

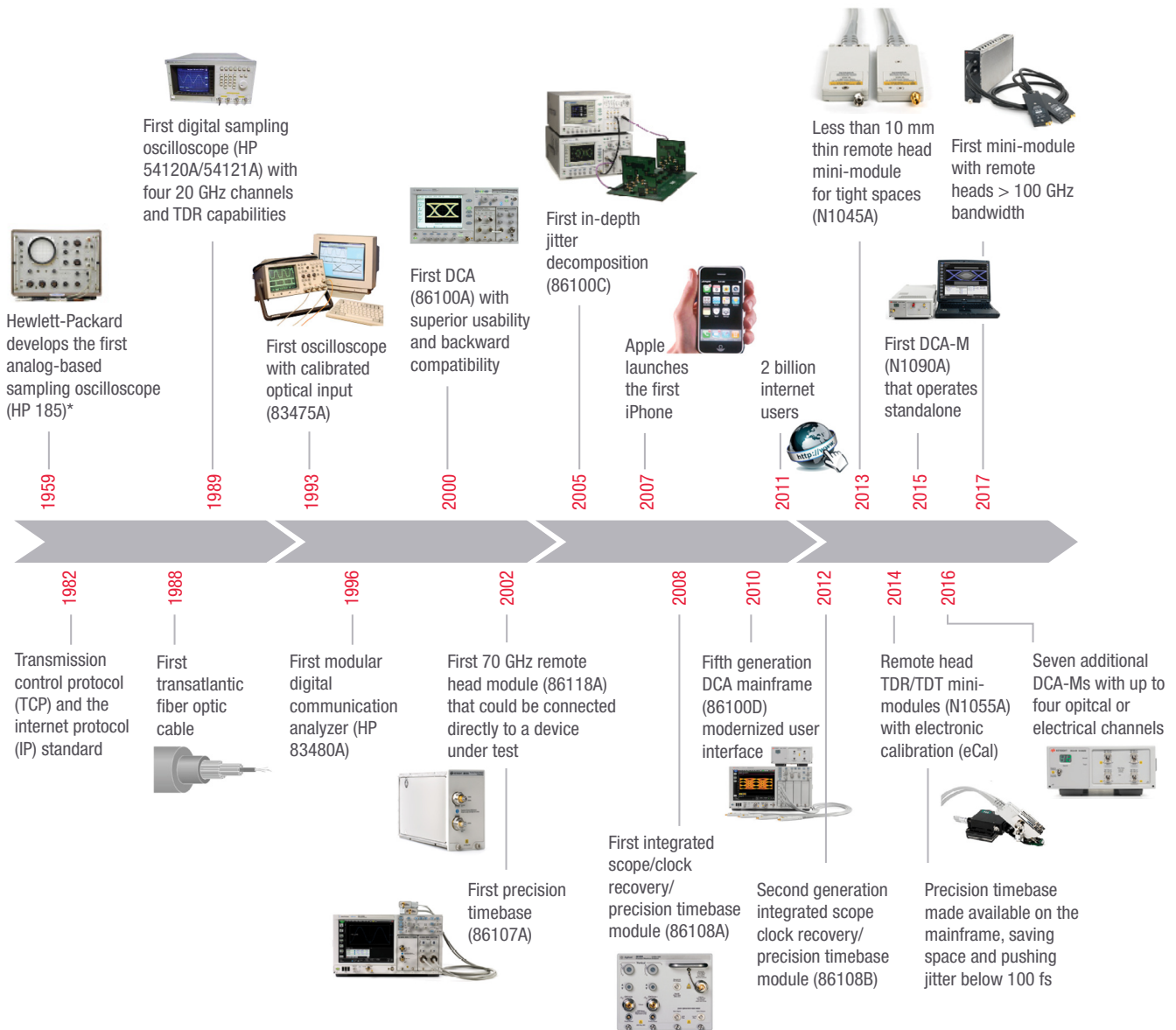
# Keysight Digital Communication Analyzer (DCA) Solutions

