

N109256CB OIF-CEI 4.0 Measurement and Debug Application

Characterize CEI-56G-VSR/MR/LR Electrical TX Designs using N1000A/86100D DCA-X and N109X DCA-M Oscilloscopes

Introduction

Several industry and standards bodies have adopted pulse amplitude modulation 4-level (PAM4) technology to increase throughput within a given bandwidth compared to Non-Return-to-Zero (NRZ) technology. As an example, an implementation agreement (IA) developed by the Optical Internetworking Forum - Common Electrical Interface (OIF-CEI) defines 56 Gb/s operation in OIF-CEI 4.0 using 26/28 PAM4 signaling (CEI-56G-VSR/MR/LR).

The Keysight N109256CB OIF-CEI 4.0 software is a measurement application for the DCA-X/DCA-M equivalent-time sampling oscilloscopes designed to save you time and money by automating the task of performing PAM4 and NRZ transmitter (TX) test measurements



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Transform Complexity into Simplicity

The N109256CB is an easy-to-use TX test application that:

- Saves time in understanding details of standards
- Reduces the time it takes to characterize your PAM4 and NRZ design from hours to minutes
- Helps debug your device using custom configurations
- Allows you to quickly generate HTML reports that summarize the performance of your device

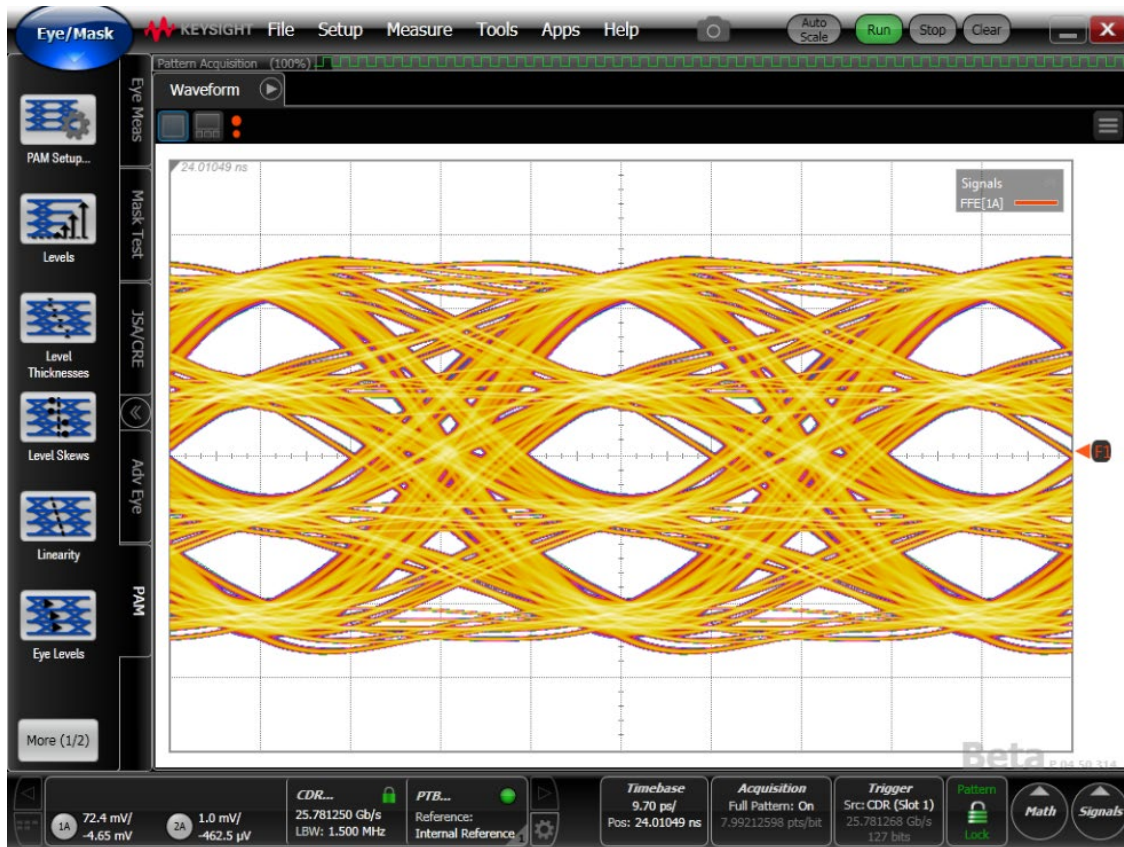


Figure 1. PAM4 eye diagram

Select Industry-leading Hardware

Configure your oscilloscope for single or multi-channel capability. The N109256CB application supports a variety of digital communication analyzer (DCA) oscilloscope configurations, including the N1000A/86100D DCA-X wide-bandwidth oscilloscope platform, and the N109X DCA-M family of oscilloscopes. For return loss, the software controls an N1055A TDR module (or an economy or performance network analyzer) and performs S-parameter measurements. For more hardware configuration details, refer to the Ordering Guide in this document.



Figure 2. N1000A DCA-X Wide-Bandwidth Oscilloscope Mainframe and N1060A Precision Waveform Analyzer

Select the Desired Software Test Suite

The N109256CB OIF-CEI 4.0 TX test application covers PAM4 and NRZ transmitter measurements outlined in Clauses 56G-VSR/MR/LR of OIF-CEI-04.0 (PAM4) and OIF2014.277.08 (NRZ). The tests are sorted conveniently by clause. Click on the desired test group, and the appropriate tests are offered in Select Tests (factory-installed options shown).

