 Gb/s) 14 $\mu$ W (27.7 Gb/s) 40 $\mu$ W (40 GHz)	36 $\mu$ W (39.8/43.0 Gb/s) 50 $\mu$ W (55 GHz) 70 $\mu$ W (60 GHz) 125 $\mu$ W (65 GHz)
Maximum	1310 nm	18 $\mu$ W (17 Gb/s) 20 $\mu$ W (25.8 Gb/s) 30 $\mu$ W (27.7 Gb/s) 120 $\mu$ W (40 GHz)	102 $\mu$ W (39.8/43.0 Gb/s) 127 $\mu$ W (55 GHz) 225 $\mu$ W (60 GHz) 300 $\mu$ W (65 GHz)
	1550 nm	15 $\mu$ W (17 Gb/s) 18 $\mu$ W (25.8 Gb/s) 21 $\mu$ W (27.7 Gb/s) 80 $\mu$ W (40 GHz)	68 $\mu$ W (39.8/43.0 Gb/s) 85 $\mu$ W (55 GHz) 150 $\mu$ W (60 GHz) 200 $\mu$ W (65 GHz)

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

2. Generally represents the power level where an ideal eye diagram will approach 0% mask margin due to noise of the oscilloscope. Provides a non-specified figure of merit to compare sensitivities of various optical channels.

3. Contact Agilent for broader wavelength specifications.

## Modules specifications

### single-mode optical/electrical

High bandwidth single-mode optical/electrical modules		86116C
<b>Optical channel specifications (continued)</b>		
Scale factor		
Minimum	200 $\mu$ W/division	
Maximum	5 mW/division	
CW <sup>1</sup> accuracy (single marker, reference to average power monitor)	$\pm 150 \mu\text{W} \pm 4\%$ (reading-channel offset)	
CW offset range (referenced two divisions from screen button)	+8 to -12mW	
Average power monitor (specified operating range)	-23 to +9 dBm	
Factory calibrated accuracy	$\pm 5\% \pm 100 \text{ nW} \pm \text{connector uncertainty, } 20 \text{ to } 30 \text{ }^\circ\text{C}$	
User calibrated accuracy	$\pm 2\% \pm 100 \text{ nW} \pm \text{power meter uncertainty, } < 5 \text{ }^\circ\text{C change}$	
Maximum input power		
Maximum non-destruct average	10 mW (+10 dBm)	
Maximum non-destruct peak	50 mW (+17 dBm)	
Fiber input	9/125 $\mu\text{m}$ , user-selectable connector	
Input return loss (HMS-10 connector fully filled fiber)	20 dB	
<b>Electrical channel specifications</b>		
Electrical channel bandwidth	80 (93), 55 and 30 GHz	
Transition time (10% to 90% calculated from $T_r = 0.35/BW$ )	6.4 ps (55 GHz) 4.4 ps (80 GHz)	
<b>RMS noise</b>		
Characteristic	0.5 mV (30 GHz) 0.6 mV (55 GHz) 1.1 mV (80 GHz)	
Maximum	0.8 mV (30 GHz) 1.1 mV (55 GHz) 2.2 mV (80 GHz)	
Scale factor (per division)		
Minimum	2 mV/division	
Maximum	100 mV/division	
DC accuracy (single marker)	$\pm 0.4\%$ of full scale $\pm 3 \text{ mV} \pm 2\%$ of (reading-channel offset), $\pm 2\%$ of offset (all bandwidths)	
DC offset range (referenced to center of screen)	$\pm 500 \text{ mV}$	
Input dynamic range (relative to channel offset)	$\pm 400 \text{ mV}$	
Maximum input signal	$\pm 2 \text{ V (+16 dBm)}$	
Nominal impedance	50 $\Omega$	
Reflections (for 20 ps rise time)	10% (DC to 70 GHz) 20% (70 to 100 GHz)	
Electrical input	1.85 mm (male)	

1. CW refers to an unmodulated optical signal.

# Modules specifications

## Dual electrical

Dual electrical channel modules	86112A	54754A
Electrical channel bandwidth	12.4 and 20 GHz (30 GHz <sup>1</sup> )	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)
<b>RMS noise</b>		
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 (per division)		
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 ±2 mV ±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)
DC 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)	
<b>RMS noise</b>		
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 (per division)		
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)
DC 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 (male)

1 A special option, 86112-HBW, extends the bandwidth from 20 GHz to 30 GHz. All other specifications remain unchanged.



## Modules specifications

### dual electrical

Dual electrical channel modules		86108A	86108B-LBW	86108B-HBW
Bandwidth	(Low / High BW Setting)	16 GHz and > 32 GHz, (35 GHz)	20 GHz and 35 GHz	35 GHz and 50 GHz
"Transition time (10% to 90% calculated from $T_r = 0.35/BW$ )"		10 ps	10 ps	7ps
<b>RMS noise</b>				
Characteristic	(Low / High BW Setting)	240 $\mu$ V/420 $\mu$ V	300 $\mu$ V/500 $\mu$ V	600 $\mu$ V/750 $\mu$ V
Maximum	(Low / High BW Setting)	350 $\mu$ V/700 $\mu$ V	350 $\mu$ V/700 $\mu$ V	800 $\mu$ V/980 $\mu$ V
Scale factor (per division)				
Minimum		2 mV/division	1 mV/division	1 mV/division
Maximum		100 mV/division	140 mV/division	140 mV/division
DC accuracy (single marker)				
	Low BW Setting:	$\pm 0.7\%$ of full scale, $\pm 2$ mV $\pm 1.5\%$ of (reading-channel offset) (16 GHz)		
	High BW Setting:	$\pm 0.7\%$ of full scale, $\pm 2$ mV $\pm 3\%$ of (reading-channel offset) (32 GHz)		
CW offset range (referenced from center of screen)		$\pm 500$ mV	$\pm 700$ mV	$\pm 700$ mV
Input dynamic range (relative to channel offset)		$\pm 400$ mV	$\pm 560$ mV	$\pm 560$ mV
Maximum input signal		$\pm 2$ V (+16 dBm)	$\pm 2.5$ V (+18 dBm)	$\pm 2.5$ V (+18 dBm)
Nominal impedance		50 $\Omega$	50 $\Omega$	50 $\Omega$
Reflections (for 30 ps rise time)		5%	5%	5%
Electrical input		3.5 mm	3.5 mm	2.4 mm
CH1 to CH2 skew		< 12 ps	< 10 ps	< 10 ps

