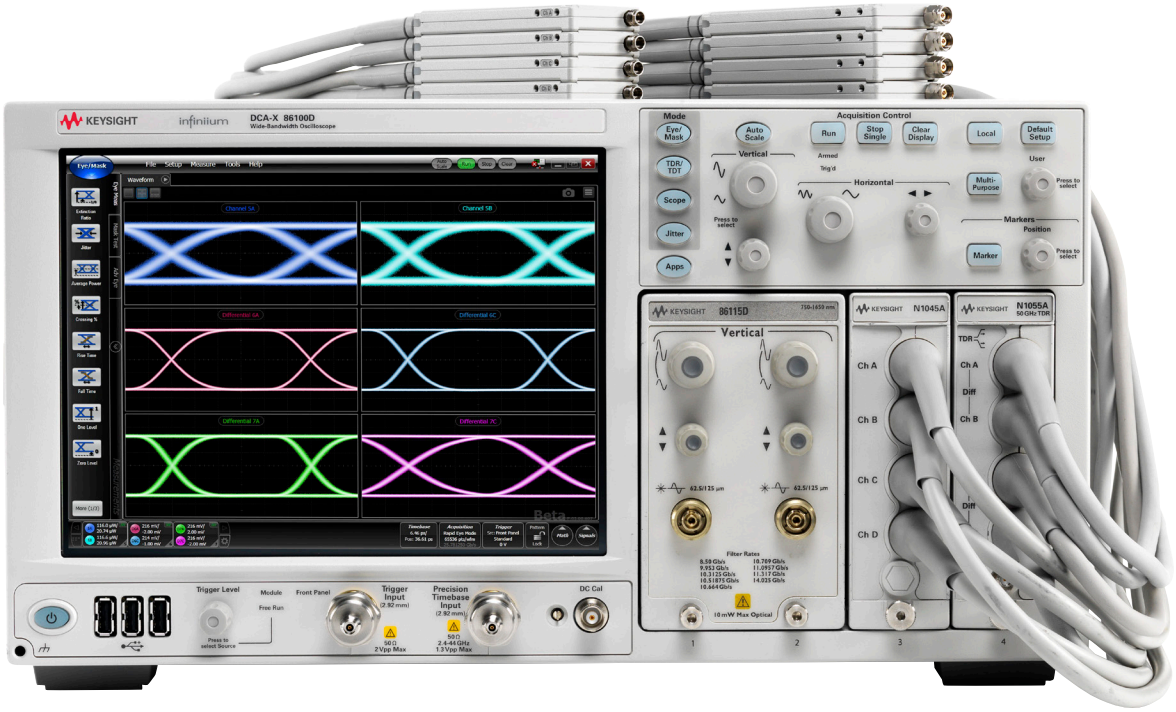
Keysight Technologies
Infiniium DCA-X 86100D Wide-Bandwidth Oscilloscope Mainframe and Modules

Data Sheet



KEYSIGHT TECHNOLOGIES

Introduction

See the TRUE performance of your designs.

The 86100D DCA-X performs precision measurements on high-speed digital designs from 50 Mb/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

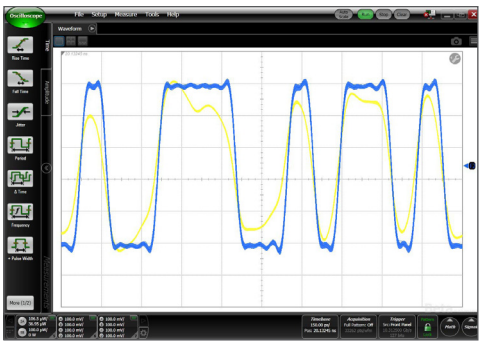
TDR/TDT/S-Parameter
- Serial bus designs, cables, and PCB characterization

Table of Contents

Overview of the Infiniium DCA-X

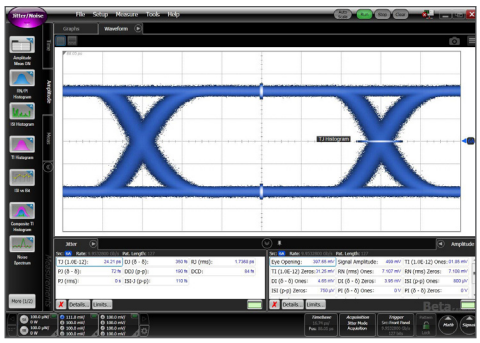
The 86100D DCA-X can be viewed as four powerful instruments in one:

Scope mode



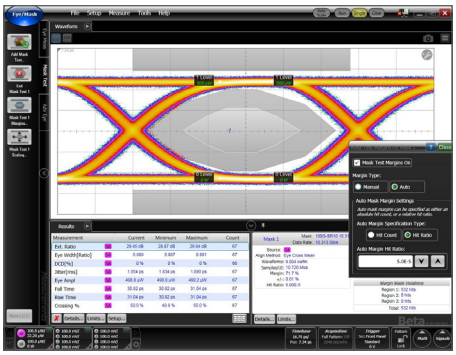
High-fidelity waveform characterization (Yellow: raw trace, Blue: de-embedded waveform)

Jitter mode



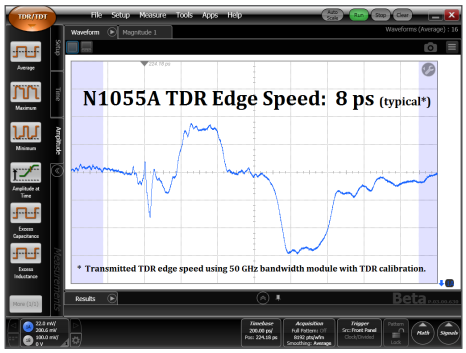
Precision jitter, amplitude, and frequency analysis capability

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 complimented by the following features that provide additional insight and analysis capability:

- De-embedding, embedding, equalizer capability
- Phase noise/Jitter spectrum analysis
- Phase locked loop (PLL) analysis
- And more...

Precision measurements, more margin, and more insight

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

Modular

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

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/N108XA Series test applications.

Specifications

General and mainframe

Specifications describe warranted performance over the temperature range of +10 to +40 °C (unless otherwise noted). The specifications are applicable for the temperature after the instrument is turned on for one 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 months.

