Infiniium DCA-X

86100D
Wide-Bandwidth Oscilloscope Mainframe and Modules

Data Sheet

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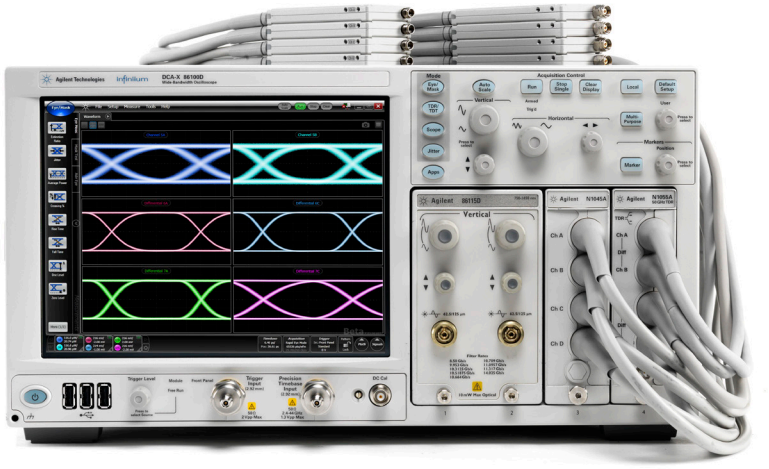

See the TRUE performance of your designs.

The 86100D DCA-X performs precision measurements on high-speed digital designs from 50Mb/s to more than 80 Gb/s on up to 16 channels simultaneously. 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

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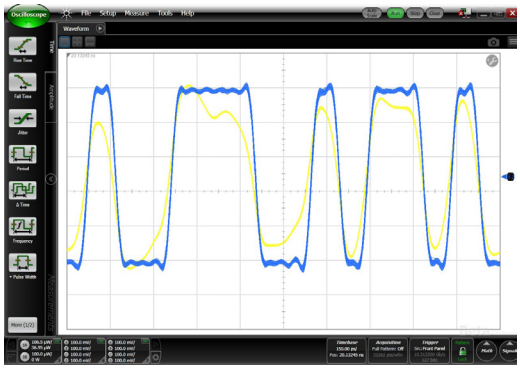
Agilent Technologies

Overview of the Infiniium DCA-X

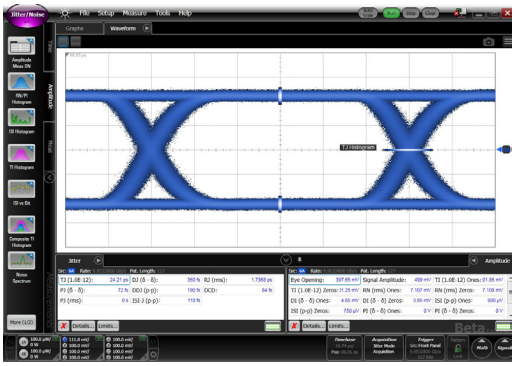
the 86100D DCA-X can be viewed as four powerful instruments in one:

Scope mode



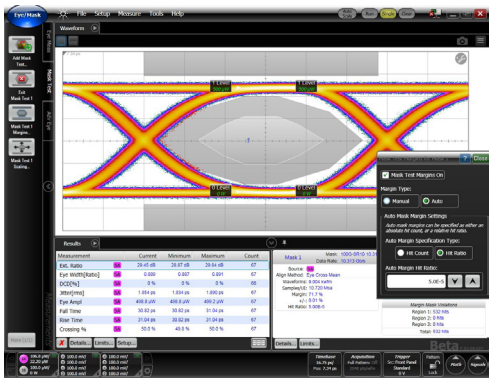
High-fidelity waveform characterization (Yellow: raw trace, Blue: de-embedded waveform)

Jitter mode



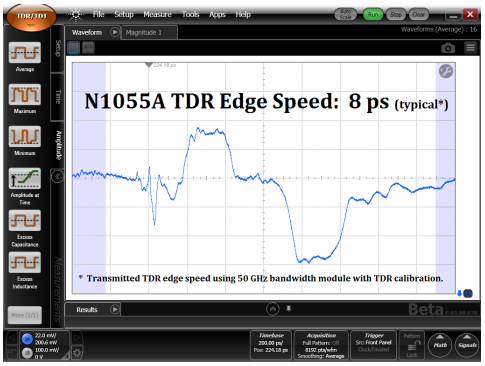
Precision jitter, amplitude, and frequency analysis capability

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.

High channel count

The DCA-X can measure from one to 16 channels simultaneously with no significant loss in throughput. Create an affordable high-capacity test system by measuring multiple signals in parallel.

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, 86100D-SIM for de-embedding and/or embedding of fixtures and cables, and the N1012A/N1014A/N1081-Series test applications.

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)
Max relative humidity	80% for temperatures up to 31°C decreasing linearly to 50% relative humidity at 40°C	
Supply voltage variation	86100D system can operate with supply voltage fluctuations up to ± 10% of the nominal voltage	

Mainframe specifications

Horizontal system (time base)		**Pattern lock**
Scale factor (full scale is ten divisions)		
Minimum	2 ps/div (with 86107A or 86100D-PTB : 500 fs/div)	
Maximum	1 s/div	250 ns/div
Delays[1]		
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[2]	1 ps + 1.0% of Δ time reading[3] or 8 ps, whichever is smaller	
Jitter mode operation[4]	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)	

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 + Nx4)ns ± 100 ps delay setting, where N=0,1,2....18. If delta time measurement spanexceeds 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)
Vertical system (channels)		
Number of channels	16 (simultaneous acquisition)	
Vertical resolution	54xxx, 83xxx, 86xxx: 14 bit A/D converter (16 or more bits with averaging). N10xx: 16 bit A/D converter	
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[5]	
Trigger modes		
Internal trigger[1]	Free run	Free run
External direct trigger[2]		
Limited bandwidth[3]	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 *(15 GHz, 32 GHz with option PTB)*
PatternLock	N/A	50 MHz to 13 GHz *(50 MHz to 15 GHz)*
Module Bay Trigger[7]	N/A	Yes, supported.
Jitter		
Characteristic	< 1.0 ps RMS + 5*10E-5 of delay setting[4]	1.2 ps (750 fs option PTB) RMS for time delays less than 100 ns[6]
Maximum	1.5 ps RMS + 5*10E-5 of delay setting[4]	1.7 ps (1.2 ps option PTB) RMS for time delays less than 100 ns[6]
Option PTB	N/A	1.2 ps (750 fs) (50 MHz to 32 GHz) in PTB mode[8]: 200 fs (2.4 to 4 GHz) 120 fs (4 to 9 GHz) 90 fs (9 to 44 GHz)
Trigger sensitivity	200 mV_{pp} (sinusoidal input or 200 ps minimum pulse width)	200 mV_{pp} sinusoidal input: 50 MHz to 13 GHz, (to 32 GHz with option PTB)
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 µs + trigger period + Maximum 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 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.*
8. *In precision timebase (PTB) operation with 750 mV input (500 mV input, 9 to 44 GHz)*