## Increased Accuracy of Wireline Communications Infrastructure Test



# Keysight Digital Communication Analyzer (DCA) Solutions

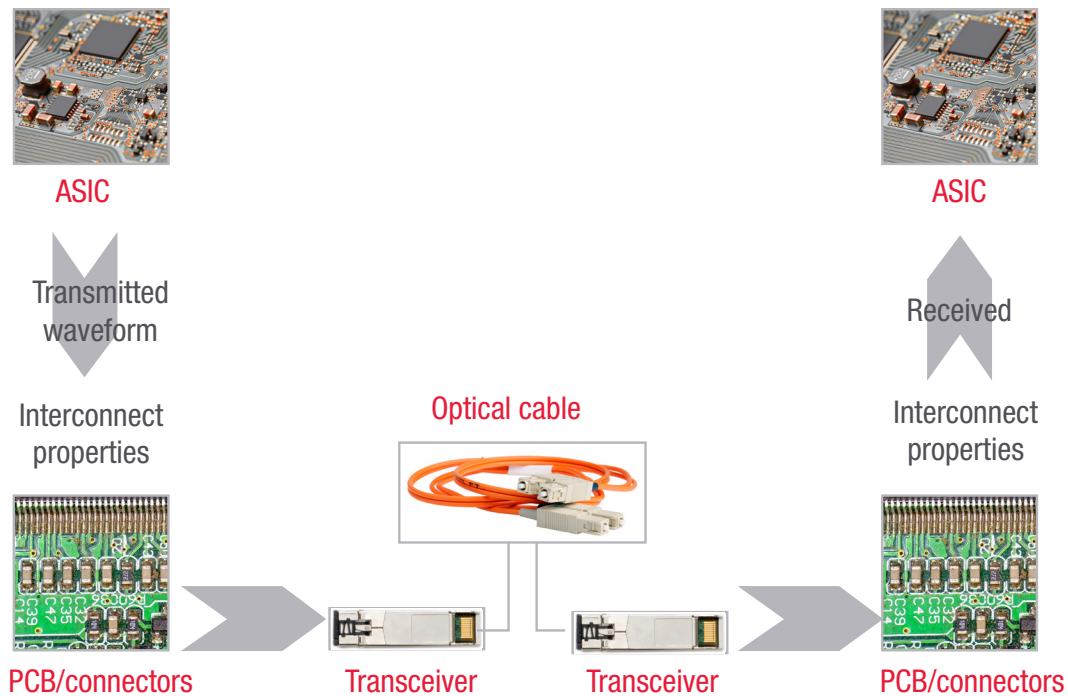
For more than 25 years, Keysight has been the leader in the sampling scope industry. We've designed Digital Communications Analyzer (DCA) solutions to increase the efficiency and accuracy of test. Along the way, we've proudly created industry-leading sampling scopes, modules, accessories and software 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.



\*Photo Credit: Marc Mislange hpmemoryproject.org

## 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 400G Ethernet and 64G Fibre Channel.



## What does a DCA measure?

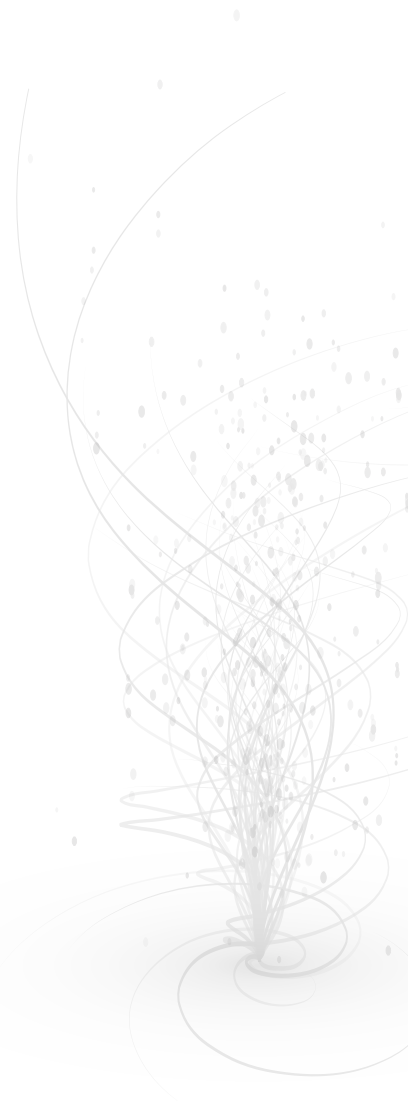
A Digital Communications Analyzer (DCA) is Keysight's term for instruments otherwise known as sampling oscilloscopes or equivalent-time sampling oscilloscopes — instruments used to view the time-domain waveforms of optical and electrical transmitters used in high-speed serial communications systems due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