General specifications

Temperature	Operating	10 to +40 °C (50 to +104 °F)
	Non-operating	–40 to +65 °C (–40 to +158 °F)
Altitude	Operating	Up to 4,600 meters (15,000 feet)
Power (max)	100/120 Vac 50/60/400 Hz	With typical modules: 150 to 230 VA at 25 °C
	220/240 Vac 50/60 Hz, 700 W maximum	
Weight	Mainframe without modules	20.5 kg (43 lbs)
	Typical module	1.2 kg (2.6 lbs)
Mainframe dimensions (excluding handle)	Without front connectors and rear feet	221 mm (H) x 426 mm (W) x 530 mm (D) (7 in x 16.76 in x 20.9 in)
	With front connectors and rear feet	234 mm (H) x 426 mm (W) x 601 mm (D) (9.23 in x 16.76 in x 23.67 in)
	With front cover and rear feet	234 mm (H) x 426 mm (W) x 612 mm (D) (9.23 in x 16.76 in x 24.1 in)
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 [2,3]	1 ps + 1.0% of Δ time reading 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)	
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 16 K samples	
	FlexDCA without pattern lock: 16 to 64 K samples	
	FlexDCA with pattern lock: 16 up to 32 M samples [5]	

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 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 (Continued)

Mainframe specifications (Continued)

	86100D with option STR	86100D with option ETR or with options ETR + PTB
Module triggering [3]		
	Not supported	Not supported
Internal trigger		
	Free run	Free run
External direct trigger (DC coupled)		
Limited bandwidth	DC to 100 MHz	DC to 100 MHz
Full bandwidth	DC to 3.2 GHz	DC to 3.2 GHz
Trigger configuration		
Triggering level adjustment	–1 V to +1 V	–1 V to +1 V
Edge select	Positive or negative	Positive or negative
Hysteresis [2]	Normal or high sensitivity	Normal or high sensitivity
Trigger sensitivity	Sinusoidal or 200 ps minimum pulse width 200 mVpp	Sinusoidal or 200 ps minimum pulse width 200 mVpp
Maximum input signal	2 Vpp	2 Vpp
System jitter	Tested at 2.5 GHz, 200 mVpp 1.5 ps rms + 50 ppm of delay setting *< 1.0 ps rms + 5 ppm of delay setting (Characteristic)*	Tested at 2.5 GHz, 200 mVpp 1.5 ps rms + 50 ppm of delay setting *< 1.0 ps rms + 5 ppm of delay setting (Characteristic)*

Specifications (Continued)

Mainframe specifications (Continued)

	86100D with option STR	86100D with option ETR or with options ETR + PTB
External divided trigger (AC coupled)	**Not available with option STR**	
Input frequency range	N/A	50 MHz - 13 GHz (effective divide by 2) *50 MHz - 15 GHz (characteristic)* **Option PTB:** 50 MHz - 32 GHz (effective divide by 1)
Pattern lock frequency range	N/A	50 MHz - 13 GHz *50 MHz - 15 GHz (characteristic)* **Option PTB:** 50 MHz - 32 GHz
Pattern lock pattern length range	N/A	1 to 2^23 UI in Scope and Eye/Mask Modes 1 to 2^16 UI in Jitter Mode
Trigger sensitivity	N/A	Slew rate > 2 V/ns: 200 mVpp
Maximum input signal	N/A	Max Trigger input: 2 Vpp **Option PTB:** Max PTB Input: 1.3 Vpp with DC offset up to + 200 mV
System jitter	N/A	Tested at 10 GHz, 200 mVpp 1.2 ps rms for time delays less than 100 ns, (Maximum) *750 fs rms at minimum delay setting, (characteristic)* **Option PTB when PTB is enabled:** Condition [1]: 2.4 GHz – < 4.0 GHz trigger, tested at 2.4 GHz, 750 mVpp *≤ 200 fs (characteristic)* *< 400 fs, with 54XXX, 8348X, or N1045A (non Option LOJ) module (characteristic)* Condition [1]: 4 GHz – 9.0 GHz trigger, tested at 5 GHz, 750 mVpp *≤ 120 fs (characteristic)* *< 400 fs, with 54XXX, 8348X, or N1045A (non Option LOJ) module (characteristic)* Condition [1]: > 9.0 GHz – 44.0 GHz trigger, tested at 10, 20, and 40 GHz, 500 mVpp *≤ 90 fs (characteristic)* *< 200 fs, with 54XXX, 8348X, or N1045A (non Option LOJ) module(characteristic)*
Inputs		
Trigger input connector	2.92 mm (male)[4]	2.92 mm (male)[4] **Option PTB:** PTB input: 2.92 mm (male)[4]
Trigger input nominal impedance	50Ω	50 Ω **Option PTB:** PTB input: 50 Ω

1. The internal precision timebase works with typical digital clock signals, such as a BERT output, as well as sine waves. If the rise time or fall time of the clock signal is less than 15% of the period of the clock (for example, less than 15 ps for a 10 GHz clock), reduce the edge speed by using an external low-pass filter. or length of cable. For the lowest jitter, use a signal that is as close as possible to the maximum signal amplitude (1.3 Vpp) and minimize any sub-harmonics.
2. 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.
3. Module triggering enables precision waveform analyzer modules (86108), clock recovery modules (83496) and TDR modules to be used as a trigger source. Without support for module triggering, external connections between the module and the mainframe may be required.
4. 86100D mainframes ship with a 2.92mm (f) to (f) adapter for this port.

Specifications (Continued)

Computer system and storage

Computer system and storage	
CPU	Intel Core i5 3550S CPU at 3.0 GHz
Mass storage	80 GB internal hard drive (default) or 80 GB 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]
USB [2]	Three low-power USB 2.0 ports; Voltage: 5.00 ± 0.25 V; Current: 100 mA each
Precision timebase input (Option PTB only)	2.92 mm [4]
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 ± 0.25 V; 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 (Continued)

Precision time base (86108 configurations)

The 86108 has an integrated precision timebase within the plug-in module. 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.) 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

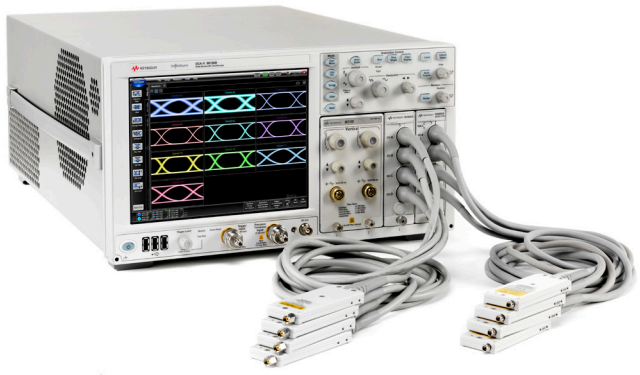
1. Verified with maximum level input signal (~800 mVpp)
2. The precision timebase performs optimally with a sinusoidal input. Non-sinusoidal signals will operate with some degradation in timebase linearity.
3. 86108B-LBW are shipped with a 3.5 mm (female) to 3.5 mm (female) connector saver on the input 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.