Specifications
computer system and storage

Computer system and storage	
CPU	Intel Core i5 3550S CPU at 3.0 GHz
Mass storage	80 GByte internal hard drive (default) or 80 GByte removable hard drive (Option 090)
Operating system	Microsoft Windows 7 embedded standard (64 bit)
Display[1]	
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	2.92 mm[4], 50 Ω, 2 Vpp base max
Precision timebase input (Option PTB only)	2.92 mm[4], 50 Ω, 2 Vpp max
USB[2]	Three low-power USB 2.0 ports; Voltage: 5.00V ±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[3]	Fully programmable, complies with IEEE 488.2
RS-232	9 pin D-sub (male)
LAN	
USB[2]	Four USB 2.0 ports; Voltage: 5.00 ±0.25V; Current: 500 mA each
Precision timebase delay path (option PTB only)	Two female SMA connectors, nominal length jumper cable included

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 2.92 mm female-female connector saver (P/N 1250-4105).*

Specifications
precision time base operation and integrated precision timebase

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 timebase capability is achieved using the 86107A precision timebase plug-in module or integrating the precision timebase system within the 86100D mainframe (86100D option PTB). 86100D-PTB does not consume a mainframe plug-in slot.[6]

Precision time base 86100D option PTB or 86107A				
	86107A Option 010	86107A Option 020	86107A Option 040	86100D-PTB
Trigger bandwidth	2.0 to 15.0 GHz	2.4 to 25.0 GHz	2.4 to 48.0 GHz	2.4 - 44 GHz
Typical jitter (RMS) using 86100D mainframe[4]	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	2.4 - 4 GHz < 200 fs, 4 GHz - 9 GHz < 120 fs, 9 GHz - 44 GHz < 90 fs
Typical jitter (RMS) using 86100D mainframe[5]	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	2.4 - 5 GHz < 400 fs, 5 GHz - 10 GHz < 300 fs, 10 GHz - 44 GHz < 200 fs
Time base linearity error	< 200 fs			
Input signal type	Synchronous clock[1]			
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 impedance (nominal)	50 Ω			
Connector type[3]	3.5 mm (male)		3.5 mm (male) 2.4 mm (male)	2.92 mm[4]

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 sub harmonics and provide a sinusoid to the 86107 input (not required for 86100D-PTB).*
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, or 86100D-PTB, and an 861xx, N1045 option LOJ, or N1055A module (electrical channel).*
5. *With 86107A module, or 86100D-PTB, and 54xxx, 8348x, and N1045A plug-in modules.*
6. *If an 86107A module is used in an 86100D frame with option PTB, the internal precision timebase is disabled.*

The 86108 has an integrated precision timebase within the plug-in module. The 86108A/B can be triggered through clock recovery of the

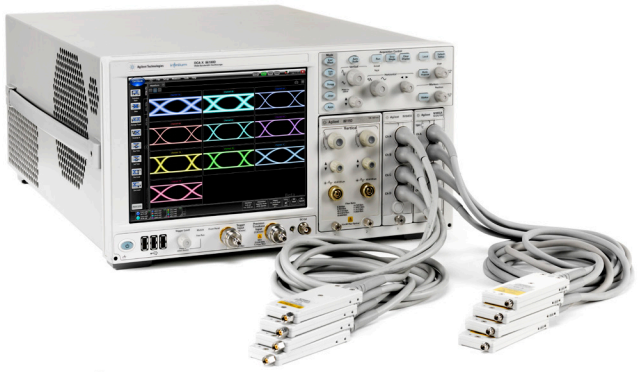
Specifications
precision time base (86108 configurations)

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.) If the 86108A/B is placed in a mainframe that has an integrated precision timebase (86100D-PTB), the integrated mainframe precision timebase is disabled.

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)[1]	< 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)[1]	< 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[2]	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[3]	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 selection table