## Modules specifications

### dual electrical

Clock recovery	86108A	86108B-216	86108B-232
Data rate input range (Continuous tuning)	0.05 to 14.2 Gb/s (requires FW revision 8.1 or higher)	0.05 to 16 Gb/s	0.05 to 32 Gb/s
Clock frequency input range (Continuous tuning)	0.025 to 6.75 GHz	0.025 to 8 GHz	0.025 to 16 GHz
Minimum input level to acquire lock	175 mV <sub>pp</sub>	175 mV <sub>pp</sub>	175 mV <sub>pp</sub>
Recovered clock random jitter (used as internal trigger) <sup>1</sup>	Internal recovered clock trigger < 500 fs at 2 Gb/s < 400 fs at 5 and 10 Gb/s	< 350 fs at data rate < 2 Gb/s < 300 fs at data rate ≥ 2 Gb/s	< 350 fs at data rate < 2 Gb/s < 300 fs at data rate ≥ 2 Gb/s
Clock recovery adjustable loop bandwidth range (user selectable)	0.015 to 10 MHz	0.015 to 20 MHz	0.015 to 20 MHz
Clock recovery loop peaking range	Up to 4 settings (dependent on loop BW)		
Loop bandwidth accuracy	±30%		
<i>Tracking range (includes spread spectrum tracking)</i>	±2500 ppm ±0.25%		
<i>Acquisition range</i>	±5000 ppm		
Maximum consecutive identical digits to lock	150		
Auto relocking	If signal lock is lost, system can automatically attempt to regain phase-lock. User selectable to enable/disable		
<i>Residual spread spectrum</i>	-72 ±3 dB @ 33 kHz	-84 ±3 dB @ 33 kHz	-84 ±3 dB @ 33 kHz
<i>Front panel recovered clock amplitude</i>	0.15 to 1.0 V <sub>pp</sub> (0.3 to 1.0 V <sub>pp</sub> )		
Front panel recovered clock divide ratio (user selectable)	1, 2, 4, 8, 16 2, 4, 8, 16	1, 2, 4, 8, 16 2, 4, 8, 16	1, 2, 4, 8, 16 2, 4, 8, 16
Recovered clock front panel connector type	SMA		
Internal frequency counter accuracy	±10 ppm		

1. These values indicate performance with the internal precision timebase disabled. With precision timebase enabled, system jitter performance is dramatically decreased. See page 7.

## Module specifications

### dual/quad electrical

Dual/Quad electrical channel modules	N1045A <sup>1</sup>	
Channel options (number of channels; F = female; M = male)	02F/02M	04F/04M
Number of channels <sup>2</sup>	2	4
Electrical channel bandwidth	20/35/45/60 GHz (Max BW 65 GHz typical)	
Transition time (10% to 90% calculated from TR = 0.35/BW)	17.5/10/7.8/5.8 ps	
Channel-to-channel skew range	± 100 ps	
<b>RMS noise</b>		
Characteristic	275/425/500/750 $\mu$ V	
Maximum	950 $\mu$ V (60 GHz)	
Scale factor (per division)		
Minimum	1 mV/division	
Maximum	100 mV/division	
DC accuracy (single marker)	±0.4% of full scale ±2 mV ±4% of (reading-channel offset), (60 GHz)	
DC 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 $\Omega$	
Reflections (for 30 ps rise time)	20%	
Electrical input <sup>3</sup>	1.85 mm (female or male option)	

1. Module is supported by 86100D DCA-X mainframe and later.
2. Upgradable from 2 channel to 4 channel after purchase (return to Agilent).
3. Connector style is the same on all channels and is selected at time of order.

# Modules specifications

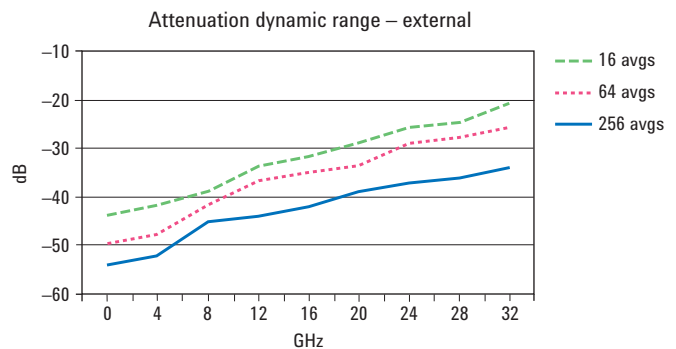
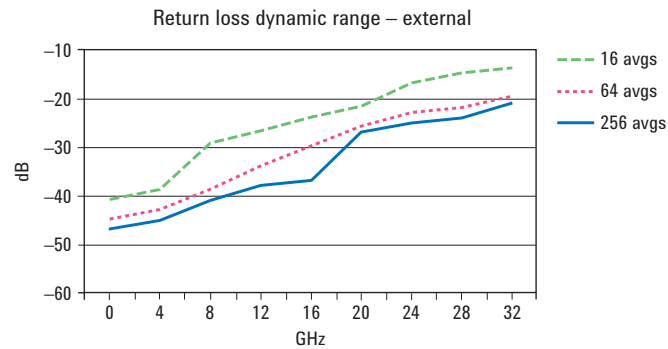
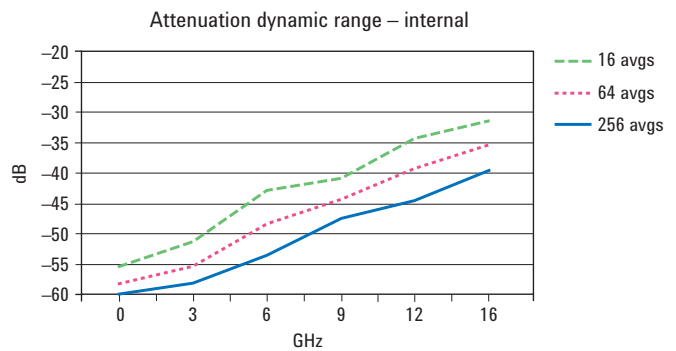
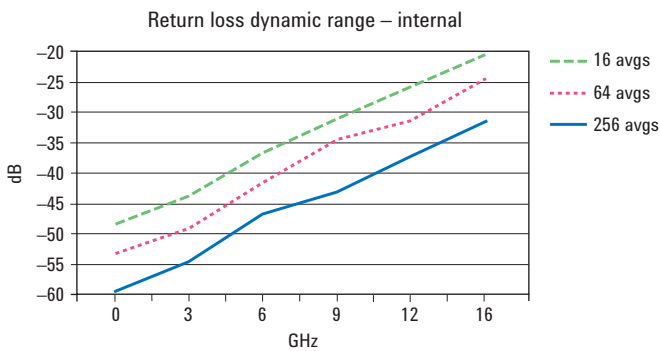
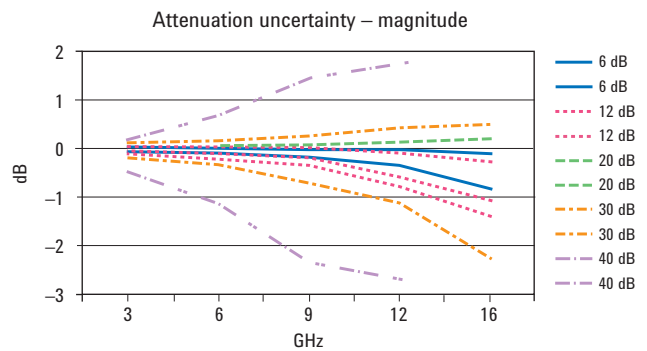
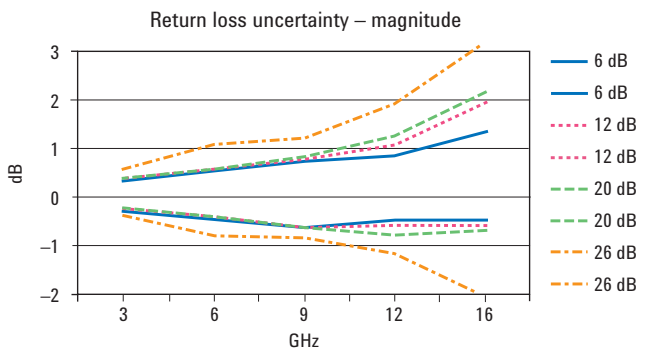
## TDR system