Also consider the N1090 and N1092 DCA-M solutions from Keysight which support additional data rates. Download the N1090A, N1092A/B/C/D/E and N1094 DCA-M Optical and Electrical Sampling Oscilloscopes datasheet from www.keysight.com/find/N1092A.



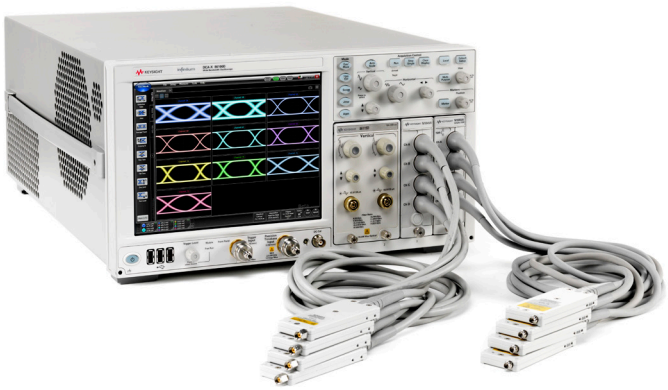
Module	Option	No. of optical channels	No. of electrical channels	TDR/TDT/S-parameters	Probe power [1]	Wavelength range (nm)	Unfiltered optical bandwidth (GHz)	Electrical bandwidth (GHz)	Fiber input (µm)	Mask test sensitivity (dBm) [9]	Filtered data rates: 155 Mb/s	622 Mb/s	1063 Mb/s	1244/1250 Mb/s	2125 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 to 1650	8.5	20	62.5	–20	●	●	●	●	●	●	●	●	●	●	●	●	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]						
	200	1	1			750 to 1650	8.5	20	62.5	–16										○ [7]	○ [7]	●	●	●	●	●	●	●	●	○ [7]						
	300 [2]	1	1			750 to 1650	8.5	20	62.5	–16	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○ [7]						
86105D [3,6]		1	1			750 to 1650	20	35	62.5	–12										○ [7]	○ [7]	●	●	●	●	●	●	●	●	●	○ [7]	○ [7]	○ [7]			
	100	1	1			750 to 1650	20	35	62.5	–12										○ [7]	○ [7]	●	●	●	●	●	●	●	●	○ [7]	○ [7]	○ [7]	○ [7]			
	200	1	1			750 to 1650	20	35	62.5	–12										○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	●	○ [7]	○ [7]	○ [7]			
86105D	281	1	1			750 to 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 to 1650	20		62.5	–12										○ [7]	○ [7]	●	●	●	●	●	●	●	●	●	○ [7]	○ [7]	○ [7]			
	102	2	0			750 to 1650	20		62.5	–12										○ [7]	○ [7]	●	●	●	●	●	●	●	●	○ [7]	○ [7]	○ [7]	○ [7]			
	142	2	0			750 to 1650	20		62.5	–12										○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	●	○ [7]	○ [7]	○ [7]			
	004 [5]	4	0			750 to 1650	20		62.5	–11										○ [7]	○ [7]	●	●	●	●	●	●	●	●	●	○ [7]	○ [7]	○ [7]			
	104	4	0			750 to 1650	20		62.5	–11										○ [7]	○ [7]	●	●	●	●	●	●	●	●	○ [7]	○ [7]	○ [7]	○ [7]			
	144	4	0			750 to 1650	20		62.5	–11										○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	○ [7]	●	○ [7]	○ [7]	○ [7]			
86115D	282	2	0			750 to 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 to 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 to 1620	65	80	9	–5																					○ [7]	○ [7]	○ [7]	●	●	●

1. Module has receptacle to supply power for external probe.
2. Pick any four 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 Keysight 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 two optical-to-electrical (O/E) converters.
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" (Keysight 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 Keysight 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 (Continued)

86100 family plug-in module matrix (Continued)

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]	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
86118A		0	2			70
N1045A [4]	02F/02M	0	2			60
N1045A [4]	04F/04M	0	4			60
N1046A [4]	71F	0	1			75
N1046A [4]	81F	0	1			85
N1046A [4]	11F	0	1			100
N1046A [4]	72F	0	2			75
N1046A [4]	82F	0	2			85
N1046A [4]	12F	0	2			100
N1046A [4]	74F	0	4			75
N1046A [4]	84F	0	4			85
N1046A [4]	14F	0	4			100
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 Keysight 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 to ≤ 4.25 Gb/s, –19 dBm – > 4.25 to 11.3 Gb/s, –16 dBm	850 nm: – 8.5 to 11.3 Gb/s, –9 dBm – 14.025 Gb/s, –6 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: – ≤ 2.666 Gb/s, –21 dBm – > 2.666 to ≤ 4.25 Gb/s, –20 dBm – > 4.25 to 11.3 Gb/s, –17 dBm	1310 nm/1550 nm: – 8.5 to 11.3 Gb/s, –12 dBm – 14.025 Gb/s, –9 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 to ≤ 4.25 Gb/s, 1.5 µW – > 4.25 to 11.3 Gb/s, 2.5 µW	850 nm: – 8.5 to 11.3 Gb/s, 10 µW – 14.025 Gb/s, 16 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/1550 nm: – ≤ 2.666 Gb/s, 0.8 µW – > 2.666 to ≤ 4.25 Gb/s, 1.0 µW – > 4.25 to 11.3 Gb/s, 1.4 µW	1310/1550 nm: – 8.5 to 11.3 Gb/s, 5 µW – 14.025 Gb/s, 8 µW	1310 nm: – 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: – ≤ 2.666 Gb/s, 2.0 µW – > 4.25 Gb/s to 11.3 Gb/s, 4.0 µW	850 nm: – 8.5 to 11.3 Gb/s, 12 µW – 14.025 Gb/s, 24 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/1550 nm: – ≤ 2.666 Gb/s, 1.3 µW – > 2.666 to ≤ 4.25 Gb/s, 1.5 µW – > 4.25 to 11.3 Gb/s, 2.5 µW	1310/1550 nm: – 8.5 to 11.3 Gb/s, 7 µW – 14.025 Gb/s, 12 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. Options 102 and 104 do not include filters for 14.025 Gb/s. Options 142 and 144 include filters for 14.025 Gb/s and no other rates.