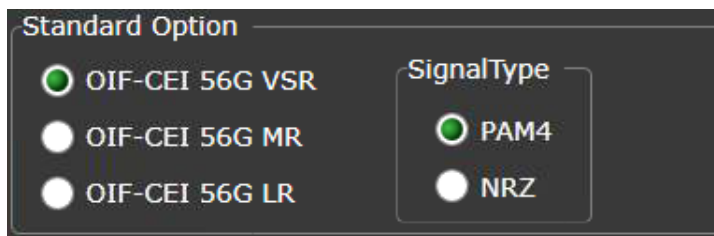


Figure 3. N109256CB OIF-CEI 4.0 TX test application covers PAM4 and NRZ transmitter measurements

The N109256CB test application covers most TX tests outlined in the tables below. For a comprehensive and up-to-date list of specific tests covered by the application, download the N109256CB application from www.keysight.com, install it on a PC, and run the application in “Demo Mode”. No license (or hardware) is required to run the software application in “Demo Mode”.

OIF-CEI-56G-VSR (OIF2014.277.08 NRZ, OIF-CEI-04.0 PAM4)

OIF-CEI Reference	Description 1,2
Section 15.3.2	Host to module at TP1a, Table 15-1 (NRZ)
Section 15.3.3	Module to host at TP4, Table 15-4 (NRZ)
Appendix 15.B.1.1	Host to module at TP0a, Table 15.9 (NRZ)
Section 16.3.2	Host to module at TP1a (host output), Table 16-1 (PAM4)
Section 16.3.3	Module to host at TP4 (module output), Table 16-4 (PAM4)
Appendix 16.B.1.1	Host to module at TP0a, Table 16.10 (PAM4)

OIF-CEI-56G-MR (OIF-CEI-04.0)

OIF-CEI reference	Description
Section 17.3.1	Table 17-2 and 17-3 (MR-PAM4)

OIF-CEI-56G-LR (OIF-CEI-04.0)

OIF-CEI reference	Description
Section 21.3.1	Table 21-2 and 21-3 (LR-PAM4)

Configure Your Measurements

Customize parameters that are specific to your setup, such as signaling rate and CTLE setting. Use default values or enter your own settings including number of waveforms taken, type of pattern, and pattern symbol length. Choose Normal mode to test within limits or choose Debug mode to test to your custom limits and adjust other test parameters.

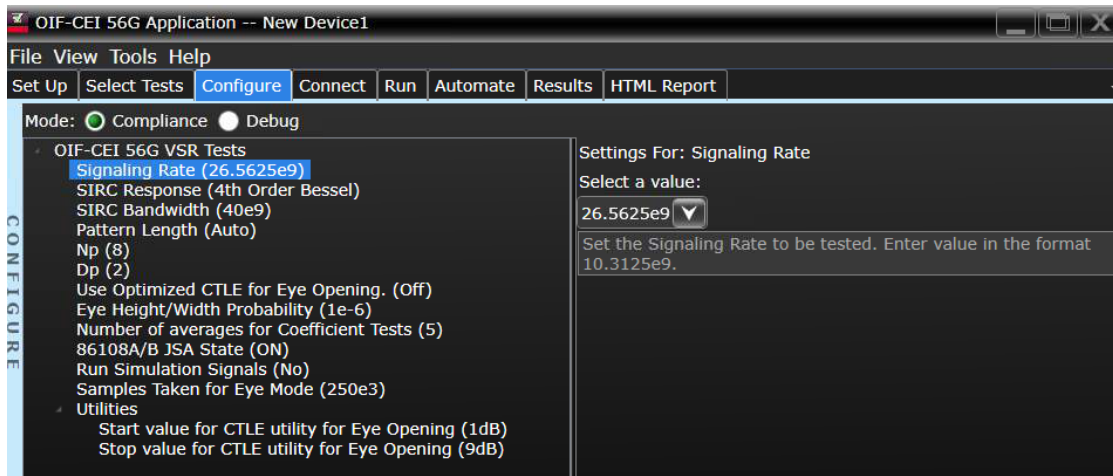


Figure 4. N109256CB OIF-CEI 4.0 Application Configuration Interface

Choose Your Test

The N109256CB OIF-CEI 4.0 TX test application provides comprehensive coverage of most PAM4 and NRZ tests that are specific to the clause you are testing. You may click on all available tests, a group of tests, or select individual tests to run. The full test name appears in the test list and is also shown in the test results and reports. A description of the test and reference to the Standard is shown for each test.