- 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, but specifically 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 for 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 50 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 rate (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	Real-Time Scope	Sampling Scope
Signal requirement	One-time or repeating	Repeating for waveforms and jitter/interference analysis Eye diagram measurements can use non-repeating streams)
External clock/trigger	Not required (can use software clock recovery)	Required from DUT (or must use hardware clock recovery)
Intrinsic Noise	Several millivolts	Sub-millivolts
A/D conversion	Fewer bits	More bits
Waveform fidelity	Very good	Best
Memory depth	G Samples/waveform	M Samples/waveform
Single events & glitches	Can be captured	Cannot be captured
Electrical signals	Up to 4 channels	Up to 32 channels
Optical Signals	1 (external O/E conversion)	Up to 32 channels
TDR/S-parameters	Not available	Up to 16 channels
Platform	Fixed (upgradeable)	Modular or compact
Compliance testing	Many standards	Selected standards

# N1000A DCA-X Mainframe

## FlexDCA scope software

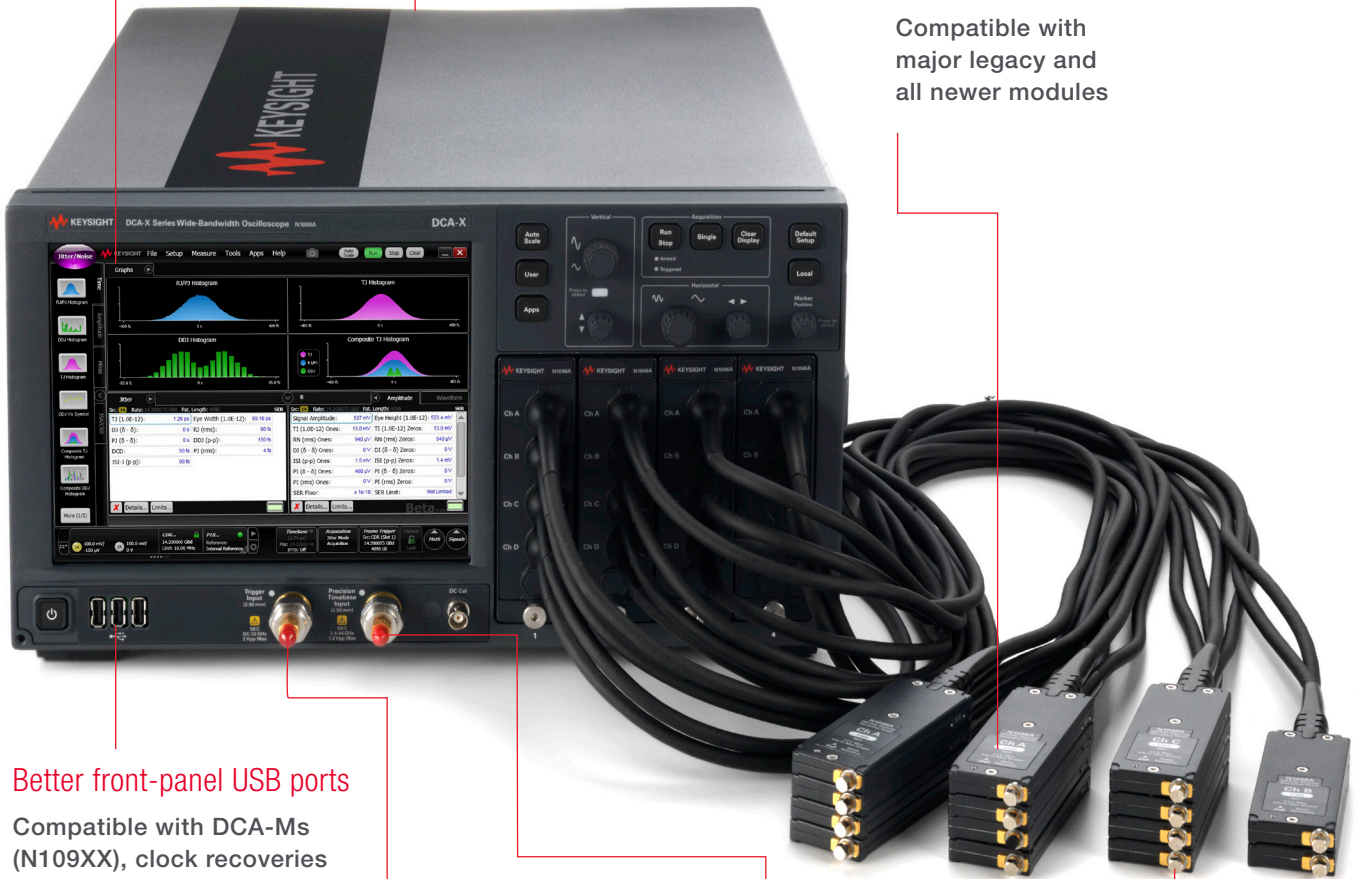
Modern, easy-to-use interface that provides high productivity and deep insights into DUT or signal