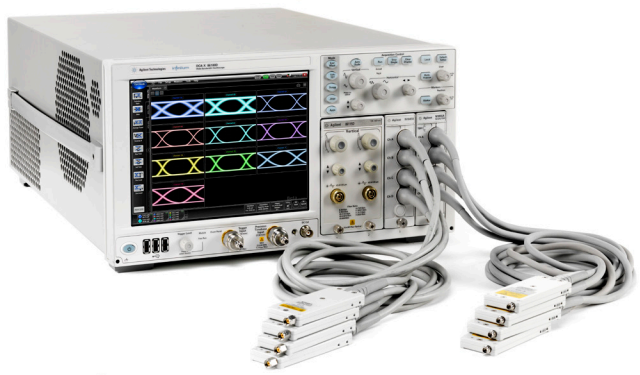
86100 family plug-in module matrix

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

Module	Option	No. of optical channels	No. of electrical channels	TDR/TDT/S-parameters	Probe power[1]	Wavelength range (nm)	Unfiltered optical bandwidth (GHz)	Electrical bandwidth (GHz)	Fiber input (µm)	Mask test sensitivity (dBm)[9]	Filtered data rates: 155 Mb/s	622 Mb/s	1063 Mb/s	1244/1250 Mb/s	2125 Mb/s	2488/2500 Mb/s	2.666 Gb/s	3.125 Gb/s	4.25 Gb/s	5.00 Gb/s	6.25 Gb/s	8.50 Gb/s	9.953 Gb/s	10.3125 Gb/s	10.51875 Gb/s	10.664 Gb/s	10.709 Gb/s	11.096 Gb/s	11.317 Gb/s	14.025 Gb/s	25.80 Gb/s	27.70 Gb/s	28.05 Gb/s	39.813 Gb/s	41.250 Gb/s	43.018 Gb/s
86105C[6]	100[2]	1	1			750-1650	8.5	20	62.5	-20	●	●	●	●	●	●	●	●	●	●	●	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]						
	200	1	1			750-1650	8.5	20	62.5	-16										○[7]	○[7]	●	●	●	●	●	●	●	●	○[7]						
	300[2]	1	1			750-1650	8.5	20	62.5	-16	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○[7]						
86105D[3,6]		1	1			750-1650	20	35	62.5	-12										○[7]	○[7]	●	●	●	●	●	●	●	●	●	○[7]	○[7]	○[7]			
	100	1	1			750-1650	20	35	62.5	-12										○[7]	○[7]	●	●	●	●	●	●	●	●	○[7]	○[7]	○[7]	○[7]			
	200	1	1			750-1650	20	35	62.5	-12										○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	●	○[7]	○[7]	○[7]			
86105D	281	1	1			750-1650	34	50	62.5	-7												○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	●[10]	●	●	●	○[7]	○[7]	○[7]
86115D[3,6]	002	2	0			750-1650	20		62.5	-12										○[7]	○[7]	●	●	●	●	●	●	●	●	●	○[7]	○[7]	○[7]			
	102	2	0			750-1650	20		62.5	-12										○[7]	○[7]	●	●	●	●	●	●	●	●	○[7]	○[7]	○[7]	○[7]			
	142	2	0			750-1650	20		62.5	-12										○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	●	○[7]	○[7]	○[7]			
	004[5]	4	0			750-1650	20		62.5	-11										○[7]	○[7]	●	●	●	●	●	●	●	●	●	○[7]	○[7]	○[7]			
	104	4	0			750-1650	20		62.5	-11										○[7]	○[7]	●	●	●	●	●	●	●	●	○[7]	○[7]	○[7]	○[7]			
	144	4	0			750-1650	20		62.5	-11										○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	●	○[7]	○[7]	○[7]			
86115D	282	2	0			750-1650	34	50	62.5	-7												○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	●[10]	●	●	●	○[7]	○[7]	○[7]
86116C[3,6]	025	1	1			1300-1620	45	80	9	-10												○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	○[7]	●	●	○[7]	○[7]	○[7]	○[7]
86116C[3,6]	041	1	1			1300-1620	65	80	9	-5																					○[7]	○[7]	○[7]	●	●	●

1. *Module has receptacle to supply power for external probe.*
2. *Pick any 4 rates (155 Mb/s to 6.25 Gb/s).*
3. *This module is not compatible with the 86100A and 86100B Digital Communication Analyzer (DCA) mainframes. If you would like to upgrade older DCA's contact Agilent Technologies and ask for current trade-in deals.*
4. *The 86108A/B uses all module slots and includes an internal clock recovery and precision timebase capabilities.*
5. *4 optical input ports are switched internally to 2 optical-to-electrical (O/E) converter*
6. *All modules with optical channels can use option -IRC to enhance the effective operating range. Reference receivers can be created at any rate within ±50% of the hardware capability. IRC also corrects non-ideal (but compliant) hardware performance to yield ideal reference receiver responses.*
7. *With option IRC. Requires FlexDCA using Pattern Lock, 86100D mainframe with option ETR, and signals <= PRBS16-1. For more details, see application note "Techniques for Higher Accuracy Optical Measurements" (Agilent literature number 5990-8812EN).*
8. *Requires 86100D mainframe (not compatible with 86100A/B/C).*
9. *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.*
10. *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.*

Modules selection table (cont'd)



86100 family plug-in module matrix

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Module	Option	No. of optical channels	No. of electrical channels	TDR/TDT/S-parameters	Probe power[1]	Electrical bandwidth (GHz)
54754A		0	2	•	•	18
86108A[3,4]		0	2		•	32
86108B[3,4]	LBW	0	2		•	35
	HBW	0	2		•	50
86112A		0	2		•	20
	HBW	0	2		•	30
86117A		0	2			50
86118A		0	2			70
N1045A[4]	02F/02M	0	2			60
N1045A[4]	04F/04M	0	4			60
N1055A[4]	32F/32M	0	2	•		35
N1055A[4]	34F/34M	0	4	•		35
N1055A[4]	52F/52M	0	2	•		50
N1055A[4]	54F/54M	0	4	•		50

1. *Module has receptacle to supply power for external probe.*
2. *This module is not compatible with the 86100A and 86100B Digital Communication Analyzer (DCA) mainframes. If you would like to upgrade older DCA's contact Agilent Technologies and ask for current trade-in deals.*
3. *The 86108A/B uses all module slots and includes internal clock recovery and precision timebase capabilities.*
4. *Requires 86100D mainframe (not compatible with 86100A/B/C).*

