PRODUCT BROCHURE

Keysight Digital Communication Analyzer (DCA) Solutions

Increased accuracy for wireline communications infrastructure test

KEYSIGHT

Table of Contents

Keysight Digital Communication Analyzer (DCA) Solutions 3

Engineered for Unmatched Measurement Accuracy 4

What Does a DCA Measure? 5

How is Such High Performance Achieved? 5

How Do DCA Sampling Scopes Compare to Real-Time Scopes? 6

DCA-X Series 7

DCA-X Modules 9

DCA-M Series 11

Optical and Electrical Clock Recovery Series 13

N1010A FlexDCA Software 15

FlexOTO Application Software 16

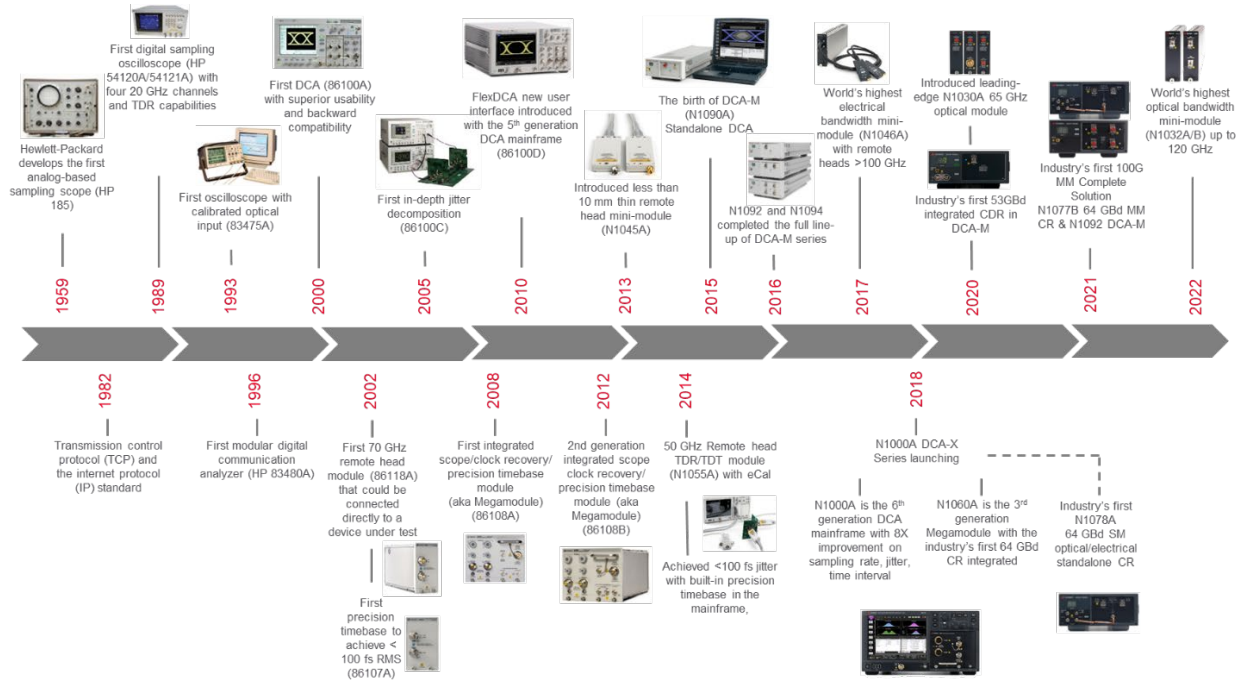
DCA Compliance Test Software 17

Complementary Products 18

Learn More 19

Keysight Digital Communication Analyzer (DCA) Solutions

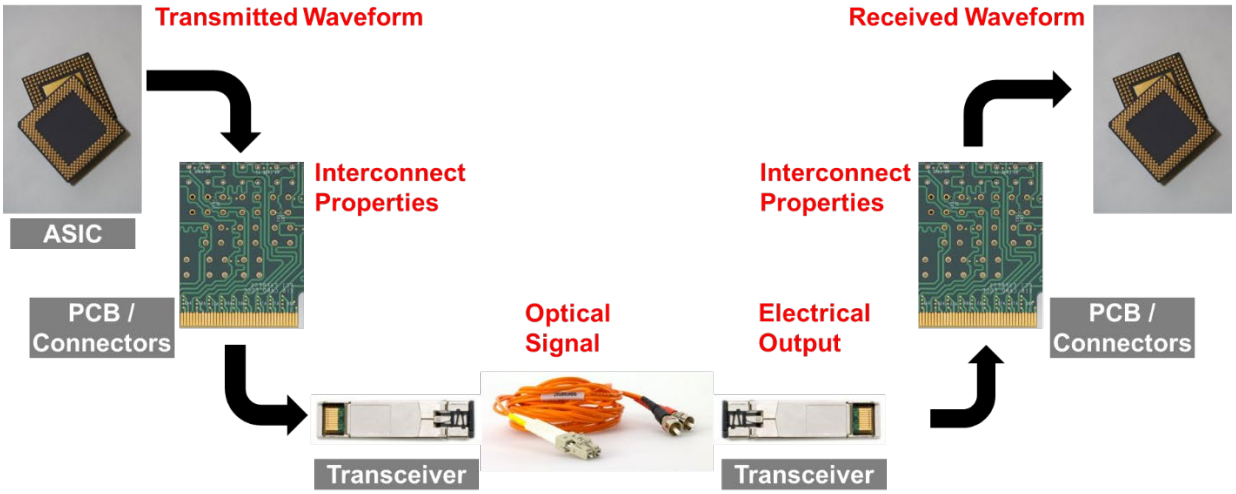
For more than 25 years, Keysight has been the leader in the sampling scope industry. We've designed Digital Communications Analyzer (DCA) solutions to increase the efficiency and accuracy of test. Along the way, we've proudly created industry-leading sampling scopes, modules, accessories and software used to test communications infrastructure from the serial I/O semiconductors to optical transceivers in modern data centers. We innovate so you stay on the leading edge.

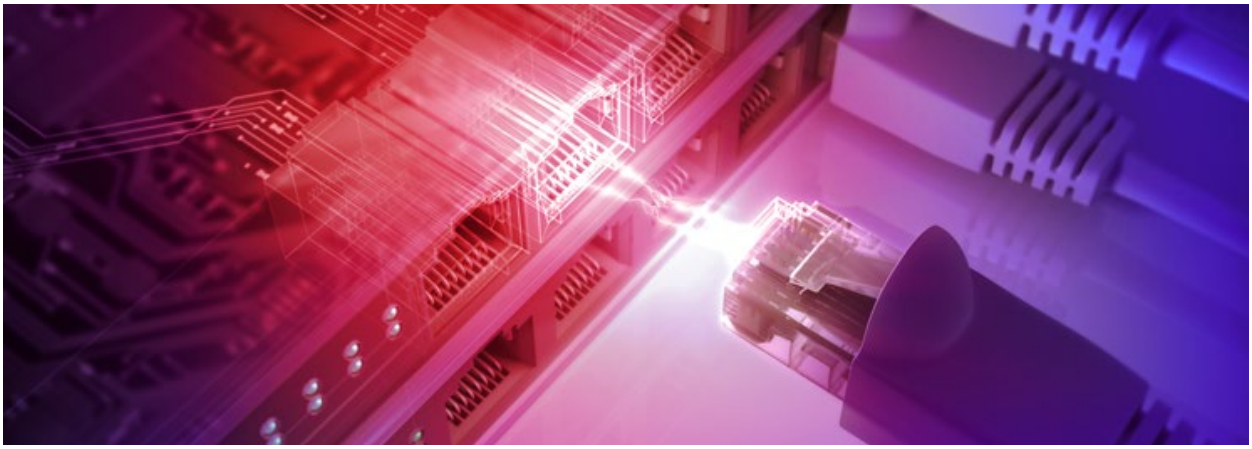


Engineered for Unmatched Measurement Accuracy

As the market demands faster and more data, you respond by designing high-speed digital communications infrastructure components that perform nearly error-free and accommodate signals with shorter bit periods and faster edge speeds. You employ techniques such as emphasis and equalization and take great care to minimize jitter and noise impairments on signals. Built to test communications infrastructure, our DCA solution family provides industry-leading measurement accuracy for high-speed digital designs such as 800G/1.6T Ethernet and 128G Fibre Channel.

The Keysight DCA platform features a wide variety of optical, electrical, and TDR/TDT modules, compliance applications, and a common FlexDCA user interface to ensure more efficient testing in both R&D and manufacturing. Keysight DCA solutions provide engineers with critical insights and data to quickly and accurately analyze complex waveforms to optimize the performance and reliability of electrical and optical system designs.





What Does a DCA Measure?

A Digital Communications Analyzer (DCA) is Keysight's term for instruments otherwise known as sampling oscilloscopes or equivalent-time sampling oscilloscopes. Due to its superior accuracy, dedicated analysis features, and lower cost than other oscilloscope technologies, the DCA is the ideal instruments used to view the time-domain waveforms of optical and electrical transmitters used in high-speed serial communications systems.