## 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



## Better front-panel USB ports

Compatible with DCA-Ms (N109XX), clock recoveries (N107XX), ECal (TDR/TDT)

## 32 GHz trigger bandwidth

Improved sub-rate jitter detection and reduced trigger delay

## Internal precision timebase

Drastically reduces intrinsic jitter without occupying a module slot

## Remote heads

Connect directly to DUT and avoid cable losses

# N1000A Improvements



## Security/Privacy

Protect your information from accidental or hostile leakage

- Removable hard drive (a standard feature that can be removed to protect sensitive data)
- Calibration data stored in instrument hardware (hard drive can be removed before calibration/repair)

## 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

Applications offer variations in technical requirements and price. DCA modules provide a wide range of configurations and performance options to interchange the bandwidth, channel count, and features.

### N1030A/B Single/Dual Channel Optical Mini-Module



- 65 GHz single-mode optical channel(s)
- Option EC1: 95 GHz electrical channel, 1.0 mm input
- Hardware filters for 53-56 GBd NRZ/PAM4
- Optional hardware filters for 25-28 GBd NRZ
- Optical and electrical System Impulse Response Correction (SIRC)

### N1040A Dual Channel Electrical Mini-Module

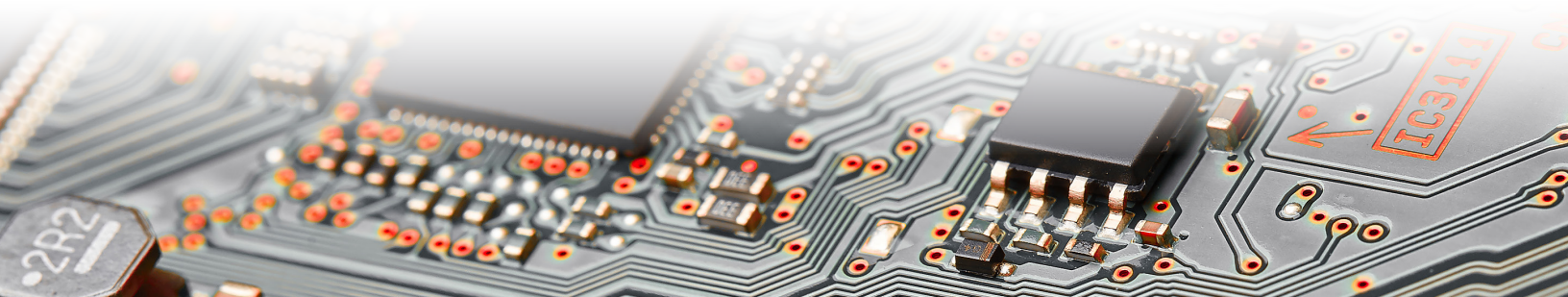


- Option 033: 20/33 GHz bandwidth, 2.92 mm inputs
- Option 060: 20/33/40/60 GHz bandwidth, 1.85 mm inputs
- Electrical System Impulse Response Correction (SIRC)

### N1060A Precision Waveform Analyzer



- 2 channel / clock recovery / precision timebase combo
- 50 or 85 GHz bandwidth
- 16, 32 or 64 G NRZ and PAM4 clock recovery
- Jitter Spectrum Analysis and Clock Recovery Emulation
- Electrical inputs: 1.0 mm male (1.0 female to 1.85 female adapters included)





## Remote Head Modules

Remote heads allow you to directly connect the device under test (DUT). This reduces or eliminates measurement errors due to cable losses or imperfect matching of differential pairs.