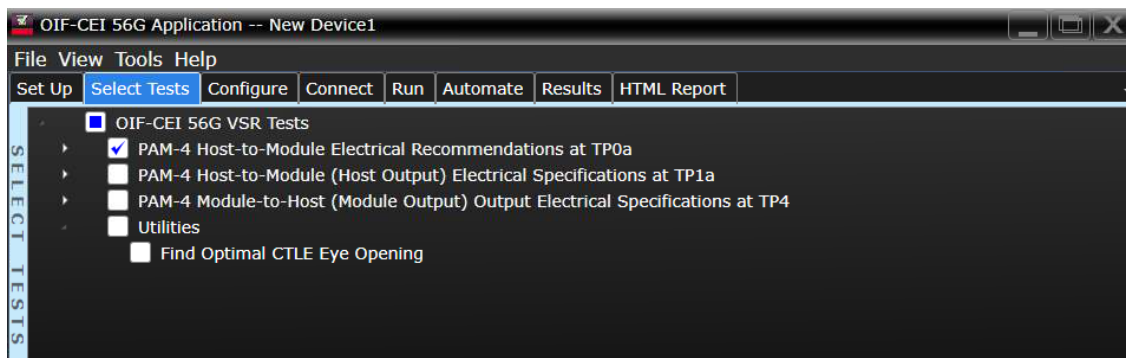


Figure 5. N109256CB OIF-CEI 4.0 Application Transmitter Test Configuration Interface

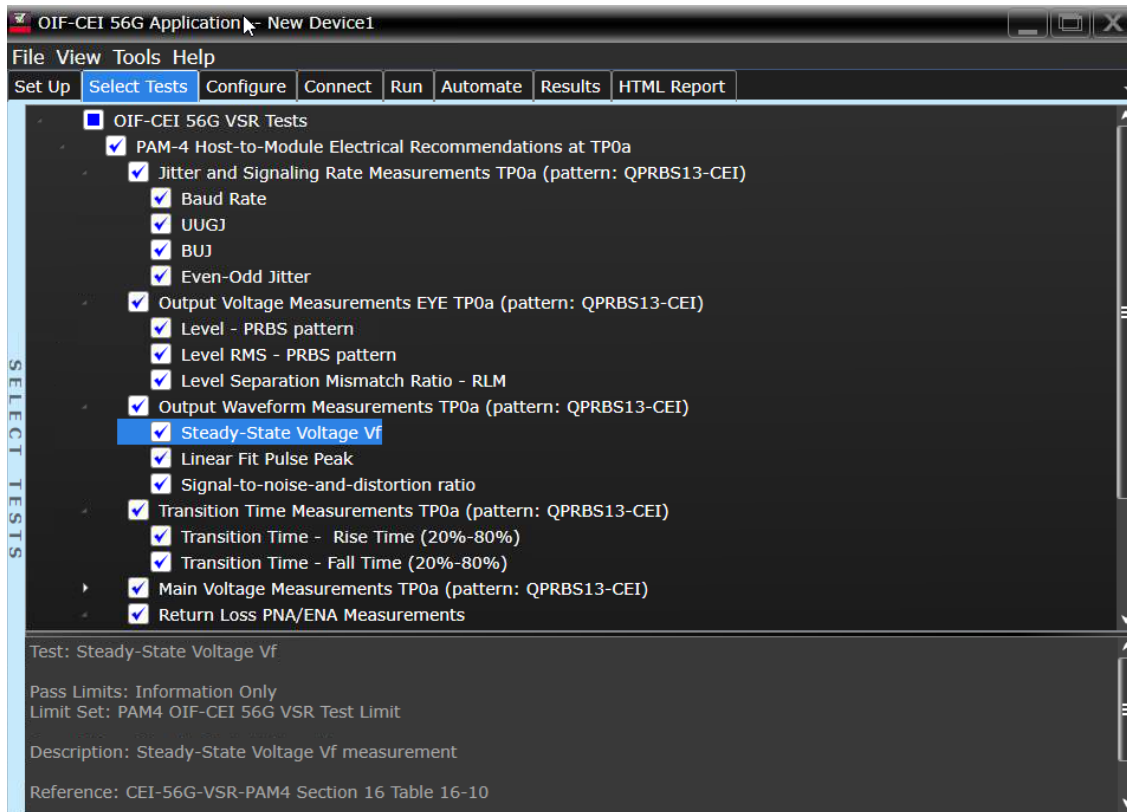


Figure 6. N109256CB OIF-CEI 4.0 Application | Selection of Transmitter Test

Automated return loss measurement

When used in conjunction with an N1055A TDR module or vector network analyzer (ENA or PNA), the N109256CB OIF-CEI 4.0 TX test application performs differential and common mode return loss measurements.

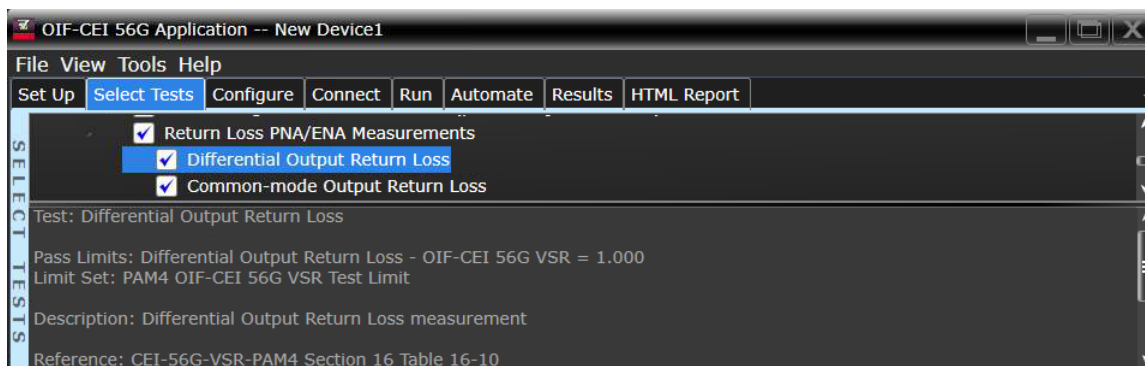


Figure 7. Return Loss Measurement Test Selection

Guided Connection Diagrams for Easy Setup

Simply follow the steps to connect and configure your device under test and click Run Tests. The N109256CB OIF-CEI 4.0 TX test application automatically configures and controls your supported DCA-X or DCA-M oscilloscope.