- Wide bandwidth in excess of 100 GHz
- Low noise and low jitter
- High vertical resolution, up to 16 bits
- 30 GHz configurations starting at 40K$ and 100 GHz starting at 90K$

How is Such High Performance Achieved?

A synchronization signal is essential for instrument timing which is typically achieved with a clock signal, synchronous to the signal being measured, injected into the DCA that dictates when waveform samples are taken. Synchronous triggering allows the DCA to operate with a much lower sample rate. There are two key restrictions. If the actual bit sequence is to be displayed, the data pattern must repeat to allow for multiple observations by the DCA to reconstruct the waveform. If the signal does not repeat, it can still be accurately observed as an eye-diagram.

The DCA is a modular instrument, where the bandwidth, channel count, and channel type are configurable with a large family of plug-in modules. One special DCA configuration that takes advantage of the very wide instrument bandwidth is time-domain reflectometry (TDR). TDR allows for very high resolution impedance characterization of electrical digital data transmission lines. The DCA has the concept of operation 'modes' that provide easy to use menus to make specific classes of measurements.

How Do DCA Sampling Scopes Compare to Real-Time Scopes?

Today's high-end electronics deliver signaling speeds from at least a few Gbaud to over 100 Gbaud. The physical properties of semiconductors and other materials can make it very hard to design a product that works at the desired low bit or symbol error ratio (BER, SER). While a BER or SER tester measures the overall digital performance of a channel or link, oscilloscopes provide insight into the signal properties of a transmitter and consequently allow engineers to identify parts of the design which need further improvement. Practically all high-end oscilloscopes fall into two groups: real-time oscilloscopes, and equivalent-time, or sampling oscilloscopes. The following table highlights the differences between the two classes of oscilloscopes.

The DCA-X mainframe with remote heads can run up to 16 channels at the same time

The DCA-M offers up to four electrical or optical channels and provides the same measurements as the DCA-X

UXR Series oscilloscopes capture signals in real-time

Criteria	Sampling Scope	Real-Time Scope
Signal requirement	Repeating for waveforms and jitter/interference analysis (Eye diagram measurements can use non- repeating streams)	One-time or repeating
External clock/trigger	Required from DUT (or must use hardware clock recovery)	Not required (can use software clock recovery)
Intrinsic Noise	Sub-millivolts	Several millivolts
A/D conversion	More bits	Fewer bits
Waveform fidelity	Best	Very good
Memory depth	M Samples/waveform	G Samples/waveform
Single events & glitches	Cannot be captured	Can be captured
Electrical signals	Up to 32 channels	Up to 4 channels
Optical Signals	Up to 32 channels	Up to 4 channels (external O/E conversion)
TDR/S-parameters	Up to 16 channels	Not available
Platform	Modular or compact	Fixed (upgradeable)
Compliance testing	Selected standards	Many standards

DCA-X Series

N1000A DCA-X mainframe

FlexDCA scope software

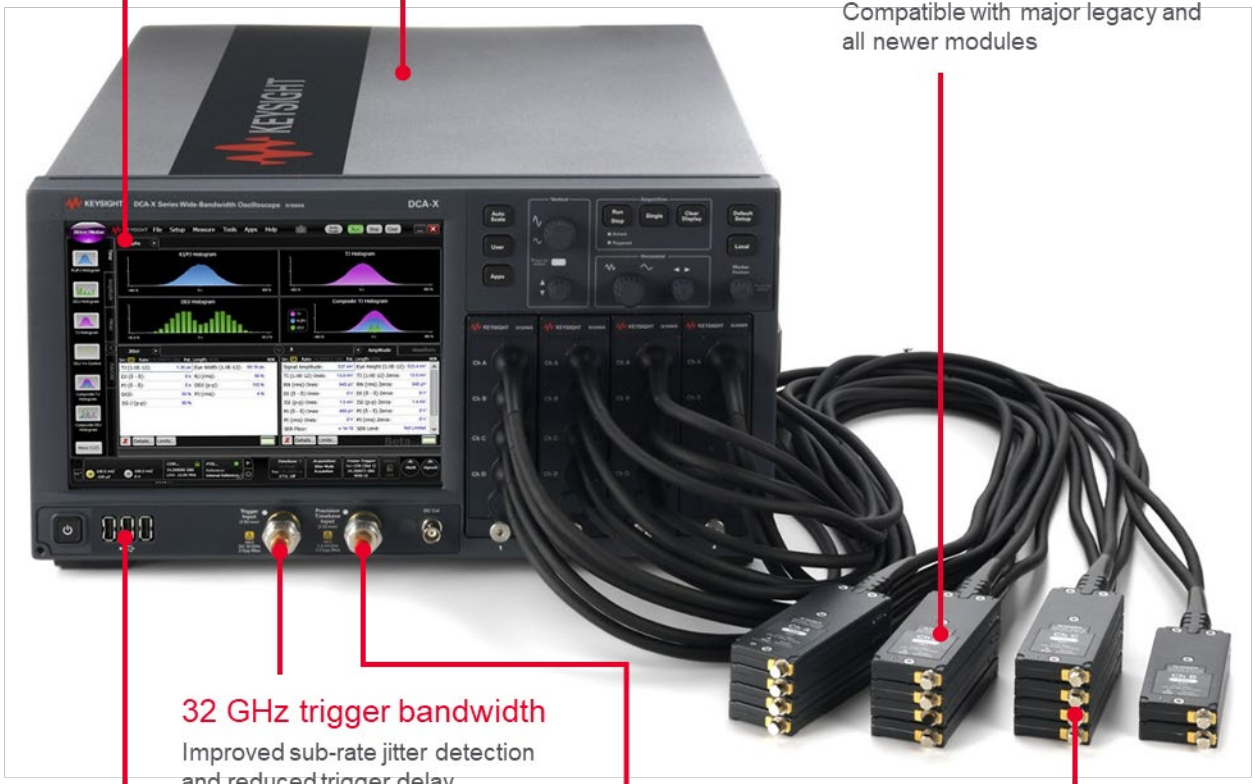
Modern, easy-to-use interface that provides high productivity and deep insights into DUT or signal