Modules Specifications (Continued)

Single-mode and multimode optical/electrical (Continued)

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	850 nm: – 8.5 to 11.3 Gb/s, –8 dBm – 14.025 Gb/s, –5 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: – 8.5 to 11.3 Gb/s, –12 dBm – 14.025 Gb/s, –9 dBm	1310/1550 nm: – 8.5 to 11.3 Gb/s, –11 dBm – 14.025 Gb/s, –8 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	850 nm: – 8.5 to 11.3 Gb/s, 12 µW – 14.025 Gb/s, 20 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
	1310/1550 nm: – 8.5 to 11.3 Gb/s, 5 µW – 14.025 Gb/s, 8 µW	1310/1550 nm: – 8.5 to 11.3 Gb/s, 6 µW – 14.025 Gb/s, 10 µW	1310 nm: – 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	850 nm: – 8.5 to 11.3 Gb/s, 14 µW – 14.025 Gb/s, 30 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
	1310/1550 nm: – 8.5 to 11.3 Gb/s, 7 µW – 14.025 Gb/s, 12 µW	1310/1550 nm: – 8.5 to 11.3 Gb/s, 8.5 µW – 14.025 Gb/s, 14 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. Options 102 and 104 do not include filters for 14.025 Gb/s. Options 142 and 144 include filters for 14.025 Gb/s and no other rates.

Modules Specifications (Continued)

Single-mode and multimode optical/electrical (Continued)

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%	Single-mode: – ± 25 µW ± 2% (8/10 Gb/s) – 4% (14 Gb/s) – 6% (Unfiltered)	– ± 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)	Single-mode: – ± 25 µW ± 2% (8/10 Gb/s) – 4% (14 Gb/s) – 6% (Unfiltered)
	Multimode: ± 25 µW ± 10%	Multimode: ± 25 µW ± 10%		Multimode: ± 25 µW ± 10%	Multimode: ± 25 µW ± 10%
CW offset range (referenced two divisions from screen bottom)	+0.2 to –0.6 µW	+1 µW/–3 µW	+1 to –3 mW	+1 µW/–3 µW	+1 µW/–3 µW
Average power monitor (specified operating range)	–30 to 0 dBm	–30 to +3 dBm	–30 to +3 dBm	–30 to +3 dBm	–30 to +3 dBm
Average power monitor accuracy					
Single-mode	± 5% ± 200 nW	± 5% ± 200 nW	± 5% ± 200 nW	± 5% ± 100 nW	± 5% ± 200 nW
	± Connector	± Connector	± Connector	± Connector	± Connector
	Uncertainty	Uncertainty	Uncertainty	Uncertainty (20 to 30 °C)	Uncertainty
Multimode (characteristic)	± 10% ± 200 nW	± 5% ± 200 nW	± 10% ± 200 nW	± 5% ± 200 nW	± 5% ± 200 nW
	± Connector	± Connector	± Connector	± Connector	± Connector
	Uncertainty	Uncertainty	Uncertainty	Uncertainty	Uncertainty

1. CW refers to an unmodulated optical signal.
2. Options 102 and 104 do not include filters for 14.025 Gb/s. Options 142 and 144 include filters for 14.025 Gb/s and no other rates.

Modules Specifications (Continued)

Single-mode and multimode optical/electrical (Continued)

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	± 2% ± 100 nW	± 3% ± 200 nW	± 2% ± 100 nW	± 2% ± 100 nW
	± Power meter	± Power meter	± Power meter	± Power meter	± Power meter
	Uncertainty	Uncertainty	Uncertainty	Uncertainty	Uncertainty
	< 5 °C change			< 5 °C change	
Multimode (characteristic)	± 10% ± 200 nW	± 10% ± 200 nW	± 10% ± 200 nW	± 10% ± 200 nW	± 10% ± 200 nW
	± Power meter	± Power meter	± Power meter	± Power meter	± Power meter
	Uncertainty	Uncertainty	Uncertainty	Uncertainty	Uncertainty
	< 5 °C change				
Maximum input power					
Maximum non-destruct average	0.5 mW (–3 dBm)	5 mW (7 dBm)	5 mW (+7 dBm) 1310/1550 nm	5 mW (7 dBm)	5 mW (7 dBm)
			Single mode: 5 mW (+8 dBm) 850 nm		
			Multimode: 3 mW (+5 dBm)		
Maximum non-destruct peak	5 mW (+7 dBm)	10 mW (10 dBm)	5 mW (+10 dBm)	10 mW (10 dBm)	10 mW (10 dBm)
Fiber input	62.5/125 µm	62.5/125 µm	62.5/125 µm	62.5/125 µm	62.5/125 µm
		User-selectable		User-selectable	User-selectable
		Connector		Connector	Connector
Polarization dependent loss at 1550 nm			0.2 dB (characteristic)		
Input return loss (HMS-10 connector fully filled fiber)	850 nm > 13 dB	27 dB single-mode	> 24 dB (1550 nm single mode)	27 dB single-mode	27 dB single-mode
	1310 nm/1550 nm	14 dB multimode	> 24 dB (1310 nm single mode)	14 dB multimode	14 dB multimode
	> 24 dB		> 13 dB (850 nm multimode)		

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

Modules Specifications (Continued)

Single-mode and multimode optical/electrical (Continued)

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 35 GHz		
Transition time (10 to 90% calculated from TR = 0.35/BW)	28.2 ps (12.4 GHz)	14 ps (25 GHz)	12 ps (25 GHz)		
	17.5 ps (20 GHz)	10 ps (35 GHz)	7 ps (50 GHz)		
RMS noise					
Characteristic	0.25 mV (12.4 GHz)	0.25 mV (25 GHz)	0.25 mV (25 GHz)		
	0.5 mV (20 GHz)	0.5 mV (35 GHz)	0.6 mV (50 GHz)		
Maximum	0.5 mv (12.4 GHz)	0.5 mV (25 GHz)	0.5 mV (25 GHz)		
	1 mV (20 GHz)	1 mV (35 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. Options 102 and 104 do not include filters for 14.025 Gb/s. Options 142 and 144 include filters for 14.025 Gb/s and no other rates.