TDR system (Mainframe with 54754A module)	Oscilloscope/TDR performance	Normalized characteristics
Rise time	40 ps nominal < 25 ps normalized	Adjustable from larger of 10 ps or 0.08 x time/div Maximum: 5 x time/div
TDR step flatness	$\leq \pm 1\%$ after 1 ns from edge $\leq \pm 5\%$ , $-3\% < 1$ ns from edge	$\leq 0.1\%$
Low level High level	0.00 V $\pm 2$ mV $\pm 200$ mV $+2$ mV	

### 86100D Option 202 enhanced impedance and S-parameter software characteristics

#### Return loss

#### Attenuation

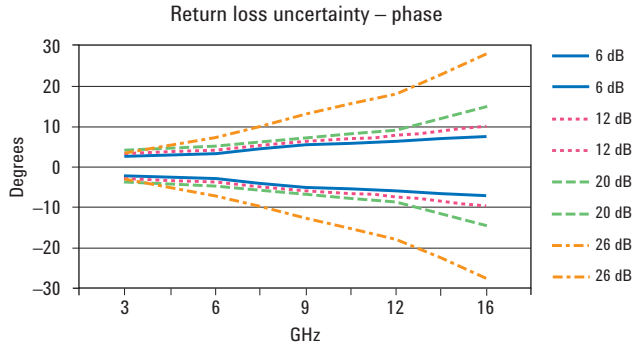


# Modules specifications

## TDR system

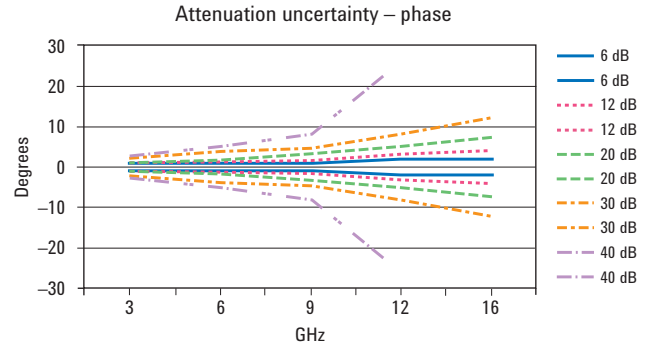
### 86100D Option 202 characteristics

#### Return loss



\*See end notes for additional phase uncertainties

#### Attenuation



\*See end notes for additional phase uncertainties

## Performance characteristics for 86100D Option 202

### Test conditions

- Mainframe and module have been turned on for at least one hour and have been calibrated
- TDR calibration has been performed using N1024B
- Internal measurements use 54754A as stimulus and either 54754A or 86112A as receiver
- External measurements use 54754A and Picosecond Pulse Labs Accelerator as stimulus and 86118A as receiver
- All characteristics apply to single-ended and differential
- Derived from measurements of wide range of devices compared to vector network analyzer measurements
- Averages of 256 except as noted in dynamic range

### Phase uncertainty

- Longer equipment warm-up times and careful calibration provide the best phase performance – perform module and TDR calibrations again if temperatures change
- Phase uncertainty is the sum of the uncertainty from the desired graph plus the two additional components which are estimated below
- Sampling points - S-parameters are determined from the sampling points record length<sup>1</sup> over the time interval, which is time per division multiplied by ten divisions. The reference plane is determined to nearest sampling point with uncertainty given by this equation:

$$\text{Uncertainty in degrees (sampling points)} = \frac{\text{time per division (sec)} * 10 \text{ divisions} * f \text{ (Hz)} * 360}{4096 * 2}$$

$$\text{Simplified version} = \text{time per division (sec)} * f(\text{Hz}) / 2.28$$

- Time base drift with temperature - the amount of drift can be observed by placing the calibration short at the reference plane and reading the amount of time difference in picoseconds. The phase uncertainty is given by this equation:

$$\text{Uncertainty in degrees (temp drift)} = \text{time diff (sec)} * \text{frequency (Hz)} * 360$$

1. Record length is user-defined from 16 to 16384. However, the minimum record length used for S-parameters is 4096, independent of user settings.