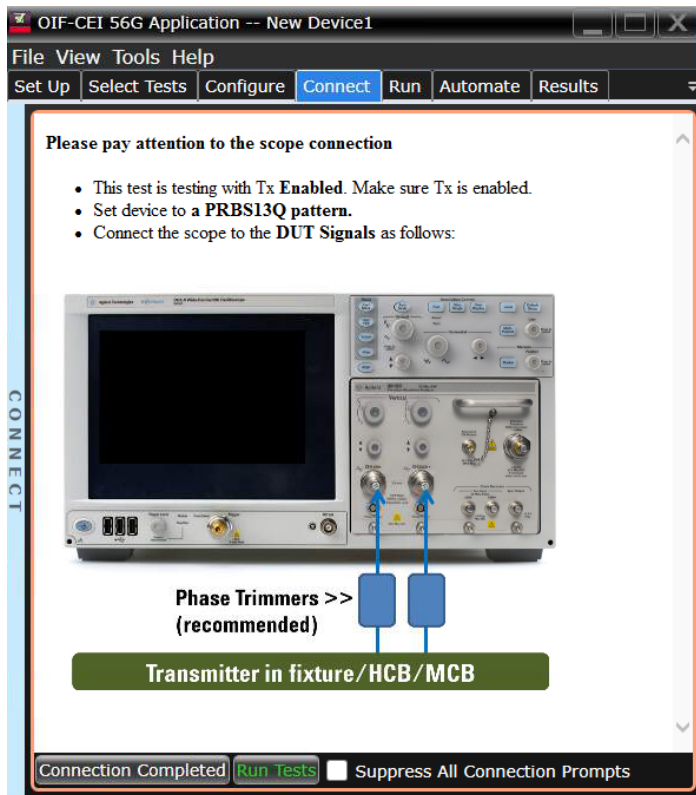


Figure 8. Easy Setup | Guided Connection Diagrams | Step by Step Configuration

More Features Streamline Development

Generate reports

Your team members and your customers are interested in the performance of your device. Share a test result report with them that shows the test conditions, summary of pass/fail, summary of all tests, and details for each test. Many include a test-specific screen shot of the measured parameter.

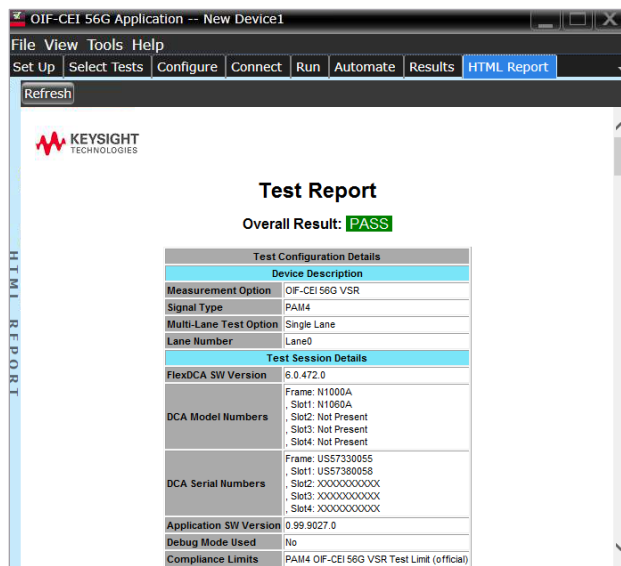


Figure 9. Test Report

Control your device or other equipment

The Automate tab enables you to enter commands to control external devices or equipment, and to further sequence your tests or to control timing.

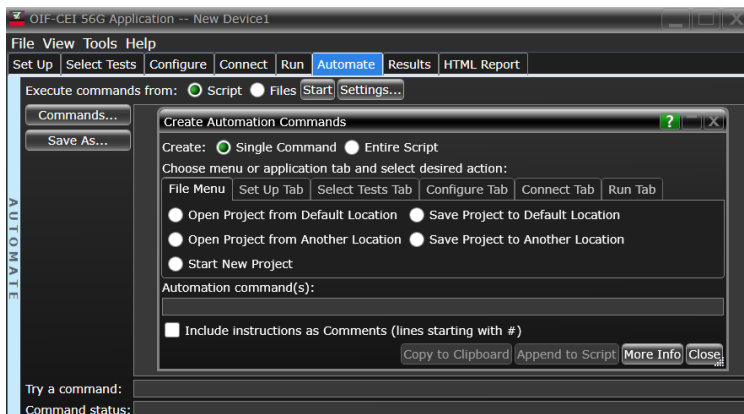


Figure 10. Automation tab enables you to enter commands to control external devices or equipment

Configure your solution in three ways

The hardware and software architecture provide wide flexibility. The N109256CB TX test application may be run as follows:

1. N1000A/86100D DCA-X runs the N109256CB application locally and controls remote ENA/PNA via LAN
2. PC runs the N109256CB application and controls remote N1000A/86100D DCA-X, ENA/PNA via LAN
3. PC runs both the N109256CB and N1010A FlexDCA software applications and controls remote N1000A/86100D DCA-X and ENA/PNA via LAN, or a DCA-M via USB connection.

