PRODUCT BROCHURE

Keysight DCA Sampling Oscilloscopes

Increased accuracy for wireline communications infrastructure test

KEYSIGHT

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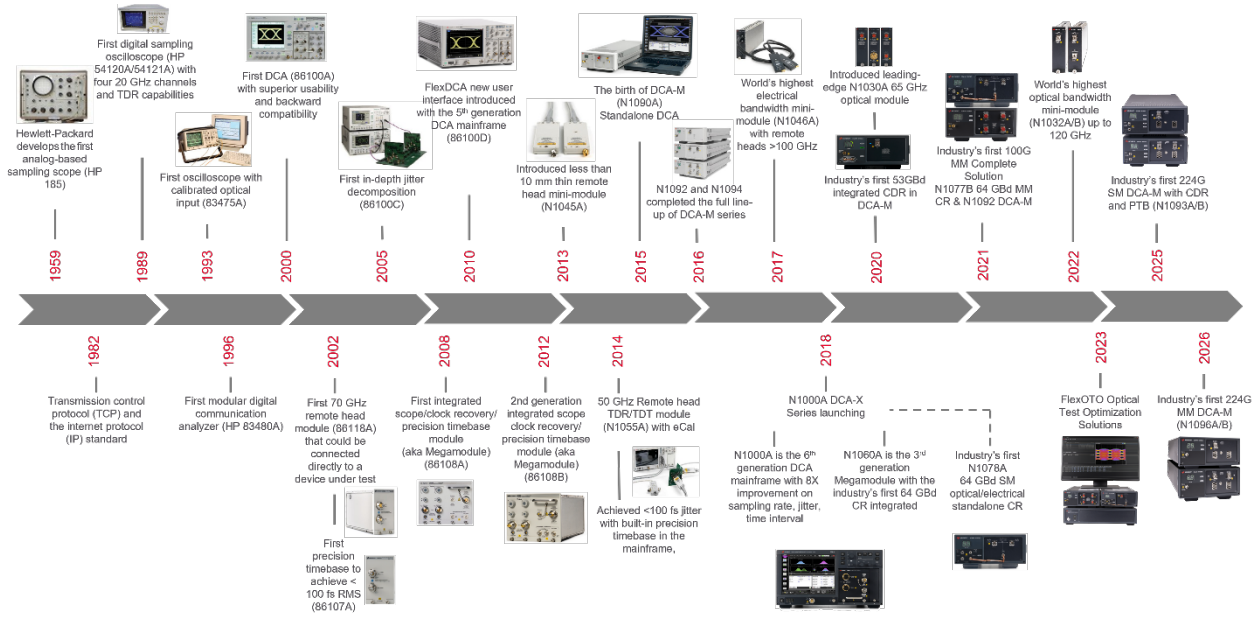
Keysight Digital Communication Analyzer (DCA) Solutions

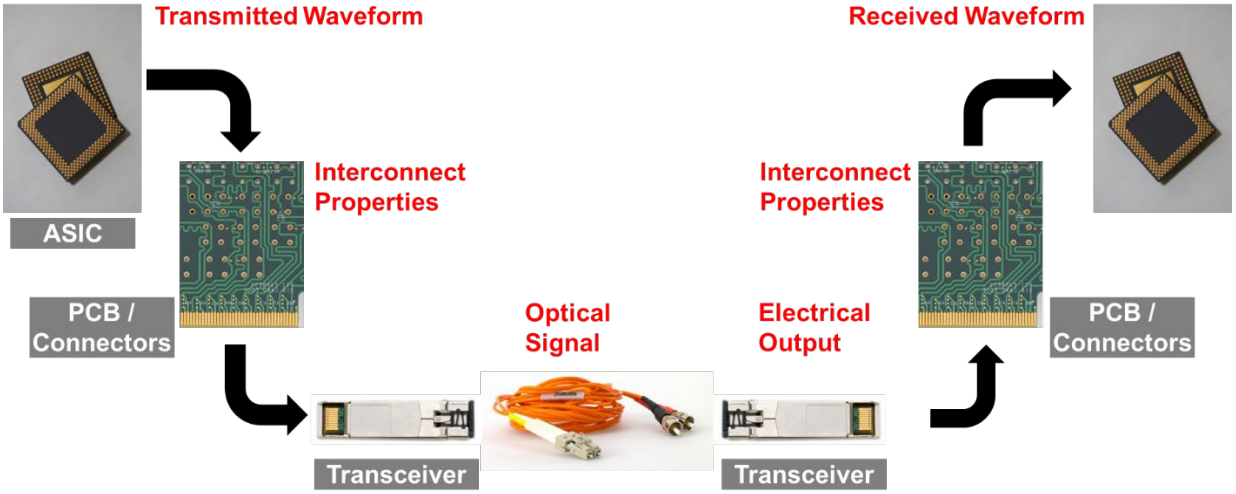
For more than 25 years, Keysight has been the leader in the sampling oscilloscope industry. Keysight sampling oscilloscopes are now offered in two capability classes across modular, fixed configuration, and clock recovery units. Modular sampling oscilloscopes include the DCA-X modular oscilloscope mainframe and DCA-X Series modules. SX2-class fixed configuration oscilloscopes include our DCA-M series sampling oscilloscopes. SX1-class clock recovery products include our DCA-M series clock data recovery (DCR) units. We've designed our sampling oscilloscopes to increase the efficiency and accuracy of tests. Along the way, we've proudly created industry-leading sampling oscilloscopes, 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.