Modules Specifications (Continued)

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 to 1620 nm [3]	
Calibrated wavelengths		1300 nm/1550 nm	
Optical sensitivity [2]	1310 nm	–9 dBm (17 Gb/s)	–3 dBm (39.8/43.0 Gb/s)
		–8 dBm (25.8 Gb/s)	
		–7 dBm (27.7 Gb/s)	
	1550 nm	–10 dBm (17 Gb/s)	–5 dBm (39.8/43.0 Gb/s)
		–9 dBm (25.8 Gb/s)	
		–8 dBm (27.7 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)	54 µW (39.8/43.0 Gb/s)
		17 µW (25.8 Gb/s)	75 µW (55 GHz)
		20 µW (27.7 Gb/s)	105 µW (60 GHz)
		60 µW (40 GHz)	187 µW (65 GHz)
	1550 nm	10 µW (17 Gb/s)	36 µW (39.8/43.0 Gb/s)
		12 µW (25.87 Gb/s)	50 µW (55 GHz)
		14 µW (27.7 Gb/s)	70 µW (60 GHz)
		40 µW (40 GHz)	125 µW (65 GHz)
Maximum	1310 nm	18 µW (17 Gb/s)	102 µW (39.8/43.0 Gb/s)
		20 µW (25.8 Gb/s)	127 µW (55 GHz)
		30 µW (27.7 Gb/s)	225 µW (60 GHz)
		120 µW (40 GHz)	300 µW (65 GHz)
	1550 nm	15 µW (17 Gb/s)	68 µW (39.8/43.0 Gb/s)
		18 µW (25.8 Gb/s)	85 µW (55 GHz)
		21 µW (27.7 Gb/s)	150 µW (60 GHz)
		80 µW (40 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 Keysight for broader wavelength specifications.

Modules Specifications (Continued)

Single-mode and multimode 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	± 5% ± 100 nW ± connector uncertainty, 20 to 30 °C
User calibrated accuracy	± 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 (Continued)

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)	28.2 ps (12.4 GHz)
	17.5 ps (20 GHz)	19.4 ps (18 GHz)
RMS noise		
Characteristic	0.25 mV (12.4 GHz)	0.25 mV (12.4 GHz)
	0.5 mV (20 GHz)	0.5 mV (18 GHz)
Maximum	0.5 mv (12.4 GHz)	0.5 mv (12.4 GHz)
	1 mV (20 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	± 0.4% of full scale
	± 2 mV ± 1.5% of (reading-channel offset)	± 2 mV ± 0.6% of (reading-channel offset)
	(12.4 GHz) ± 0.4% of full scale	(12.4 GHz) ± 0.4% of full scale or marker reading (whichever is greater)
	± 2 mV ± 3% of (reading-channel offset) (20 GHz)	± 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	**86118A**	
Electrical channel bandwidth	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	0.7 mV (50 GHz)	
	1.3 mV (70 GHz)	
Maximum	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 ± 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)	20%	
Electrical input	1.85 mm (male)	

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

Modules Specifications (Continued)

Dual electrical (Continued)

Dual electrical channel modules	**86108A**	**86108B-LBW**	**86108B-HBW**
Bandwidth (low/high BW setting)	16 and > 32 GHz, (35 GHz)	20 and 35 GHz	35 and 50 GHz
Transition time (10 to 90% calculated from Tr = 0.35/BW)	10 ps	10 ps	7 ps
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	± 700 mV	± 700 mV
Input dynamic range (relative to channel offset)	± 400 mV	± 560 mV	± 560 mV
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 (Continued)

Dual electrical (Continued)

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	< 350 fs at data rate < 2 Gb/s	< 350 fs at data rate < 2 Gb/s
	< 400 fs at 5 and 10 Gb/s	< 300 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 at 33 kHz	–84 ± 3 dB at 33 kHz	–84 ± 3 dB at 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	1, 2, 4, 8, 16	1, 2, 4, 8, 16
	2, 4, 8, 16	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 9.

Phase trimmers	86108B-PT3 (= qty 2 N1027A-PT3)	86108B-PT2 (= qty 2 N1027A-PT2)
Nominal impedance	50 Ω	50 Ω
Frequency range	DC to 26 GHz	DC to 50 GHz
Insertion loss (at f max)	0.8 dB	0.8 dB
Time delay	238 to 293 ps	172 to 195 ps
Connectors	SMA (m-f)	2.4 mm (m-f)

Modules Specifications (Continued)

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, 5]	35 GHz [4, 5]	35/50 GHz [5]	35/50 GHz [5]
Transition time (characteristic) (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		± 150 ps			
RMS noise						
Characteristic	275/425/500/750 µV		600 µV		600/750 µV	
Maximum	950 µV (60 GHz)		730 µV		950 µV	
Scale factor (per division)						
Minimum	1 mV/division		1 mV/division			
Maximum	100 mV/division		100 mV/division			
DC accuracy (single marker)	± 2 mV ± 4% of (reading-channel offset), (60 GHz)		± 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)	

TDR system

TDR system (Mainframe with 54754A module)	Oscilloscope/TDR performance		Normalized characteristics	
Rise time	40 ps nominal		Adjustable from larger of 17 ps or 0.08 x time/div	
	< 25 ps normalized		Maximum: 5 x time/div	
TDR step flatness	≤ ± 1% after 1 ns from edge		≤ 0.1%	
	≤ + 5%, –3% < 1 ns from edge			
Low level	0.00 V ± 2 mV			
High level	± 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 [6])	< 18 ps	Adjustable from 15 ps, characteristic	< 7 ps	Adjustable from 6 ps, characteristic

1. Module is supported by 86100D DCA-X mainframe and later.
2. Upgradable from two channel to four channel after purchase (return to Keysight).
3. Connector style is the same on all channels and is selected at time of order.
4. Upgradable from 35 to 50 GHz after purchase (return to Keysight).
5. Tuned to be –3 dB (± measurement uncertainty) at stated bandwidth(s) using NIST traceable swept-sine test system.
6. Defined as the transition time at the output of the remote head. It is calculated by deconvolving the receiver transition time from the measured transition time when the remote head is terminated with a short. Measured on a negative TDR step.

Modules Specifications (Continued)

Specifications describe warranted performance while characteristics provide useful, nonwarranted information and performance. Characteristics are listed below in italics.