## Modules specifications

### clock recovery

Clock Recovery Modules	83496B-100	83496B-101
Channel type	Differential or single-ended electrical	Single-mode or multimode optical, differential or single-ended electrical (no internal electrical splitters)
Data rates (divide by 2 for clock signals)	Standard: 50 Mb/s to 7.1 Gb/s continuous tuning Option 200: 50 Mb/s to 14.2 Gb/s continuous tuning Option 201: 7.1 to 14.2 Gb/s continuous tuning	
Minimum input level to acquire lock (voltage or OMA <sup>1</sup> )	150 m Vpp	Single-mode (OMA <sup>1</sup> ): -11 dBm @ 50 Mb/s to 11.4 Gb/s -8 dBm @ > 11.4 Gb/s -12 dBm @ 7.1 Gb/s to 14.2 Gb/s (w/Opt 200) -14 dBm @ 1 Gb/s to 7.1 Gb/s -15 dBm @ 50 Mb/s to 1 Gb/s Multimode 1310 nm (OMA <sup>1</sup> ): -10 dBm @ 50 Mb/s to 11.4 Gb/s -7 dBm @ > 11.4 Gb/s -11 dBm @ 7.1 Gb/s to 14.2 Gb/s (w/Opt 200) -13 dBm @ 1 Gb/s to 7.1 Gb/s -14 dBm @ 50 Mb/s to 1 Gb/s Multimode 850 nm (OMA <sup>1</sup> ): -8 dBm @ 50 Mb/s to 11.4 Gb/s -7 dBm @ > 11.4 Gb/s -9 dBm @ 7.1 Gb/s to 14.2 Gb/s (w/Opt 200) -11 dBm @ 1 Gb/s to 7.1 Gb/s -12 dBm @ 50 Mb/s to 1 Gb/s Electrical: 150 m Vpp
Output random jitter (RMS) <sup>2</sup>	Internal recovered clock trigger < 500 fs 7.2 Gb/s to 11.4 Gb/s (300 fs @ 10 Gb/s) < 700 fs 4.2 Gb/s to 7.2 Gb/s, 11.4 Gb/s to 14.2 Gb/s (400 fs @ 4.25 Gb/s, 500 fs @ 2.5 Gb/s) < 3 mUI 50 Mb/s to 4.2 Gb/s (700 fs @ 1.25 Gb/s) Front panel recovered clock < 700 fs 7.2 Gb/s to 11.4 Gb/s (300 fs @ 10 Gb/s) < 900 fs 4.2 Gb/s to 7.2 Gb/s, 11.4 Gb/s to 14.2 Gb/s (400 fs @ 4.25 Gb/s, 500 fs @ 2.5 Gb/s) < 4 mUI 50 Mb/s to 4.2 Gb/s (700 fs @ 1.25 Gb/s)	
Clock recovery adjustable loop bandwidth range (user selectable)	Standard: 270 kHz or 1.5 MHz <sup>3</sup> ; Option 300: 15 kHz to 10 MHz <sup>4</sup> continuous tuning (fixed value or a constant rate/N ratio)	
Loop bandwidth accuracy	Standard: ±30% Option 300: ±25% for transition density = 0.5 and data rate 155 Mb/s to 11.4 Gb/s (±30% for 0.25 ≤ transition density ≤ 1.0 and all data rates)	
Tracking range	±2500 ppm 83496B, ±1000 ppm 83496A	
Aquisition range	±5000 ppm	
Internal splitter ratio	50/50	50/50 single-mode 30/70 multimode Electrical signals have input only (no internal power dividers)
Input return loss	22 dB (DC to 12 GHz) electrical 16 dB (12 to 20 GHz) electrical	20 dB single-mode, 16 dB multimode 22 dB min (DC to 12 GHz) electrical 16 dB min (12 to 20 GHz) electrical
Input insertion loss	7.2 dB max (DC to 12 GHz) electrical 7.8 dB max (12 to 20 GHz) electrical	4 dB max single-mode optical, 4 dB max multimode optical (no electrical data output signal path)

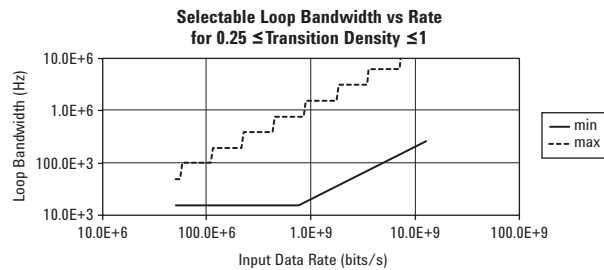
See footnotes on next page.

# Modules specifications

## clock recovery

Clock Recovery Modules	83496B-100	83496B-101
Electrical through-path digital amplitude attenuation <sup>5</sup>	7.5 dB	(No electrical data output signal path)
Wavelength range		830-860 nm and 1260-1360 nm multimode 1260-1360 nm and 1490-1600 nm single mode
		Electrical: 150 m Vpp
Front panel recovered clock output amplitude	1 Vpp max, 220 mVpp min, 300 mVpp	
Consecutive identical digits (CID)	150 max	
Front panel recovered clock output divide ratio (user selectable) <sup>6</sup>	N=1 to 16 @ data rates 50 Mb/s to 7.1 Gb/s N=2 to 16 @ data rates 7.1 Gb/s to 14.2 Gb/s	
Data input/output connectors	3.5 mm male	FC/PC <sup>7</sup> 9/125 μm single-mode optical FC/PC <sup>7</sup> 62.5/125 μm multimode optical 3.5 mm male electrical (input only)
Front panel recovered clock output connector	SMA	

- To convert from OMA to average power with an extinction ratio of 8.2 dB use:  $P_{avgdBm} = OMA_{dBm} - 1.68 \text{ dB}$ .
- Verified with PRBS7 pattern, electrical inputs > 150 mVp-p and optical inputs > 3 dB above specification for minimum input level to acquire lock. Output jitter verification results of the 83496B can be affected by jitter on the input test signal. The 83496B will track jitter frequencies inside the loop bandwidth, and the jitter will appear on the recovered clock output. Vertical noise (such as laser RIN) on the input signal will be converted to jitter by the limit amplifier stage on the input of the clock recovery. These effects can be reduced by lowering the Loop bandwidth setting.
- At rates below 1 Gb/s, loop bandwidth is fixed at 30 KHz when Option 300 is not installed.
- Without Option 200 loop bandwidth is adjustable from 15 KHz to 6 MHz. Available loop bandwidth settings also depend on the data rate of the input signal. For transition density from 0.25 to 1, the Loop Bandwidth vs Rate chart shows available loop bandwidth settings. Higher loop bandwidths can be achieved when average data transition density is maintained at or above 50%.
- $20 \cdot \log(V_{amp_{out}}/V_{amp_{in}})$  measured with PRBS23 at 14.2 Gb/s.
- Minimum frequency of divided front panel clock output is 25 MHz.
- Other types of optical connectors are also available.