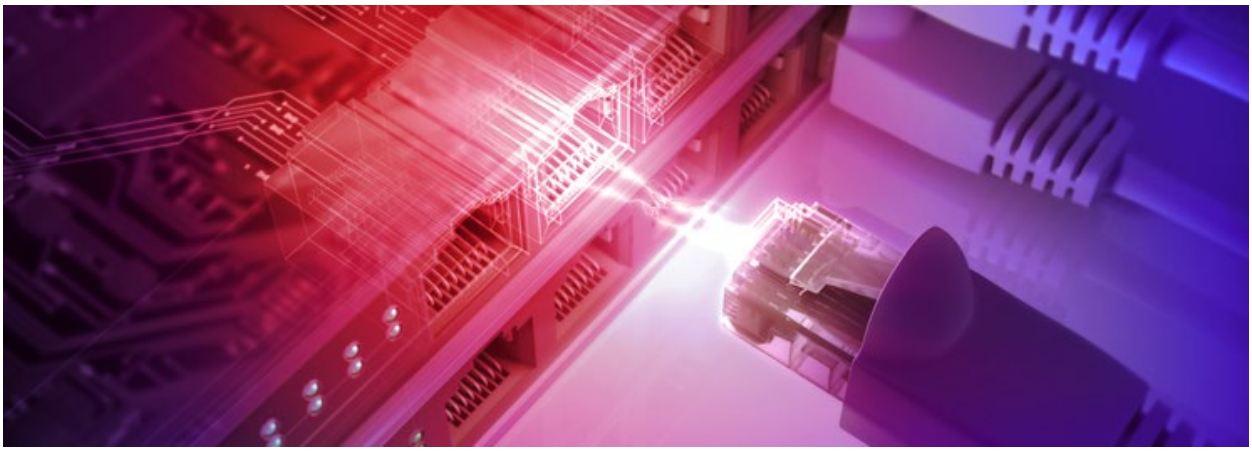


Engineered for Unmatched Measurement Accuracy

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, supporting the demands of next-generation 1.6T data centers and AI clusters.

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?

Sampling oscilloscopes are sometimes referred to as Digital Communication Analyzers (DCAs) or equivalent time 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 $50K and >100 GHz starting at $120K

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 a fixed configuration with up to four electrical or optical channels and standalone clock data recovery