This lets you use your PC for more processing power and other applications, or you can have all measurement capability consolidated into a compact solution. For return loss measurements, the N109256CB application can control an N1055A TDR or ENA/PNA vector network analyzer to perform measurements automatically

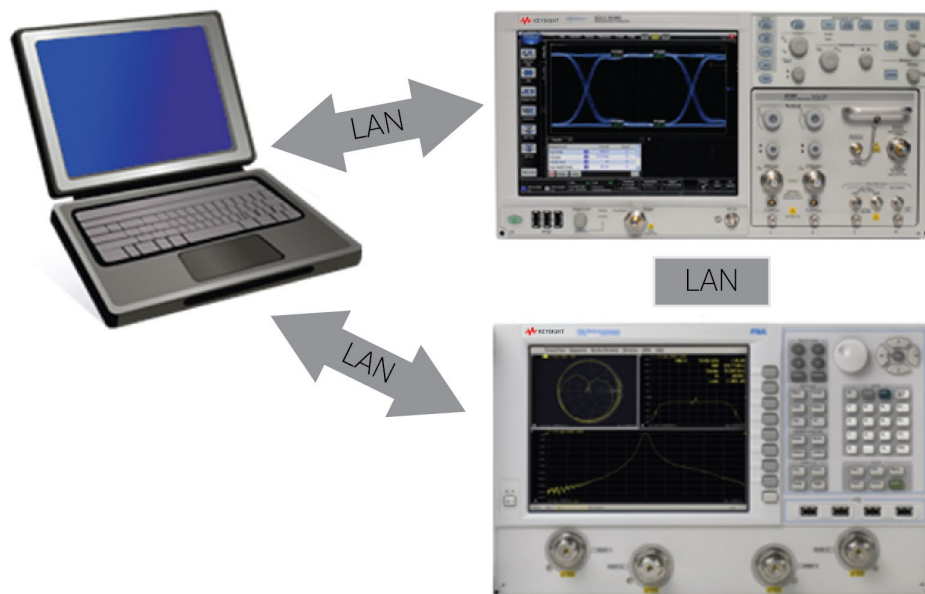


Figure 11. PC runs both DCA time-equivalent oscilloscope and PNA via LAN

Oscilloscope Compatibility

Keysight offers a wide range of electrical and optical test solutions to address current and emerging communications standards. For OIF-CEI-04.0 testing, you may choose a hardware combination that addresses your test needs for today, and into the future:

1. N1000A/86100D DCA-X with N1060A/86108B (integrated “One-Box” solution) - recommended
2. N1000A/86100D DCA-X with DCA module and external clock recovery
3. N109X electrical DCA-M with external clock recovery

Solution 1: Keysight N1000A DCA-X Mainframe + N1060A “MegaModule” (Recommended)

- Highest accuracy
- Easy setup
- Integrated solution c



TX test using digital communications analyzer	Mainframe Model No.	Mainframe Hardware Options	Mainframe Software Options (Fixed or Transportable Licenses)
	N1000A DCA-X (or 86100D DCA-X)	Required: STR, PLK (N1000A), ETR (86100D)	Required: N1010100A or Legacy 200, 201, 9FP/9TP (for PAM4 analysis)
		Optional: LOJ/PTB (not used with N1060A/86108B)	Optional: SIM (for de-embedding cables)
	Plug-In Module Model No.	Plug-In Module Options	Max # of Modules/Diff Channels supported by- N109256CB
	N1060A (or 86108B)	232/050 (N1060A) 232/HBW (86108B)	1/1 (slot 1 only)
	Software		
	N109256CB	Electrical TX Test SW for OIF-CEI-4.0	
	N1010A	FlexDCA FW Rev 6.4 or later (included with N1000A/86100D mainframe)	
	Keysight IO libraries	Rev 16.3 or later, automatically installed with FlexDCA installation	
	Accessories		
Return Loss Measurements	N1060A 86108B-PT2 or N1027A-PT2	N1060A: No accessories are required (all modules include integrated de-skew) 86108B: Phase trimmers (Qty 2), for modules with 2.4 mm connectors (86108B)	
	N1060A-DC2, 86108B-DC2, or N9398F	DC blocks, 50 GHz (Qty 2)	
	N1060A-CA2 or 86108B-CA2	Matched cable set (Qty 1)	
	Model No. (Pick TDR or PNA)	Description	
N1055A TDR/TDT	35/50 GHz 2/4 Port TDR/TDT Remote Sampling Head for the N1000A/86100D DCA-X (any option) equipped with one of the following SW licenses: N1010200A, N1010300A or legacy 202.		
Network analyzer (ENA/PNA)	N5224A, N5244A or other 4-port PNA's greater than 32 GHz N1930B PLTS Software		

Solution 2: Keysight N1000A/86100D DCA-X Mainframe with DCA Module + External Clock Recovery

- Highest flexibility
- Scalable solution
- High fidelity – remote heads minimize loss between DUT and oscilloscope