Modules specifications
single-mode and multimode optical/electrical

Multiple and single-mode optical/electrical modules	86105C	86105D	86105D Option 281
Optical channel specifications			
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[1]	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: 15 Gb/s, –9 dBm 25.78 Gb/s, –6 dBm, 27.85 to 28.05 Gb/s, –5 dBm 1310 nm/1550 nm: 15 Gb/s, –8 dBm 25.78 Gb/s, –7 dBm, 27.95 to 28.05 Gb/s, –6 dBm 1550 nm: 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
RMS noise			
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: 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: 15 Gb/s, 7 µW, 25.78 Gb/s, 13 µW, 27.95 to 28.05 Gb/s 15 uW, unfiltered, 18 µW 1550 nm: 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: 15 Gb/s, 15 µW 25.78 Gb/s, 30 µW, 27.95 to 28.05 Gb/s, 30 µW unfiltered, 35 µW 1310 nm: 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: 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[2]	86115D Option 004, 104, 144[2]	86115D Option 282
Optical channel specifications			
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[1]	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: 15 Gb/s, –9 dBm 25.78 Gb/s, –6 dBm, 27.85 to 28.05 Gb/s, –5 dBm 1310 nm/1550 nm: 15 Gb/s, –8 dBm 25.78 Gb/s, –7 dBm, 27.95 to 28.05 Gb/s, –6 dBm 1550 nm: 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
RMS noise			
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: 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: 15 Gb/s, 8 µW, 25.78 Gb/s, 13 µW unfiltered, 18 µW 1550 nm: 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: 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: 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: 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[2]	86115D Option 004, 104, 144[2]
Optical channel specifications (continued)					
Scale factor (per division)					
Minimum	2 µW	20 µW	20 µW	20 µW	20 µW
Maximum	100 µW	500 µW	500 µW	500 µW	500 µW
CW[1] accuracy (single marker, referenced to average power monitor)	Single-mode: ±25 µW ±3% Multimode: ±25 µW ±10%	Single-mode: ±25 µW ±(2% (8/10 Gb/s), 4% (14 Gb/s) 6% unfiltered) Multimode: ±25 µW ±10%	±25 µW ±4% (14.025 Gb/s), ±25 µW ±4% (15.0 Gb/s), ±25 µW ±6% (25.78125 Gb/s), ±25 µW ±6% (27.7393 Gb/s to 28.05 Gb/s), ±25 µW ±6% (unfiltered)	Single-mode: ±25 µW ±(2% (8/10 Gb/s), 4% (14 Gb/s) 6% unfiltered) Multimode: ±25 µW ±10%	Single-mode: ±25 µW ±(2% (8/10 Gb/s), 4% (14 Gb/s) 6% unfiltered) Multimode: ±25 µW ±10%
CW offset range (referenced two divisions from screen bottom)	+0.2 µW to –0.6 µW	+1 µW/–3 µW	+1 mW to –3 mW	+1 µW/–3 µW	+1 µW/–3 µW
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
Average power monitor accuracy					
Single-mode	±5% ±200 nW ±connector uncertainty	± 5%±200 nW ±connector uncertainty	±5% ± 200 nW ± connector uncertainty	±5% ±100 nW ±connector uncertainty (20 to 30 °C)	± 5%±200 nW ±connector uncertainty
Multimode (characteristic)	±10% ±200 nW ±connector uncertainty	± 5% ±200 nW ±connector uncertainty	±10% ± 200 nW ± connector uncertainty	± 5% ±200 nW ±connector uncertainty	± 5% ±200 nW ±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[1]	86115D Option 004, 104, 144[1]
Optical channel specifications (continued)					
User calibrated accuracy					
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
Maximum input power					
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[1]	86115D Option 004, 104, 144[1]
Electrical channel specifications					
Electrical channel bandwidth	12.4 and 20 GHz	25 and 35 GHz	25 and 50 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)		
RMS noise					
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)		
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				
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)		2.4 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
Optical channel specifications			
Optical channel unfiltered bandwidth		45 GHz	65 GHz
Wavelength range		1300 nm to 1620 nm[3]	
Calibrated wavelengths		1300 nm/1550 nm	
Optical sensitivity[2]	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 Tr = 0.48/BW optical)		7.4 ps (FWHM)[1]	
RMS noise			
Characteristic	1310 nm	13 µW (17 Gb/s) 17 µW (25.8 Gb/s) 20 µW (27.7 Gb/s) 60 µW (40 GHz)	54 µW (39.8/43.0 Gb/s) 75 µW (55 GHz) 105 µW (60 GHz) 187 µW (65 GHz)
	1550 nm	10 µW (17 Gb/s) 12 µW (25.87 Gb/s) 14 µW (27.7 Gb/s) 40 µW (40 GHz)	36 µW (39.8/43.0 Gb/s) 50 µW (55 GHz) 70 µW (60 GHz) 125 µW (65 GHz)
Maximum	1310 nm	18 µW (17 Gb/s) 20 µW (25.8 Gb/s) 30 µW (27.7 Gb/s) 120 µW (40 GHz)	102 µW (39.8/43.0 Gb/s) 127 µW (55 GHz) 225 µW (60 GHz) 300 µW (65 GHz)
	1550 nm	15 µW (17 Gb/s) 18 µW (25.8 Gb/s) 21 µW (27.7 Gb/s) 80 µW (40 GHz)	68 µW (39.8/43.0 Gb/s) 85 µW (55 GHz) 150 µW (60 GHz) 200 µW (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
Optical channel specifications (continued)	
Scale factor	
Minimum	200 µW/division
Maximum	5 mW/division
CW[1] accuracy (single marker, reference to average power monitor)	± 150 µW ± 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 User calibrated accuracy	±5% ±100 nW ±connector uncertainty, 20 to 30 °C ±2% ±100 nW ±power meter uncertainty, < 5 °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 µm, user-selectable connector
Input return loss (HMS-10 connector fully filled fiber)	20 dB
Electrical channel specifications	
Electrical channel bandwidth	80 *(93)*, 55 and 30 GHz
Transition time *(10% to 90% calculated from Tr = 0.35/BW)*	*6.4 ps (55 GHz)* *4.4 ps (80 GHz)*
RMS noise	
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)	±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)	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[1])	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 (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)	
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 (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 Tr = 0.35/BW)"	*10 ps*	10 ps	7ps
RMS noise			
Characteristic (Low / High BW Setting)	240 µV/420 µV	300 µV/500 µV	600 µV/750 µV
Maximum (Low / High BW Setting)	350 µV/700 µV	350 µV/700 µV	800 µV/980 µV
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:	±0.7% of full scale, ±2 mV ±1.5% of (reading-channel offset) (16 GHz)		
High BW Setting:	±0.7% of full scale, ±2 mV ±3% of (reading-channel offset) (32 GHz)		
CW offset range (referenced from center of screen)	±500 mV	±700mV	±700mV
Input dynamic range (relative to channel offset)	±400 mV	±560mV	±560mV
Maximum input signal	*±2 V (+16 dBm)*	±2.5 V (+18 dBm)	±2.5 V (+18 dBm)
Nominal impedance	50 Ω	50 Ω	50 Ω
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 aquire lock	175 mV_{pp}	175 mV_{pp}	175 mV_{pp}
Recovered clock random jitter (used as internal trigger)[1]	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%		
Tracking range (includes spread spectrum tracking)	±2500 ppm ±0.25%		
Aquisition range	±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		
Residual spread spectrum	–72 ±3 dB @ 33 kHz	–84 ±3 dB @ 33 kHz	–84 ±3 dB @ 33 kHz
Front panel recovered clock amplitude	0.15 to 1.0 Vpp (0.3 to 1.0 Vpp)		
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[1]		N1055A[1]			
Channel options (number of channels; F = female; M = male)	02F/02M	04F/04M	32F/32M	34F/34M	52F/52M	54F/54M
Number of channels[2]	2	4	2	4	2	4
Electrical channel bandwidth	20/35/45/60 GHz		35 GHz [4]	35 GHz [4]	35/50 GHz	35/50 GHz
Transition time (10% to 90% calculated from TR = 0.35/BW)	17.5/10/7.8/5.8 ps		10 ps		10 /7 ps	
Channel-to-channel skew range	± 100 ps		± 100 ps			
RMS noise						
Characteristic	275/425/500/750 µV		550 uV		550 / 950 uV	
Maximum	950 µV (60 GHz)		650 uV		980 uV	
Scale factor (per division)						
Minimum	1 mV/division		1 mV/division			
Maximum	100 mV/division		100 mV/division			
DC accuracy (single marker)	±0.4% of full scale ±2 mV ±4% of (reading-channel offset), (60 GHz)		±0.4% of full scale ±2 mV ±4% of (reading-channel offset), (50 GHz)			
DC offset range (referenced from center of screen)	±500 mV		±500 mV			
Input dynamic range (relative to channel offset)	±400 mV		±400 mV			
Maximum input signal	±2 V (+16 dBm)		+2 V / -1 V			
Nominal impedance	50 Ω		50 Ω			
Reflections (for 30 ps rise time)	20%		20%			
Electrical input[3]	1.85 mm (female or male option)		2.92 mm (female or male option)		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.*
4. *Upgradable from 35 GHz to 50 GHz after purchase (return to Agilent).*
5. *3 dB bandwidth relative to amplitude at 10 MHz reference frequency,*