Multiple electrical channel modules		**N1046A**	
Channel options	71F/72F/74F	81F/82F/84F	11F/12F/14F
Number of channels	1/2/4	1/2/4	1/2/4
Electrical channel bandwidth (maximum) [1]	75 GHz	85 GHz	100 GHz
Electrical channel bandwidth settings (user-selectable)	45, 60, 75 GHz	45, 60, 75, 85 GHz	45, 50, 75, 85, 100, *122 GHz (characteristic)*
Transmision time (10 to 90% calculated from TR = 0.35/bandwidth)	7.8, 5.9, 4.7 ps	7.8, 5.9, 4.7, 4.2 ps	7.8, 5.9, 4.7, 4.2, 3.5, *< 3.2 ps*
Channel-to-channel skew range	± 100 ps	± 100 ps	± 100 ps
RMS noise			
Characteristic	*400, 580, 740 µV*	*400, 580, 740, 860 µV*	*400, 580, 740, 860, 1005, 2000 µV*
Maximum	550, 700, 950 µV	550, 700, 950, 1150 µV	550, 700, 950, 1150, 1350, *2000 (characteristic)* µV
Scale factor (per division)			
– Minimum	1 mV/division	1 mV/division	1 mV/division
– Maximum	100 mV/division	100 mV/division	100 mV/division
DC accuracy (V_{AVG} measurement)			
– Specified at calibration temperature ± 0.5 °C. (Perform a new module calibration if hardware skew has been applied.)	*± 2 mV (characteristic)*		
– Specified at calibration temperature ± 5 °C	± 2 mV ± 4% of (reading – channel offset)		
DC offset range (referenced from center of screen)	± 500 mV	± 500 mV	± 500 mV
Input dynamic range (relative to channel offset)	± 400 mV	± 400 mV	± 400 mV
Maximum input signal	± 2V (+16 dBm)	± 2V (+16 dBm)	± 2V (+16 dBm)
Nominal impedance (*characteristic*)	*50 Ω*	*50 Ω*	*50 Ω*

How does Keysight test and setup your module?

The N1046A bandwidth is tested using a very fast electrical impulse that is generated by a photodiode driven by a femtosecond optical impulse source. The high bandwidth photodiode is calibrated and NIST traceable through 110 GHz. For frequencies beyond 110 GHz, photodiode performance is based on a linear extrapolation of the photodiode response through 110 GHz but test data beyond 110 GHz is not provided.

User note:
For customers needing the maximum possible bandwidth, the 122 GHz setting is recommended. For customers needing high bandwidth with “matched” performance across channels, the 100 GHz setting is recommended.

1. Tuned to be –3 dB (± measurement uncertainty) at stated bandwidth(s) EXCEPT for the 122 GHz setting which is tuned for maximum bandwidth while keeping channel noise ≤ 2.5 mV RMS.

Modules Specifications (Continued)

Clock recovery

The DCA platform offers clock recovery capability in the form of standalone clock recovery solutions such as the N1076/N1077A. For more information on standalone clock recovery solutions, please download the Electrical and Optical Clock Data Recovery Solutions datasheet which covers the N1076, N1077 and N1078 solutions. It is available from www.keysight.com/find/N1077A

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 and some TDR applications
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
86100D – 401 advanced eye analysis (Jitter on PRBS31)

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

Electrical/PLL	Electrical/PLL	Electrical	Optical	Optical	TDR/TDT
1 to 12 Gb/s	1 to 16/32 Gb/s (high performance)	20, 40 Gb/s (high performance)	1 to 12Gb/s	20, 40 Gb/s	Single-ended, differential
86112A Dual channels BW > 20 GHz each	**86108B** Dual channels BW > 35/50 GHz with integrated precision timebase & clock recovery	**86118A** Dual remote heads BW > 70 GHz each	**86105C** 9 GHz optical channel 20 GHz electrical channel	**86105D-281** 34 GHz optical channel (780 to 1630 nm)	**54754A** Dual 18 GHz channels
83496B Electrical clock recovery (#100, 200, 300)		**86107A or 86100D-PTB** precision timebase (#40)		**86116C** 65 GHz optical channel 80 GHz electrical channel	**N1055A** 2 or 4 channels
				86107A (#40) or 86100D-PTB precision timebase	**35 or 50 GHz channels** Note - TDR/TDT modules also perform as electrical-only receivers

1. Contact your local Keysight 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 equalizers (CTLE, LFE, DFE), User Operators and User Defined Measurements.

86100D-202 enhanced impedance and S-parameter

Option 202 works in TDR mode and provides live S-parameter responses, including magnitude (return loss, insertion loss, etc.), phase and group delay. Single-ended, differential and mixed-mode responses are available simultaneously. Also enables quick and easy saving of measurement results in Touchstone files (.s2p, .s4p, etc.).

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.

86100D-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-9FP PAM-N analysis software

Accurately and quickly analyze Pulse Amplitude Modulation (PAM) signals as described in IEEE 802.3bj Clause 94 and developing standards such as OIF-CEI-56G and IEEE 400G.

86100D-TFP IEEE TDECQ Analysis software

A lower cost subset of option 9FP capabilities that targets optical Transmitter production test applications

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, 802.3bj and 802.3bm are 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.

N1085A PAM4 Ethernet and OIF-CEI Measurement Application

The N1085A software application covers PAM-4 transmitter measurements outlined in IEEE P802.3bs and four OIF-CEI-4.0 (56G) clauses.

86100D-BFP Automatic Fixture Removal (AFR)

When measuring physical layer devices with non-coaxial interfaces, test fixtures or probes are often used to connect the device under test (DUT) to the measurement equipment. For accurate measurements of the DUT, the fixtures or probes need to be characterized and their effects removed from the composite measurement of the DUT plus test fixture or probe combination. This option adds the Automatic Fixture Removal (AFR) capability from Keysight's powerful N1930B Physical Layer Test System (PLTS) software to help you characterize a fixture or probe with non-coaxial interfaces. Fixtures and probes to be characterized can be single-ended or differential.

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 wWidth, 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

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

- Markers and delta markers on live frequency domain responses such as S-parameter magnitude, phase and group delay

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

- Measurements
  Total interference (TI), deterministic interference (dual-dirac model, DI), random noise (RN), periodic interference (PI), and Inter-symbol interference (ISI), RIN (dBm or dB/Hz), Q-factor
- Data displays
  TI histogram, RN/PI histogram, ISI histogram

Option 400 PLL and jitter spectrum measurement software

- Jitter spectrum/phase noise measurements integrated jitter: Total jitter (TJ), random jitter (RJ), deterministic jitter (DJ); DJ amplitude/frequency, jitter spectrum graph, jitter versus time graph, frequency versus time graph, jitter histogram, post processed jitter measurements, phase noise graph dBc/Hz versus frequency
- Phase locked loop (PLL) measurements PLL bandwidth, PLL peaking, data rate, jitter transfer function (JTF) graph, observed jitter transfer (OJTF) graph, JTF model.

Option 401 advanced eye analysis

- * Jitter 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 (Continued)

Option 500 productivity package including TDEC

Option 500 enables Rapid Eye acquisition and TDEC (transmitter dispersion and eye closure) measurements. 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 sub-rates are eliminated. TDEC is a complex eye diagram measurement required for new high data rate standards deployed over multimode fiber. It is easily and quickly achieved with the automated TDEC measurement. (IEEE 802.3bm and T11 FC-PI-6P require a specific TDEC channel bandwidth, achieved with 86105D/86115D-Option 168.)