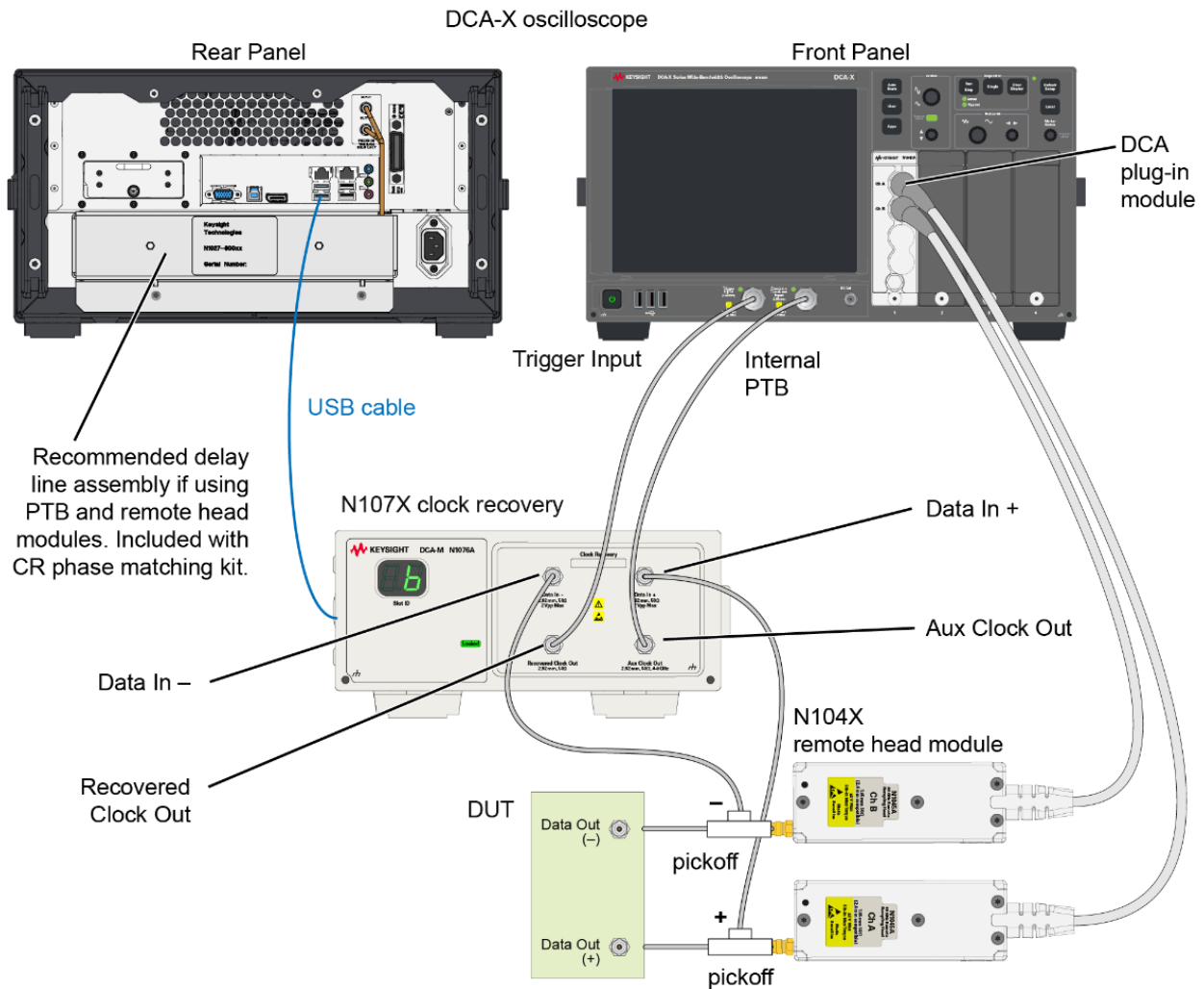


Figure 12. Keysight N1000A/86100D DCA-X Mainframe with DCA Module + External Clock Recovery

Equipment configuration for solution 2: Keysight N1000A/86100D DCA-X Mainframe with DCA Module + External Clock Recovery

TX test using digital communications analyzer (DCA)	Mainframe Model No.	Mainframe Hardware Options	Mainframe Software Options (Fixed or Transportable Licenses)
	N1000A DCA-X (or 86100D DCA-X)	Required: PLK/LOJ/PTB (N1000A), ETR/PTB (86100D)	Required: N1010100A or Legacy 200, 201, 9FP/9TP (for PAM4 analysis) Optional: SIM (for de-embedding cables)
	Plug-In Module Model Number (Pick ONE)	Plug-In Module Options	Max # of Modules/Diff Channels supported by N109256CB
	N1045A/B	Any	2/4 (slot 1 & slot 2 only)
	N1055A	Any	2/4 (slot 1 & slot 2 only)
	N1046A	12F, 14F, 72F, 74F, 82F, 84F (any 2 or 4 channel config)	2/4 (slot 1 & slot 2 only)
	N1040A	Any	2/2 (slot 1 & slot 2 only)
	Clock Recovery Model Number (Pick ONE)	Clock Recovery Options (Pick ONE)	
	N1076A	232	
	N1076B	232/264	
	N1077A	232	
	N1078A	232/264	
Software			
N109256CB	Electrical TX Test SW for OIF-CEI-4.0		
N1010A	FlexDCA FW Rev 6.4 or later (included with N1000A/86100D mainframe)		
Keysight IO libraries	Rev 16.3 or later, automatically installed with FlexDCA installation		