## 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

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  
 500 – Productivity Package  
 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<sup>1</sup> 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 16/32 Gb/s  
(high performance)

**86108B**  
Dual channels  
BW > 35/50 GHz  
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

**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.

# Measurements

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 impedance 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, JitterHistogram, Post Processed Jitter Measurements, Phase Noise Graph dBc/Hz versus frequency

## Option 500 productivity package

Option 500 enables Rapid Eye acquisition. Rapid Eye achieves two significant benefits. First, unlike conventional sampling and data display, when an eye mask test is performed, every acquired sample will be compared to the mask, as the central eye is composed of all acquired samples. Effective throughput is improved at least 60%. Second, incomplete eye diagram displays that can occur when triggering at subrates are eliminated.



# Measurements

## • 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,  $\Delta$  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 measurements
- 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

### • $\Delta$ 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)

# Measurements

## 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.

# Measurements

## 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 control

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

## Ordering information

### 86100D Infiniium DCA-X mainframe

#### 86100D Hardware Options

86100D-STR Standard trigger  
86100D-ETR Enhanced trigger  
86100DU-ETR Enhanced trigger upgrade kit  
86100D-GPI GPIB card interface installed (default)  
86100D-GPN No GPIB card interface  
86100D-090 Removable hard drive  
86100D-092 Internal hard drive (default)

#### 86100D Software Options

86100D-xxx are permanent fixed-node licenses installed by the factory  
86100DU-xxx are permanent fixed-node licenses installed by the customer (software upgrades)  
86100DT-xxx are permanent transportable licenses installed by the customer

*The "-xxx" option code provides the same functionality independent of the prefix (i.e., 86100D or 86100DU or 86100DT)*

86100D-061 MATLAB - Basic Oscilloscope Package  
86100D-062 MATLAB - Standard Oscilloscope Package  
86100D-200 Enhanced Jitter analysis software  
86100DT-200 Transportable 86100DU-200 license  
86100D-201 Advanced waveform analysis software  
86100D-202 Enhanced impedance and S-parameter software  
86100D-300 Amplitude analysis/RIN/Q-factor  
86100DU-400 PLL and Jitter Spectrum software<sup>1</sup>  
86100DU-401 Advanced EYE analysis software<sup>1</sup>  
86100D-SIM InfiniiSim-DCA software  
86100D-500 Productivity Package software

#### Misc Options

86100D-AFP Module slot filler panel  
86100D-AX4 Rack mount flange kit  
86100D-AXE Rack mount flange kit with handles  
86100D-UK6 Commercial cal certificate with test data

#### NOTE:

*Options 200, 201, and SIM require Option ETR (enhanced trigger).  
Option 300 requires Options 200 and ETR.  
Option 400 and 401 require Microsoft Office Excel 2003/2007/2010.  
Option 401 requires Options ETR/200 for DDPWS measurement.*

### Optical/electrical modules

<b>86105C</b>	9 GHz optical channel; single-mode and multimode, amplified (750 to 1650 nm) 20 GHz electrical channel
86105C-100	155 Mb/s through 8.5 Gb/s (choose 4 filter rates from Options 86105C-110 through 86105C-195)
86105C-110	155 Mb/s
86105C-120	622 Mb/s (also covers 614 Mb/s)
86105C-130	1.063 Gb/s
86105C-140	1.244/1.250 Gb/s (also covers 1.229 Mb/s)
86105C-150	2.125 Gb/s
86105C-160	2.488/2.500 Gb/s (also covers 2.458 Gb/s)
86105C-170	2.666 Gb/s

86105C-180	3.125 Gb/s (also covers 3.072 Gb/s)
86105C-190	4.250 Gb/s
86105C-193	5.0 Gb/s
86105C-195	6.250 Gb/s (also covers 6.144 Gb/s)
86105C-200	8.5, 9.953, 10.3125, 10.519, 10.664, 10.709, 11.096, 11.317 Gb/s
86105C-300	Combination of rates available in 86105C-100 and 86105C-200
<b>86105D<sup>2</sup></b>	20 GHz optical channel; single-mode and multimode, (750-1650 nm); filters for 8.5, 9.953, 10.3125, 10.519, 10.664, 10.709, 11.096, 11.317, 14.025 Gb/s; 35 GHz electrical channel
86105D-100	Identical capability as 86105D, 14.025 Gb/s filter not included
86105D-200	Identical capability as 86105D, only filter provided is 14.025 Gb/s
86105D-IRC <sup>3</sup>	System impulse response correction calibration
86105D-281	34 GHz optical channel, filters for 15, 25.78, 27.95, 28.05 Gb/s (contact Agilent for additional 14.025 Gb/s filter) <sup>4</sup> , 50 GHz electrical channel
<b>86115D<sup>2</sup></b>	20 GHz multi-optical port plug-in module; single-mode and multimode (750-1650 nm); filters for 8.5, 9.953, 10.3125, 10.519, 10.664, 10.709, 11.096, 11.317, 14.025 Gb/s
86115D-002	Two optical channels with filters for all rates listed (8.5 to 14.025 Gb/s)
86115D-102	Identical capability as 86115D-002, 14.025 Gb/s filters not included
86115D-142	Identical capability as 86115D-002, only filters provided are 14.025 Gb/s
86115D-282	Two optical channels with filters for 15, 25.78, 27.95, 28.05 Gb/s (contact Agilent for 14.025 Gb/s filter) <sup>4</sup>
86115D-004	Four optical ports with filters for all rates listed (8.5 to 14.025 Gb/s) multiplexed to two optical channels through 2 integral 1X2 optical switches
86115D-104	Identical capability as 86115D-004, 14.025 Gb/s filters not included
86115D-144	Identical capability as 86115D-004, only filters provided are 14.025 Gb/s
86115D-IRC	System impulse response correction calibration
<b>86116C<sup>2</sup></b>	40 to 65 GHz optical / 80 GHz electrical sampling module, 1300 to 1620 nm
86116C-IRC <sup>3</sup>	System impulse response correction calibration

This module is not compatible with the 86100A and 86100B DCA mainframes. If you want to upgrade older DCAs, contact Agilent Technologies to discuss current trade-in deals.