Removable hard drive

Keep your data private during calibration/repair

Module bay supports up to 16 Channels

Compatible with major legacy and all newer modules



32 GHz trigger bandwidth

Improved sub-rate jitter detection and reduced trigger delay

Better front-panel USB ports

Compatible with DCA-Ms (N109xx), Clock Recovery Modules (N107xx), ECal (TDR/TDT)

Internal precision timebase

Drastically reduces intrinsic jitter without occupying a module slot

Remote heads

Connect directly to DUT and avoid cable losses

N1000A DCA-X mainframe improvements

More accurate results

- 8X improvement in time interval accuracy
- Standard/low jitter timebase
- Temperature controlled timebase improves tolerance to ambient changes
- Optional internal precision timebase
- Timebase user calibration

Dramatically improves test throughput

- 10X faster than 86100C/D
- Raw sampling rate increased 6X on supported modules
- Smarter Pattern Lock: maximizes the sample rate

Better DUT yield for highest performance design

- 8x lower jitter than 86100C/D
- Standard timebase: < 400 fs
- Low jitter timebase: < 200 fs
- Internal precision timebase: < 100 fs

Supports next generation communication designs

- 2.5X better trigger bandwidth: increased to 32 GHz for all timebase configurations
- Reduced trigger delay
- Improved sub-rate jitter detection

Higher resolution for deeper insight

- 2-8X more samples/waveform
- Without pattern lock: 128K
- With pattern lock: up to 256M

DCA-X Modules

You can configure the DCA-X mainframes by selecting from a variety of plug-in modules that perform precision optical, electrical, and time domain reflection / transmission (TDR / TDT) measurements. Select specific modules to obtain the desired bandwidth, filtering, and sensitivity that match your measurement needs.

Model	Description	Key Features
N1032A/N1032B 	90/120 GHz Single/Dual Channel Optical Module	• One 90 GHz (standard)/120 GHz (optional) optical channel • Jitter as low as 90 fs • Ideal for analyzing 112 GBd (224 Gbps) optical signals or any application that requires ultra-wide optical receiver > 65 GHz bandwidth (-3 dBo) • Impulse response correction (Option IRC) is a standard feature and hardware filters for standards-based rates are optional
N1030A/N1030B 	65 GHz Single/Dual Channel Optical Module	• 65 GHz optical bandwidth • Optional electrical channel with 33/40/50/70/85/95 GHz BW settings • Jitter as low as 90 fs • Ideal for analyzing optical signals > 53 GBd and 112 GBd (224 Gbps) TDECQ • Impulse response correction on all channels (optical and electrical)
N1060A 	50/85 GHz Precision Waveform Analyzer	• 2 channel / clock recovery / precision timebase integrated seamlessly • Bandwidth up to > 90 GHz • Best Fidelity: Low-noise samplers, residual jitter as low as 50 fs and adjustable clock recovery peaking & loop bandwidth to 64 GBd (112 Gb/s) (NRZ & PAM4)
N1046A 	75/85/100 GHz, 1/2/4 Port, Electrical Remote Sampling Head Module	• 1/2/4 Port, Electrical Remote Sampling Head • 75 GHz, 85 GHz or > 100 GHz maximum available bandwidth (upgradable) • High bandwidth and low-noise samplers, ideal for analyzing high-speed signals used in emerging designs such as 224 Gb/s
N1040A 	33/60 GHz Dual Electrical Channel Module	• Bandwidth up to 60 GHz, jitter as low as 90 fs • Flexible: choose 33 GHz or 60 GHz maximum bandwidth • Low cost of test: Sample rates up to 250 kSa/s and up to 8 channels per mainframe, provides high throughput