Accessories*		
	N1027A-76B (rec.)	Clock Recovery Phase Matching Kit for use with N104XA remote head and N4877A/N107X CR
	N1027A-76A	Clock Recovery Phase Matching Kit for use with N104XA remote head and N4877A/N107X CR
	N1027A-MC1	Clock Recovery Phase Matching Kit for use with N104XA remote head and N4877A CR
	N1027A-2P2	Pick-Off tees (Qty 2), for remote head modules with 1.85 mm/2.4 mm connectors (N1045A/B, N1046A, N1055A), (including in N1027A-76A/76B Kit)
	N1027A-PT2	Phase trimmers, 50 GHz (Qty 2), for 861XX DCA modules with 2.4 mm connectors (86117A)
	N9398F or N9399F	DC block, 50 GHz (Qty 2)
	Model No. (Pick TDR or PNA)	Description
Return Loss Measurements	N1055A TDR/TDT	35/50 GHz 2/4 Port TDR/TDT Remote Sampling Head for the N1000A/86100D DCA-X (any option) equipped with one of the following SW licenses: N1010200A, N1010300A or 202.
	Network analyzer (ENA/PNA)	N5224A, N5244A, or other 4-port PNA's greater than 32 GHz N1930B PLTS Software

*For more information on clock-to-data delay matching, refer to the Keysight N1076A/B, N1077A, and N1078A Clock Recovery DCA-M User Guide

Solution 3: Keysight N109X Electrical DCA-M + External Clock Recovery

- Flexible configuration
- Lowest cost
- Scalable

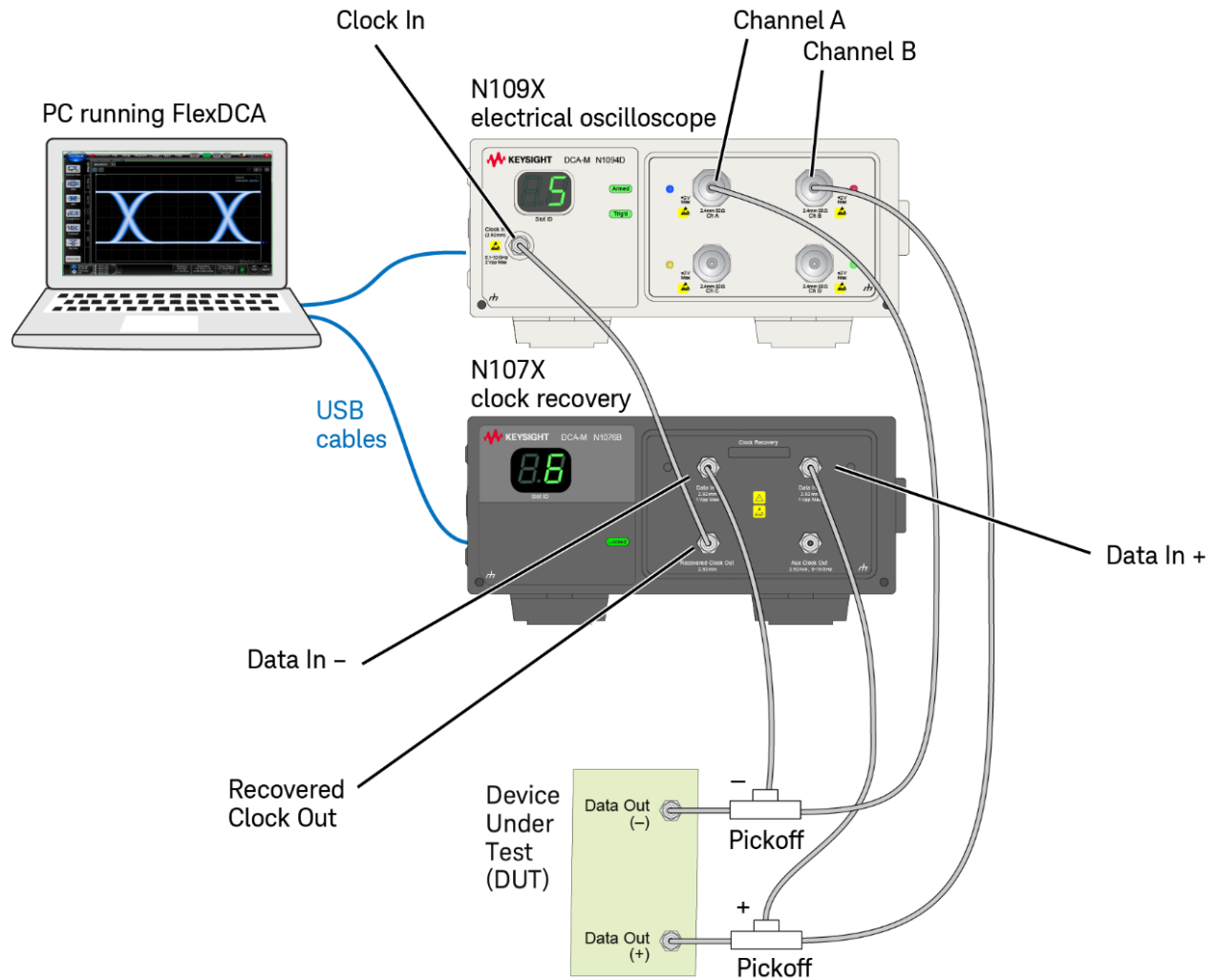


Figure 13. N109X Electrical DCA-M | External Clock Recovery

Equipment configuration for solution 3: Keysight N109X Electrical DCA-M + External Clock Recovery