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)
- 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

Option 9FP PAM-N analysis software

- Electrical and optical signals
- Eye width, eye height, eye skew
- Level amplitude, level noise, level skew
- Linearity measurements
- TDECQ, Outer OMA, Outer ER

Option TFP IEEE TDEFCQ Analysis software

- TDECQ, Outer OMA, Outer ER

TDR/TDT mode (requires TDR module)

Some also usable within measurement regions:
Prior to average add:

- Time domain responses available in volts, percent reflection and ohms (where applicable)
- X-axis in time or distance
- Average
- Min
- Max
- Amplitude at time
- Excess capacitance
- Excess inductance
- Rise time
- Fall time
- Delta time
- Time at max
- Time at min
- Time at amplitude
- Limit lines
- Time at edge

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)

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

Limit lines

- With the limit line editor, you can modify an existing limit line or create a new limit line from a current waveform or manual data entry.
- Limit lines are displayed boundaries used for pass/fail testing in oscilloscope and TDR/TDT instrument modes, and they are similar to masks in Eye/Mask mode.
- Any data point that occurs above an upper limit line or below a lower limit line causes a failed condition. A failed portion of a waveform that is beyond the limit line boundary is displayed in red.

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 does not acquire data.

Measurements (Continued)

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

- Δ time definition
  - First edge number, edge direction, threshold
  - Second edge number, edge direction, threshold
- Jitter mode
  - Units (time or unit interval, watts, volts, or unit amplitude)
  - Signal type (data or clock)
  - Measure based on edges (all, rising only, falling only)
  - Graph layout (single, split, quad)

Quick measure configuration

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

- Four user-selectable measurements for each mode, eye-mask, TDR, etc.
- Default settings (Eye/Mask mode) extinction ratio, jitter RMS, average power, crossing percentage
- Default settings (Oscilloscope mode) rise time, fall time, period, V amptd

Histograms

Configure

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

Math measurements - classic DCA user interface

- Four user-definable functions operator — Magnify, invert, subtract, versus, min, max
- Source — Channel, function, memory, constant, response (TDR)

Signal processing measurements - FlexDCA

- Math — Add, subtract, multiply, average, invert, maximum, minimum, median
- Signal processing — Difference (differentiate), summation (integrate), interpolation (linear, Sin(x)/x), filters: 4th order bessel, butterworth, gaussian
- Transforms — FFT, versus
- Equalizer (Option 201) — Linear feed-forward
- Equalizer (LFE, up to 64 taps)
- Simulation (Option SIM) — De-embedding, embedding, random jitter, random noise

Calibrate - classic DCA user interface

- All calibrations
  - Module (amplitude)
  - Horizontal (time base)
  - Extinction ratio
  - Probe
  - Optical channel
- Front panel calibration output level
  - User selectable –2 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

Measurements (Continued)

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 Keysight Technologies, Inc. N490X, M8000 Series BERTs

Error performance analysis represents an essential part of digital transmission test products. Together, the Keysight 86100D and BERT products create a powerful test solution. If stimulus only is needed, the 81133A and 81134A pattern generators work seamlessly with the 86100D.

Transitioning from the Keysight 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 Keysight 86100A, 86100B, 86100C and Keysight 83480A digital communications analyzers and Keysight 54750A wide-bandwidth oscilloscope. All modules used in the Keysight 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 Keysight 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-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-BFP	Automatic fixture removal
86100D-061	MATLAB - Basic Oscilloscope package
86100D-062	MATLAB - Standard Oscilloscope package
86100D-200	Enhanced jitter analysis software
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]
86100D-401	Advanced EYE analysis software [1]
86100D-SIM	InfiniiSim-DCA software
86100D-500	Productivity package software
86100D-9FP	PAM-N analysis software, fixed perpetual license
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	IEEE 802.3bj XLAUI, CAUI-10 and nPPI; IEEE 802.3bm CAUI-4 (Option -4TP)
N1083A	IEEE 802.3 40GBASE-CR4 and 100GBASE-CR10
N1084A	IEEE802.3 KR4/CR4 application
N1085A	PAM4 Measurement application for Ethernet and OIF-CEI IEEE Measurements option 1TP OIF-CEI Measurements option 4TP
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:

- Option BFP requires Option 202.
- For complete PAM4 analysis capability, Option 9FP requires Options 200/201/300/401.
- 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.

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 to 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 Keysight for additional 14.025 Gb/s filter) [4]. 50 GHz electrical channel

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 Keysight 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 Keysight for a special option that verifies compliance of the 86105D-281 and 86115D-282 to the 16X Fibre Channel reference receiver specification.

Ordering Information (Continued)

Optical/electrical modules (Continued)	
86115D [2]	20 GHz multi-optical port plug-in module; single-mode and multimode (750 to 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 Keysight 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 [1, 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 Keysight 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.

Select exactly one reference receiver option:	
86116C-025	40 GHz optical/80 GHz electrical channels, 17.0/25.8/27.7 Gb/s reference receiver
86116C-041	65 GHz optical/80 GHz electrical 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
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
N1046A	100 GHz, 1/2/4 port electrical remote sampling head
N1046A-71F	1 channel, 75 GHz remote head, 1 mm, female
N1046A-81F	1 channel, 85 GHz remote head, 1 mm, female
N1046A-11F	1 channel, 100 GHz remote head, 1 mm, female
N1046A-72F	2 channel, 75 GHz remote head, 1 mm, female
N1046A-82F	2 channel, 85 GHz remote head, 1 mm, female
N1046A-12F	2 channel, 100 GHz remote head, 1 mm, female
N1046A-74F	4 channel, 75 GHz remote head, 1 mm, female
N1046A-84F	4 channel, 85 GHz remote head, 1 mm, female
N1046A-14F	4 channel, 100 GHz remote head, 1 mm, female
TDR/TDT modules	
54754A [1, 5]	Differential TDR module with dual 18 GHz TDR/electrical channels
N1055A [1, 2]	35/50 GHz, 2/4 port, TDR/TDT remote head
N1055A-FS1	Fast sampling, mandatory option
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
N1055A-FS1	Fast sampling

1. 86100D-ETR is recommended when;
   a. More than 1 TDR module is connected to the same DUT.
   b. 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 Keysight Technologies to discuss current trade-in deals.
4. Supports both DCA-X and DCA-M platforms. For detailed N1076A/N1077A specifications, refer to the data sheet located at www.keysight.com/find/N1077A. Standalone clock recovery instruments are controlled via a USB connection to an 86100D DCA-X mainframe or a user-supplied PC running N1010A FlexDCA software.
5. Included with each of these TDR modules is a TDR trigger cable, two 50 Ω SMA terminations and one SMA short.