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

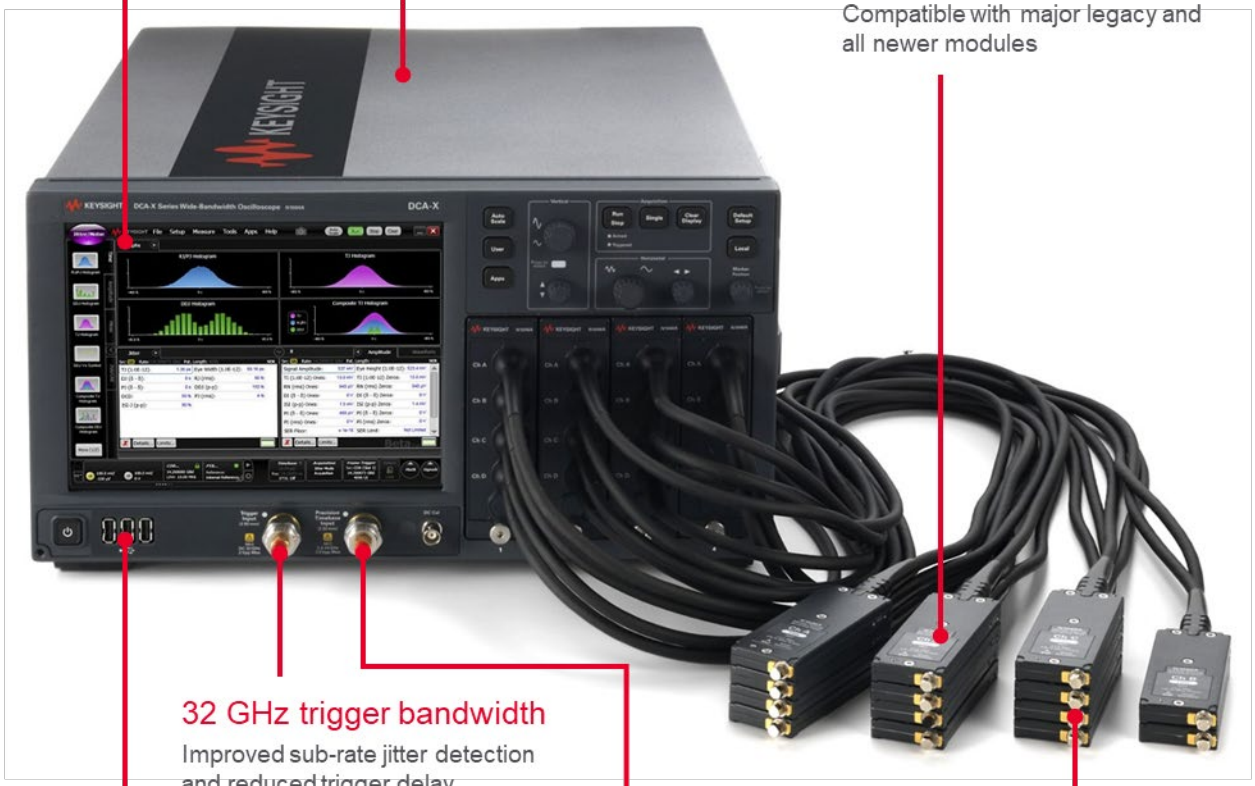
Modern, easy-to-use interface that provides high productivity and deep insights into DUT or signal

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 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) • 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 kHz

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 with a host PC with a host PC or connected with an 86100D or N1000A system to increase the number of test channels while delivering the industry's lowest cost-of-test.

- The DCA-M offers high accuracy and sensitivity, delivering precise measurements without the added cost of an R&D modular test system, ensuring it meets your price point
- Analyze a wide range of data rates, from 1.244 Gb/s through 120 GBaud
- Characteristic intrinsic jitter as low as 105 fs RMS
- Noise as low as 1μW (optical) and 275 μV (electrical)
- Achieve high throughput with just 7 seconds of acquisition time on the SSPRQ pattern
- Supported both multimode and single-mode for single to quad channels models

224 Gb/s Optical Measurements for 1.6T Applications

N1093A/B 60GHz Single-mode DCA-M Sampling Oscilloscope

Optimize production test efficiency and throughput

Benefits: FlexOTO Optical Test Optimization software seamlessly integrates with the N1093 DCA-M to maximize instrument utilization and test efficiency while reducing total cost-of-test, leveraging the industry-leading FlexDCA measurement science platform for high-quality optical waveform analysis.

Minimize test system complexity and ensure compliance

Benefits: Integrated clock recovery supports baud rates up to 120 GBd, enabling the DCA-M to recover the clock at the full data rate, as prescribed by the standards, and eliminating the need to configure and route a separate sub-rate signal for clocking.

Maximize measurement margin

Benefits: High sensitivity, low jitter, wide precise bandwidth and leading-edge measurement science maximize measurement margin. Less than 15 µW noise and 105 fs of intrinsic jitter deliver superior accuracy to enable R&D and manufacturing engineers to meet tight specifications and ensure design reliability with higher throughput.