### N1045B Remote Head Module



- 60 GHz bandwidth
- 2 or 4 channels per module
- Electrical Inputs: 1.85mm male or female

### N1046A Remote Head Module



- 75, 85 or 100+ GHz bandwidth (upgradeable)
- 1, 2 or 4 channels per module
- Electrical inputs: 1.0 mm male (1.0 female to 1.85 female adapters included)

### N1055A Remote Head TDR/TDT



- 35 or 50 GHz bandwidth
- 2 or 4 channels per module
- TDR/TDT capabilities with risetime under 7 ps
- Electrical inputs: 1.85 mm male or female

## DCA-M Series - Standalone Mini DCAs

Focused on the needs of optical transceiver R&D and manufacturing to provide customization for the greatest insights, highest throughput, and various levels of bandwidth and intrinsic jitter. DCA-Ms can be used standalone or as part of a 86100D or N1000A system and offer the best price per channel in the industry.

N1090A DCA-M Oscilloscope



- 1 optical or 1 optical + 1 electrical channel
- Single-and multimode compatible
- Reference receiver for 1.25, 2.5, 3.25 or 8.5-11.3 Gb/s NRZ signals
- Up to 100 K samples/sec

N1092A/B/C/D/E DCA-M Oscilloscope

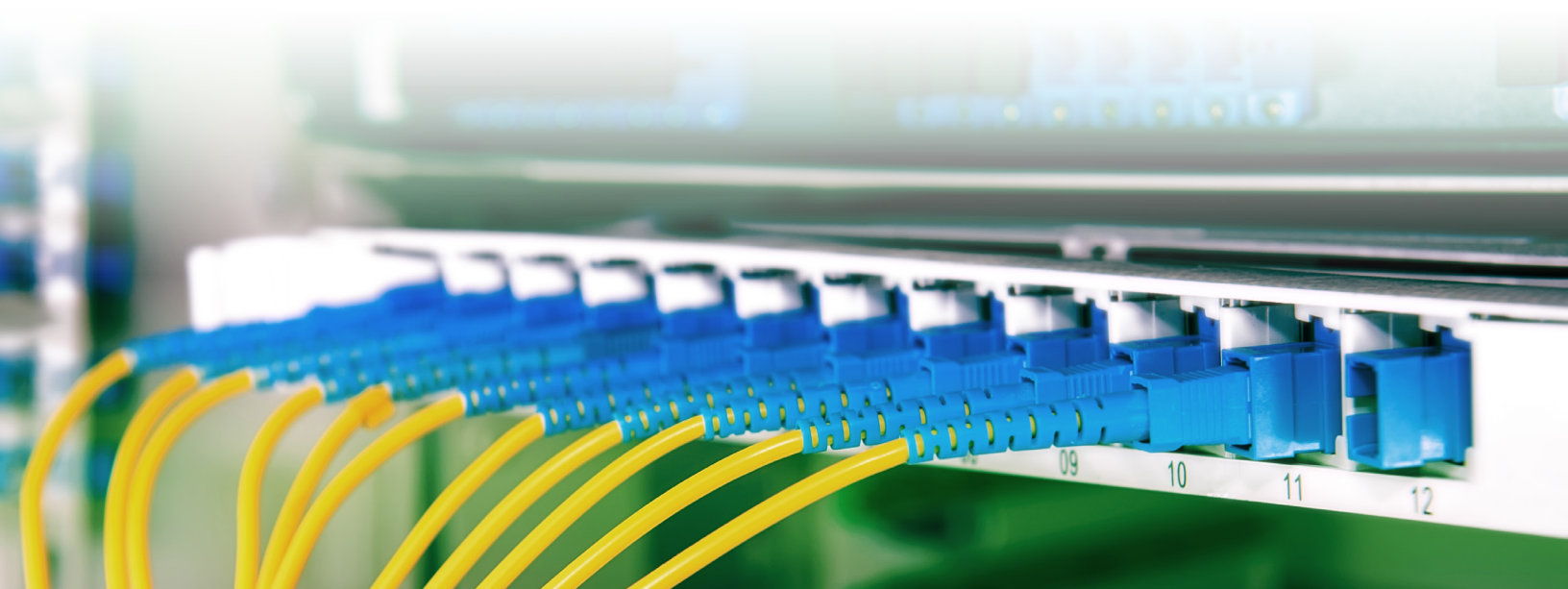


- 1, 2, 4 optical or 1 optical + 2 electrical or 2 optical + 2 electrical channels
- Single-and multimode compatible
- Supports 20-30 GBd NRZ, PAM4 and 53 GBd PAM4
- Up to 250 K samples/sec
- Clock recovery option for 24-29 and 48-58 GBd rates