Ordering Information (Continued)

External clock recovery solutions [4]	
N1076A electrical clock recovery	
N1076A-216	Clock recovery range: 50 MBd to 16 GBd
N1076A-232	Clock recovery range: 50 MBd to 32 GBd
N1076A-JSA	Jitter spectrum analysis
N1076B electrical clock recovery	
N1076B-216	Clock recovery range: 125 MBd to 16 GBd
N1076B-232	Clock recovery range: 125 MBd to 32 GBd
N1076B-264	Clock recovery range: 125 MBd to 64 GBd (56 GBd for PAM4 signals)
N1076B-EVA	Integrated variable equalizers (mandatory option)
N1076B-JSA	Jitter Spectrum Analysis
N1077A optical/electrical clock recovery	
N1077A-216	Clock recovery range: 50 MBd to 16 GBd
N1077A-232	Clock recovery range: 50 MBd to 32 GBd
N1077A-SMS	Internal SM and MM splitters
N1077A-SXT	No splitter (supplied by user)
N1077A-JSA	Jitter spectrum analysis
N1078A optical/electrical clock recovery	
N1078A-216	Clock recovery range: 125 MBd to 16 GBd
N1078A-232	Clock recovery range: 125 MBd to 32 GBd
N1078A-264	Clock recovery range: 125 MBd to 64 GBd
N1078A-S50	Internal 50-50 SM optical splitter
N1078A-SXT	No splitter (splitter supplied by user)
N1078A-JSA	Jitter spectrum analysis
N1078A-EVA	Integrated variable equalizers in electrical input path (mandatory option)
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 to 2.4 mm, 24 inch
86108B-CA3	Matched cable pair, 3.5 to 3.5 mm, 18 inch
86108B-DC2	Two DC blocks, 2.4 mm, 16 V, 50 kHz to 50 GHz
86108B-DC3	Two DC blocks, 3.5 mm, 16 V, 50 kHz to 26.5 GHz
86108B-PT2	Two 2.4 mm phase trimmers for ext. skew adjustment
	Phase trimmers Nominal impedance Frequency range Insertion loss (at f max) Time delay Connectors
86108B-PT3	Two 3.5 mm phase trimmers for ext. skew adjustment
	Phase trimmers Nominal impedance Frequency range Insertion loss (at f max) Time delay Connectors

1. 86100D-ETR is recommended when;
   a. More than 1 TDR module is connected to the same DUT.
   b. 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 Keysight Technologies to discuss current trade-in deals.
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5. Included with each of these TDR modules is a TDR trigger cable, two 50 Ω SMA terminations and one SMA short.

Ordering Information (Continued)

Warranty options (for all products)	
R1280A	Customer return repair service
R1282A	Customer return calibration service

Accessories

See the "DCA Accessories" Guide for available accessories

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 Keysight for connectivity and probing solutions not listed above.

Firmware and software

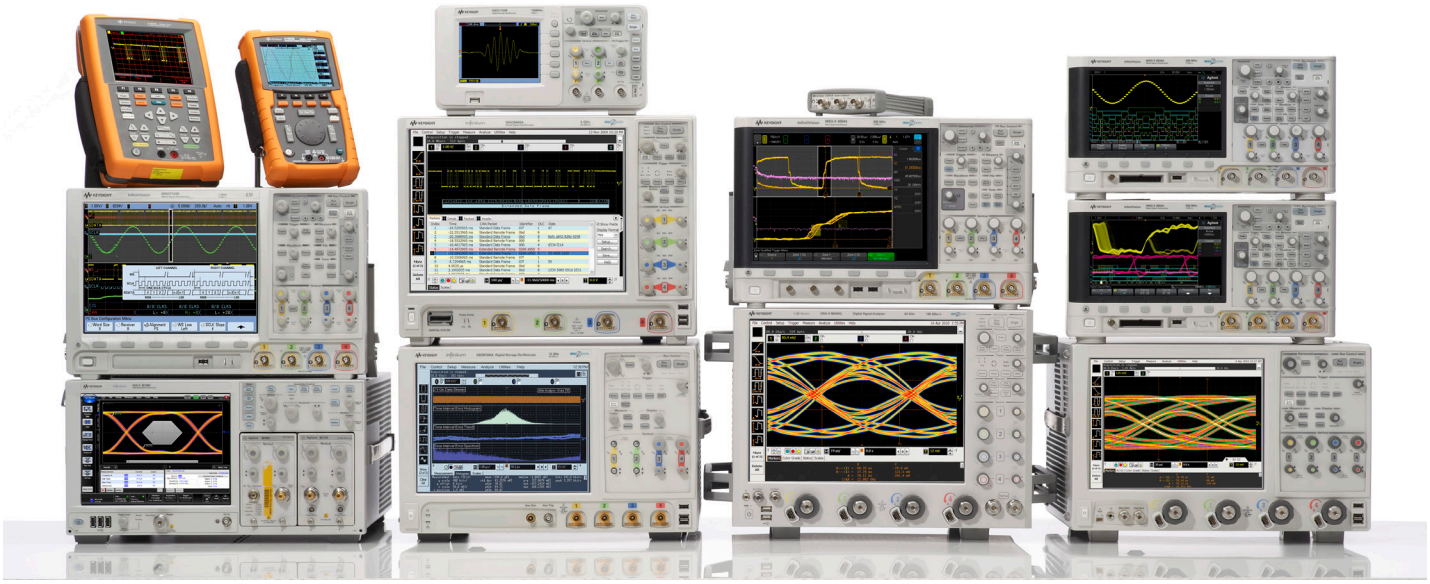
Firmware and software upgrades are available through the Web or your local sales office. www.keysight.com/find/dcax

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.keysight.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.keysight.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.keysight.com and search on 5989-5822EN.



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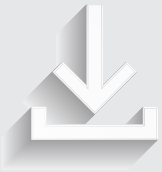

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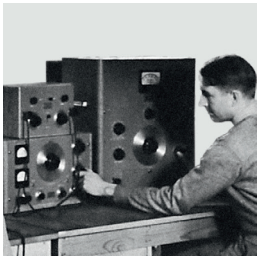

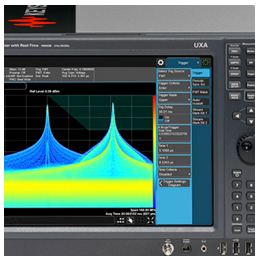

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