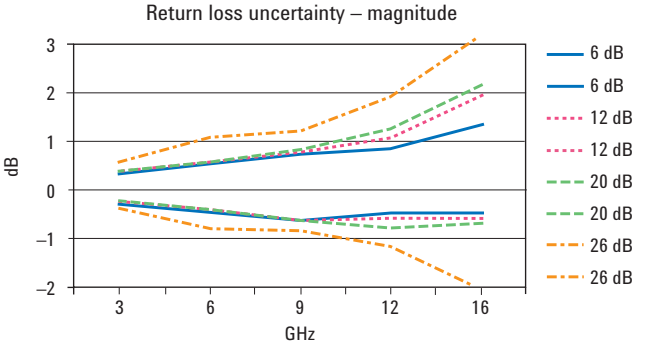
Modules specifications
TDR system

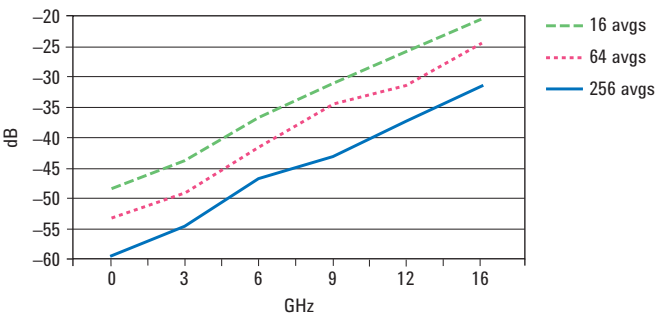
TDR system (Mainframe with 54754A module)	Oscilloscope/TDR performance	Normalized characteristics
Rise time	40 ps nominal < 25 ps normalized	Adjustable from larger of 10 ps or 0.08 x time/div Maximum: 5 x time/div
TDR step flatness	≤ ±1% after 1 ns from edge ≤ ±5%, –3% < 1 ns from edge	≤ 0.1%
Low level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

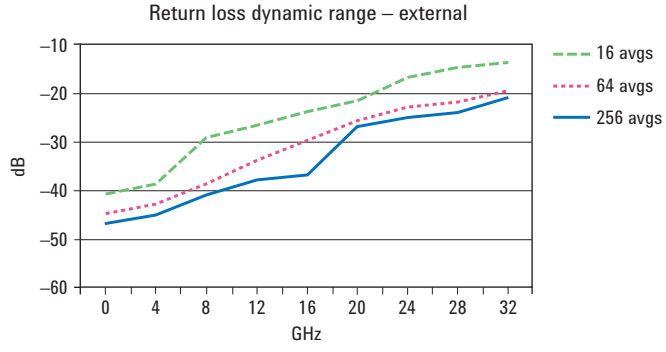
TDR system (Mainframe with N1055A module)	N1055A - 3xx (35 GHz bandwidth)		N1055A - 5xx (50 GHz bandwidth)	
	Without TDR calibration	With TDR calibration	Without TDR calibration	With TDR calibration
Step rise/fall time (Transmitted, typical)	18 ps	Adjustable from 18 ps	9 ps	Adjustable from 8 ps