Model	Description	Key Features
N1055A 	35/50 GHz, 2/4 Port, TDR/TDT Remote Sampling Head Module	• 2/4 Port Electrical Remote Sampling Head with TDR/TDT • Bandwidth options: 35 or 50 GHz (upgradable) • Highest resolution TDR/TDT measurements with edge speed (10 to 90%) of 18 ps (35 GHz) or 8 ps (50 GHz) • Fast and accurate S-parameter measurements (with N1010300A Signal Integrity software package)
N1045B 	60 GHz, 2/4 Port, Electrical Remote Sampling Head Module	• 60 GHz, 2/4 Port Electrical Remote Sampling Head • Low-noise samplers • Electrical inputs: 1.85 mm male or female (user-selectable option) • Simultaneous data acquisition up to 16 channels at a sample rate of 250 kSa/s

Powerful Analysis Means Deeper Insights

The consistency and flexibility of the DCA-X series ensure high accuracy in any measurement:

- Platform consists of a mainframe and a wide variety of modules for flexible testing
- Consistent FlexDCA interface increases productivity in R&D and manufacturing
- Optical modules available for in-depth analysis of transceiver design and manufacturing
- Comprehensive solutions ready for all digital wireline communication tests

DCA-M Series

Built on Keysight's DCA technology, the DCA-M family is the industry standard for verifying optical transmitter compliance to communications standards. With single to quad optical and electrical channels in a compact form factor, the DCA-M is ideal for both manufacturing and research and development (R&D) applications. DCA-Ms can be used standalone or as part of a 86100D or N1000A system and offer the lowest cost-of-test in the industry.

- The DCA-M provides the measurement accuracy of the N1000A/86100D series, without the extra cost associated with an R&D test solution
- Analyze a wide range of data rates, from 8.4 GBd through 64 GBaud
- Characteristic intrinsic jitter as low as 160 fs RMS
- Noise as low as 1µW (optical) and 275 µV (electrical)
- Achieve the fastest throughput with a high sample rate up to 250 KHz
- Supported both multimode and single-mode for single to quad channels models

Standalone mini DCAs

Model	N1090A	N1092A/B/C/D/E	N1094A/B
Description	The N1090A DCA-M builds on that legacy by using the high-performance elements of 86100 and 86105C. It can be configured to perform thorough optical transmitter compliance tests at a variety of standard data rates from 1.244 to 11.3 Gb/s.	High accuracy, low-cost solutions for optical and electrical waveform analysis including solutions for 20 Gb/s through 64 GBaud, very low noise and jitter, and fast sampling rates for high throughput.	The N1094 DCA-M builds on that legacy by using the high-performance elements of 86100 and electrical channel hardware of N104X plug-in modules. Electrical channels are available with 30 GHz and 50 GHz bandwidths.
Bandwidth, -3 dBo / -3dB	10 GHz optical / 20 GHz electrical	Up to 45 GHz optical / 50 GHz electrical	Up to 50 GHz electrical
Channel	1 optical / 1 electrical (optional)	Up to quad channels with the combination of optical and electrical	2/4 electrical
Integrated Clock Recovery	No	Optional on A and B models	No
Jitter	500 fs rms	160 fs rms	135 fs rms
RMS Noise	As low as 0.8 µW	As low as 3 µW	As low as 275 µV
Filter Range	1.244Gb/s to 11.3 Gb/s	8.4 GBd to 64 GBd	-
Wavelength	750 nm to 1650 nm	830 nm to 1600 nm	-
Sample Rate	60 kHz	Up to 250 kHz	
Supported Signal Type	PAM 4 / NRZ		
Key Features	• High accuracy, Cost-effective solution • Low noise, high-sensitivity calibrated optical reference receivers • Small form factor for both manufacturing and R&D applications • Integrated clock recovery provides lower capital cost and simplified setup		

High accuracy, compact form, low cost solutions for optical and electrical waveform and jitter analysis

Optical and Electrical Clock Recovery Series

Ideal for many transmitter test setups for wireline communication standards with an excellent data rate range from 125 MBd to 64 GBd NRZ and PAM4. A core clock recovery circuit works for single-ended and differential electrical signals, and equalizers help to lock onto closed eyes. In addition, an optical-to-electrical (O/E) converter enables it to work for both electrical and optical applications.