All optical modules have FC/PC connectors installed on each optical port. Other connector adapters available as options are: Diamond HMS-10, DIN, ST and SC.

- Fixed node customer installed or transportable customer installed (86100DU or 86100DT). Not available as a factory-installed license.*
- This module is not compatible with the 86100A and 86100B DCA mainframes. If you want to upgrade older DCAs, contact Agilent Technologies to discuss current trade-in deals*
- System impulse response correction calibration provides a unique calibration file for the optical channel(s). The FlexDCA user interface uses this calibration file to create ideal reference receiver responses for more accurate and consistent transceiver compliance testing. IRC also allows reference receivers to be defined at any data rate within +/- 50% of the hardware response. This allows optical receivers to significantly extend their operating range.*
- A 15 Gb/s filter is provided with Option 281 and 282 that closely approximates the response required for 16X Fibre Channel compliance testing. Contact Agilent for a special option that verifies compliance of the 86105D-281 and 86115D-282 to the 16X Fibre Channel reference receiver specification.*

# Ordering information

**86116C<sup>1</sup>** 40 to 65 GHz optical / 80 GHz electrical sampling module, 1300 to 1620 nm

Select exactly one reference receiver option:

86116C-025: 40 GHz opt./80 GHz elec. channels, 17.0/25.8/27.7 Gb/s reference receiver

86116C-041: 65 GHz opt./80 GHz elec. channels, 39.81/41.25/43.02 Gb/s reference receiver

## Dual/Quad electrical channel modules

**86112A** Dual 20 GHz electrical channels

86112A-HBW Dual 30 GHz electrical channels

**86117A** Dual 50 GHz electrical channels

**86118A** Dual 70 GHz electrical remote sampling channels

86118A-H01 Differential De-Skew

**N1045A<sup>2</sup>** 2/4 Port 60 GHz electrical remote head

N1045A-02F 2 channel remote head, 1.85 mm, female

N1045A-02M 2 channel remote head, 1.85 mm, male

N1045A-04F 4 channel remote head, 1.85 mm, female

N1045A-04M 4 channel remote head, 1.85 mm, male

## TDR/TDT modules<sup>1</sup>

Included with each of these TDR modules is a TDR trigger cable, two 50 Ω SMA terminations and one SMA short.

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

## Precision timebase 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<sup>1</sup>

The following modules provide a recovered clock from the data signal for triggering at indicated data rates:

**83496B** 50 Mb/s to 7.1 Gb/s Clock recovery module. This module is not compatible with the 86100A and 86100B DCA mainframes. If you want to upgrade older DCAs, contact Agilent Technologies and ask for current trade-in deals.

83496B-100 Single-ended and differential electrical with integrated signal taps

83496B-101 Single Mode (1260-1360 nm and 1490-1600 nm) and multimode (830-860 nm and 1260-1360 nm) optical. Integrated signal taps. Single-ended or differential electrical inputs (no signal taps)

83496B-200 Increase operating range to 50 Mb/s to 14.2 Gb/s

83496BU-200 Data rate 0.05 Gb/s to 14.2 Gb/s upgrade

83496B-201 Shift operating range to 7.1 to 14.2 Gb/s

83496BU-201 Shift operating range to 7.1 to 14.2 Gb/s upgrade

83496B-300 Add tunable loop bandwidth "golden PLL" capability

83496BU-300 Adjustable loop bandwidth upgrade

## External clock recovery solutions

**N4877A** 50 Mb/s to 32 Gb/s electrical clock recovery instrument with 1:2 demultiplexer

N4877A-216 50 Mb/s to 16 Gb/s operation

N4877A-232 50 Mb/s to 32 Gb/s operation

**N1075A** Optical pickoff and electrical converter

N1075A-M14 Multimode and single-mode to > 16 Gb/s<sup>4</sup>

N1075A-S32 Single-mode to > 32 Gb/s

**N1070A** Bundle N4877A and N1075A for an optical clock recovery solution

## Precision waveform analyzer module<sup>1, 3</sup>

Dual electrical channel module with integrated clock recovery and precision timebase.

**86108A-100** Dual 32 GHz electrical channels, integrated clock recovery (50 Mb/s to 14.2 Gb/s) with integrated precision timebase

**86108A-001** Two 3.5 mm phase trimmers for skew adjustment

**86108A-002** Two precision 3.5 mm 18 inch cables

**86108A-400** Auxiliary Clock Recovery Input

**86108B options:**

**86108B-LBW** Dual 35 GHz electrical channels

**86108B-HBW** Dual 50 GHz electrical channels

**86108B-216** Clock recovery 50 Mb/s to 16 Gb/s

**86108B-232** Clock recovery 50 Mb/s to 32 Gb/s

**86108B-300** Adjustable loop bandwidth/peaking

**86108B-400** Auxiliary clock recovery input

**86108B-PTB** Integrated precision timebase

**86108B-JSA** Jitter Spectrum Analysis and Software Clock Recovery Emulation

**86108B-A23** Two Adapters, 2.4 mm (f) to 3.5 mm (f)

**86108B-CA2** Matched Cable Pair, 2.4 mm - 2.4 mm, 24 inch

**86108B-CA3** Matched Cable Pair, 3.5 mm - 3.5 mm, 18 inch

**86108B-DC2** Two DC Blocks, 2.4 mm, 16V, 50 KHz - 50 GHz

**86108B-DC3** Two DC Blocks, 3.5 mm, 16V, 50 KHz - 26.5 GHz

**86108B-PT2** Two 2.4 mm phase trimmers for ext. skew adjustment

**86108B-PT3** Two 3.5 mm phase trimmers for ext. skew adjustment

1. 86100D-ETR is recommended when using a DCA module equipped with a rear-panel trigger circuit. Examples include 54754A, 83496x, and 86108A/B modules. If operating these modules in an 86100D with Option STR, an external cable (such as P/N 5062-6690) must be connected from the module's front panel trigger/clock output to the 86100D's trigger input.

2. Requires 86100D mainframe (not compatible with 86100A/B/C).

3. This module is not compatible with the 86100A and 86100B DCA mainframes. If you want to upgrade older DCAs, contact Agilent Technologies to discuss current trade-in deals.