N1094A/B DCA-M Oscilloscope



- 2 or 4 electrical channels
- 30 or 50 GHz bandwidth
- Up to 250 K samples/sec



# Legacy Modules

Keysight wants to help you protect your investment. The N1000A mainframe provides backward compatibility to all modules sold after 2010, and to selected older modules:

- FlexDCA supports all N10xxx series of DCA modules
- All N10xxx series of DCA-Ms (channels and clock recoveries)
- Legacy electrical modules: 54752A, 83484A, 86108A/86108B, 86112A, 86117A, 86118A
- Legacy optical modules: 86105C/86105D, 86115D, 86116C
- Legacy specialty products: 54754A (TDR), 83496A/83496B (clock recovery), 86107A (precision timebase), N4877A (external CDR).

## 86105C Optical/Electrical Module



Optimized for greatest flexibility for 155 Mbaud to 11.3 Gbaud signaling rates

## 86105D Optical/Electrical Module



Optimized for best accuracy for 8.5 Gbaud to 14.025 Gbaud signaling rates

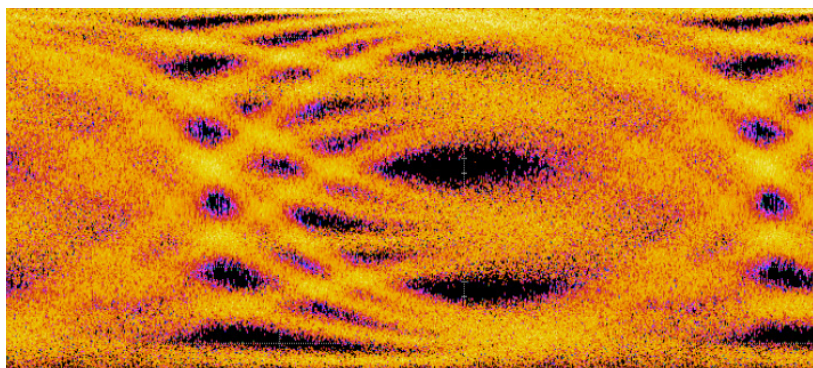
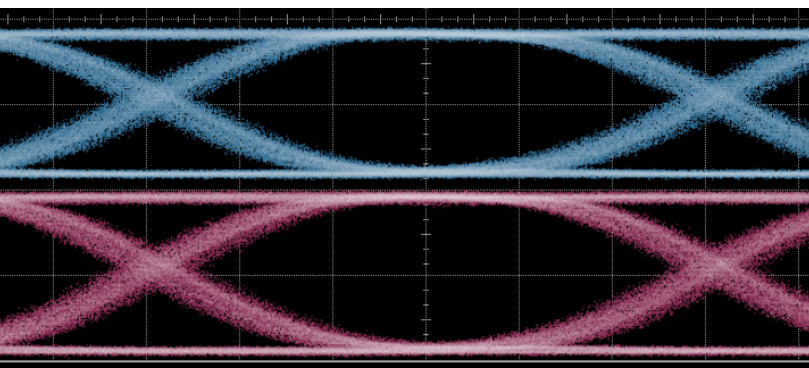
## 86115D Optical Module



Dual channel version of the 86105D

## Standalone Clock Recovery Units

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.



N1076B



- Electrical-only clock recovery
- 125 MBd to 16, 32 or 64 GBd NRZ or PAM4
- Integrated variable equalizer
- Optional external equalizers
- Full rate or sub-rate clock output
- Low-jitter AUX output for precision timebase

N1077A



- Electrical and optical clock recovery
- Single- and multimode
- 50 MBd to 16 or 32 GBd NRZ or PAM4
- Optional external equalizers
- Full rate or sub-rate clock output
- Low-jitter AUX output for precision timebase