N1096A/B 60GHz Multimode DCA-M Sampling Oscilloscope

Unlock 224 Gbps MM Measurements

Benefits: The N1096 DCA-M offers 58 GHz single and dual optical channel configurations, delivering 224 Gbps or 112 GBd PAM4 measurement capability for 1.6T multimode (MM) short-reach applications.

High-Sensitivity 224G MM Testing

Benefits: Delivered best-in-class sensitivity with ≤35 µW noise and pairs seamlessly with the N1077B Multimode Optical Clock Recovery at half rate to provide a complete solution for accurate 224G measurements.

Standalone mini DCAs

Model	N1096A/B	N1093A/B	N1092A/B/C/D/E	N1094A/B	N1090A
Description	The N1096 multimode DCA-M supports 224 Gbps or 112 GBd PAM4 measurement capability for multimode (MM) short-reach applications for next-generation AI infrastructure.	224G high-sensitivity optical channels with integrated clock recovery up to 120 GBd for optical waveform and jitter measurements enabling more reliable 1.6T AI networks.	A high-sensitivity solution with flexible configuration options, enabling 8.4 GBd to 64 GBd optical and electrical waveform analysis.	The N1094 DCA-M builds on that legacy by using the high-performance elements of 86100 and N104X electrical plug-in modules, offering electrical channels with 30 GHz and 50 GHz bandwidths.	The N1090A DCA-M builds on that legacy by using the high-performance elements of 86100 and 86105C for 1.244 Gb/s to 11.3 Gb/s optical and electrical waveform analysis.
Bandwidth, -3 dBo / -3dB	58 GHz optical (with SIRC)	60 GHz optical (with SIRC)	Up to 45 GHz optical / 50 GHz electrical	Up to 50 GHz electrical	10 GHz optical / 20 GHz electrical
Channel	1/2 optical	1/2 optical	Up to 4 channels	2/4 electrical	1 optical / 1 electrical (optional)
Integrated Clock Recovery	No, pairs with the N1077B CDR at half rate	Yes, up to 120 GBd	Yes, up to 64 GBd[1]	No	No
Jitter	160 fs rms (with LOJ)	105 fs rms (with PTB)	160 fs rms (with LOJ)	135 fs rms (with LOJ)	500 fs rms
RMS Noise	≤35 µW	<15 µW	As low as 3 µW	As low as 275 µV	As low as 0.8 µW
Filter Range[2]	52 GBd to 115.5 GBd	26.6 GBd to 120 GBd	8.4 GBd to 64 GBd	-	1.244Gb/s to 11.3 Gb/s
Wavelength	780 to 1100 nm	1250 nm to 1350 nm	830 nm to 1600 nm	-	750 nm to 1650 nm
Sample Rate	250 kHz		Up to 250 kHz		60 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				

1. Optional on A and B models. Jitter Spectrum Analysis (JSA) can be enabled by N1010100A or N1010300A FlexDCA Software Package
2. The filter range represents the combination of NRZ and PAM4 reference receivers.

High accuracy, low noise, compact 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	N1078A	N1077B
Description	64 GBd 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	125 MBd to 64 GBd	125 MBd to 64 GBd
Input Signal	Electrical	Optical and Electrical	Optical and Electrical
Wavelength	-	1260 nm - 1620 nm	830 nm - 1340 nm[2]
Modulation Format	PAM4 and NRZ	PAM4 and NRZ	PAM4 and NRZ
Splitter Type	Internal	Internal and External	Internal and External
Integrated Equalizer	Yes (Variable)	Yes (Variable)	Yes (Variable)
Jitter Spectrum Analysis (JSA)[1]	Yes	Yes	Yes

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

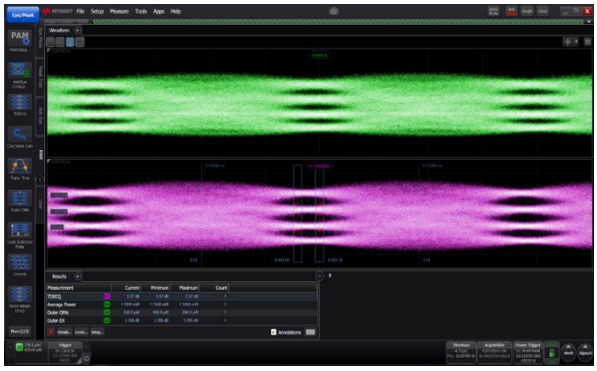
Make precise measurements
with Keysight state-of-the-art clock recovery solutions