4. The N1070 solution can provide clock recovery for multimode signals to data rates in excess of 28 Gb/s if optical modulation power is large. See N4877A/N1070A specifications.

# Ordering information

## Warranty options (for all products)

<b>R1280A</b>	Customer return repair service
<b>R1282A</b>	Customer return calibration service

## Accessories

<b>11898A</b>	Extender module for plug-in modules
<b>N1000-40008</b>	Front cover
<b>86101-60017</b>	Filler panel (¼ of module bay)
<b>0960-2929</b>	USB keyboard (included with 86100D)
<b>1150-7913</b>	USB mouse (included with 86100D)
<b>9300-1308</b>	ESD Heel strap
<b>N1040-66410</b>	TDR/TDT, Equalization & de-embedding demo board
<b>9300-1367</b>	ESD Wrist strap
<b>9300-1484</b>	ESD Desk mat
<b>9300-0980</b>	ESD Wrist strap ground cord

## Optical connector adapters

Note: Optical modules come standard with one FC/PC connector adapter

<b>81000FI</b>	FC/PC connector interface
<b>81000SI</b>	DIN connector interface
<b>81000HI</b>	E2000 connector interface
<b>81000LI</b>	LC connector interface
<b>81000MI</b>	MU connector interface
<b>81000VI</b>	ST connector interface
<b>81000KI</b>	SC Connector interface
<b>N9355CK01</b>	DC coupled limiter for overload and ESD protection (3.5 mm only)

## RF/Microwave accessories<sup>1</sup>

<b>11636B</b>	Power divider, DC to 26.5 GHz, APC 3.5 mm
<b>N4910A</b>	2.4 mm male-to-male matched coaxial cable pair, 61 cm
<b>N4871A</b>	3.5 mm male-to-male matched coaxial cable pair, 91 cm
<b>11636C</b>	Power divider, DC to 50 GHz, 2.4 mm
<b>11742A</b>	45 MHz to 26.5 GHz DC blocking capacitor
<b>N9398G</b>	1.85 mm male-to-female DC Block 16V 700 kHz-67 GHz
<b>N9398F</b>	2.4 mm male-to-female DC Block 16V 50 kHz-50 GHz
<b>N9398C</b>	3.5 mm male-to-female DC Block 16V 50 kHz-26.5 GHz
<b>11742A-K01</b>	50 GHz DC blocking capacitor
<b>8493C-003</b>	3.5 mm 3 dB attenuator
<b>8493C-006</b>	3.5 mm 6 dB attenuator
<b>8493C-010</b>	3.5 mm 10 dB attenuator
<b>8493C-020</b>	3.5 mm 20 dB attenuator
<b>8490D-003</b>	2.4 mm 3 dB attenuator

<b>8490D-006</b>	2.4 mm 6 dB attenuator
<b>8490D-010</b>	2.4 mm 10 dB attenuator
<b>8490D-020</b>	2.4 mm 20 dB attenuator

<b>11900A</b>	2.4 mm male to 2.4 mm male adapter/connector saver
<b>11900B</b>	2.4 mm female to 2.4 mm female adapter/connector saver
<b>11900C</b>	2.4 mm female to 2.4 mm male connector saver
<b>11901A</b>	2.4 mm male to 3.5 mm male adapter
<b>11901B</b>	2.4 mm (f) to 3.5 mm (f) adapter
<b>11901C</b>	2.4 mm (m) to 3.5 mm (f) adapter
<b>11901D</b>	2.4 mm (f) to 3.5 mm (m) adapter
<b>5061-5311</b>	3.5 mm (f-f) connector saver (e.g., for 86100C/D trigger input)
<b>85130-60010</b>	2.4 mm female to 3.5 mm male NMD bulkhead adapter
<b>1250-1158</b>	SMA (f-f) adapter
<b>83059A</b>	3.5 mm male to 3.5 mm male adapter/connector saver
<b>83059B</b>	3.5 mm female to 3.5 mm female adapter/connector saver
<b>83059C</b>	3.5 mm female to 3.5 mm male connector saver
<b>909D-011</b>	3.5 mm female 50 Ohm load
<b>909D-301</b>	3.5 mm male 50 Ohm load
<b>85138A</b>	2.4 mm male 50 Ohm load
<b>85138B</b>	2.4 mm female 50 Ohm load
<b>85140A</b>	2.4 mm male short
<b>85140B</b>	2.4 mm female short

## Passive probe

<b>54006A</b>	6 GHz passive probe
<b>N1021B</b>	18 GHz Differential TDR Probe Kit
<b>N1024B</b>	TDR Calibration kit

## Infiniimax I active probes (1.5 to 7 GHz)

Note: The N1022B probe adapter is required to use these probes with the 86100 DCA

### Infiniimax I probe amplifiers

Note: Order one or more Infiniimax I probe head or connectivity kit for each amplifier

<b>1130A</b>	1.5 GHz probe amp
<b>1131A</b>	3.5 GHz probe amp
<b>1132A</b>	5 GHz probe amp
<b>1134A</b>	7 GHz probe amp

### Infiniimax I probe heads

<b>E2675A</b>	InfiniiMax differential browser probe head and accessories. Includes 20 replaceable tips and ergonomic handle. Order E2658A for replacement accessories.
<b>E2676A</b>	InfiniiMax single-ended browser probe head and accessories. Includes two ground collar assemblies, 10 replaceable tips, a ground lead socket and ergonomic browser handle. Order E2663A for replacement accessories.

1. 2.4 mm connectors are mechanically compatible with 1.85 mm. 2.92 mm connectors are mechanically compatible with 3.5 mm and SMA connectors.

## Ordering information

<b>E2677A</b>	InfiniiMax differential solder-in probe head and accessories. Includes 20 full bandwidth and 10 medium bandwidth damping resistors. Order E2670A for replacement accessories.
<b>E2678A</b>	InfiniiMax single-ended/differential socketed probe head and accessories. Includes 48 full bandwidth damping resistors, six damped wire accessories, four square pin sockets and socket heatshrink. Order E2671A for replacement accessories.
<b>E2679A</b>	InfiniiMax single-ended solder-in probe head and accessories. Includes 16 full bandwidth and eight medium bandwidth damping resistors and 24 zero ohm ground resistors. Order E2672A for replacement accessories.