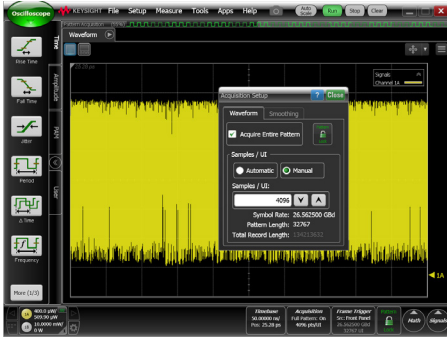
N1078A



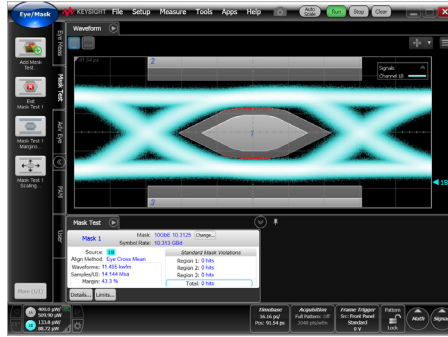
- Electrical and optical clock recovery
- Single-mode only
- 125 MBd to 16, 32 or 64 GBd NRZ or PAM4
- Integrated variable equalizer
- Optional external equalizers
- Full rate or sub-rate clock output
- Low-jitter AUX output for precision timebase

# FlexDCA software

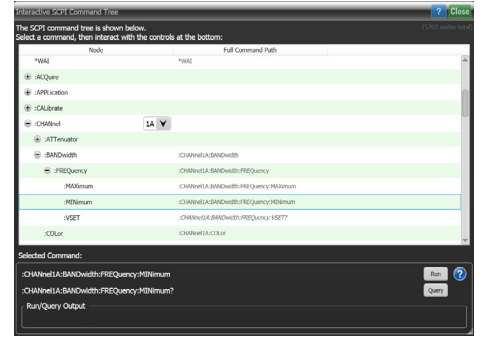
FlexDCA (N1010A) software runs on DCA mainframes (86100D and N1000A), as well as on external PCs/laptops. FlexDCA can be used either standalone using imported or simulated waveforms, or connected to a DCA-M or DCA-X. It provides a locally or remotely controlled interface, has powerful analysis options for deeper insights into signals and devices, and includes a host of tools to make engineers more productive.



Oscilloscope mode can acquire over one hundred million samples per waveform



Eye diagram mode is the most common tool for quickly analyzing the quality of an optical or electrical digital signal stream



A rich SCPI tool set helps software engineers to quickly develop remote control programs



Jitter mode gives you insights into the root causes of both jitter and interference



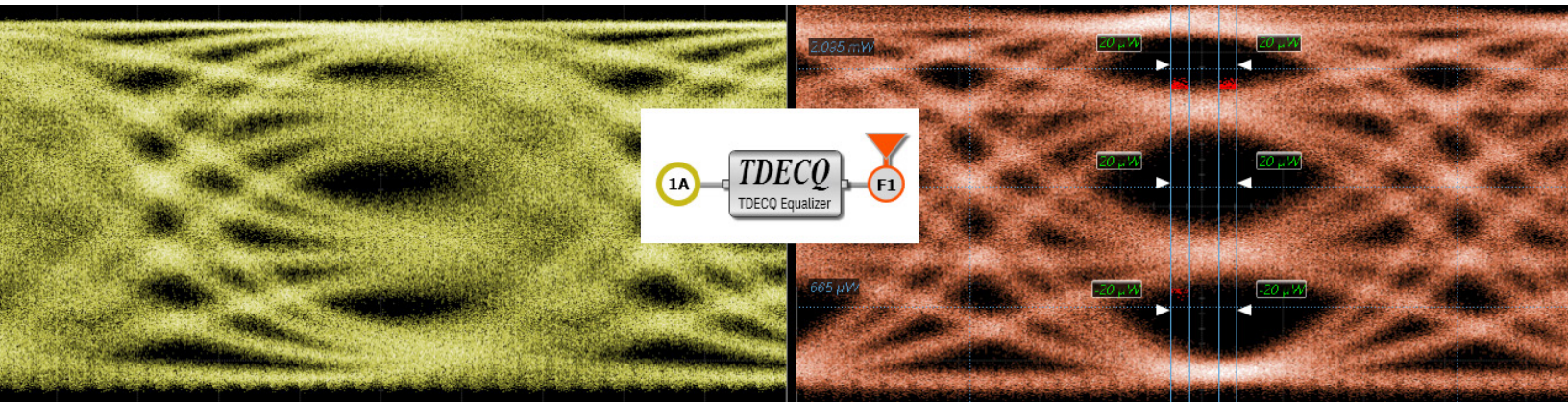
TDR/TDT mode shows the properties (in time/distance or the frequency domain) of electrical channels



The Documentation Wizard saves all relevant information in a single file with just one click

## Deeper insights and higher throughput with FlexDCA packages

Manage software fast and easy. Our flexible model for software management is the easiest way to get proactive updates and ensured support for your Keysight applications. Upgrading to the new model keeps your instrument current with the latest performance updates, industry standards and security enhancements.