- Achieve optimal measurement accuracy with an adjustable loop bandwidth and selectable peaking
- Analyze with ultra-low residual random jitter < 100 fs RMS
- Gain deeper insight with the jitter spectrum analysis (JSA) capability
- Be confident with your testing with a golden phase-locked loop (PLL) for compliant operations
- Recover clocks from closed eyes with the integrated variable equalizers in the N1076B, N1077B and N1078A clock data recovery solutions

Standalone clock recovery units

Model	N1076B	N1077A	N1078A	N1077B
Description	64 GBd Electrical Clock Recovery	32 GBd Single-mode & Multimode Optical / Electrical Clock Recovery	64 GBd Single-mode Optical / Electrical Clock Recovery	64 GBd Multimode & Single-mode Optical / Electrical Clock Recovery
Data Rate	125 MBd to 64 GBd	50 MBd to 32 GBd	125 MBd to 64 GBd	125 MBd to 64 GBd
Input Signal	Electrical	Optical and Electrical	Optical and Electrical	Optical and Electrical
Wavelength	-	850 nm - 1600 nm	1260 nm - 1620 nm[2]	830 nm - 1340 nm
Modulation Format	PAM4 and NRZ	PAM4 and NRZ	PAM4 and NRZ	PAM4 and NRZ
Splitter Type	Internal	Internal and External	Internal and External	Internal and External
Integrated Equalizer	Yes (Variable)	No	Yes (Variable)	Yes (Variable)
Jitter Spectrum Analysis (JSA)[1]	Yes	Yes	Yes	Yes

1. Required N1010100A or N1010300A FlexDCA Software Package
2. Clock Pattern Distortion Compensation feature must be enabled for single-mode wavelength

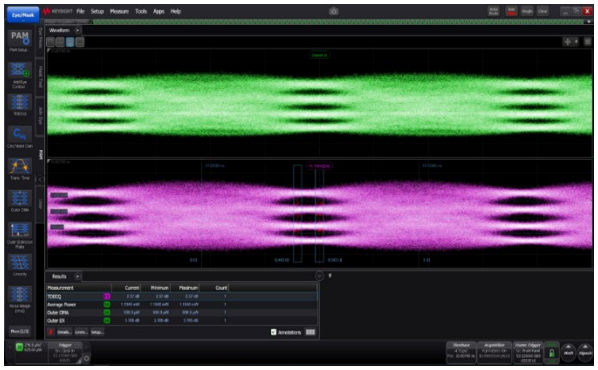
Make precise measurements
with Keysight state-of-the-art clock recovery solutions

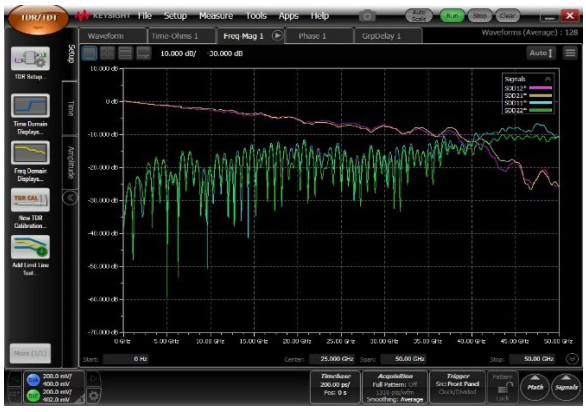
N1010A FlexDCA Software

Keysight's N1010A FlexDCA software runs our DCA family of sampling oscilloscopes. N1010A FlexDCA software helps visualize and analyze the analog properties of highspeed signals such as those used in wireline telecom and data center links.

While FlexDCA comes installed on DCA-X mainframes, you can also install it on a PC to control a DCA-M or remotely control a DCA-X. In addition to the N1010A FlexDCA's data acquisition and basic measurement capabilities, Keysight offers a large selection of software tools with powerful capabilities:

- **N1010100A RND Package**: This package is intended for R&D engineers who want to characterize their designs and gain more insight into why a signal deviates from the expected performance. It includes Jitter and PAM4 test suites and FlexRT Advanced for optical measurements on UXR-Series Oscilloscopes.
- **N1010200A Manufacturing Package**: This package focuses on cost of test in optical transceiver manufacturing applications with capabilities such as FlexEye that enhance measurement flexibility. It includes measurements such as TDECQ and FlexRT Basic for optical measurements on UXR-Series Oscilloscopes.
- **N1010300A Signal Integrity Package**: This package adds powerful tools to measure impedances, transfer characteristics, S-parameter calculations to the basic TDR / TDT measurements, and FlexPLL for phase-locked loop measurements.