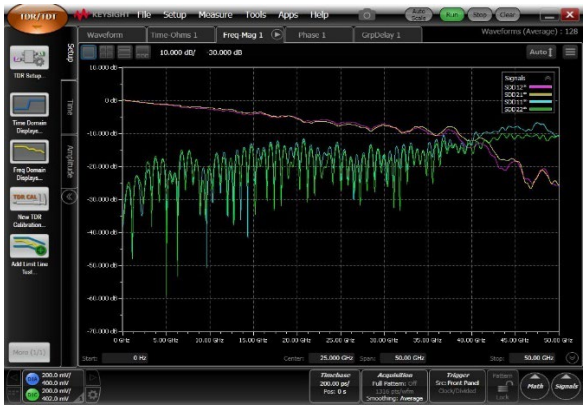
N1010A FlexDCA Software

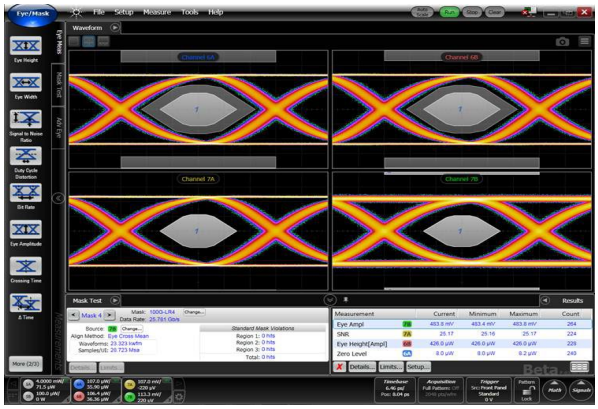
Keysight's N1010A FlexDCA software runs our DCA family of sampling oscilloscopes. N1010A FlexDCA software helps visualize and analyze the analog properties of highspeed signals such as those used in wireline telecom and data center links.

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.





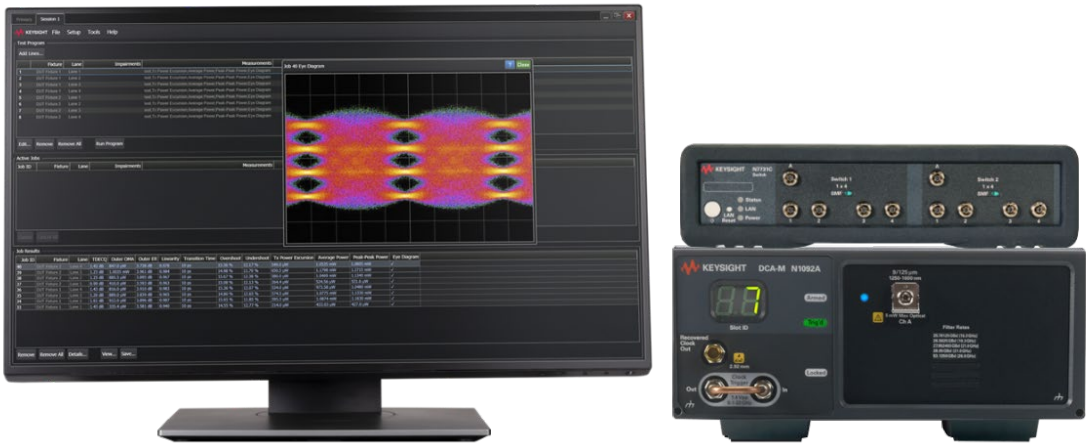


FlexDCA Sampling Oscilloscope Software Technical Overview (5992-3319EN) provides you more information on FlexDCA software features and capabilities.