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

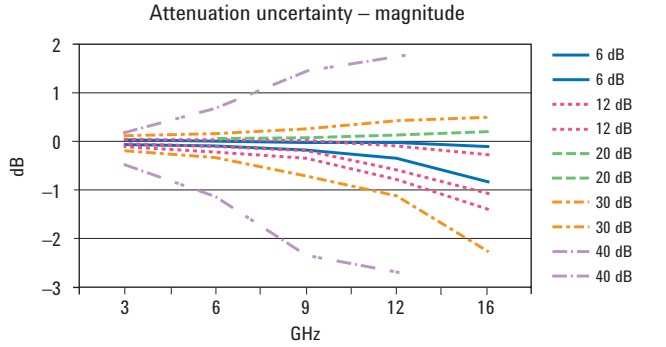
Return loss

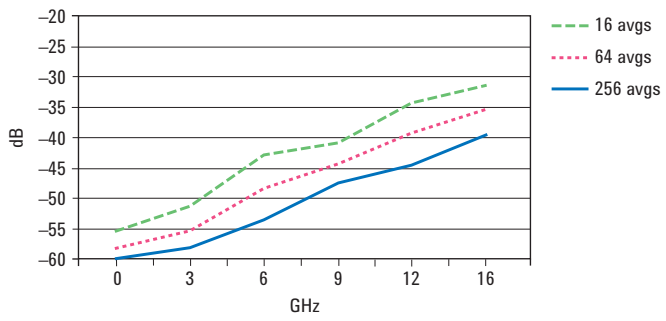


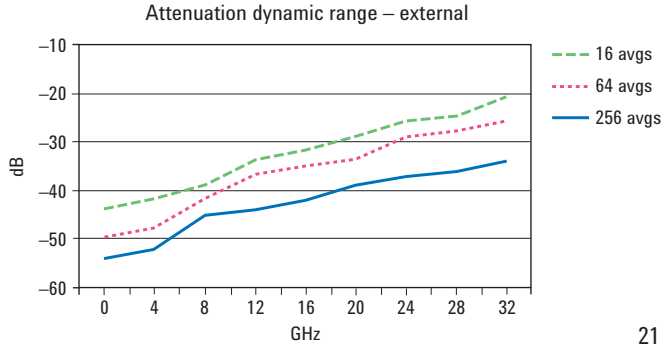




Attenuation



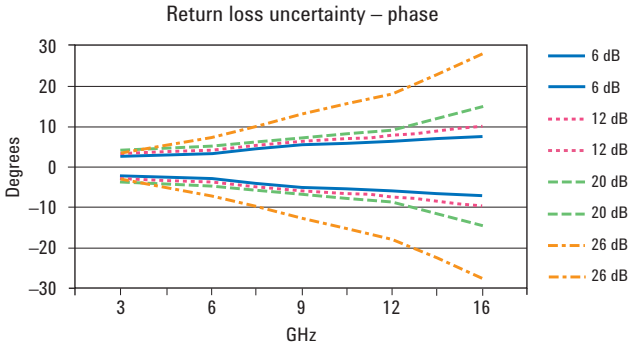




Modules specifications
TDR system

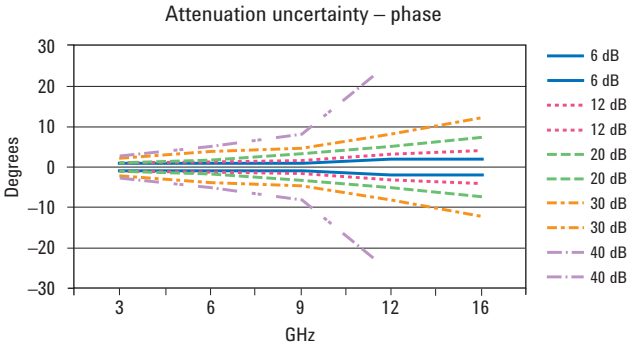
86100D Option 202 characteristics

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[1] 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:

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

Simplified version = time per division (sec) * f(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:

Uncertainty in degrees (temp drift) = time diff (sec) •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 For rates above 14 Gb/s, the N4877A and N1070A operate from 50 Mb/s to 32 Gb/s	
Minimum input level to acquire lock (voltage or OMA[1])	150 m Vpp	Single-mode (OMA[1]): –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[1]): –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[1]): –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)[2]	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[3]; Option 300: 15 kHz to 10 MHz[4] 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)

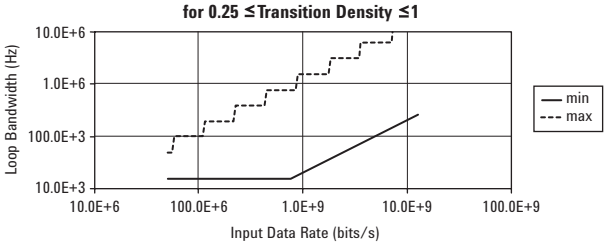
See footnotes on next page.

Modules specifications
clock recovery

Clock recovery modules	83496B-100	83496B-101
Electrical through-path digital amplitude attenuation[5]	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)[6]	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[7] 9/125 µm single-mode optical FC/PC[7] 62.5/125 µm multimode optical 3.5 mm male electrical (input only)
Front panel recovered clock output connector	SMA	

1. *To convert from OMA to average power with an extinction ratio of 8.2 dB use: PavgdBm = OMA_{dBm} –1.68 dB.*
2. *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.*
3. *At rates below 1 Gb/s, loop bandwidth is fixed at 30 KHz when Option 300 is not installed.*
4. *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%.*
5. *20*log($Vamp_{out}$/$Vamp_{in}$) measured with PRBS23 at 14.2 Gb/s.*
6. *Minimum frequency of divided front panel clock output is 25 MHz.*
7. *Other types of optical connectors are also available.*

Selectable Loop Bandwidth vs Rate for 0.25 ≤Transition Density ≤1



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
PTB – Integrated precision timebase for low residual jitter

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[1] applications)

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

Electrical / PLL
1 to 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 or 86100D-PTB
precision timebase
(#40)

Optical
1 to 12 Gb/s
86105C
9 GHz optical channel
20 GHz electrical channel

Optical
20, 40 Gb/s
86105D-281
34 GHz optical channel
(780-1630 nm) 50 GHz electrical channel
86116C
65 GHz optical channel
80 GHz electrical channel
86107A (#40) or 86100D-PTB
precision timebase

TDR/TDT
Single-ended, differential
54754A
Dual 18 GHz channels
N1055A
2 or 4 channels
35 or 50 GHz channels
Note - TDR/TDT modules also perform as electrical-only receivers

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

Software applications

86100D-200 enhanced jitter analysis

Option 200 provides extensive and accurate jitter decomposition, which is increasingly important as data rates increase and margins reduce. Quickly customize your view of many parameters and take advantage of advanced features such as jitter spectrum analysis.

86100D-201 advanced waveform analysis

Take advantage of powerful features in Option 201 to generate much deeper waveform files, integrate MATLAB analysis, and use the built-in linear feed-forward equalizer.

86100D-202 enhanced impedance and S-parameter

Option 202 provides fast and easy characterization of return loss and insertion loss for a wide range of devices and allows you to see changes in your device as you make adjustments. Several impedance parameters help you troubleshoot your designs to optimize performance.

86100D-300 amplitude analysis/RIN/Q-factor

Extend the many capabilities from jitter mode into the amplitude domain and see the decomposition of the amplitude into several factors. Option 300 also reports relative intensity noise (RIN) and Q-factor.

86100D-400 PLL and jitter spectrum

Option 400 quickly characterizes key parameters of phase-locked loops and provides the jitter spectrum of your signal including spread spectrum clocks. Control of the jitter source and receiver is integrated to ensure fast results.