### InfiniiMax I connectivity kits (popular collections of the above probe heads)

<b>E2669A</b>	InfiniiMax connectivity kit for differential measurements
<b>E2668A</b>	InfiniiMax connectivity kit for single-ended measurements

### InfiniiMax II active probes (10 to 13 GHz)

*Note: The N1022B probe adapter is required to use these probes with the 86100 DCA*

#### InfiniiMax II probe amplifiers

*Note: Order 1 or more InfiniiMax II probe heads for each amplifier. InfiniiMax I probe heads and connectivity kits can also be used but will have limited bandwidth.*

<b>1168A</b>	10 GHz probe amp
<b>1169A</b>	13 GHz probe amp

#### InfiniiMax II probe heads

<b>N5380A</b>	InfiniiMax II 12 GHz differential SMA adapter
<b>N5381A</b>	InfiniiMax II 12 GHz solder-in probe head
<b>N5382A</b>	InfiniiMax II 12 GHz differential browser

### InfiniiMax III active probes (16 to 30GHz)

*Note: The N5477A probe adapter is required to use these probes with the 86100 DCA*

#### InfiniiMax III probe amplifiers

<b>N2800A</b>	16 GHz probe amp
<b>N2801A</b>	20 GHz probe amp
<b>N2802A</b>	25 GHz probe amp
<b>N2803A</b>	30 GHz probe amp

#### InfiniiMax III probe heads

<b>N5439A</b>	ZIF Probe Head
<b>N5440A</b>	450 $\Omega$ ZIF Tip
<b>N5447A</b>	200 $\Omega$ ZIF Tip
<b>N5444A</b>	2.92 mm/3.5 mm/SMA
<b>N5448A</b>	2.92 mm Extension Cables
<b>N5441A</b>	Solder-in Probe Head
<b>N5445A</b>	Browser Probe Head

### Probe adapters

<b>N5477A</b>	Sampling Scope Adapter. Adapts the InfiniiMax III system probes to the 86100 InfiniiMax DCA
<b>N1022B</b>	Adapts 113x/115x/116x active probes to 86100 InfiniiMax DCA

The N1022A/B and N5477A adapters are powered by connecting it to the built-in probe power connector available on some DCA modules or to an external probe power supply. On modules that do not have a built-in probe power connector, use an 1143A external power supply. It is recommended to order option 001 on the 1143A, which provides a 5-foot power extension cable (01143-61602). The 1143A power supply can power two probes. The N1022A/B and N5477A adapters are compatible with male 3.5 mm NMD bulkhead inputs. Insert an 85130-60010 2.4 mm female NMD to 3.5 mm male NMD adapter in order to use them for 2.4 mm NMD bulkhead inputs.

### Connectivity solutions

#### ATCA

*Note: These are available from F9 Systems, see [www.f9-systems.com](http://www.f9-systems.com)*

**Advanced TCA Tx/Rx Signal Blade™**

**Advanced TCA Tx/Rx Bench Blade™**

Call Agilent for connectivity and probing solutions not listed above.

### Firmware and software

Firmware and software upgrades are available through the Web or your local sales office. [www.agilent.com/find/dcac](http://www.agilent.com/find/dcac)

**N1010A** FlexDCA Remote Access Software

FlexDCA Pro runs on the 86100D as well as on a PC or laptop.

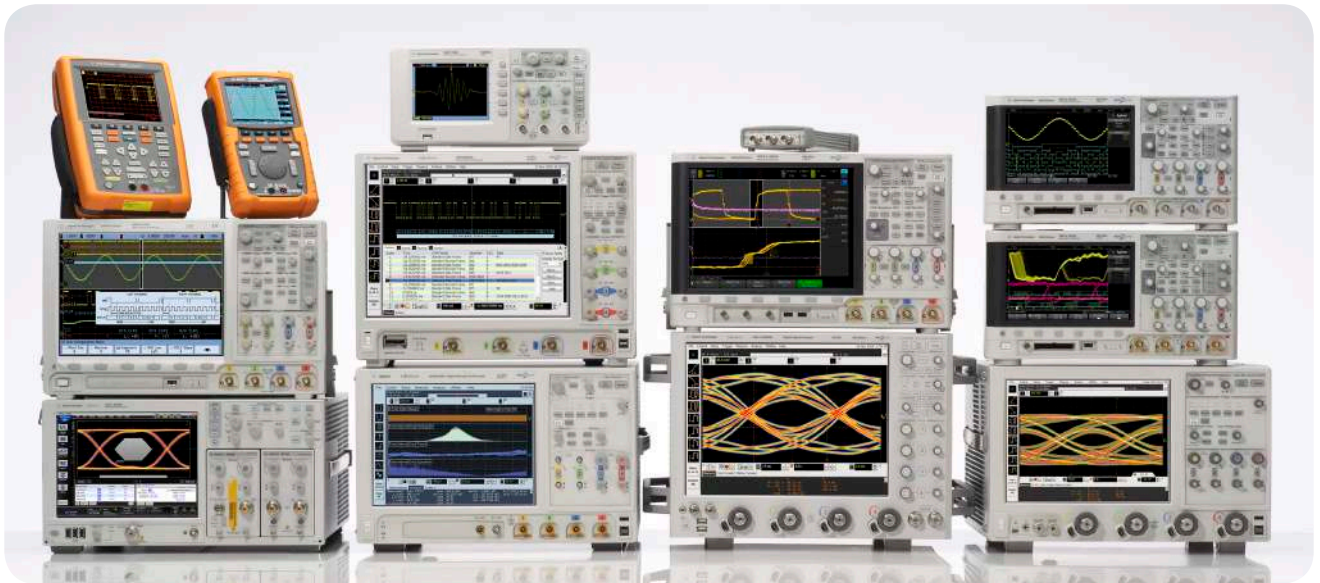
Software licenses allow connectivity to an 86100C or D mainframe, advanced analysis or productivity packages, and more.

[http://www.agilent.com/find/flexdca\\_download](http://www.agilent.com/find/flexdca_download)

FlexDCA express is the same as FlexDCA Pro except that it does not include any functionality requiring a license. It is available free of charge from [http://www.agilent.com/find/flexdca\\_express](http://www.agilent.com/find/flexdca_express)

### 86100D DCA-X Brochure

For more information on the features and benefits of the 86100D DCA-X and DCA modules, download the 86100D DCA-X Brochure. Go to: [www.agilent.com](http://www.agilent.com) and search on 5989-5822EN.



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