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/P31A and N1002L33A/P33A bundles provide a cost-saving solution for software and hardware

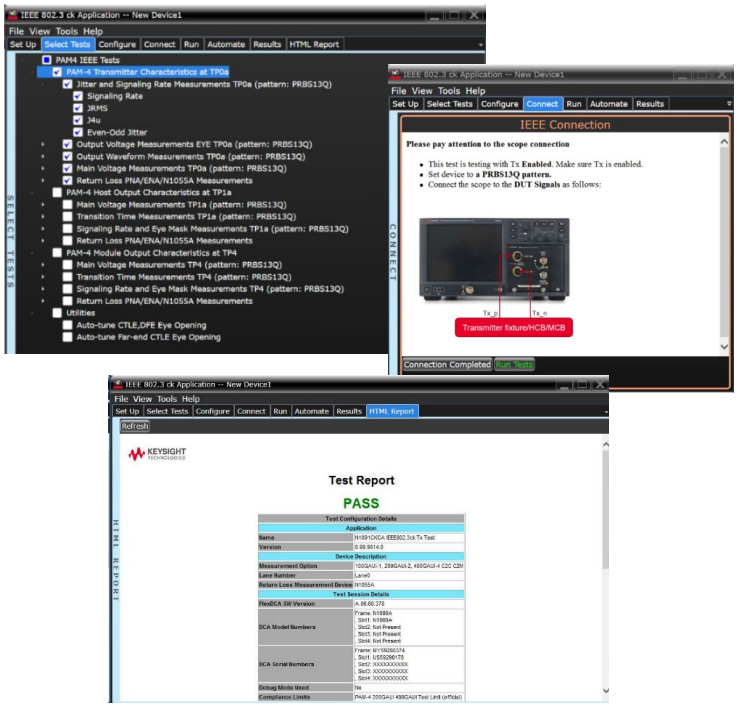


Product model	Product description
N1002000A	FlexOTO Optical Test Optimization SW for Basic Optimization
N1002014A	FlexOTO Optical Test Optimization SW for up to 17 ports
N1002048A	FlexOTO Optical Test Optimization SW for up to 48 ports
N1002128A	FlexOTO Optical Test Optimization SW for up to 128 ports
N1002L31A	FlexOTO Optical Test Optimization Dual 1x4 Bundle for 800G/1.6T (1 year subscription license)
N1002P31A	FlexOTO Optical Test Optimization Dual 1x4 Bundle for 800G/1.6T (Node-locked perpetual license)
N1002L33A	FlexOTO Optical Test Optimization 1x16 Bundle for 800G/1.6T (1 year subscription license)
N1002P33A	FlexOTO Optical Test Optimization 1x16 Bundle for 800G/1.6T (Node-locked perpetual license)

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.
N1095DJCA	224G Optical Transmitter Conformance Test Software for IEEE 802.3dj
N1091DJPA	224G Electrical Transmitter Test Software for IEEE 802.3dj
N1081PLCA	PLL Test SW for PCI Express
N109212CA	Electrical TX Test SW for OIF-CEI-112G
N1091CKCA	Electrical TX test SW for IEEE 802.3ck
N1095BSCA	Optical TX Test SW for IEEE 802.3bs/cd/cu
N1091BSCB	Electrical TX Test SW for IEEE 802.3bs/cd
N109256CB	Electrical TX Test SW for OIF-CEI-4.0
N1091BJCA	Electrical TX Test SW for IEEE 802.3bj (100G)
N1091BACA	Electrical TX Test SW for IEEE 802.3ba (40G/100G)
N1091BMCA	Electrical TX Test SW for IEEE 802.3bm
N1091APCA	Electrical TX Test SW for IEEE 802.3ap (10G/40G)
D9010UDAA	User Defined Application Software (for DCA-X and RT Scopes)



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.

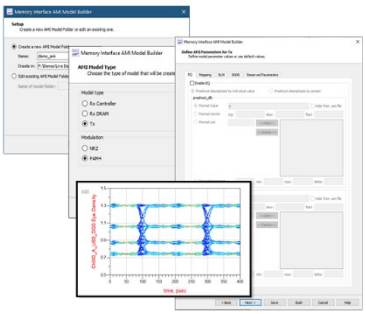
- Multilevel / multichannel digital signals up to 160 Gbaud PAM4, such as 400GbE or 1TbE
- Coherent optical applications up to 160 GBaud/64QAM (quadrature amplitude modulation)
- 5G, HDMI, MIPI
- Radar, electronic warfare, satellite, and general RF applications

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
- FlexDCA (main page): www.keysight.com/find/flexdca_pro
- FlexDCA (download page): www.keysight.com/find/flexdca_download

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.

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