### FlexDCA offers three different tailored packages

- N1010100A - Research and Development
- N1010200A - Manufacturing
- N1010300A - Signal Integrity (TDR/TDT and S-Parameters)

Packages are available as permanent or time-based licenses that are node-locked, transportable, USB dongle or server based<sup>1</sup>. Renewable support subscriptions ensure that the packages include all the latest enhancements, such as new measurements required by emerging standards.

<sup>1</sup> Contact Keysight for availability of USB dongle and server based licenses.

## DCA Compliance Applications

FlexDCA (N1010A) software runs on DCA mainframes (86100D and N1000A), as well as on external PCs/laptops. FlexDCA can be used either standalone using imported or simulated waveforms, or connected to a DCA-M or DCA-X. It provides a locally or remotely controlled interface, has powerful analysis options for deeper insights into signals and devices, and includes a host of tools to make engineers more productive.

Product number	Description
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/bj (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

## Sample Configurations

FlexDCA (N1010A) software runs on DCA mainframes (86100D and N1000A), as well as on external PCs/laptops. FlexDCA can be used either standalone using imported or simulated waveforms, or connected to a DCA-M or DCA-X. It provides a locally or remotely controlled interface, has powerful analysis options for deeper insights into signals and devices, and includes a host of tools to make engineers more productive.

	8-14 Gbaud (e.g., 10 GbE, 8/16G FC)	20-30 Gbaud (e.g., 100 GbE, 16/32G FC)	50-60 Gbaud (e.g., 400 GbE)	General Purpose
Electrical Transmitters	N1094A/B; N1000A with N1045A; N1000A with N1060A	N1094A/B; N1000A with N1045A; N1000A with N1060A	N1000A with N1046A; N1000A with N1060A	N1000A with N104XX; N1000A with N1060A; N1094A/B
Optical Transmitters	N1090A; N1000A with 86105C/D	N1092A/B/C/D/E	N1092A/B/C/D/E; N1000A with N1030A/B	N1000A with 86105C/D; N1092A/C
Clock Recovery	N1076B; N1077A; N1078A	N1076B; N1077A; N1078A	N1076B; N1078A	N1076B; N1077A; N1078A
PLL Characterization	N1076B; N1078A; N1000a with N1060A	N1076B; N1077A; N1078A	N1076B; N1078A; N1060A	N1076B; N1078A; N1060A
Signal Integrity	Keysight ENA	N1000A with N1055A		N1000A with N1055A
Compliance Verification	N109228CA; N109310CA	N109228CA; N1091BACA; N1091BJCA; N1091BMCA	N1085A; N1091BSCA; N109256CA	N/A



## Complementary products

### High Performance Arbitrary Waveform Generators



Achieve superior fidelity with high-performance arbitrary waveform generators that use low noise clocks to provide unmatched performance and high quality signal generation. Whether you need bench top, system ready AXIe, LXI or PXI, Keysight's high performance arbitrary waveform generators offer clean, complex and real world signals.

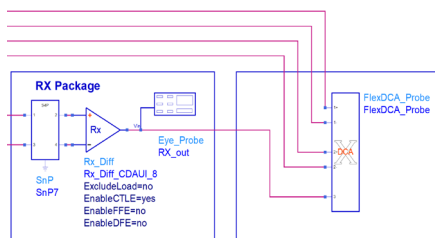
- Push aerospace system designs farther with highly realistic signals
- Build a strong foundation for highly reliable satellite communication
- Generate multi-level signals and reproduce analog imperfections

### Bit Error Ratio Test (BERT) Solution



Make the next leap forward with Keysight BERTs - covering affordable manufacturing test and high-performance characterization and compliance testing up to 32 Gb/s. Keysight's Bit Error Ratio Test (BERT) solutions allow the most accurate and efficient design verification, characterization, compliance and manufacturing test of high-speed communication ports for today's ASICs, components, modules and line-cards in the semiconductor, computer, storage and communication industry.

### Advanced Design System (ADS)



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 about the DCA solution family

### Literature

- Mainframe and modules specifications: 5992-3271EN
- DCA family configuration guide: 5992-3372EN
- DCA-M specifications: 5992-1454EN
- Clock recovery specifications: 5992-1620EN
- DCA accessories: 5991-2340EN
- FlexDCA overview: 5992-3319EN