86100DU-401 advanced EYE analysis

For device testing with long patterns and to obtain BER-contour mask testing, Option 401 integrates with the classic or FlexDCA interfaces to decompose the jitter and amplitude interference measurements into the key parameters. When using the embedded capability within FlexDCA or the included automation application, you may characterize jitter on simultaneous multiple lanes and obtain concise and visual results.

86100D-SIM InfiniiSim-DCA

At higher data rates, the effect of measurement fixtures and channels is prominent and can be accounted for through the de-embedding capabilities within Option SIM. You may also view measurements on live and simulated signals, allowing you to compare design intent to actual performance.

N1012A OIF CEI compliance and debug application

The N1012A application lets you fully characterize the ~120 transmitter test parameters (including 28G-VSR), reducing your test time from hours to minutes. Included are return loss tests and several utilities to improve your test productivity. Debug mode enables you to characterize your devices well beyond the parameters prescribed in the implementation agreements.

N1014A SFF-8431 compliance and debug application

The N1014A application lets you fully characterize ~70 test parameters including all transmitter tests for host, module and host copper and all test signals for receiver testing. Return loss tests and utilities are also included.

N1019A user-defined application

You may create your own test application or suite of tests using the DCA-X and other instruments. Quickly and intuitively create groups of tests, test descriptions, user prompts and test limits. Use concise HTML reports to share your multiple test results with your users.

N1081-4A IEEE802.3 Ethernet applications

The extensive requirements for IEEE802.3-2012 and 802.3bj are fully covered in these four applications, which comprise ~400 tests. Characterize your device for one, four or ten lanes, and analyze trends over time/temperature and between devices.

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 impedence

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 401 advanced eye analysis

* Jitter analysis on long patterns

FlexDCA Version: Total Jitter (TJ), Deterministic Jitter (DJ), Random Jitter (RJ), J2, J5, J9. Jitter can be measured on long patterns such as PRBS23, PRBS31, live traffic.

Microsoft Excel version: All of the above, plus BER contour mask testing.

Measurements

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.

• 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), J5 Jitter (J5), J9 Jitter (J9), Data Dependent Pulse Width Shrinkage (DDPWS)*
** Requires 86100D-200*

• Amplitude measurements

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

• Mask test

Pass/Fail Status, BER limit

Option SIM InfiniiSim-DCA

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

TDR/TDT mode (requires TDR module)

• Quick TDR, TDR/TDT Setup,

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

Additional capabilities

Standard functions

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

Markers

- Two vertical and two horizontal (user selectable)

TDR markers

- Horizontal — seconds or meter
- Vertical — Volts, Ohms or Percent Reflection
- Propagation — Dielectric Constant or Velocity

Limit tests

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

• Measurement limit test

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

• Outside limits, always fail, never fail

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

Configure measurements

• Thresholds

10%, 50%, 90% or 20%, 50%, 80% or Custom

• Eye Boundaries

- Define boundaries for eye measurments
- Define boundaries for alignment

• Format Units for

- Duty Cycle Distortion — Time or Percentage
- Extinction/Contrast Ratio — Ratio, Decibel or Percentage
- Eye Height — Amplitude or Decibel (dB)
- Eye Width — Time or Ratio
- Average Power — Watts or Decibels (dBm)

• Top base definition

Automatic or Custom

• Δ time definition

- First Edge Number, Edge Direction, Threshold
- Second Edge Number, Edge Direction, Threshold

• Jitter mode

- Units (time or unit interval, watts, volts, or unit amplitude)
- Signal type (data or clock)
- Measure based on edges (all, rising only, falling only)
- Graph layout (single, split, quad)

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 TTLcompatible 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 contro

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-PTB Precision timebase integrated in the mainframe
86100DU-PTB Upgrade mainframe with integrated precision timebase
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[1]
86100DU-401 Advanced EYE analysis software[1]
86100D-SIM InfiniiSim-DCA software
86100D-500 Productivity Package software
N1012A OIF CEI compliance and debug application
N1014A SFF-8431 compliance and debug application
N1019A user-defined application
N1081A IEEE 802.3 KR/KR4 application
N1082A IEEE802.3 CR4/CR10 application
N1083A IEEE802.3 nAUI/nPPI application
N1084A IEEE802.3 KR4/CR4 application

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
86100DU-WN7 Upgrade to Windows 7 operating system

NOTE:
Options 200, 201, and SIM require Option ETR (enhanced trigger).
Option 300 requires Options 200 and ETR.
Option 400 requires Microsoft Office Excel 2007/2010
Option 401 requires Options ETR/200 for DDPWS measurement and Excel for amplitude interference measurements

Optical/electrical modules

86105C	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
86105D[2]	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[3]	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)[4]. 50 GHz electrical channel
86115D[2]	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

1. Fixed node customer installed or transportable customer installed (86100DU or 86100DT). Not available as a factory-installed license.
2. 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
3. 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.
4. 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

(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)[4]

86115D-004 Four optical ports with filters for all rates listed (8.5 to 14.025 Gb/s) mulitplexed 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

86116C[2] 40 to 65 GHz optical / 80 GHz electrical sampling module, 1300 to 1620 nm

86116C-IRC[3] 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.

86116C[1] 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[2] 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

54754A[1,5] Differential TDR module with dual 18 GHz TDR/electrical channels

N1055A[2] 35/50 GHz, 2/4 port, TDR/TDT remote head

N1055A-32F 35 GHz, 2 channel remote head, 2.92 mm, female

N1055A-32M 35 GHz, 2 channel remote head, 2.92 mm, male

N1055A-34F 35 GHz, 4 channel remote head, 2.92 mm, female

N1055A-34M 35 GHz, 4 channel remote head, 2.92 mm, male

N1055A-52F 50 GHz, 2 channel remote head, 1.85 mm, female

N1055A-52M 50 GHz, 2 channel remote head, 1.85 mm, male

N1055A-54F 50 GHz, 4 channel remote head, 1.85 mm, female

N1055A-54M 50 GHz, 4 channel remote head, 1.85 mm, male

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[1]

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

1. Fixed node customer installed or transportable customer installed (86100DU or 86100DT). Not available as a factory-installed license.
2. 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
3. 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.
4. 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

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[4]
N1075A-S32	Single-mode to > 32 Gb/s
N1070A	Bundle N4877A and N1075A for an optical clock recovery solution