TX test using digital communications analyzer (DCA)	Software Model No. (For User-Supplied PC)	Software Options (Install On PC, Or Purchase Fixed SW Licenses for the DCA-M)	
	N1010A FlexDCA	Required: N1010100A or Legacy 200, 201, 9FP/9TP (for PAM4 analysis)	
		Optional: SIM (for de-embedding cables)	
	DCA-M Model No. (Pick One)	DCA-M Options	# Of Diff Channels
	N1092C	Required: LOJ, PLK Optional: FS1	1
	N1092E	Required: LOJ, PLK Optional: FS1	1
	N1094A	Required: LOJ, PLK, 030 or 050 Optional: FS1	1
	N1094B	Required: LOJ, PLK, 030 or 050 Optional: FS1	2
	Clock Recovery Model No. (Pick ONE)	Clock Recovery Options (Pick ONE)	
	N1076A	232	
	N1076B	232/264	
	N1077A	232	
	N1078A	232/264	
		Software	
N109256CB		Electrical TX Test SW for OIF-CEI-4.0	
N1010A		FlexDCA FW Rev 6.4 or later (included with N1000A/86100D mainframe)	
Keysight IO libraries		Rev 16.3 or later, automatically installed with FlexDCA installation	

Accessories*	
N1027A-2P2	Pick-Off Tees (Qty 2), for remote head modules with 1.85 mm/2.4 mm connectors (N1045A/B, N1046A, N1055A), (included in N1027A-76A/76B Kit)
N9398F or N9399F	DC block, 50 GHz (Qty 2)
Model No. (Pick TDR or PNA)	Description
N1055A TDR/TDT	35/50 GHz 2/4 Port TDR/TDT Remote Sampling Head for the N1000A/86100D DCA-X equipped with one of the following SW licenses: N1010200A, N1010300A or 202
Network analyzer (ENA/PNA)	4-port ENA/PNA's greater than 19 GHz (e.g. N5230C 140/145, N5224A, N5244A) N1930B PLTS software

*For more information on clock-to-data delay matching, refer to the Keysight N1076A/B, N1077A, and N1078A Clock Recovery DCA-M User Guide

Ordering Information

The N109256CB Electrical TX Test SW for OIF-CEI-4.0 may be licensed using any of four different methods. Choose a license type and term that best suits your requirements:

License types

1. **Node-locked:** Allows you to use the license on one specified instrument or computer.
2. **Transportable:** Allows you to move the license from one instrument or computer to another using Keysight's online tool.
3. **USB portable:** Allows you to move the license from one instrument or computer to another with a certified USB dongle.
4. **Floating:** Allows you to access the license on networked instruments or computers from a server, one at a time. Three types of floating licenses are available:
 - a. **Single Site:** 1-mile radius from the server
 - b. **Single Region¹:** Americas; Europe; Asia;
 - c. **Worldwide:** export restriction identified in END User License Agreement (EULA)

1. Americas (North, Central, and South America, Canada); Europe (European Continent, Middle Eastern Europe, Africa, India); Asia (North and South Asia Pacific Countries, China, Taiwan, Japan)

License terms

Each of the license types are offered as perpetual (licenses can be used indefinitely) or subscription (licenses can be used through the term of the license: 6, 12, 24, or 36 months).

KeysightCare Software Support Subscription:

- Perpetual licenses are sold with a 12 (default), 24, 36, or 60-month KeysightCare software support subscription
- Software subscription licenses include KeysightCare Software Support through the term of the license

For more information, visit: KeysightCare Software Support Subscriptions, [5992-3419EN](#).

Required Software Options

The N109256CB software requires that the N1010100A R&D Package (or equivalent legacy licenses, see below) be licensed on the platform.

1. N1010100A R&D Package for FlexDCA (recommended)

or
2. Legacy license options: 200, 201, 9FP/9TP (Optional: SIM)

Subscription based Compliance Test Software Suites

A new ownership model of multiple Compliance Test Software Applications is now available.

With this new subscription-based model, the OIF-CEI software suites bundle the Compliance Test Software Applications under a model number. Using a subscription-based ownership, you can enjoy all the test software features covered under OIF-CEI across multiple generations and variants.

Software support and continuity

Under the subscription plan, software support is made available with no extra support cost. Ensuring your software always stays up to date with the latest enhancements and measurement standards while having access to our team of technical experts when you need support.

On top of that all upgrades are made available to you as the OIF-CEI standards progresses with no additional costs.

Subscription-based Compliance Test Software Suites

Each suite comes with a 12, 24, or 36-month software suite subscription.

Model Number	Options Available
SW00DCAO OIF-CEI TX Validation License (for DCA)	<ul style="list-style-type: none">• OIF-CEI-112G Electrical TX Test (N109212CA)• OIF-CEI 4.0 Electrical TX Test (N109256CB)

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