FlexDCA Sampling Oscilloscope Software Technical Overview (5992-3319EN) provides you more information on FlexDCA software features and capabilities.

FlexOTO Application Software

Using instrumentation-grade optical switching, FlexOTO application software allows test system designers the ultimate flexibility in creating high port count, e.g. 800G/1.6T, CPO/NPO, and multi-channel applications, to improve test efficiency and increase utilization of DCA-M hardware without compromising measurement integrity.

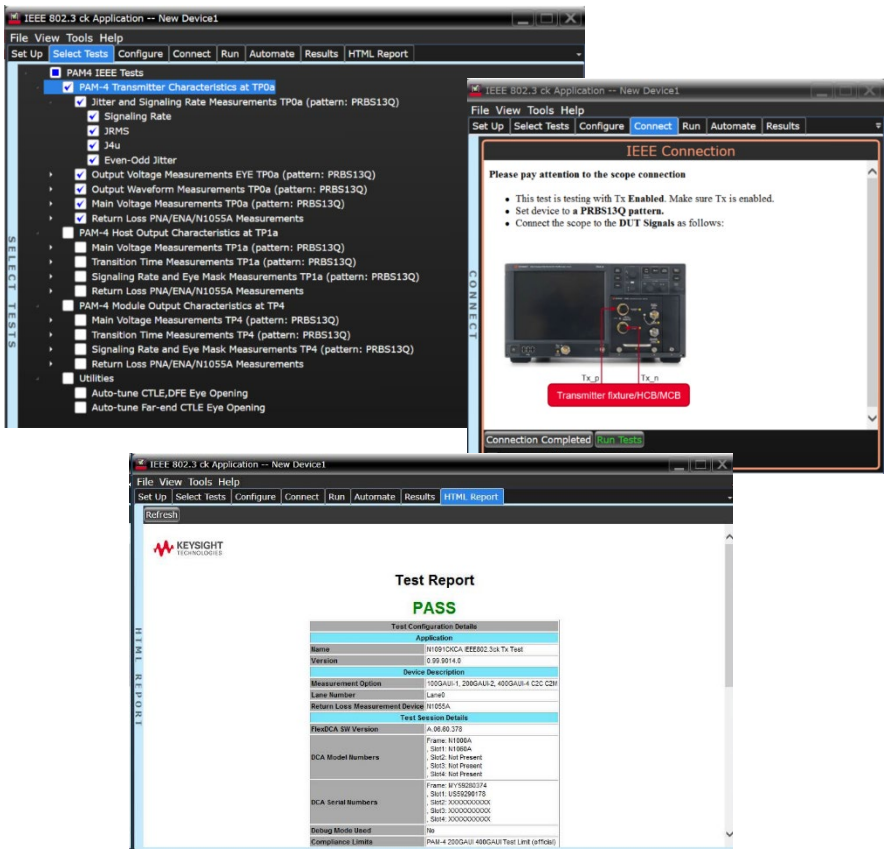
- Create high channel count test systems with up to 128 ports, using a variety of optical switch solutions
- Easily tradeoff throughput and test system expense to achieve lowest cost-of-test
- Leverage existing DCA-M investments to meet your high channel count testing demands at a minimal cost
- Easy setups for complex measurements ensure highest measurement integrity
- Simple SCPI interface for easy integration into overall manufacturing test flow
- Maximize utilization of existing DCA assets, beyond what can be achieved with common SCPI automation
- N1002L31A and N1002L33A bundles provide a cost-saving solution for software and hardware

Product model	Product description
N1002000A	FlexOTO Optical Test Optimization SW for Basic Optimization
N1002014A	FlexOTO Optical Test Optimization SW for up to 17 ports
N1002048A	FlexOTO Optical Test Optimization SW for up to 48 ports
N1002128A	FlexOTO Optical Test Optimization SW for up to 128 ports
N1002L31A	FlexOTO Optical Test Optimization Dual 1x4 Bundle for 800G/1.6T
N1002L33A	FlexOTO Optical Test Optimization 1x16 Bundle for 800G/1.6T

DCA Compliance Test Software

Keysight's DCA Compliance Applications software is the ideal tool to help you achieve compliance and ensure your products meet the highest quality standards. You can easily and accurately verify compliance with a wide range of industry standards, including IEEE, OIF-CEI, and SFF.