Precision waveform analyzer module[1, 3]

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

Warranty options (for all products)

R1280A	Customer return repair service
R1282A	Customer return calibration service

Accessories

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

Optical connector adapters

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

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

RF/Microwave accessories[1]

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

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

Ordering information

8493C-010 3.5 mm 10 dB attenuator
8493C-020 3.5 mm 20 dB attenuator
8490D-003 2.4 mm 3 dB attenuator
8490D-006 2.4 mm 6 dB attenuator
8490D-010 2.4 mm 10 dB attenuator
8490D-020 2.4 mm 20 dB attenuator

11900A 2.4 mm male to 2.4 mm male adapter/connector saver
11900B 2.4 mm female to 2.4 mm female adapter/ connector saver
11900C 2.4 mm female to 2.4 mm male connector saver
11901A 2.4 mm male to 3.5 mm male adapter
11901B 2.4 mm (f) to 3.5 mm (f) adapter
11901C 2.4 mm (m) to 3.5 mm (f) adapter
11901D 2.4 mm (f) to 3.5 mm (m) adapter
5061-5311 3.5 mm (f-f) connector saver (e.g., for 86100C/D trigger input)
85130-60010 2.4 mm female to 3.5 mm male NMD bulkhead adapter
1250-1158 SMA (f-f) adapter
83059A 3.5 mm male to 3.5 mm male adapter/connector saver
83059B 3.5 mm female to 3.5 mm female adapter/connector saver
83059C 3.5 mm female to 3.5 mm male connector saver

909D-011 3.5 mm female 50 Ohm load
909D-301 3.5 mm male 50 Ohm load
85138A 2.4 mm male 50 Ohm load
85138B 2.4 mm female 50 Ohm load
85140A 2.4 mm male short
85140B 2.4 mm female short

Passive probe

N1021B 18 GHz Differential TDR Probe Kit
N1024B 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

1130A 1.5 GHz probe amp
1131A 3.5 GHz probe amp
1132A 5 GHz probe amp
1134A 7 GHz probe amp

Infiniimax I probe heads

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 two 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, six damped wire accessories, four 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 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)

E2669A InfiniiMax connectivity kit for differential measurements
E2668A 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

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

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.

1168A 10 GHz probe amp

1169A 13 GHz probe amp

Infiniimax II probe heads

N5380A InfiniiMax II 12 GHz differential SMA adapter

N5381A InfiniiMax II 12 GHz solder-in probe head

N5382A InfiniiMax II 12 GHz differential browser

Infiniimax III active probes (16 to 30 GHz)

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

Infiniimax III probe amplifiers

N2800A 16 GHz probe amp

N2801A 20 GHz probe amp

N2802A 25 GHz probe amp

N2803A 30 GHz probe amp

Infiniimax III probe heads

N5439A ZIF Probe Head

N5440A 450 Ω ZIF Tip

N5447A 200 Ω ZIF Tip

N5444A 2.92 mm/3.5 mm/SMA

N5448A 2.92 mm Extension Cables

N5441A Solder-in Probe Head

N5445A Browser Probe Head

www.agilent.com/find/infiniimax3

Probe adapters

N5477A Sampling Scope Adapter. Adapts the Infiniimax III system probes to the 86100 Infiniium DCA

N1022B Adapts 113x/115x,/116x active probes to 86100 Infiniium 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

For a wide range of test adapters to connect to one or more lanes for SFP+, QSFP+, Fibre Channel, PCIe and many others, please see adapters information from Wilder Technologies at:
http://www.wilder-tech.com/

Call Agilent for connectivity and probing solutions not listed above.

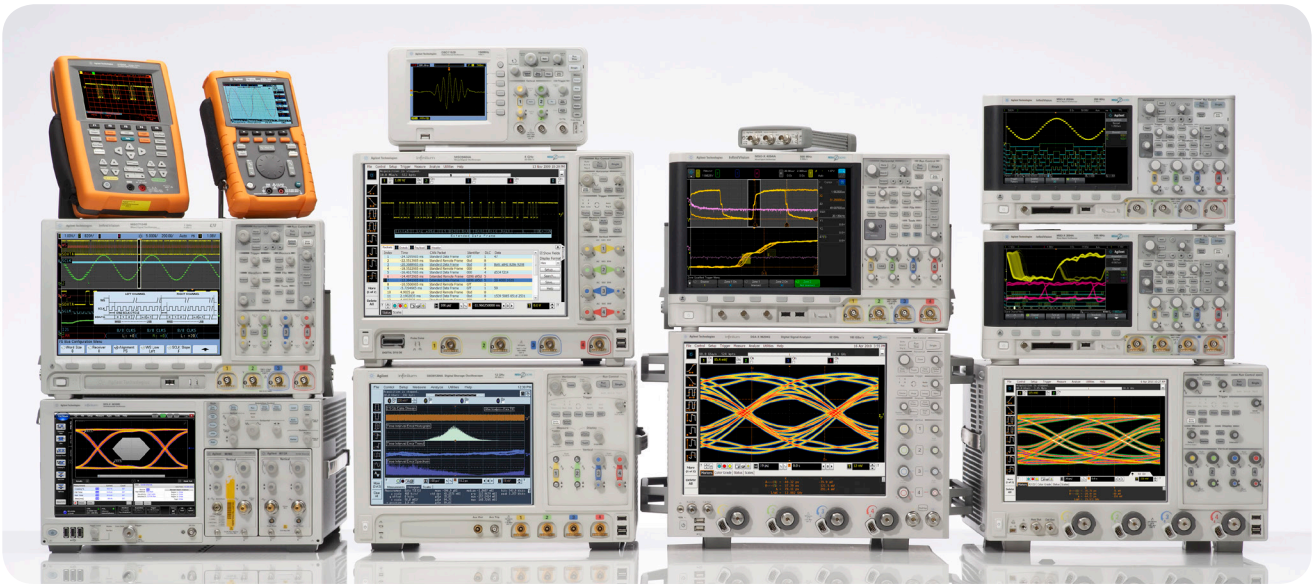
Firmware and software

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

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
FlexDCA express is the same as FlexDCA Pro except that it does not included any functionality requiring a license. It is available free of charge from 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 and search on 5989-5822EN.



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