SW application model	SW application description See the application software datasheet to confirm hardware requirements.
N109228CA	Electrical TX Test SW for OIF-CEI-3.1
N109310CA	Electrical TX Test SW for SFF-8431 (SFP+)
D9010UDAA	User Defined Application Software (for DCA-X and RT Scopes)
N1091APCA	Electrical TX Test SW for IEEE 802.3ap (10G/40G)
N1091BMCA	Electrical TX Test SW for IEEE 802.3bm
N1091BACA	Electrical TX Test SW for IEEE 802.3ba (40G/100G)
N1091BJCA	Electrical TX Test SW for IEEE 802.3bj (100G)
N1091BSCB	Electrical TX Test SW for IEEE 802.3bs/cd
N109256CB	Electrical TX Test SW for OIF-CEI-4.0
N1095BSCA	Optical TX Test SW for IEEE 802.3bs/cd/cu
N1091CKCA	Electrical TX test SW for IEEE 802.3ck
N109212CA	Electrical TX Test SW for OIF-CEI-112G
N1081PLCA	PLL Test SW for PCI Express



Complementary Products

M8100A Series Arbitrary Waveform Generators

The Keysight family of AWGs offers stimulus sources that address a wide range of applications. The precision, high speeds, and flexibility of the M8100A Series AWGs help meet your most difficult challenges. The M8190A, M8194A, M8195A, M8199A, and M8199B high-performance AWGs support all of today's applications, from low-observable radar to 64QAM optical signals.

- Multilevel / multichannel digital signals up to 160 Gbaud PAM4, such as 400GbE or 1TbE
- Coherent optical applications up to 160 GBaud/64QAM (quadrature amplitude modulation)
- 5G, HDMI, MIPI
- Radar, electronic warfare, satellite, and general RF applications

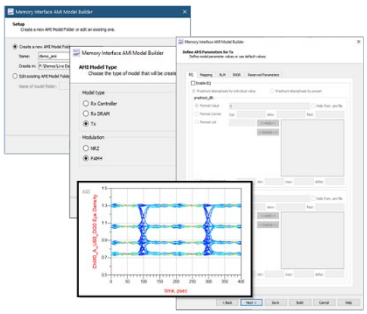
M8000 Series Bit Error Ratio Test (BERT) Solution

The Keysight M8000 Series is a highly-integrated bit error ratio (BER) test solution for physical layer characterization, validation, and compliance testing. With support for a wide range of data rates and standards, the M8000 Series provides accurate, reliable results that accelerate your insight into the performance margins of high-speed digital devices.

- Pulse amplitude modulation 4 (PAM4) and non-return-to-zero (NRZ) formats software-selectable using one piece of hardware
- NRZ data rates from 2 to 64 Gbit/s pattern generation and error analysis
- PAM4/6/8 data rates from 2 to 120 GBd pattern generation and up to 120 GBd error analysis (when used with a UXR-Series oscilloscope)
- Built-in clock / data recovery and equalization from 2 to 120 Gbaud
- Integrated de-emphasis and adjustable intersymbol interference (ISI)

Advanced Design System (ADS)

Pathway ADS provides very fast yet accurate channel simulation by bit-by-bit and statistical simulation technology. Along with the support of industry standard IBIS-AMI models, ADS offer comprehensive solutions for most serial link standards such as PAM4.



Learn More

Literature references

Description	Publication number
DCA Family - Brochure	5992-3301EN
DCA Wide-Bandwidth Oscilloscope Family - Configuration Guide	5992-3372EN
N1000A DCA-X Mainframe and Modules - Data Sheet	5992-3271EN
N1092A/B/C/D/E DCA-M - Data Sheet	5992-3886EN
N1094A/B DCA-M - Data Sheet	5992-3700EN
N1090A DCA-M - Data Sheet	5992-3655EN
Keysight DCA Family Clock Data Recovery Solutions - Data Sheet	5992-1620EN
DCA Accessories – Technical Overview	5991-2340EN
Keysight DCA Family FlexDCA Sampling Oscilloscope Software - Technical Overview	5992-3319EN
Flexible Optical Test Optimization (FlexOTO) Software and Solutions – Flyer	3123-1111EN

Web resources

Generic: www.keysight.com/find/<product number> for any product number mentioned here

- Keysight Digital Communication Analyzer (DCA) Solutions: www.keysight.com/find/dca
- DCA-X Family: www.keysight.com/find/dca-x
- DCA-M Family: www.keysight.com/find/dca-m
- Clock Recovery Solutions: www.keysight.com/find/cdr
- FlexOTO Optical Test Optimization Solutions and N1002A: www.keysight.com/find/flexoto
- FlexDCA (main page): www.keysight.com/find/flexdca_pro
- FlexDCA (download page): www.keysight.com/find/flexdca_download